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# Cloning an industry: Strategy typologies of Shanghai biotechnology companies

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## Abstract

Insight into the development of the medicinal biotechnology sector of China is provided through interviews of 19 Shanghai-based companies. Two commonly accepted strategy typologies are used to provide a predictive frame towards understanding their potential in the market. Most of the companies interviewed use the Miles & Snow Analyser Strategy. Two companies were clearly Prospectors, with founders of both discovering their technologies in laboratories of developed countries. The Porter Generic Strategy typology indicated that most are using Cost Leadership strategies. The strategic choice of these companies is problematic given the dynamics of the global market in which they could participate but are more sensible within the context of a protected market. For example, it appears that government-sponsored monopoly policies are driving low-cost strategies rather than innovation-based differentiation strategies.

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## INTRODUCTION

Most research on the biotechnology industry focuses on the United States, Europe and

Japan, but the dynamics of the biotechnology industry in other regions continues to be an important aspect of understanding the commercial aspects of biotechnology. While recent studies have provided valuable insight into the biotechnology industry in Canada,<sup>1</sup> Cuba,<sup>2</sup> Latin America,<sup>3</sup> South Africa,<sup>4</sup> India,<sup>5,6</sup> Australia<sup>7</sup> and Singapore,<sup>8</sup> the

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world's largest emerging economy has received little attention.

This paper will report on data collected from interviews with 19 Shanghai-based medicinal biotechnology companies, place the data in the context of two generic strategy typologies and provide analysis on the role of these companies within the broader scope of the Chinese biotechnology industry.

The Chinese Government has made the development of a world leading biotechnology industry a national priority. While some of this is done by recruiting branch operations of large companies from Europe and North America, they are also emphasising the growth of their own infrastructure. 'Initial goals of a ten-year development plan include establishing 20 world-level research and development centres and ten biotech centres with an annual output value of 36bn US dollars.'<sup>9</sup>

The Chinese Government has also undertaken the development of extensive research and development in biotechnology by its building of the largest biotech incubator in Asia.<sup>10</sup> Additionally, the Chinese Government has taken extensive steps to encourage ex-patriot biotechnology scientists to return to China with the promises of government-sponsored funding of research and development.<sup>11</sup>

While the Chinese Government has made substantial commitments, evidence regarding the direction of the Chinese-based for-profit sector is minimal. Will Chinese companies lead innovation and intellectual property development, be low-cost manufacturers of generic medicines, create a niche in traditional Chinese medicines or commercialise products that Western ethics find objectionable? There are differing answers put forth to these and other related questions.

Chien<sup>12</sup> predicts that China will become a world leader in biotech, especially technology based on traditional Chinese medicines. Yu and Dai<sup>13</sup> believe that Chinese biotechnology is not following a path of innovation. Salter *et al.*<sup>14</sup>

and his associates identify key academic assets that ought to make the Chinese leaders in stem cell research but do not comment on the commercialisation capabilities. Finnegan and Pinto's<sup>15</sup> analysis has China functioning as the world's low-cost manufacturer. Grace opines that Chinese biotech companies are producing only generic medicines, but identifies impressive academic research assets, especially in genomics and traditional Chinese medicine.<sup>16</sup> Grace further predicts that tightening of Chinese intellectual property laws will result in less focus on low-cost manufacturing. The Economist raises concerns that the most open space for Chinese innovation in biotechnology is in human cloning and other areas which Western ethics prevent developed nations from pursuing.<sup>17</sup> Trade journals point out that low-cost early-phase clinical trials may be attractive to multinational corporations, but the infrastructure in China is not conducive to innovative start-up companies requiring private venture capital.<sup>18</sup>

The popular literature and research performed for trade associations and government agencies provided for all of the views above, but the academic literature provides no empirical studies in support or otherwise. There are, however, a set of strategy typologies that could be used in combination with empirical data to provide guidance. 'Typologies provide an excellent vehicle in this regard since their primary strengths are codification and prediction.'<sup>19</sup>

Towards contributing to the goal of predicting future directions within the biotechnology industry of China, this study provides an analysis of the least studied sector of the Chinese biotechnology industry by focusing on Shanghai-based medicinal biotechnology companies. A company was considered as Shanghai-based if its only R&D facilities and its senior management team were located in Shanghai. The company was considered to be participating in medicinal biotechnology if its products, or the products it is developing, are intended to find end

application in the treatment of human diseases and it is applying 'indigenous and/or scientific knowledge to the management of (parts of) microorganisms, or of cells and tissues of higher organisms, so that these supply goods and services of use to human beings.'<sup>20</sup>

## STRATEGY MODELS

Miles and Snow<sup>19</sup> provide a well-established model for analysing the strategies of business units through classifying them as Prospectors, Analysers, Defenders or Reactors (1978). In this typology, Prospectors react quickly to perceived changes in the marketplace, are constantly on the development of new products and services, and seek to gain advantage through speed to market and product differentiation. Defenders do not seek new technologies, preferring to focus on delivering the appropriate quality product at the lowest possible cost. Analysers are rapid followers of new technologies, preferring to wait until a Prospector has shown success. Reactors have no clear strategy.

Porter<sup>21</sup> provides an alternative typology, stating that business units either try to gain advantage through product differentiation or through cost structure. Additionally, businesses may seek to be niche (focused) on a narrow range of products or diversified across a market sector.<sup>22</sup> Thus, the Cost Leadership type provides a range of products and manages towards elimination of cost from their system. The Differentiation type attempts to develop a range of new products that are different in their value proposition from competitors. The Focused types either produce a narrow set of products at a low cost, or in a differentiated manner.

Porter and Miles and Snow are frequently seen as competing typologies in that they both attempt to label and describe the common forms of competitive behaviour. Miles and Snow is more relevant to an organisational typology, while Porter is focused more on economic intent.<sup>23</sup> Thus, rather than viewing them as competitive typologies, they are used here as

complementary, each providing a different insight of value.

Despite their widespread acceptance and longevity, both strategy typologies have been challenged regarding their utility in areas relevant to this study. Nascent industries, developing nations with high levels of state-owned businesses and laxness in intellectual property protection are all factors that have been minimally tested for in these models but are certainly important aspects for this analysis.

Both established typologies have been tested primarily in developed nations and in developed industries. In many developing nations, there are factors not broadly present in developed nations. Among these are a significant number of state-owned businesses. Peng *et al.*<sup>24</sup> demonstrated that Miles and Snow typology had applicability in China specifically with respect to ownership. They found state owned enterprises were generally Defenders, whereas privately held companies were Prospectors. Companies that had both state and private ownership were Analysers.

Carter *et al.*<sup>25</sup> have called into question the utility of the Porter and Miles and Snow typologies for new ventures, demonstrating that these typologies fail to capture the breadth and diversity of new venture strategies. They also demonstrated that industry type had a significant influence on the strategies employed.

Additionally, China has a poorly developed system of intellectual property protection.<sup>26</sup> Lax enforcement of intellectual property laws allows companies to copy products and services under patent protection in developed nations (knock-offs). However, creating a knock-off medicinal biotechnology product in China does not necessarily eliminate the need to obtain State Drug Administration approval (SDA).<sup>27</sup> As will be demonstrated in the findings, typing these companies as Analysers, Prospectors or Defenders is problematic. For similar reasons, the Porter Generic Strategy typology also has shortcomings.

Providing a further complication to Porter's and Miles and Snow's typologies are the large

numbers of pre-revenue companies in the nascent biotech industry. Thus, typology must be based solely on the expressed intent of management. The actual intent may be obscured by a high level of uncertainty about the technology and the market, the need to sell a vision of large returns to investors, the availability of significant grant funding from government agencies and the possibility of being acquired or selling their technology.

While admitting that these typologies have some shortcomings, they provide the only established tool for the analysis at hand and by keeping these shortcomings in mind, it is possible to use the typologies in a manner which serves the purpose of best understanding the companies interviewed.

## METHODOLOGY

The selection process of the companies created unavoidable elements of bias in the study which limits the ability to broadly apply the findings to the biotech industry in China as a whole. It was the intent of the study to sacrifice this broader applicability in order to reasonably obtain a depth of knowledge regarding the companies interviewed. The details of the selection process are described here, towards the end of highlighting these areas of bias.

The study was undertaken as part of the National Science Foundation's Integrative Graduate Education and Research Traineeship grant, 'Entrepreneurship at the Interface of Medicinal Chemistry & Polymer Science'. The data were collected by four PhD candidates in Medicinal Chemistry and eight PhD candidates in Polymer Science, each having received extensive technology commercialisation training including the development of original biotechnology business plans. These students were teamed with economic development and entrepreneurship faculty to perform the data collection. This combination of technical, business and research competency was needed to obtain a deep understanding of the companies interviewed.

In addition to the students and faculty identified above, English fluent graduate science students from Tongji University in Shanghai were present for translation and assistance at all interviews. In all but one case, representatives for the companies spoke English well, and there was no need for translation.

An initial pool of companies was formed by using a basic set of criteria, that they self-proclaim being in the medicinal biotechnology sector, that they be principally Chinese operations (rather than multinationals with operations in China) and that they be located in the Shanghai region. The central planning nature of China facilitated the identification of a large pool of companies, as a science park development in Shanghai (Zhangjiang High-Tech Park) was designed to specifically encourage biomedical companies to locate there. In addition to contacting the companies found on the parks website, the companies contacted were asked to provide names of other biotech companies in the Shanghai area. In general, these companies confirmed that most companies meeting the criteria would be located in the Zhangjiang High-Tech Park.

A total of 55 companies were identified through this process and were contacted by e-mail and phone to schedule interviews. All of the companies with the exception of five were contacted by phone, email or fax. Meetings with the five exceptions were facilitated by one of the Chinese companies contacted.

Phone and e-mail were the primary means of initiating communication with the companies. An email was sent to the companies, followed by a phone call to discuss interests in the information presented in the email. E-mail was used to update companies on scheduling information throughout the process. Contact by phone was also used to schedule, verify and discuss the date and time of the meetings. Many of the companies had at least one employee who spoke English fluently enough to discuss plans

for the interview. A Chinese national on the research team provided translation in the few cases of necessity. Additionally, the anonymity of the participants was promised. All participants chose voluntarily to participate in the study.

Twenty-seven companies were understood to have accepted the proposed interview during the week of 21st–25th May, 2007. After the study was complete, the number of companies that were successfully visited and interviewed was 19, six companies cancelled appointments just prior to the interviews and two chose not to provide information during the interview, apparently as a result of misunderstanding the intent of the interview. Thus, 19 companies met expectations of proposed research and provided adequate information necessary for the study.

Secondary research of the companies through online methods was conducted prior to the meetings and provided the interview team with a foundation and understanding of the companies that were participating in the study. This background research also provided additional information that assisted in the interviews with the companies. If the company's website was available, it generally provided guiding information regarding the leadership of the company and their primary business objectives. Many of the Chinese company websites had English versions and others were translated to assist in the initial research. The information disclosed on the companies' websites was checked in the interviews to verify the information.

Interviewers gained insight into the company's strategy by taking note of any differences in the information and documenting for further analysis. Furthermore, comparing the secondary research about each company was used to find trends prior to the interviews; thus, informing avenues of questioning for the interviews. Additional confirmatory secondary website research was conducted after the interviews were conducted to follow-up on information gleaned in the interview process. This information was used to verify patent

information, management backgrounds and company profiles.

The instrument used in the interviews provided a guide for the interviewers, and consisted entirely of open-ended questions. This allowed the interviewers to explore the nuances of each company and thoroughly understand their strategic intent.

In all cases, the interviews were carried out with a person identifying themselves as a member of the senior management team, and this was generally the Chief Executive Officer. The interviewee was directly asked about their intent to produce a differentiated product, if they intended to enter new markets and how they viewed their competitive advantage. In addition to asking questions which directly addressed the strategic typologies, a range of questions delving into the business background of the company, the management team and other staff (education, employment history, etc), consultants, boards or advisory committees, financing methods, ownership structure, intellectual property management, and marketing tactics were used to discern if their stated strategy met with their actions.

## **FINDINGS AND ANALYSIS BY ESTABLISHED STRATEGY TYPOLOGIES**

First, some basic descriptors of the companies are presented. Then Porter's Generic Strategy model and Miles and Snow's model is applied as a framework for analysing these companies.

### **Business descriptions**

In general, the businesses were pre-revenue with regards to medicinal biotechnology products. This section first describes those businesses that have no revenue and then those that have revenue from nonmedicinal biotechnology products. It then delineates the differing approaches in the market which are unrelated to the revenue status of the companies, with one set of companies intending sales to only Chinese consumers

through the prescriptions of MDs and another set intending to sell intermediates or services to businesses without necessarily limiting the region to China.

Half of the businesses interviewed were pre-revenue (Table 1). With two exceptions, the pre-revenue companies are performing process development in order to copy products and services under patent protection in developed nations (knock-offs). The knock-offs must still pass through a variety of government approval processes. The companies reported that the approval processes in China have many similarities to the United States Food & Drug Administration, requiring three phases of clinical trials and taking five or more years to complete. In addition to the substantial development time that is needed to complete clinical trials, the companies reported substantial resources directed into the development of Good Manufacturing Procedures (GMP). Thus, even with the intent of producing knock-off products, these

companies reported expectations of up to ten years of being pre-revenue and substantial development costs.

Company B and Company F are exceptions to the pre-revenue companies interviewed in that they are both developing new to the world products. In both cases, the founders discovered the technology while working in a developed nation where they had obtained citizenship.

Only Company K and Company I have revenue from medicinal biotechnology products. Each has two products on the market. They also have further products in various phases of clinical trials and GMP approval. For example, Company K launched their first product in March of 2007, ten years after the company was founded. They have two products that have completed clinical trials and are awaiting SDA approval, and six that are in clinical trials. Company K was originally founded with the intent of creating new to the world medicinal biotechnology products; however, after several years of

**Table 1:** Basic description of companies interviewed

Company designation	Start-up year	2006 sales (000 RMB)	Number of employees	Current business model*	Primary sales region**
A	1994	Pre-revenue	<20	Mfg and sales of products to businesses	Global
B	2000	Pre-revenue	40	Mfg and sales of products through MDs	China
C	2001	Pre-revenue	9	Mfg and sales of intermediates to businesses	China
D	2002	Pre-revenue	30	Selling R&D services	China
E	2002	Pre-revenue	5	Mfg and sales of products through MDs	China
F	2003	Pre-revenue	30	Sell IP to big Pharma and/or be acquired	China
G	2003	Pre-revenue	10	Selling R&D services	China
H	2005	Pre-revenue	9	Mfg and sales of intermediates to businesses	Global
I	1992	75,000	200	Mfg and sales of products through MDs	China
J	1993	5,500,000	150	Mfg and sales of intermediates to businesses	Global
K	1996	50	54	Mfg and sales of products through MDs	China
L	1996	1,095,000	2,500	Mfg and sales of products through MDs	N America
M	1998	10,000	400	Mfg and sales of intermediates to businesses	Global
N	2001	2,000	< 100	Mfg and sales of products through MDs	China
O	2001	8,000	150	Mfg and sales of products through MDs	China
P	2001	?	90	Mfg and sales of intermediates to businesses	China
Q	2002	?	45	Mfg and sales of products through MDs	China
R	2004	900	11	Mfg and sales of intermediates to businesses	Global
S	2004	< 1,000	11	Sales of products to businesses	Global

\*For pre-revenue businesses, this is their intended model. For businesses with existing sales, this is the model for their on-going business.

\*\*For pre-revenue businesses, this is their intended sales region. For businesses with existing sales, this is their current sales region.

struggling for funding, they were acquired by an investor group from Hong Kong which refocused Company K's efforts on knock-offs.

Similarly, Company I, which has its origins in a company founded in the early 1990s, has two recently launched products on the market. One of these products is a knock-off that five other Chinese companies produce and the other product is a knock-off in which they have a sole position in China.

Additionally, they have three products through clinical trials awaiting government approval and dozens of other products in various stages of development.

Other companies had significant revenue histories but not from medicinal biotech products; for example, Company L and Company M primarily produce vitamins, peptides, amino acids and other intermediates intended as food additives. Within the definition used for this analysis, these would not be considered medicinal biotechnology products. These companies, however, are actively working towards the approval, manufacture and distribution of medicinal biotechnology products.

Additionally, Company S has revenue through multiple products; however, they are currently only a distributor of biotechnology products. They serve as an intermediary with customers in developed nations and manufacturing facilities in China. While distributors such as Company S are an important part of the international biotechnology industry, it is of value to realise that in China starting a business as a distributor is often considered a stepping stone to owning a manufacturing facility and eventually to the production of new products. Company S's owner founded the business out of his own pocket and after three years of operation has entered negotiations for purchasing a manufacturing operation.

Whether the companies are pre-revenue or not, they overwhelmingly intend to make money by producing tangible products and distributing them. In general, these companies view the competitive advantage of being in

China as providing them with a low-cost manufacturing position.

The exceptions to this are Company G and Company D, which provide services related to the discovery and development of new products. Several other companies have provided contract research services as a means to short-term revenues, but do not consider such activities to be a core part of their business.

Only Company F plans to profit by selling their technology or by being acquired. Company F was founded by researchers employed at Harvard, Boston University, Johns-Hopkins and Princeton. It was one of two companies interviewed that had US citizens as its primary owners.

Eight companies intend to sell to the end consumer through medical doctors. For example, Company I employs a sales force of 70 to convince medical doctors to prescribe their product to patients with arthritis. Facing monthly sales growth of 20 per cent, they and the others selling through this distribution channel, must hire and train hundreds if not thousands of new sales people annually. These companies report that overcoming Chinese medical doctor preference (perception of quality) for imported products to be a substantial challenge.

Thus, the companies that are developing knock-offs for the Chinese market and intending to sell them through MDs either face the need to develop large and sophisticated sales forces or to negotiate government contracts to distribute their product(s). This places much of their labour cost structure in the sales effort.

Twelve of the companies perceive China as their primary market. This is particularly the case for companies intending production of knock-offs. In such cases, sales to developed nations are not possible because of intellectual property protection. Extending sales to other developing nations, where intellectual property is not a significant concern, is considered by several companies. Obtaining approval by those countries' government drug

**Table 2:** Businesses interviewed are following a cost strategy

Company	Porter's generic strategy type
O	Cost Leadership
I	Cost Leadership
S	Cost Leadership
K	Cost Leadership
H	Cost Leadership
G	Cost Leadership
C	Cost Leadership
D	Cost Leadership
L	Cost Leadership
N	Cost Leadership
P	Cost Leadership
M	Cost Leadership
J	Focused cost
R	Focused cost
A	Focused cost
E	Focused cost
Q	Focused cost and differentiation
F	Focused differentiation
B	Focused differentiation

regulatory agencies is burdensome and only two of the companies interviewed had taken action towards seeking that approval. One of these companies had successfully obtained approval in Colombia. Both companies were attempting to sell through direct negotiations with the developing nations' governments by offering a low price alternative to European producers.

The companies that have significant sales outside of China are currently selling products that are not under any patent protection and would not, under a narrow definition of biotechnology, be considered biotechnology products. These companies are, however, developing products that are clearly biotech knock-offs and intend their sales region for these products to be limited to China.

### Applying the Porter generic strategy typologies

Porter's Generic Strategy typology provides a framework for understanding the economic competitive positions that the interviewed companies are seeking. Table 2 shows that all but three of the companies were oriented towards low-cost positions. Whether a company was typed as Cost Leadership or

Focused Cost was dependent on the number of products and diversity of markets they intend to serve.

It is not entirely obvious that a cost strategy is either an achievable position or a particularly attractive position within the biotechnology industry. There are a variety of factors in the biotech industry that do not exist in the many manufacturing industries that China-based companies have been highly successful pursuing low-cost positions.

As an example, consider the various factors that allow Chinese manufacturers to take low-cost positions in the plastics injection moulding industry. Plastics injection moulding has a long history and processes are well documented.<sup>28</sup> Equipment and raw material suppliers, motivated to obtain sales, offer detailed advice on manufacturing processes. Thus, a relatively inexperienced organisation can quickly start manufacturing with minimal knowledge acquisition costs and time. The labour force needs minimal skill levels, with only a few engineering positions requiring college education. There are few government regulatory concerns and those that do exist are generally less burdensome than in developed nations. Finally, distribution is business to business, so the cost of selling is a relatively unimportant part of the financial returns. The customer is also sophisticated in understanding the products performance and can generally provide guidance on the design specifications.

The biotech industry in China has none of these advantages. Processes are fairly new, are often closely held trade secrets and thus equipment and raw material suppliers seldom have a high level of knowledge which they can transfer. The workforce requires a relatively high level of education, training and skill levels. Assuming they may be able to overcome these challenges and maintain a cost differential with developed nations' manufacturing operations, there are several other costs which may make the manufacturing cost only a small part of the overall financial picture.



Facing a five or more years lead time needed to obtain approval from government agencies, companies must incur substantial costs of clinical trials before they reach the point of concern over manufacturing. While knock-off products are lower risk to take through the clinical approval process, this cost is still substantial.

For the many companies that are targeting sales to consumers through the prescriptions of MDs, only a small part of the overall cost structure is in the manufacturing. Distribution costs, especially for the many biotech products that are refrigerated and have short shelf lives, are as expensive for the knock-off producer as for the original producer. Adding to the distribution challenges is that many of the companies interviewed intend to sell to patients through MDs, a more expensive sales effort than business-to-business sales that are the cornerstone of China's many low-cost manufacturing sectors. Thus, sales forces in the several hundreds, if not thousands, are needed to effectively achieve market penetration. Since this sales force is located regionally, there is no substantive cost advantage for the Chinese biotech company over the company from which the product was knocked-off.

With only a fraction of the cost coming from the manufacturing process, one must look deeper to understand if, in fact, these Chinese companies are pursuing a Cost Leadership strategy, accept that they have a flaw in their strategy or consider if the Porter Generic Strategy model does not fully describe these companies.

In the latter case of considering the Porter Generic Strategy model as not fully capturing the companies' strategies is the implied, and sometimes directly spoken, intent of these companies to obtain monopoly positions through Chinese Government protection.

The SDA codes allow for some protection; for example, a Chinese company receiving approval for a Category IV biological (biologicals that have been approved for

importation in China) are granted a six-year protection from others producing in China.<sup>27</sup>

Additionally, one of the companies intending to sell to consumers through the prescriptions of MDs specified their belief that the Chinese Government would support their efforts in order to reduce the price of medicines to Chinese citizens.

Thus, these companies are generally not pursuing strategies that differentiate the performance of their products from competitors, but are generally supplementing their low-cost strategies with the hope of obtaining government-sponsored monopolies. Alternatively, one could argue that the expectation of government-sponsored monopoly is driving businesses towards a low cost rather than a differentiation strategy.

### **Applying the Miles and Snow strategy typology**

Miles and Snow categorise corporate strategy into four types: Defenders, Analysers, Prospectors and Reactors. While the Porter Typology is focused on economic intent, Miles and Snow Typology is focused on the structure in which organisations respond and shape their environment.

Only two of the businesses are clearly Prospectors, Company F and Company B are developing new to the world products. While both of these companies located in China with hopes of obtaining government financing, neither has realised such. This is in keeping with Peng's findings that Chinese companies without government ownership tend to be Prospectors.<sup>24</sup> These companies consist primarily of R&D staff, are managed by researchers, and are organised to discover and develop new products. Additionally, their researchers are hired directly from a university or from companies participating in unrelated markets. Thus, they are organised towards discovery, not copying.

None of the companies are Defenders in that none of them are organised to solely maintain their existing products and markets.

The remaining companies are either Prospectors or Analysers, depending on the nuanced definitions chosen. Exploring these nuances works towards the goal of understanding the Chinese biotechnology industry.

Various authors have interpreted Analysers differently. Miles and Snow provide a clarification to the definition from their book, 'The essence of the Analyzer strategy is the capability to be 'second in' – and in many industries a rapid second in'.<sup>23</sup>

Setting aside rapidity, something that is not feasible given the SDA approval process, all but Company F and Company B are organised to be 'second in', thus Analysers. These Analysers' research staffs are organised around developing the processes for making knock-offs, not discovering new opportunities. Researchers are frequently hired from competitors or those with strongly related technologies.<sup>29,30</sup> Marketing and business operations employees are commonly hired from competitors and are organised towards launching a 'second in' product. The senior management may have research expertise, but it is dominated by business experience.

Others have taken the typing of Analyser to indicate that a company has a base of operation that is in defender mode and is prospecting with new products or into new markets at the same time.<sup>31</sup> This would apply to half of the businesses. For the other half of the businesses however, they do not have a base of operation, especially those which are pre-revenue. These may arguably be defined as Prospectors.

Only six of the companies had partial Chinese Government ownership, while the rest were privately held. Peng had found that companies with partial government ownership were more likely to be Analysers, while those that are privately held are very likely (86 per cent) to be Prospectors.<sup>24</sup> Peng, however, did not use the criteria of offering a new to world product as a precursor to being classified as a Prospector. Rather, his

classification was based strongly on management's perception of the risk taking desires of their organisations.

In Miles and Snow's original work, two of the four case studies used to describe Prospectors involved companies prospecting into new to the company markets and new to the company products but not new to the world markets or products. In both of these cases, the companies had existing basic operations with substantial price-based competition. Classifying them as Prospectors was in keeping with spirit of their book in analysing organisational behaviour and the dynamics of a company which was always searching for new to the company opportunities.

The pre-revenue businesses management all expressed that they were taking on considerable risk in forming the venture and the very nature of operating a company with no revenue for five to ten years is much to the keeping of the spirit of the Prospector label. Additionally, all of the businesses interviewed had a dedicated effort for identifying product and market opportunities. Many of the companies were evaluating hundreds of potential products to determine their ability to enter markets with them. All of them viewed their long-term growth as coming from new (to the company) product introductions, not just penetrating their existing products/markets more deeply.

As noted above, Defenders were not found in the companies interviewed. All of the companies' managers identified a strategic orientation towards the development of new (to the company) products and demonstrated an organisational structure (especially significant R&D infrastructure) to develop these products and this is relevant to the rapidly developing biotech industry, thus none are defined as Reactors.

So arguably all of the businesses are either Analysers or Prospectors with the number of businesses in each type dependent on the details of the definition.

## CONCLUSIONS

With only two exceptions, the 19 Shanghai biotechnology companies interviewed were pursuing strategies consistent with a Porter Low Cost Strategy. The viability of this strategy is in question, especially in the face of the relative importance of manufacturing cost to the total cost structure of delivering a medicinal biotechnology product to a patient. These same companies appear structured around a Miles and Snow analyst strategy, which requires being a fast-follower of new technologies. Given the sometimes decade long lead times needed to bring even a knock-off biotech product to the medical market in China, there are serious questions as to the viability of this strategy.

As the study encompassed only a select group of 19 biotech companies, it would be inappropriate to extend this analysis to the whole of the Chinese biotech industry. It does, however, raise significant questions about the future structure of the Chinese biotech industry and interest in understanding if these findings carry across the broader scope of the whole Chinese biotech industry. While the stated goal of China is to become a world leader in development of biotechnology, the practice of the biotech firms examined in this study exposes significant disconnects between policy and practice. While China's leaders propose the protection of international patents, the practice of the firms interviewed appears to counter these aims. The development of Chinese policies protecting international patents that requires Chinese biotech companies to verify the authenticity and originality of their patents will increase the likelihood of insuring global patent security.

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### References

- Vanderbyl, S. & Kobelak, S. (2007). Critical success factors for biotechnology industry in Canada. *J. Comm. Biotechnol.* **13**(2), 68–77.
- Mola, E. L., Silva, R., Acevedo, B., Buxadó, J. A., Aguilera, A. & Herrera, L. (2006). Biotechnology in Cuba: 20 years of scientific, social and economic progress. *J. Comm. Biotechnol.* **13**(1), 1–11.
- Quezada, F. (2006). Commercial biotechnology in Latin America: Current opportunities and challenges. *J. Comm. Biotechnol.* **12**(3), 192–199.
- Akermann, B. & Kermani, F. (2006). The development of the South African biotech sector. *J. Comm. Biotechnol.* **12**(2), 111–119.
- Parmar, H. (2005). Biotechnology in India: Emerging opportunities. *J. Comm. Biotechnol.* **12**(1), 61–66.
- Palnitkar, U. (2005). Growth of Indian biotech companies, in the context of the international biotechnology industry. *J. Comm. Biotechnol.* **11**(2), 146–154.
- Herpin, T. F., Karuso, H. & Foley, J. E. (2005). Australian biotech companies: Navigating the maze. *J. Comm. Biotechnol.* **11**(2), 111–120.
- Lim, L. P. L. & Gregory, M. J. (2004). Singapore's biomedical science sector development strategy: Is it sustainable. *J. Comm. Biotechnol.* **10**(4), 352–362.
- People's Daily* (2000). China determines to boost biotech industry', [http://english.people.com.cn/english/200005/11/eng20000511\\_40611.html](http://english.people.com.cn/english/200005/11/eng20000511_40611.html), captured 25th July, 2007.
- BioSpectrum* (2006). China builds Asia's largest biotech incubator', <http://www.biospectrumasia.com/Content/310506CHN824.asp>, captured 27th July, 2007.
- San Francisco Chronicle* (2006). Beijing eyes biotech business: Scientists are returning to China after working in the United States', <http://www.sfgate.com/cgi-bin/article.cgi?f=/c/a/2006/09/16/BUGORL6MT81.DTL>, captured 25th July, 2007.
- Chien, D. (2003). The role of Asia in global drug discovery and development. *Drug Inform. J.* **37**, 3–9.
- Yu, Z. & Dai, Y. (2006). The development of China's medical biotech industry needs to be driven by innovation. *Biotechnol. J.* **1**, 1253–1257.
- Salter, B., Cooper, M. & Dickens, A. (2006). China and the global stem cell bioeconomy: An emerging political strategy? Global Biopolitics Research Group Working Paper No. 13, University of East Anglia, Norwich, UK.
- Finnegan, S. & Pinto, K. (2006). Offshoring: The globalization of outsourced bioprocessing. *BioProcess International*, **4**(8), S56–S62.
- Grace, C. (2004). The effect of changing intellectual property of pharmaceutical industry prospects in India and China: considerations for access to medicines. DFID Health Systems Resource Centre.
- Economist* (2002). Biotech's Yin and Yang **365**(8303), 71–73.

18. *Chemical Marketing Reporter* (2004). Mining the biotechnology opportunity in China. 6, June 28.
19. Miles, E. M. & Snow, C. C. (1978). *Organizational Strategy, Structure, and Process*, McGraw-Hill Book Company, New York.
20. Bunders, J., Haverkort, W. & Hiemstra, W. (1996). *Biotechnology: Building on Farmer's Knowledge*, Macmillan Education, Ltd; Hants, UK.
21. Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, Free Press, New York.
22. Baden-Fuller, C. & Stopford, J. (1992). The firm matters, not the industry, in de Wit, B. and Meyer, R. (eds.), *Strategy: Process, Content, Context*, South-Western College Pub: Cincinnati, OH, pp. 610–617.
23. Ketchen, D. J. (2003). An interview with Raymond E. Miles and Charles C. Snow. *Acad. Manage. Executive* **17**(4), 97–104.
24. Peng, M. W., Tan, J. & Tong, T. W. (2004). Ownership types and strategic groups in an emerging economy. *J. Manage. Studies* **41**(7), 1105–1129.
25. Carter, N. M., Stearns, T. M., Reynolds, P. D. & Miller, B. A. (1994). New venture strategies: theory development with an empirical base. *Strategic Manage. J.* **15**, 21–41.
26. Smith, C. (2005). A practical guide to Chinese patent law. *Seton Hall Legislative J.* **29**, 643–662.
27. Li, C. L. (2002). New developments in China's pharmaceutical regulatory regime. *J. Comm. Biotechnol.* **8**(3), 241–248.
28. Benitez-Rangel, P., Dominguez-Gonzalez, A., Herrera-Ruiz, G. & Delgado-Rosas, M. (2007). Filling process in injection molding. *Poly.-Plastics Technol. Eng.* **46**(7), 721–727.
29. Smith, M. (1998). Hiring your competitor's employee. *J. Manage. Eng.* **14**(6), 24.
30. Lehrman, S. (1997). Abbot sues Chiron over 'secrets' in heads of recruits. *Nature* **385**(6619), 760.
31. Parnell, J. A. & Wright, P. (1993). Generic strategy and performance: An empirical test of the Miles and Snow typology. *Br. J. Manage.* **4**, 29–36.