



Brazil Biotech Cluster: Minas Gerais

A Cluster Analysis

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Brazil Overview

Brazil is the biggest country in Latin America and one of the fast-growing developing BRIC countries.¹ After being close to a financial meltdown during the electoral campaign of 2002, the five-year GDP per capita growth is the highest in the past decades and its democracy has consolidated.

Brazil, Selected Indicators 2008	
Independence	1822
Land area	8,511 k sq km
Population	196 million
GDP per capita, PPP	\$10,300
GDP, PPP	\$1,99 trillion
Population	196 million
Median age	28 years
Unemployment rate	8%
Key exports	Agricultural products, metals, autos

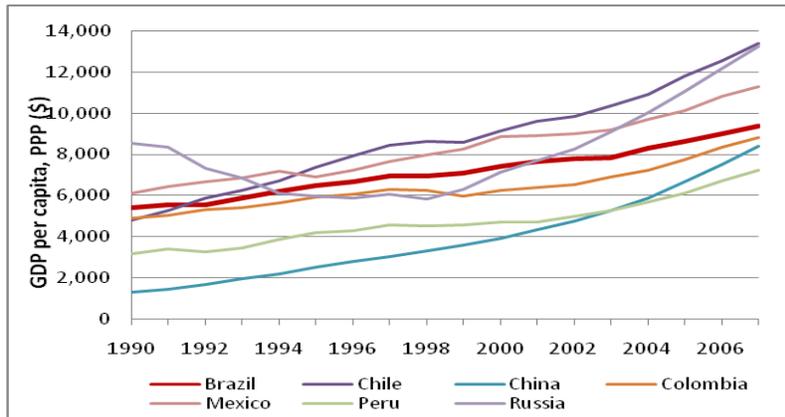
Macroeconomic Performance

Brazil’s economic growth has been outstanding. It flourished on a decade of macroeconomic reforms, FDI inflows and industrial development. Brazil’s PPP adjusted GDP per capita has almost doubled from \$5,403 in 1990 to \$10,300 in 2008. Nevertheless, Brazil is still a laggard in growth. The average annual GDP growth rate for 1993-2007 was 2.9%, while the Latin American average was 3.58% (EIU, 2007).

Growth in Brazil has been fueled mostly by demand from the domestic market. Exports, although they have grown extensively, comprise a mere 16.4% of the GDP (International Cluster Competitiveness Project, 2009). As opposed to other episodes, the current growth is not associated with excessive government spending and deteriorating external and fiscal balances.

¹ BRIC countries are Brazil, Russia, India and China. They are used as benchmarks for emerging economies.

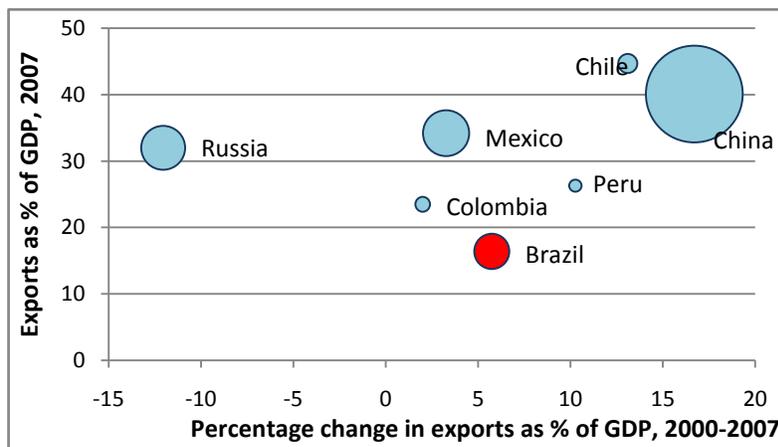
Figure 1 - GDP per capita, PPP for Selected Latin American and BRIC Countries (EIU, 2007)



Inflation has been brought under control through active macroeconomic reforms. Although inflation in Brazil was at a rampant 2000% in the mid-1990s, it has come down to a range between 5% and 10% since 2000.

Brazil has experienced a significant trade surplus in recent years, putting pressure towards appreciation of the exchange rate, hurting the relative competitiveness of the country. In May 2007, the trade surplus peaked at \$47.8 billion. However, despite the fact that the Brazilian export sector has been remarkable in volume terms, reaching \$143 billion in the same year, the Brazilian economy is less export intensive than other Latin American countries. The Brazilian Trade and Investment Promotion Agency, APEX, has undertaken efforts to diversify exports.

Figure 2 – Export Intensity of Peer Countries (EIU, 2007)



Brazil achieved significant improvements in the management of fiscal accounts, reducing also the debt to GDP ratios. FDI cumulative inflows have been over \$100bn between 2001 and 2006, but the country has recently trailed behind its Latin American peers. Brazil received only 1.7% of GDP compared to 4% in Colombia and Peru (EIU, 2006).

Brazil is also lagging behind its peer countries, such as Colombia, China in Total Factor productivity, a measure of the efficiency level of the economy (EIU).

Figure 3 - Average Annual Growth in Total Factor Productivity, 2000-2007 (EIU, 2007)

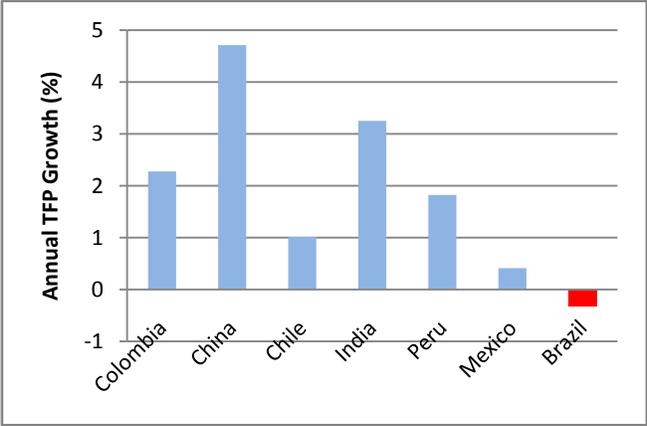
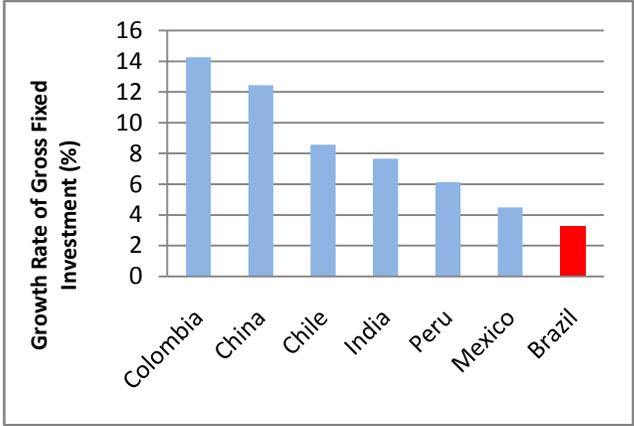


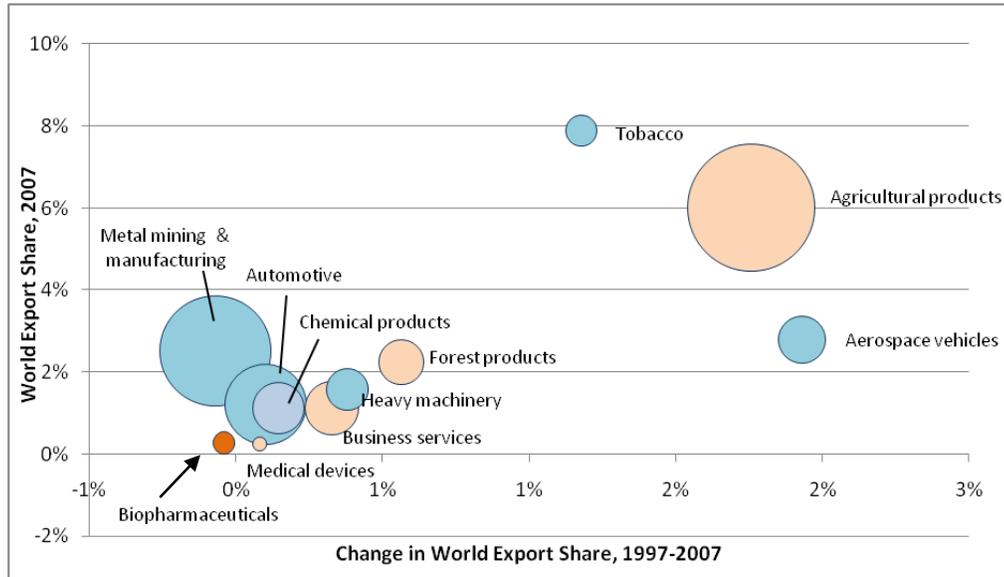
Figure 4 - Average Annual Growth in Gross Domestic Investment, 2000-2007 (EIU, 2007)



Inflation targeting policies and constant budget deficits have resulted in the world highest interest rate. This has hurt investment which has been lower than its peers (Hausmann, 2008). Brazil registered an annual growth rate of investment of 3.3% between 2000 and 2007, as opposed to 14.1% in Colombia, 12.2% in China, 8.1% in Chile (EIU).

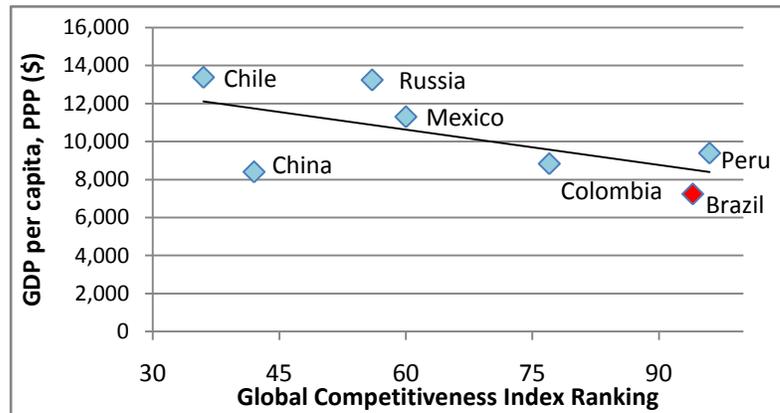
The biotech cluster is related to some of Brazil’s top-performing sectors; such as agriculture, chemical and forest products, business services, biopharmaceuticals and medical devices. These clusters have registered productivity gains in the past years, as shown in Figure 5.

Figure 5 – Top-Performing Clusters in Brazil, 2007 (International Cluster Competitiveness Project, 2009)



Beyond the recent structural and economic reforms, the country still faces challenges with regards to institutional environment. In order to improve the business competitiveness Brazil needs to address issues such as: property rights enforcement, corruption, judicial system and bankruptcy law reform (Milken Institute, 2008).

Figure 6 – Competitiveness and GDP per Capita Matrix, 2007 (EIU 2007 & International Cluster Competitiveness Project, 2009)

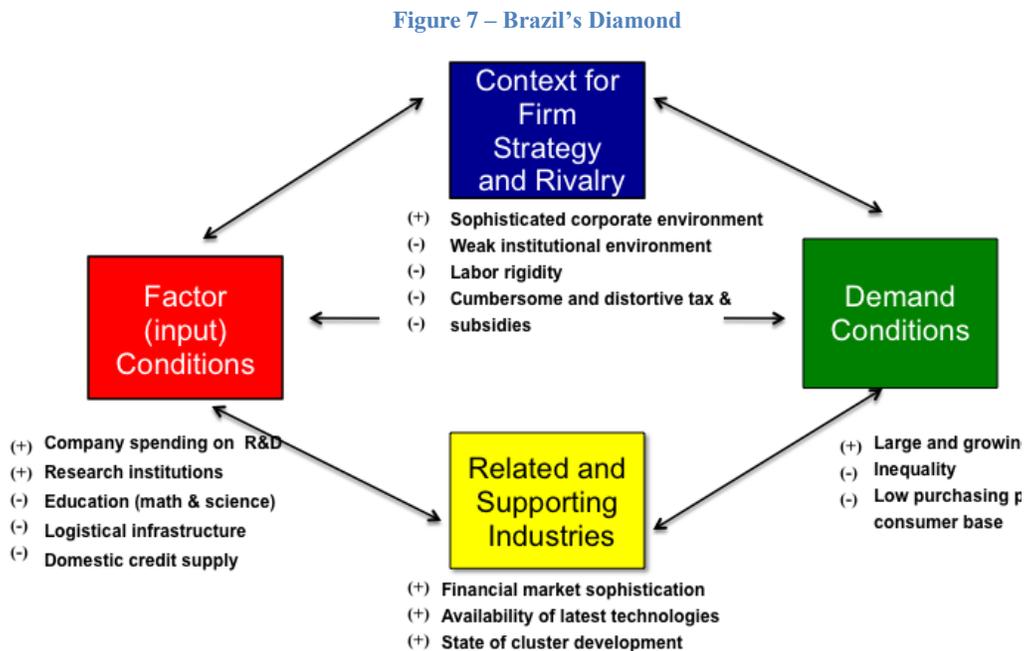


Brazil’s Business Environment

Beyond its endowments, Brazil has evolved in the past decades, as many of the policies have been directed to foster competition, private sector development and foreign direct investment.

The economy has become more reliant on markets, international trade and finance. As part of the reform, state owned enterprises were privatized, barriers to FDI were reduced as well as unilateral and multilateral tariff; market reforms in regulated sectors of the national economies such as telecommunications, banking and finance, transportation, energy and agriculture were also undertaken. (Decosimo Global, 2006). However, Brazil remains as a very heterogeneous economic landscape where competitiveness depends on the micro-economic interactions inherent to a particular industry and region.

The following figures detail the Porter Diamond for Brazil that show the most important indicators where the country either excels or is low performing.



The Global Competitiveness Indicators rank Brazil as 48th out of 134 countries in microeconomic conditions that foster competition. This includes company operations and strategy, national business environment, demand and factor conditions and the state of the related and supporting industries. However, Brazil's most urgent challenges lie in the macroeconomic,

institutional and social landscape, where it ranks 123rd and 82nd respectively.

Brazil Diamond			
Global Competitiveness Index 2008 (134 countries)			
PROS		CONS	
Context for Strategy and Rivalry			
High FDI	33	GCI macro, social, institutional	123
Infrastructure for innovation	61	(Low) Labor rigidity	93
		Impact of taxes on incentives	134
		Administrative infrastructure	132
		Distortive tax & subsidies	107
		Restriction on capital flows	111
		(Low) Tariff rate	103
Factor and Input Conditions			
Company spending on R&D	25	Education (math & science)	122
Research institutions	45	Logistical infrastructure	86
		Domestic credit supply	119
Related and Supporting Industries			
Financial market sophistication	11	Extent of cluster policy	67
Intensity of local competition	33		
Availability of latest technologies	56		
State of cluster development	43		
Demand Conditions			
Large market	196 MM people	Inequality	0.56 Gini, 10 th world *
Gov. procurement for technology	88	Low per capita GDP	\$ 10.300 PPP 2008 *
Law related to ICT	44		

* Source: World Bank

Context for Strategy and Rivalry

Brazil is a recipient of significant FDI flows. It relies on a very competitive infrastructure for innovation, starting with high performing universities, research centers and access to the latest technologies. However, the following challenges should be addressed.

Contract enforcement is weak and the judicial system in Brazil is perceived as slow, time consuming and unpredictable; and most courts have little experience with commercial cases. In Brazil 88% of cases are appealed as opposed to Mexico with 30%. To set a lawsuit, it normally takes 2.5 years on average (International Finance Corporation, 2006).

Registering property in Brazil is more difficult than in many Latin American countries; it ranks 17th out of 22. On average an entrepreneur spends 61 days and 3.5% of the value of the property in order to register it. In addition to this in all states entrepreneurs pay a 2% real state transfer tax, except in Minas Gerais, where it is 2.5%. In addition, the tax system is one of the most cumbersome in the world (International Finance Corporation, 2006). Different states have different business tax rates. Average tax burden is 147% of gross profit payable in 17 payments per year (International Finance Corporation, 2006). Labor legislation is too stringent and hinders the capacity of firms to adapt to changing environments and their willingness to take risks. Brazil ranks 93rd in low labor rigidity.

Factor Conditions

On the bright side, Brazil shows spending in Research and Development on the part of the private and public sector; it ranks 25th out of the 134 countries in the GCI. Also its supply of research institutions is also relatively high, ranking as 45th. These two aspects are key when it comes to innovation that constitutes the base of a competitive economy.

The cost and the access to credit represent a barrier when taking risks, undertaking productive endeavors and planning investments. Interest rates are extraordinarily high and big budget deficits are crowding out private investment. But beyond the cost of credit, there are regulatory barriers that further hinder access to finance. A key obstacle is the procedures of registering collateral and selling it once a loan defaults. In Brazil, banks cannot sell registered collateral without the authorization from the debtor (International Finance Corporation, 2006). Another one is the existence of restrictions on capital flows: Brazil ranks 111th in the GCIs.

In Brazil access to education is unequal and its quality is very low. Especially when it comes to

sciences and math, considered bases for innovation, Brazil ranks 122nd out of 134 countries. This shows the need to upgrade science training and education in the country.

Related and Supporting Industries

There are high barriers to creating new business. Start up procedures are scattered and no agency has oversight over all the necessary steps and costs. Registration requirements are not standardized across states and electronic processes are not permitted. Informality remains an important issue as 42% of Brazil's output between 2002 and 2003 is attributed to the informal sector. The cumbersome legislation for regularization, taxes and labor constitutes an incentive to remain informal. This implies losses in revenues for the Government and limits growth.

Demand Conditions

Inequality, poverty and crime hinder Brazil's potential of becoming a larger market with purchasing capacity. Brazil is the tenth most unequal country in the world with a Gini coefficient of 0.56 (World Bank, 2009). High levels of government expenditure result in state agencies that are important consumers boosting demand especially in areas related to public services.

Strategic Issues and Recommendations

The key strategic issues for improving Brazil's competitiveness are in three main areas: (i) institutional reform; (ii) context for competitiveness; and (iii) macroeconomic policy. Productivity and exports have not grown to their full potential and have not benefited from enough FDI. Labor rigidities have not allowed Brazilian labor to adopt international best practices fast enough, which has led to lagging productivity efficiency. And the high interest rates have made it prohibitively hard for companies to invest in innovation projects.

- **Institutional reform** - in terms of creating the enabling environment for business development, institutional reform in Brazil should focus on the development of an efficient regulatory framework. The next reform that the President of the country should dedicate his political capital on is decreasing the rigidities in the labor market. This will make it not as costly for companies to expand their operations, and compete globally in terms of labor cost efficiency. Also, tying salaries to worker productivity will incentivize companies to focus on efficiency and innovation.
- **Context for competitiveness** – easing the tax burden should be one of the key priorities of the government. Other regulatory reforms should address business start-up procedures and contract enforcement.
- **Macroeconomic policy** – the Central Bank of Brazil should aim to bring down the prohibitively high interest rate, as to allow for more potential investment opportunities to become feasible. In addition, the central government could aim to decrease its domestic borrowing as not to put an additional strain on the credit markets.

Taking advantage of fundamental macroeconomic reforms and strong industrial development, Brazil should capitalize on the developments in key sectors of the economy, and aim to increase FDI inflows and expand its influence in the global export markets.

The State of Minas Gerais

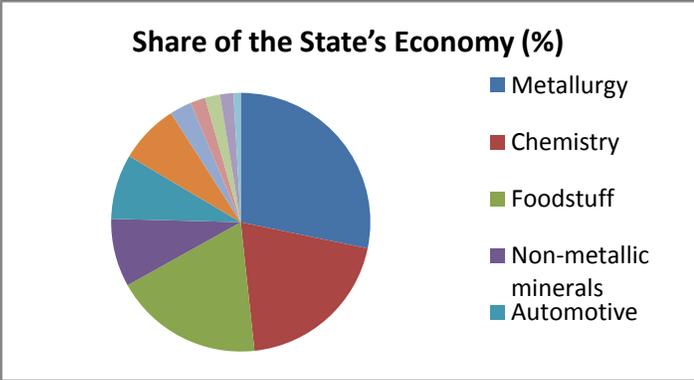
The State of Minas Gerais is located in the southeast part of Brazil. Even though it is a landlocked state, it has a very favorable geographic location for trade due to its closeness to the other two main economic centers of Brazil, Sao Paulo and Rio de Janeiro. With a population of 19.48 million people, Minas is Brazil's second most populous state.

When looking at GDP and GDP per capita, we observe that the state’s GDP is the country’s third largest, reaching USD 84 billion in 2006 and accounting for 9% of national GDP (IBGE, 2009). However, in GDP per capita terms Minas Gerais only ranks in 10th place with an average income of USD 4,381. The state income level is 14% below the national income of USD 5,094 (not PPP adjusted). The low figure is somehow offset when we look at the state’s growth data. Minas is growing at a faster pace than the rest of the country. In particular, on 2006 the state’s growth rate was 3.7%, almost doubling the national growth rate of 2%. Job creation is also growing faster in Minas than in the rest of Brazil, where in 2008 the amount of new jobs grew by 7.3%, a rate almost 1% larger than national average (IBGE, 2009).

Minas Gerais economy is primarily focused on exports. Exports are particularly important to sustain growth in the long-run because they foster a high level of productivity and competitiveness. Exports have been steadily growing in the past years, from USD 6 billion in 2000 to USD 24 billion in 2008. This situation has generated constant trade surpluses, which

have become a source of funding for investments in the state. The state’s main economic activities are Metallurgy, Chemicals and Foodstuff. Besides these, there is a wide arrange of industries well positioned in Minas’ diversify

Figure 8 - Minas Gerais Main Industrial Sectors (Source: (Swiss Business Hub Brazil , 2007)



economy. Table 8 shows the share of the state main industrial sectors.

Minas Gerais Diamond Analysis

The following table describes the main strengths and weaknesses of Minas Gerais business environment.

	Strength	Weakness
Factor Conditions	<ul style="list-style-type: none"> • Good Infrastructure • 24.000 km of highways, largest network in Brazil • 5.080 km of railways • Over 70 airports • Good University System • 4 of Brazil top ten universities • Minas Gerais Federal University ranks 9th in Latin America • Availability of Finance • 2 big venture capital firms • State finance through Minas Gerais Development Bank 	<ul style="list-style-type: none"> • Industrial production per capita lower than national average
Demand Conditions	<ul style="list-style-type: none"> • Large Local Market • Retail sales expanded 8,1% in 2008 • Proximity to large and wealthy markets 	<ul style="list-style-type: none"> • Low purchase power of local market
Context for Firm Strategy & Rivalry	<ul style="list-style-type: none"> • Government Policies • Crece Minas cluster development project • Exporta Minas • Fapemig (STI agency) • Institutions for Collaboration • Federation of Industries of the State of Minas Gerais • Biominas (business incubator) • Minas Gerais Innovation Network • Minas Gerais is the state with the smallest range to open a business, 19 days 	<ul style="list-style-type: none"> • Strong presence of Unions
Related and Supported Industries	<ul style="list-style-type: none"> • Highly diversify economy generates availability of local suppliers in several areas • Presence of dynamic industries: IT, chemicals, foodstuffs, agriculture, health • Presence of multinationals such as Google, Toshiba, Fiat, Arcelor and Telecom Italia 	

Policy Recommendations for Minas Gerais

Even though Minas Gerais exhibits a diversified economy, strong factor conditions and pro-growth policies but its industrial productivity as well as its income per capita are lower than expected. The main reason for this is the tight labor regulations that have been historically put in

place by the unions. In this respect, a labor reform is urgent if the state is willing to enhance its competitive position. The reform will promote job creation; increasing productivity and increasing income per capita. All this will allow the local market to go through a sophistication process, which in the end will upgrade the whole diamond.

Understanding Biotechnology

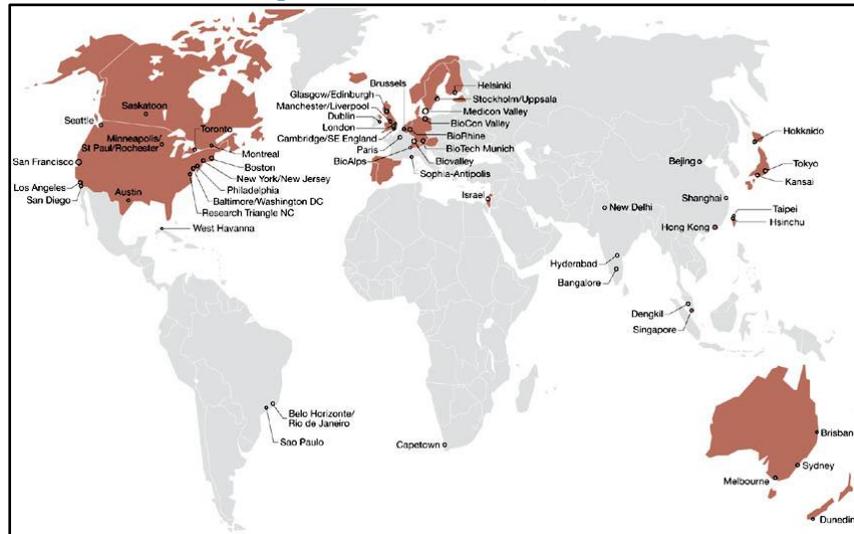
Biotechnology is a term that encompasses a number of technological activities aimed to breed or modify biological organisms to address human needs. It is associated with a variety of micro-scale technological processes such as genetic engineering, vaccine production, genetically modified crops, bio-pesticides and biological treatment of waste. In general, biotechnology combines biochemistry, molecular science and genetics. *“We can get a better handle on the meaning of the word biotechnology by thinking of it in its plural form, biotechnologies. That’s because biotechnology is a collection of technologies that capitalize on the attributes of cells, such as their manufacturing capabilities, and put biological molecules, such as DNA and proteins, to work for us.”* (Biotechnology Industry Organization, 2008)

Commercial applications of biotechnology include healthcare, agriculture, food, industrial and environment. In the health area, biotech is used for vaccines, diagnostics and therapeutics. In agriculture, crops and animal health have been improved through biotech to resist pests and diseases. Food applications include safety testing as well as processing. Industrial and environmental applications are equally broad, including the development of better industrial processes as well as cleaning agents and even biofuels.

When looking to the global biotech industry from a cluster perspective, we observe that the main clusters are located in the United States and Europe but there is also presence of biotech firms in

emerging economies such as India and Brazil. The world's major clusters are San Francisco Bay Area (USA), New England (USA), San Diego (USA), together with England, Germany and Denmark from the European region. The following map shows the global distribution of biotech clusters.

Figure 9 - Source: (Hoffman, 2006)

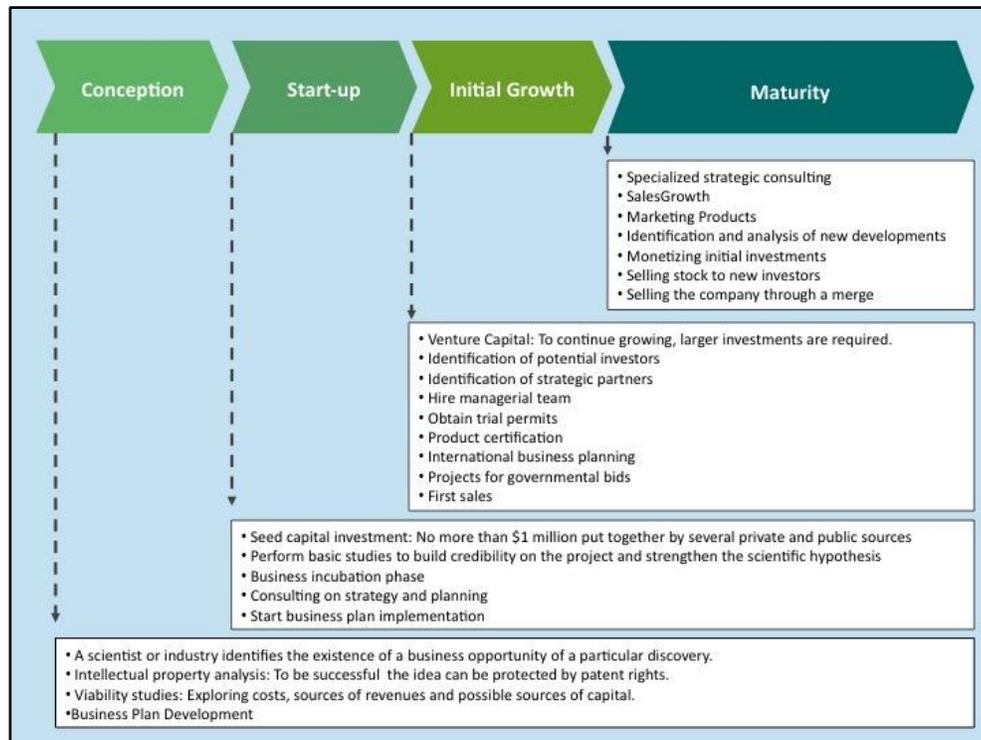


Countries colored in brown rank highly in the Growth Competitiveness Index 2004–2005.

This industry is highly regulated, knowledge intensive, requiring heavy investments in R&D. It is characterized by long product development processes and high returns when success is achieved. Although the global biotech industry is maturing, with many mergers and consolidation taking place, it is still the case that biotech firms are usually small, single established firms whose main assets are their people and research capability. Start-up companies usually come from university scientists who decide to go into business. As many other industries, marketing is a key aspect of the business process but biotech firms usually lack this ability due to the scientific background of the owners. The need to market, coupled with the high-risk nature of biotech ventures has translated into a symbiotic relationship between biotech start-up companies and venture capital firms, which assist them in going from research to market. The following

diagram shows the typical life cycle for a biotech company.

Figure 10: Biotech Company Life Cycle

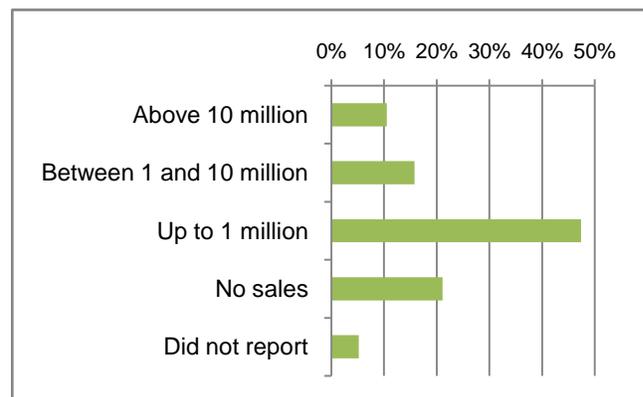


Source: Authors using info from (Hall, 2008) (Soares, 2009)

The Minas Gerais Biotech Cluster – Overview

The Minas Gerais Biotech cluster is relatively new and small. The industry structure shows that 25% of companies are young, with less than 4 years. Also, 75% are small companies with less than 20 employees (Biominas Foundation, 2009). 66% of the companies have close relations with universities and 11 companies are currently being incubated by Habitat (Biominas Foundation, 2009). In

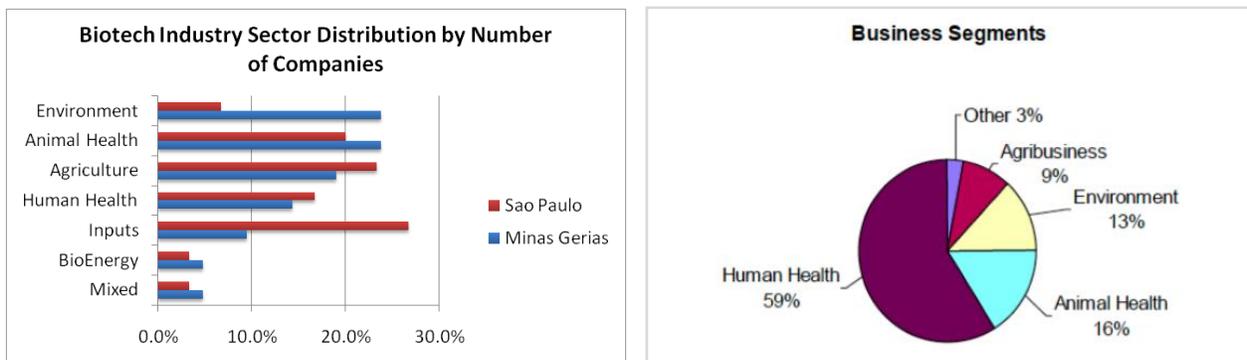
Figure 11: Distribution of Companies by Revenue (R\$) (Biominas Foundation, 2009)



2006, 68% of the companies had sales of up to R\$1 million (USD 500,000).

The cluster is mainly active in the following segments: (i) human health, (ii) agribusiness, (iii) animal health; and, (iv) environment. When compared to Sao Paulo, the other big biotech cluster in Brazil, we observe that Minas Gerais exhibits a much larger share of its companies in the environmental area. However, the sales breakdown shows that the cluster revenues are much larger in the human health segment.

Figure 12 - Source: (Biominas Foundation, 2007)

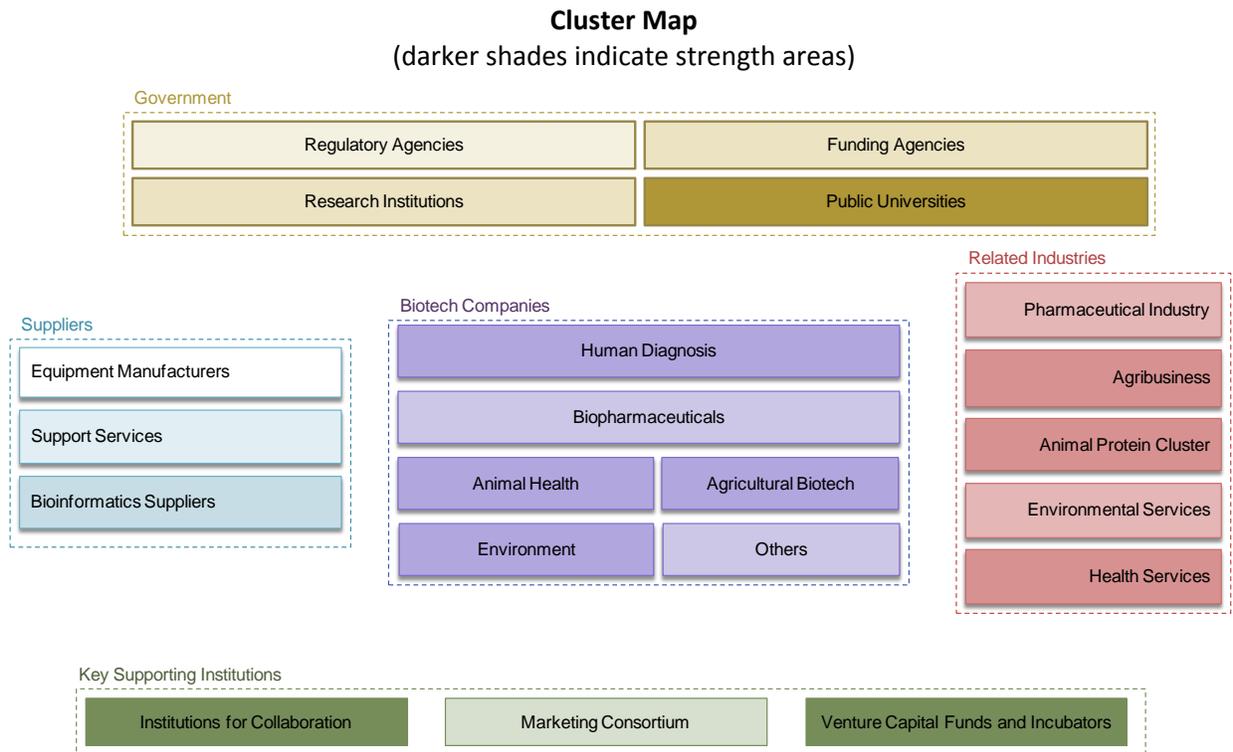


The cluster has a strong domestic-orientation. In 2002 only 15% of revenues of the cluster came from exports, and less than half of the companies had engaged in export activities (Fajnzyblber, 2002). The human health sector is largely oriented to satisfy the huge and growing local market demand for medicines that are mostly directed to the public health care system. However, developments in the agricultural sector are largely exported to the rest of the world, although research has been targeted to satisfy the needs of local crops.

Cluster activities do not only limit themselves to Belo Horizonte. Biotech companies can also be found in other cities such as Uberlandia and Uberaba and Monte Claros. In the latter, local government incentives have managed to attract to this relatively small city important companies such as BioBras and Valle (Resende, 2004).

Cluster Structure

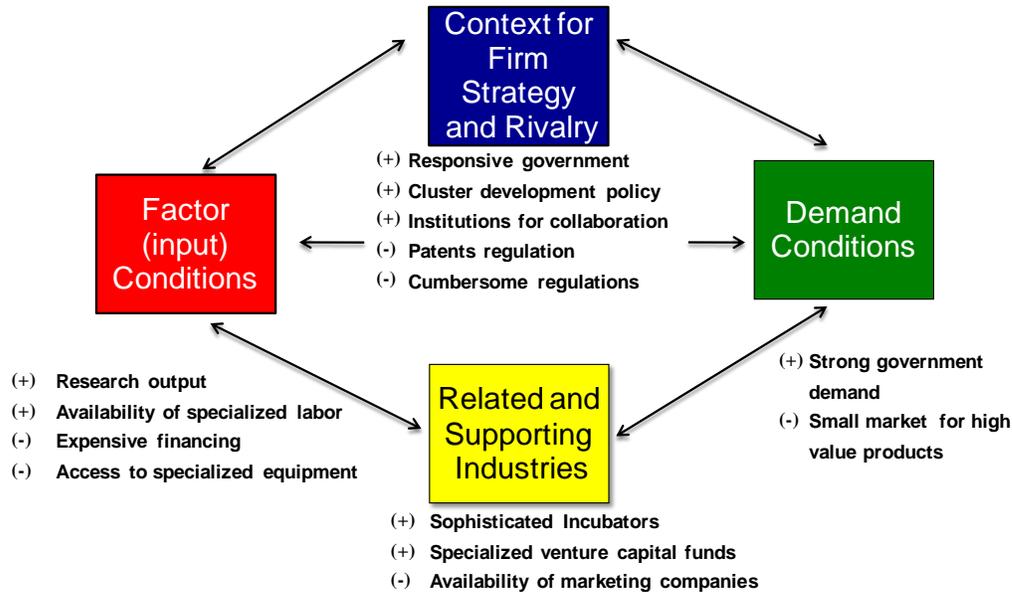
Even though the cluster is small and emerging, it has a complete structure. The next figure shows the Minas Gerais Biotech Cluster Map.



With the exception of equipment manufacturers, the cluster is well developed. Perhaps one of the strongest characteristics of the cluster, and the reason why it has developed in Minas Gerais is the presence of large and high-quality state financed universities. Research and Development is at the heart of biotechnology and in Minas the story is not different. The government in this respect has been a key actor, not only through financing universities, but also through funding agencies and other research institutions. These tend to be federal in nature, but are very responsive and active in Minas Gerais. Furthermore, the state of Minas has a number of supporting industries that strengthen the cluster. Arguably the strongest and most important components of the cluster are the institutions for collaboration which have been formed to further

boost the industry. To understand all these actors better we use a diamond analysis to evaluate the cluster and identify its strategic issues.

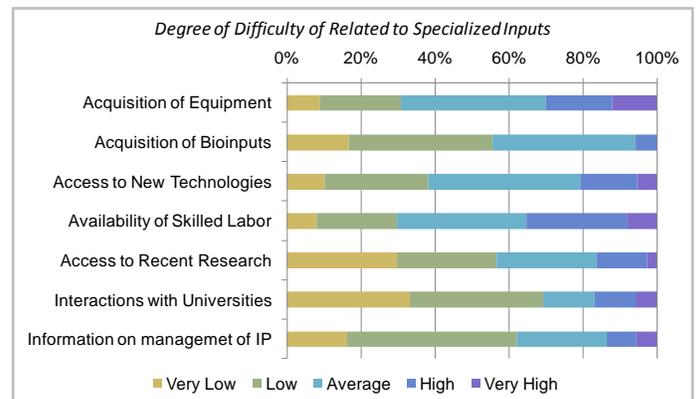
Cluster Business Environment – Diamond Analysis



Factor Conditions

The reason why the biotech cluster sprung up in Minas Gerais was the existence of a number of high quality state-funded universities. In the Federal University of Minas Gerais (UFMG) alone, there are 161 biotechnology experts (Swiss Business Hub Brazil, 2007). In addition to this, there are many other universities that offer courses not only in Genetics, but in specialized biotech fields such as

Figure 13- Source: (Biominas Foundation, 2007)



environmental biotech, or plant biotech, as well as in business areas such as biotech management. Having said that, the industry could absorb an even larger amount of highly trained labor.

Financial access is still limited in the cluster; however, venture capital is increasingly available. The main reasons for capital scarcity for biotech in Brazil are the lack of understanding of the biotech sector by Brazilian investors, the risk aversion of local venture capital funds and liability risks for angel investors for companies' activities (Rezaie, 2008). All this is exacerbated by Brazil's high interest rates, which make investors reluctant to take high risks when investing in government bonds yields such high returns. These restrictions have forced emerging companies to rely heavily on government funding or to generate fast revenues in order to sustain their operations. Companies have developed a "hybrid" business model where they fund internal development projects with cash flows that come from selling services or products marketed from their very genesis (Rezaie, 2008). Recent developments in the venture capital industry have been promising. Three firms alone, Votorantim Ventures Capital, FIR Capital and Rio Bravo, have started dedicated biotech funds and invested over \$350 millions in local firms.

Difficulty in obtaining equipment is a major hurdle cited by companies. High import tariffs have posed a problem for companies looking to own their equipment. As a result many companies resort to using university facilities when available. However, these are neither sufficient nor specific for the applications that many private companies may need. Over 25% of them in the cluster have reported high or very high degree of difficulty in obtaining equipment.

Context for Firm Strategy and Rivalry

Strong institutions for collaboration have been formed to foster cluster development. At the

beginning of the 1990s, nine biotech companies got together and created *Biomina Foundation*. This institution has become a key piece of the cluster due to its leading role in coordinating, promoting and supporting the emerging biotech sector in the state. Another important step was taken in 1997 when a business incubator was formed as a joint venture of: *Biomina*, UFMG, the municipality of Belo Horizonte and the State Government. This incubator has played a central role in providing Minas Gerais a competitive advantage due to the opportunities it generates to scientists interested in developing start-ups. Today *Habitat* (the incubator's new name) is the most important biotech incubator in Brazil, being responsible for introducing more than 21 start-ups, which have generated over R\$70 million in revenues (Swiss Business Hub Brazil , 2007). *Biomina* have also expanded its business to the organization of Brazil's largest biotech trade fair, *Biolatina*, and the provision of venture capital. Other key institutions include the *Federation of Industries of the State of Minas Gerais* (FIEMG), which has an open channel of communication with the government, and the *Minas Gerais Innovation Network*. Biotech companies have also recently started a collaborative enterprise to improve their marketing capabilities and access new markets.

The state government is also increasingly responsive to industry needs, launching in 1999 the *Cresce Minas* project. This cluster development initiative combined funds from the Inter-American Development Bank, the academic expertise of UFMG, *Biomina*'s experience and resources from the FIEMG. It analyzed 47 clusters in several dimensions such as potential growth, competitive position, completeness of the cluster and employment capabilities. In the end, the biotech cluster was one of the 5 clusters selected to be promoted. The goal was to increase its employment base from 1,800 to 5,600 in five years. The cluster success allowed to meet 75% of this goal during the first 2 years (Swiss Business Hub Brazil , 2007). As part of this

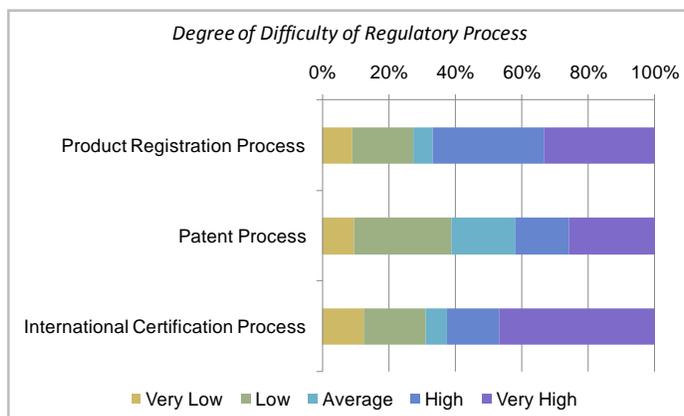
initiative, the government organized venture capital forums, supported the establishment of a technology park at UFMG as well as provided funding through the state development agency and put in place tax breaks for biotech firms.

The patent regulatory processes and burdensome approvals are a major hindrance to the cluster. In spite of progress in the regulatory front, with the passing of a new and simplified biosafety law, the reality is that most companies in the cluster still feel the heavy burden of regulation. In spite of the high research output of the

region, only 15.5% of the companies have registered a patent (Santos, 2008). Although this number may be understated due to patents filed on behalf of individual owners, it is clear that patenting “red tape” and difficulty dealing with international certification

are a problem. In some cases it has taken up to seven years to get a patent approved (Rezaie, 2008). Furthermore, although Brazil has a diverse population, which is ideal for clinical trials, for the most part their approvals have been slow to come.

Figure 14: Difficulty of Regulatory Process



Related and Supporting Industries for the Cluster

There are several related industries supporting the cluster. Minas Gerais’ huge agriculture sector can be a big customer of genetic modified crops or bio-pesticides. Also, livestock is one of the main economic activities in the state, and Brazil is the largest animal health market in Latin America (Swiss Business Hub Brazil , 2007) generating a strong local demand for animal

vaccines, particularly swine vaccines. These two industries are also closely related to the state's food processing industry and animal protein cluster, where stabilizers and other biochemicals are in demand. On human health, pharma companies and health service institutions are constantly searching for new drugs, treatments or production procedures. The cluster's companies work on delivering all these products and services.

Minas Gerais diversified industry has also provided a strong platform to the cluster regarding suppliers, but equipment manufacturers are lacking. The local informatics industry, led by the presence of Google Latin America, has been working to develop the bioinformatics platform required for knowledge exchange and ease of development processes. In addition, a number of private sector service providers have sprung up to serve the emerging biotech companies. However, there are very few equipment manufacturers in the state. This is the weakest link on the supply chain. The industry complains about the need to upgrade their production capabilities in order to be able to provide the high tech equipment required by biotech companies.

A network of laboratories with expertise in DNA sequencing has developed as a related industry to facilitate the accomplishment of Genome project goals. There are ample science development projects, for example: the cancer genome project, the sugarcane genome project, and Syngenta developing corn and cotton resistant to pests. Syngenta has also entered into an agreement with the Federal University of Viçosa, for soybean improvement, aiming at the elimination of certain toxins present in its seeds.

Demand conditions

As we have discussed biotech production in Brazil is well-diversified, including human, pharmaceutical, agriculture and environment. This is a reflection of existing demand in each of

those sectors. Its products are used by final and intermediate consumers. In human and pharmaceutical the products are tailored to the final consumer, such as insulin and immunizations – although in many cases the state is the distributor. However, this is still a contrast to agriculture and environment, where the products are delivered to agribusiness or to companies that use them to grow crops or provide sanitation, de-contamination and waste management services.

Most of the production is oriented to the domestic market. In biotech, partnerships often play a key role in getting products to market. Because R&D is a long-term, risky and knowledge based activity, many companies partner with the potential consumers. In this model, the partnerships enable biotech companies to be demand oriented, closer to the market, and to produce things that will be providing solutions to the industry. Brazilian biotech companies are increasingly engaging with foreign companies in such partnerships. However, for the most part, very few products are exported and most of the demand is coming from domestic players. On the one hand, this has been a source of strength as companies have developed products for local health problems often ignored by larger international pharmaceutical companies — including malaria, Chagas disease and dengue — and neglected markets (Rezaie, 2008). On the other hand, it means the cluster has not been a significant player in the world bioeconomy.

This demand is supported by the coordinating role of the IFCs presence in Minas Gerais such as *Biomina*s. In the case of agribusiness and animal health, the agricultural research funded by *Embrapa*, a state agency, has played the role of helping direct research efforts to those areas which are most relevant for actual producers of agricultural products. In the particular case of health products and pharmaceuticals, the demand is dominated by the public health care system, which also has its own research efforts and facilities. In the environment sector, contractors of

local governments are the most important consumers. These have grown recently as Brazil's environmental regulations are generating a high demand on environmental services at the city and state levels. This has raised the attractiveness of research investments in water sanitation and waste management technologies.

Although state-demand has helped, it provides ambiguous incentives. Because the government has played such a large role, it also has the ability to change the rules of the game on companies. In particular in the pharmaceutical industry, there is evidence that the central government has exercised monopsony power in the past when negotiating prices of medicines (Rezaie, 2008) and the story is not different for biotech. The goals of the government can often clash with those of the private sector.

Past, Present and Future

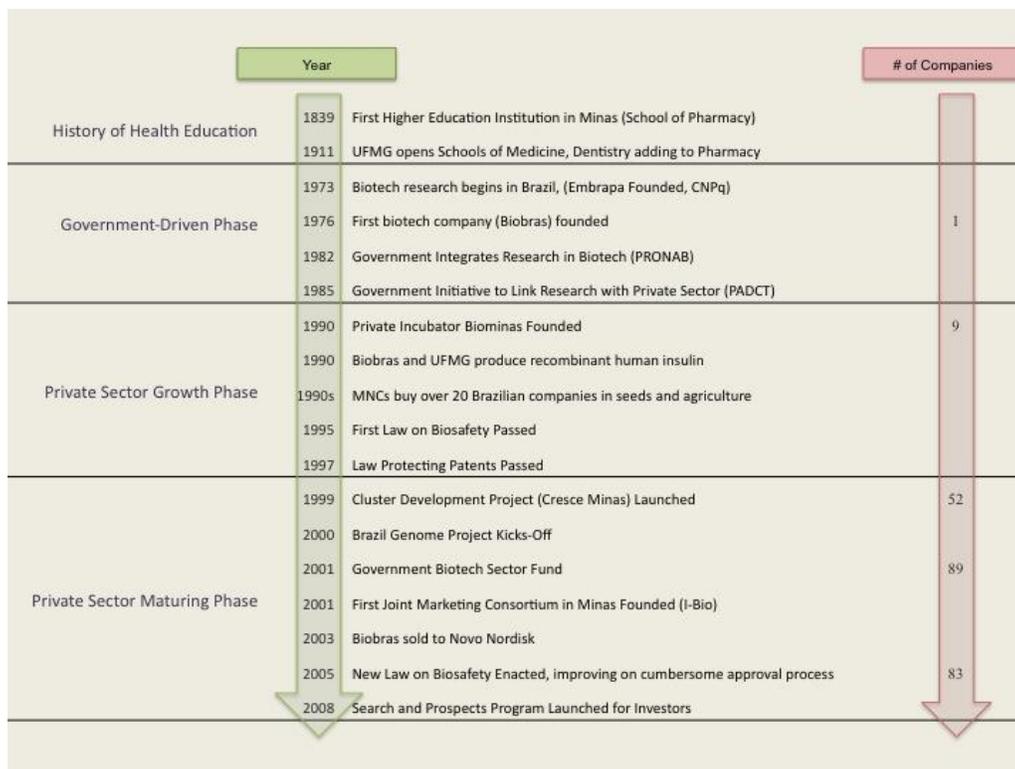
The history of the Minas Gerais biotech cluster coincides with the beginning of biotech research in Brazil in the early seventies, when *Biobras*, the first biotechnological firm in Brazil, was established in Minas Gerais. From there after we have identified 3 different development stages of the biotech sector. In the beginning is the Brazilian government who starts funding several research activities through an integrated biotech research agency. When the first biotech companies began to emerge the federal government responded by putting in place the required legal framework and the state government decided to provide funding through the state's development agency. The initial period of cluster development was marked by protectionism.

The 1990s were a period of liberalization in the Brazilian economy and the cluster saw the entrance of multinationals and competition of imports with reduction in tariffs. A study shows that 80% of the companies in the cluster experienced increasing competition from abroad during

the 90s, with many also reporting increased competition domestically as well. (Fajnzylber, 2002) This was an important period in changing the mindset of both companies and government from protectionism to competitiveness.

More recent years have brought both challenges and opportunities to the cluster. With more competition, the number of companies has stopped to grow. However, there is evidence that existing companies have been forced to upgrade their processes, achieving international certifications and become more strategic and export oriented. (Judice, 2006) The government also has taken a different approach, by focusing on cluster development as one of its priorities.

Cluster Timeline

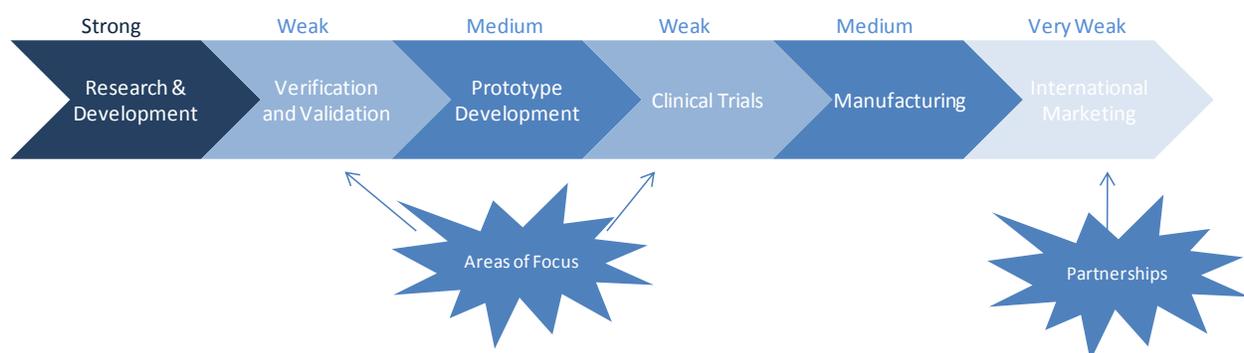


Key Strategic Issues Going Forward

The key issue faced by the cluster is international integration with the world biotech value chain.

Although the domestic market is large and growing, in order to be competitive the cluster needs to develop a strategy for integration with the world bioeconomy. Domestic demand, in particular from the government has been strong, but it cannot alone push the cluster to become competitive in the world economy. Only through increased foreign partnerships and additional exposure to world market forces will the self-reinforcing mechanism of cluster development truly take off.

The Brazilian cluster can flourish by building a competitive advantage as a low-cost provider of research and development and manufacturing. The availability of cutting-edge research faces an inability to transfer knowledge into marketable products which reach the world economy, constituting a key weakness in the cluster. This is a result of weak links across the value chain (shown in the example of pharma below), in which patenting and certification are difficult as well as in clinical trials. Furthermore, while it is unlikely that the small Brazilian firms will soon be able to distribute and market their discoveries in the global economy, they can tap into foreign partnerships to do so and thereby become fully integrated into the value chain.



Patenting and international certification issues need to be addressed, as well as clinical trials. The cluster's survival in spite of patenting problems is an accomplishment and highlights how impressive the research effort has been. A case study of what can happen when issues of intellectual property rights are solved in Brazil is the entrance *en masse* of multinational

companies in the seeds and agro sector when a new cultivars law was passed in the 1990s. We would expect that increased intellectual property protection in pharma and other biotech sectors would lead to additional interest from both foreign and local investors. Meanwhile, the pharma segment will not grow further while clinical trials are so difficult to perform.

The stronger areas of the value chain can be strengthened even further. For example, the issue of availability of key inputs such as equipments needs to be addressed. Clearly the Minas cluster developed because of availability of skilled labor, and while more professionals are needed it is not the availability of labor that is constraining the cluster. Rather, it is the lack of equipment that has significantly raised the costs of research and development.

Cluster-Specific Recommendations

Federal Government:

Improve regulations and regulators to untie value-chain constraints. Improve the performance of government institutions involved in regulation, ethics review and intellectual property (IP) assessment and approval. The process of patenting needs to be streamlined. Furthermore clinical trials need to be facilitated rather than hindered.

Facilitate integration into the global value-chain. Promote and support the filing of patents outside Brazil and develop policies that encourage partnerships between Brazilian and off-shore collaborators based on the formation of international IP assets. This should be part of the streamlined process of patenting, so that the international patenting process can be done together with the national process, or at least providing enough information and guidance on how to internationalize the patent. Modify or remove policies that levy taxes or otherwise penalize companies that must out-source portions of their development programs to off-shore vendors.

Allow private sector to flourish. Clarify the domain within which the public-sector will operate so as to allow the private sector to better target their investments. Continue to support sector through domestic demand, but with more transparency and competition. Give higher priority to research funding agencies (which fund the private sector) as opposed to doing research in government owned labs.

Minas Government:

Encourage FDI and facilitated foreign partnerships with cluster. The state government has been very responsive to the cluster and the private actors involved domestically. However, if the cluster is to develop as a globally competitive location, it will need to attract key players internationally. The entrance of Novo Nordisk is a single accomplishment in that respect. Other companies could use the Minas location for R&D and other activities.

Continue with cluster development efforts. Cresce Minas is an important milestone and tool for the government. The state government should continue to strengthen this program to ensure that it will last beyond current administrations. This means making sure all the parties involved are buying into the program and that progress is made in implementing recommendations.

Institutions for Collaboration

Facilitate foreign partnerships. Biominas and FIEMG should not be tempted to lobby for industry protection, but rather should look to provide the right support for these nascent companies to partner and compete internationally.

Work with government in drawing rules of the game. The fickle demand of the government for products and monopsonist practices have hurt the industry. More guidance from the private sector is needed to educate officials on how these actions, although beneficial in short-term can

hurt the sector in the long-term.

Companies

Think strategically about the relationship between company and cluster. In the world economy going alone is not enough when there are other competing locations that are collaborating for success. Taking a cluster perspective when thinking of a particular location in company-level strategy is essential to create value for shareholders and bring economic development for one's own location.

In conclusion, Brazil faces still some challenges to develop its biotech industry. However they could be overcome as the cluster shows that despite its emerging and nascent state, its potential for growth and inclusion in the global economy remains there to be tapped.

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