



**1.1 Country Overview** Located in between Atlantic Ocean and South America, Brazil is the world's fifth largest country both by geographical area and by population<sup>1</sup>. Brazil has experienced a fast urbanization process and nowadays more than 80% of the population in Brazil is urban and approximately 30% live in the ten principal metropolitan areas (PwC, 2006)<sup>i</sup>. It also borders with all South-American countries but Chile and Ecuador.

Figure 1. Map of Brazil



Source: US Department of State

Most of its neighbors are developing countries with abundant natural resources. (CIA, 2011). Brazil's GDP in 2010 was US\$ 2,029 billion with a GDP per capita of US\$ 11,196 (in PPP) (EIU, 2011) and the Brazilian economy grew 7.5% in 2010, being expected to grow 4% in 2011 (World Bank, 2011).

**1.2 Macro, political, legal and social context** The analysis of policy choices in Brazil reveal that the paradigms and macroeconomic policies varied widely in the second half of the 20<sup>th</sup> century, from a State oriented economy and import substitution policies toward a more open and free market economy. Brazil's policy makers realized after World War II that they needed to diversify its export basket, beyond the traditional commodities. Among other policies implemented, the exchange controls produced, overvaluation of the Cruzeiro (former currency) and encouragement of imports; at the same time, there were restrictions to capital repatriation and the remittances of earnings (Baer, 2008).

The range of government participation in economic planning was broad in this period. The National Bank of Economic Development (BNDES) was created to support industrial projects.

<sup>1</sup> <http://geography.about.com/od/specificplacesofinterest/a/geographyofbraz.htm>

BNDES collaborated with the United Nations' Economic Commission for Latin America (ECLAC) in the promotion of basic industries (steel, aluminum, cement, automotive, heavy machinery and chemicals) and import substitution policies in Brazil. (Baer, 2008).

During the dictatorship rule (1964-1985), Brazilian governments implemented several national development plans to promote import substitution policies and basic infrastructure (Baer, 2008).

In order to finance the industrialization process and to cover the cost of imported fuels, Brazil increased its international debt in a short period (Baer, 2008: 81). This extended role of the government was largely evident, as in 1974, among large firms, 39% of the net assets belonged to SOEs and 18% to multinational companies. (Baer, 2008: 223).

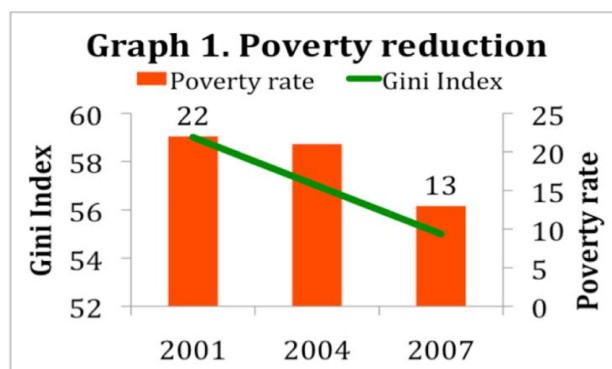
Embrapa and Embraer are good examples and exceptions of the Brazilian government intervention to promote national champions to become economic leaders. Empresa Brasileira de Pesquisa Agropecuaria (Embrapa) received substantial investments in research and human capital with the aim to boost agricultural productivity (Baer, 2008). Embraer, a former SOE manufacturer of small and fighter planes, was administered by the air force. Other leading companies were concentrated in basic industries: Companhia Vale do Rio Doce (mining), Companhia Siderurgica Nacional (steel), Petrobras (chemicals and petroleum) and Eletrobras (electricity), among others. Most of those companies exhibited low returns on assets and deterioration in the 1980s (Baer, 2008).

After the economic crisis of the 1980s, that had a negative impact in GDP growth, industrial production and hiper-inflation (greater than 1,061% in 1988), the government implemented stabilization plans, the first in 1986, known as the Cruzado Plan: new currency and, price and wage freezes in certain goods and services (Ammand, 2003).

The initial transformation began during the presidency of impeached Fernando Collor de Mello in 1990, as private sector leaders and public officials build consensus that import substitution policies were no longer viable. The approach changed toward a more open economy and integration to the world, through trade liberalization (tariff reductions), privatization (industrial, telecommunications and energy SOEs), market deregulation (increasing competitiveness in domestic markets and fostering FDI) and fiscal reform (public deficits reduction) (Ammand, 2003: 110-114). The key shift came under President Fernando Henrique Cardoso, who ruled from 1995 to 2003, the main architect of the current Brazil: “*stable, predictable macroeconomic environment in which business could flourish*” (The Economist, 2009: 3).

Against expectations, the left-wing government of President Luiz Inacio Lula da Silva (2002-2011), continued the implementation of policies toward inflation control and “fiscal austerity”, that gained him respect in the business community under Cardoso (Amman and Baer, 2009).

One key element in Brazil’s macroeconomic policies has been the continuity of reforms toward a more open economy and a better business environment, while launching a safety net welfare program, Bolsa Familia. That initiative and the expansion of employment due



Source: World Bank (2011) WDI

to the economic growth reduced poverty, from 22% in 2001 to 13% in 2007, through decreasing inequality, from a Gini index of 0.59 to 0.55 in the same period (World Bank, 2011).

Brazil also responds for the greatest absolute amount of homicides in the world. The yearly 53,000 homicides (Folha de São Paulo, 2009), makes Brazil -which comprises 3% of the world population- responsible for 11% of the world’s homicides. (Instituto Sangari, 2009).

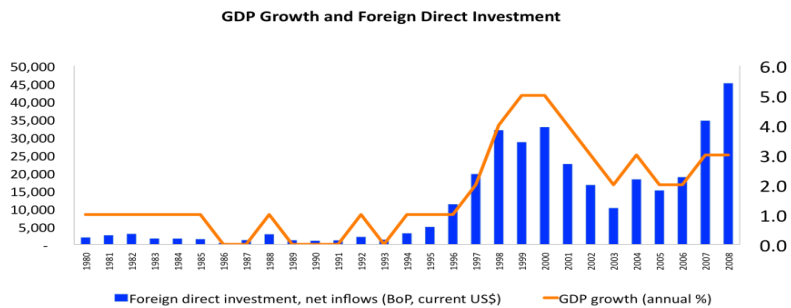
Those security concerns foster the demand for air transportation within those cities, particularly among the wealthier segments of the population. Not surprisingly Sao Paulo, Brazil's largest city, has an estimated existence of 240 helipads, with a traffic of 100 liftoffs per hour (largest in the world), that provide the wealthy Brazilians and business people a way to avoid the commute time and the lack of security (risks -violence, kidnapping, murders; Faiola, 2002)

**1.3 Macroeconomic Performance** In 2010 Brazil presented the 7<sup>th</sup> largest GDP in the world, but still was a developing country, in terms of GDP per capita. The largest country in South America (8.5 million sq km), Portuguese-speaking Brazil is endowed with vast natural resources and fresh water, as well as large oil reserves. (The Economist Intelligence Unit, 2011).

As one of the fundamental indicators of people's economic status, Brazilians have gone through high inflations during the Latin American financial crisis. Brazilian government has been putting many efforts to control the inflation. According to the most recent report of Bloomberg, Brazil's inflation has accelerated to 6.44% for the year 2011 through mid-April. It hits the highest level in more than two years.

The foreign direct investment inflow registered USD36 billion in 2009 (World Bank, 2011), making the country one of the most favorable

Graph 2.



Source: World Bank, World Development Indicators (WDI), 2011

destinations of FDI in the world. With the increasing inter-dependency and interaction of the world economy, financial investors began to put more attention into sizeable emerging countries with vast investment opportunities. Both FDI and private equity funds have identified Brazil as their core development in their future business. FDI also brings Brazil huge opportunities of upgrading its economy and technology.

For economists like Ricardo Hausmann, recent improvements in key economic indicators such as GDP per capita growth (highest in a generation) and investment growth provide the basis for a “*remarkable*” evaluation of Brazil’s macroeconomic management (Hausmann, 2008: 2). Today, Brazil is considered part of a key group emerging economies in the world, BRIC, jointly with Russia, India and China. (Goldman Sachs, 2003)

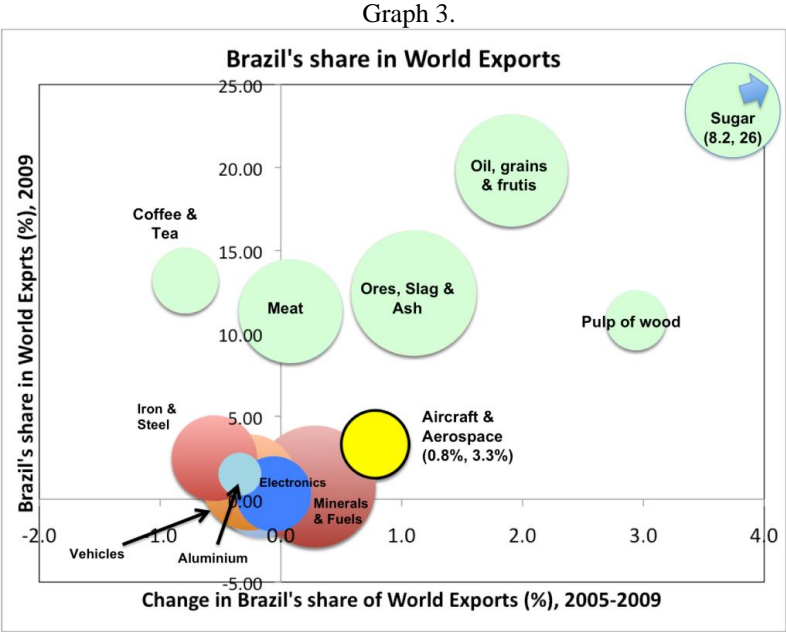
Brazil’s economic performance has evolved in the last decades, from a country whose economy was heavily controlled by a military government, with high levels of external debt and hyperinflation in the 1980s toward a democracy that was able to persevere in market oriented reforms since 1994, although variations in the political leadership. (Roett, 2010)

With the return to democracy the last two democratic governments of Presidents Cardoso and Lula, had been consistent in implementing economic and social policies that stimulate growth,

control inflation and attract foreign direct investment. (Roett, 2010) The reforms of the last two decades resulted in a positive GDP growth that peaked to 7.5% in 2010 and that has been correlated with important inward flows of direct investments. (World Bank, 2011)

The recent increase in prices of commodities has improved the trade balance for Brazil, as food commodities (sugar, grains, coffee, meat) and minerals have a leading share in exports. Beyond commodities, the industrial cluster that is gaining a larger share in world's exports is **Aircraft and Aerospace**, as shown in Graph 3. (United Nations Comtrade data, 2011).

In recent years, Brazil has run a trade balance surplus, resulting in US\$ 20.3 billion in 2010. (The Economist Intelligence Unit, 2011) As a consequence, international reserves had been increasing more than four fold in the last five years, to up to US\$ 238.5 billion in 2009. (World



Source: UN Comtrade data, 2011

Bank, 2011). Yet, in relation to its neighbors, Brazil has a lower trade intensity, of 27.4% of GDP as of 2008, but with a trend to increase. (The Economist Intelligence Unit, 2011).

**1.3 Quality of National Business Environment**

**1.3.1 Factor Conditions** Brazil's transportation network is immense and diverse, characterized by low pavement rate in roads (12%) (The Economist Intelligence Unit, 2011). Also, inefficient ports and airports in addition to a developing communications and broadband internet coverage



plus a very inefficient public mailing system, Brazil's logistics severely hamper its overall productivity. With the World Cup coming soon, Brazil has planned \$14 billion to spend on airports and other infrastructure projects, though 98.5% of the funding source is public sector (Reuters, 2011). With 49% of its population without access to sanitation, and all contamination costs on public health incurred due to matters of exposition, a high price on energy, which (Folha de Sao Paulo, 2011) when compared to neighbors like Uruguay sizes double to what is charged in this market and low connectivity capacity.

Brazil's primary and secondary Education systems include 45 million students. The municipal governments are responsible for providing primary education (IPEA 2010). The secondary level is a competency which belongs to the State but which can also be provided by the Federal government (MEC, 2010). Access is now almost universal but quality is still very low. Other fundamental problems are the lack of productivity in the production of Education since even though Brazil (5%) spends more than both Chile (3%) and Argentina (4%) on Education in terms of GDP (Schartzman, 2003) it still presents lower PISA scores than its neighbors.

Table 1. Pisa Exam Performance (2006)

Country	Science	Math	Reading
Brazil	390 (52 <sup>nd</sup> )	370 (44 <sup>th</sup> )	393 (48 <sup>th</sup> )
Argentina	391 (50 <sup>th</sup> )	381 (42 <sup>nd</sup> )	374 (52 <sup>nd</sup> )
Chile	438 (40 <sup>th</sup> )	448 (37 <sup>th</sup> )	441 (37 <sup>th</sup> )

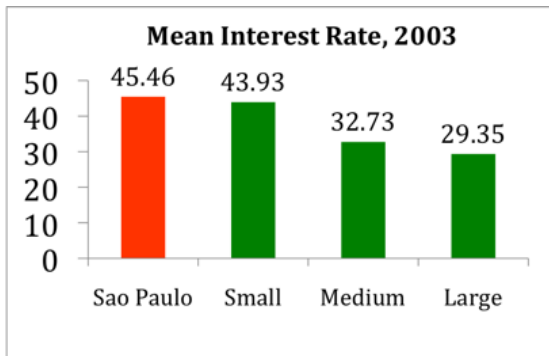
Source: (OECD, 2006)

The shortage on the supply of engineers is preoccupying and highlights the need for educational advancements to increase Brazil's competitiveness. It is alarming that the 150 thousand engineering job vacancies available in the market more than half will not be filled by 2012. There is an evasion of as much as 80% (ABE, 2011) in some states, of the 150 thousand engineering students that start the major in Brazil only 30 thousand conclude their education.



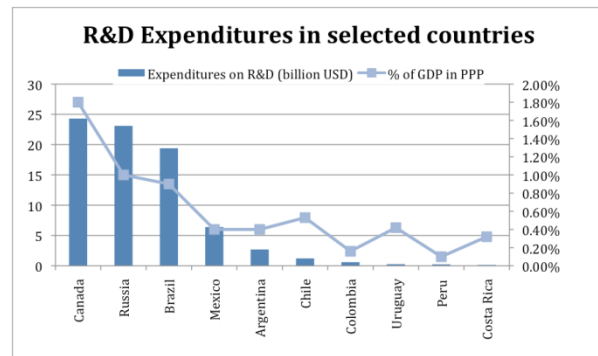
This human capital supply bottleneck translates into more costs and less competitiveness to the Brazilian companies. Forefront this scarcity, lesser competition generates problems in quality and 76% of companies have to invest in complimentary training (Folha de São Paulo, 2011).

Graph 4



Source: Qimiao, Fan, et al. 2008

Graph 5



Source: International Monetary Fund, R&D Magazine, Battelle

Although the new period of growth and stabilization of inflation, Brazil still faces numerous challenges ahead to improve its productivity and improve the conditions for business development. The interest rates are higher than other countries, particularly for small and medium size firms, a condition that threatens economic growth. A recent study by the World Bank found that comparing to India and China, SMEs in Brazil face significant higher interest rates, as shown in Graph 6. (Qimiao, Fan, et al. 2008).

Brazil has been the leader in R&D expenditures in Latin America. However, it still leaves behind other BRIC countries such as Russia and China. While Brazil invests 0.9% about of their GDP in PPP to research and development, China has invested 1.4% in 2010. (Battelle, 2011) And the gap is increasing. Moreover, Brazil lacks private funding for R&D. According to the 2011 World Bank's Doing Business Report<sup>2</sup>, Brazil's performance on doing business is ranked below the average, which is outperformed by its macroeconomic indicators.

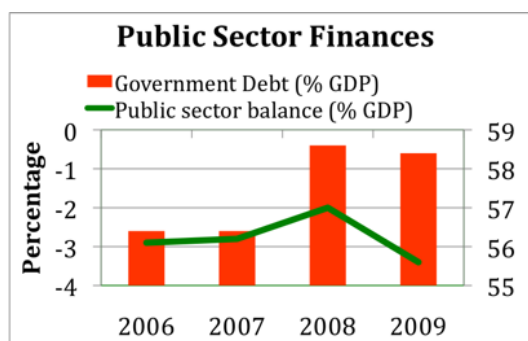
<sup>2</sup> <http://rru.worldbank.org/BESnapshots/BecpProfilePDFRedirect.aspx?economy=brazil>

**Table 2. Brazil's Doing Business rankings**

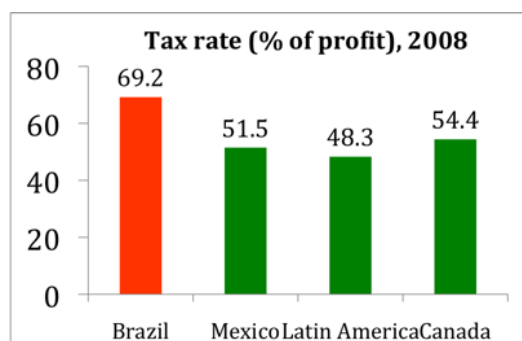
Indicator	2011 Ranking	2010 Ranking	Change in Rank
Doing Business (Overall Ranking)	128	128	0
Dealing with Construction Permits	112	113	1
Registering Property	122	121	-1
Getting Credit	89	87	-2
Protecting Investors	74	73	-1
Paying Taxes	152	149	-3
Trading Across Borders	114	98	-16
Enforcing Contracts	98	98	0
Closing a Business	132	130	-1

**1.3.2. Context for Firm Strategy and Rivalry** The new Real Plan was introduced in 1993 to accelerate economic reform, through tight monetary and fiscal policies and a new currency, the Real (Ammand, 2003). On macroeconomic performance, however, Brazil experienced public sector deficit in recent years, above the 3% of GDP, and a Government debt accounting to more than 58% of GDP (The Economist Intelligence Unit, 2011). Brazil's has public deficits while having a higher tax rate on profits (69%) than other countries in the region (World Bank, 2011).

Graph 6



Graph 7



Source: The Economist Intelligence Unit, 2011

Source: World Bank, WDI Indicators, 2011

Brazil's unemployment levels are relatively low in comparison with developed countries. However, due to lack of regulation, there is huge informal labor. There has been a significant reduction in unemployment, from 12.3% in 2003 to 6.5% in 2010 (World Bank, 2011). An

upgrade of the labor force can be reflected by the rising of formal and qualified employment.

**1.3.3 Demand Conditions** Lately, the middle class has expanded significantly in Brazil, although the recent world financial crisis. Households' incomes increased by a rate of 4.7% from 2003 to 2009, larger than the growth in GDP and per capita income. The source of new incomes was employment (not safety net programs), resulting in 29 million people accessing the new middle class (Class C) that reached 94 million in 2009 (about half the total population), while classes A and B are also growing to reach 20 million Brazilians (Neri, 2010). This is a fundamental shift in the Brazilian consumer market.

**1.3.4. Related and Supporting Industries** The most important sectors are agriculture, mining, manufacturing and service. Brazilian exports are booming due to the large demand from China. Major export products include aircraft, electrical equipment, automobiles, ethanol, textiles, footwear, iron ore, steel, coffee, orange juice, soybeans and corned beef (Economist, 2010).

## 1.4 National Diamond



## 1.5 Strategic Challenges and Recommendations

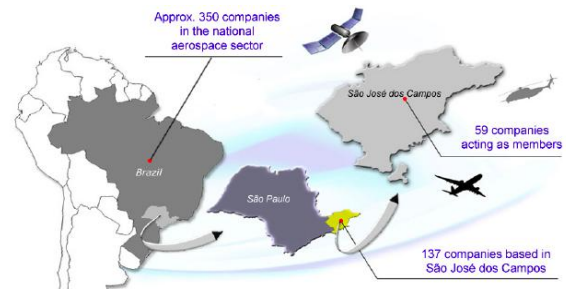
### National level

<b>Diamond Impact</b>	<b>Strategic Challenges</b>	<b>Recommendations</b>	<b>Constitutional Mandate</b>
<b>National Strategy</b>	Burdening Bureaucracy for Private R&D at Public Universities and Institutes	Simplify Agreement Term requirements for private R&D finance in key clusters' related areas at public Universities	MEC – Ministry of Education and State Governments
<b>National Strategy</b>	Credit to SMEs	Fine tune BNDES credit to also reach clusters' SMEs	Ministry of Finance and BNDES
<b>National Strategy</b>	Private Credit Availability	Fiscal Reform and better regulation of abusive 36% Credit Spread used in the MKT	Congress and Ministry of Finance
<b>National Strategy</b>	High Internal Debt	Fiscal, Budget and Social Security Reform	Congress
<b>Factor Conditions</b>	Inefficient Public Air-ports	Privatize air-ports to spark greater growth in internal demand	Ministry of Defense and Infraero (Air-transport Regulatory Agency)
<b>Factor Conditions</b>	Low Productivity - Education	Align Educational Curriculum with Market Demand at Secondary and Tertiary Levels	Ministry of Education and State Governments
<b>Factor Conditions</b>	Low Productivity – Cost of Infrastructure	Foster Public-Private partnerships to enable investments	Ministry of Planning, State and Municipal Governments
<b>Factor Conditions</b>	Shortage of skilled labor Supply	Living conditions Quality of education	Ministry of Labour Ministry of Education
<b>Factor Conditions</b>	Bureaucracy to do Business	Government capacity building and E-government	Congress, State and City governments
<b>Related and Supporting Industries</b>	Technological Dependency	Decrease Taxes and Tariffs for technologically dense industries	Ministry of Finance
<b>State Level - Related and Supporting Industries</b>	Nascent Technologically Dense Clusters	Use FIESP's network to foment IFCs related to the State's Cluster	FIESP and State Government of São Paulo
<b>State Level – Factor Conditions</b>	Public Safety	Use São Paulo's Experience on Public Safety as a model for the country	State Governments with Support of Ministry of Justice

## 2. Cluster Analysis

### 2.1 BRASIL (Sao Paulo): Location, Economy, Performance

The state of Sao Paulo has a population of 40 million, distributed in 645 municipalities. It exhibits Brazil's highest concentration of skilled workforce, infrastructure, industrial complex development and economic output. The city of



Sources: Brazilian Aerospace Cluster. Design: Eduardo

Sao Paulo (capital) hosts the largest Stock Exchange in Latin America and the majority of banking transactions in Brazil. In 2008, Sao Paulo concentrated 33% of Brazil's GDP and 41% of the national industrial production (Government of the State of Sao Paulo, 2011). According to the 2010 Census, 95.9% of the population in Sao Paulo lives in urban areas, with high levels of basic services (electricity and sanitation; IBGE, 2011).

Both the State of Sao Paulo and the cluster's basis, the town of Sao José dos Campos, have better SES indicators than the rest of the country. In Sao José dos Campos, the comparatively higher industrial productivity concentrated in that area has improved income per capita and lowered levels of poverty and inequality compared to both country and state levels, as

**Table X** shows. The Vale do Paraíba region (composed

**Table 3. Socio Economic Indicators in Sao Paulo and Sao Jose dos Campos**

of the towns of Caraguatatuba, Cruzeiro, Guaratinguetá, Taubaté and São José dos Campos) has come to be known as “Technology Valley” because it has the highest concentration of high-tech firms in Brazil, and because by the beginning of this century it was responsible for

Indicators 2008	Sao Paulo	São José dos Campos
Population (million)	41.2	0.63
GDP per capita(Reales)	24,457	34,007
Industry (% of GDP)	18.7	44.4
Gini	0.45	0.41
Poverty (%)	26.6	13.2

Source: Brazilian Institute of Geography and Statistics (IBGE), Censo Demográfico 2010 e Pesquisa de Orçamentos Familiares - POF 2002/2003

3% of Brazilian GDP and 15% of exports (Cassiolato, 2002; Goldstein, 2002)

About 56% of the labor force in Sao Paulo has completed secondary education (compared to 43% in Brazil), while hosting the largest proportion of universities and the best research and educational institutions in Brazil (Government of the State of Sao Paulo, 2011).

## 2.2 The Global Context for Competition

**2.2.1 Overview of the regional jet market** In the last decade the regional jets market has been a duopoly between Embraer and the Canadian company Bombardier, mirroring the Boeing-Airbus duopoly in the large jets market. Both sets of duopolies are threatened to be broken in the years ahead, as Bombardier enters the single aisle market, and new entrants from the other BRIC countries (Russia, India and China) alongside Japan, seek to take advantage of the envisioned growth in demand for commercial aircraft in emerging markets over the next twenty years (Bédier et al, 2008):

- **Japan:** the Mitsubishi Regional Jet, powered by Pratt and Whitney's Turbofan, backed by the Japanese government and a consortium of blue-chip Japanese companies is on the making to be introduced by 2013.
- **China:** as well as Embraer's own ERJ and EMB final assembly site in Harbin, China has established two companies to compete in the regional jet and larger single-aisle markets. The state-backed COMAC aims to produce a 150-seat single aisle plane by 2020. AVIC meanwhile has already introduced its ARJ 100 seat regional jets built with substantial Western components to directly compete with Embraer from 2013/14.
- **Russia** – the country's Government-majority owned UAC is set to introduce the Sukhoi Superjet imminently. Primarily aimed at domestic customers, the SSJ will compete directly with the E-170-190 family based on cost.

In its turn, **Bombardier intends to launch its C-Series**, pitching itself into the large single aisle segment from 2014 onwards. Embraer has not yet made a commitment to following suit, and it is unclear what plans it has to replace the E-170-E-190 family.

**2.2 Clusters' Characteristics Assessment** Bédier et al (2008) identified key factors of success for emerging markets to be able to develop and sustain an indigenous aircraft manufacturing industry: it has to be a key national priority, structured around a single lead firm capable of developing economies of scale with access to capital while supported by local demand (through public procurement) for a product with aimed at global appeal. Takahashi (2006), for example, argued that Japan failed to advance because its efforts were split between a consortium of companies (Mitsubishi, Kawasaki and Fuji) while government support functions were divided between MITI and the Department of Transport. The strategy of the Brazilian government by contrast led by the Aeronautics Ministry was to allow the leading company to achieve the economies of scale and financial buttressing necessary to become globally competitive and technologically advanced.

## **2.3 Aeronautics Cluster History**

**2.3.1 Birth of the cluster** Brazil was no latecomer to aviation as the local pioneer/aviator Alberto Santos Dumont is credited with the first public demonstration of an autonomous flight in Paris, 1906. The roots of the modern Brazilian effort to create an indigenous aircraft industry can be traced back to the 1930s and 40s, when at its height, one plane a week was being produced for the Allies by one of four Brazilian manufacturers (Marques, 2004).

The post-war Brazilian government stepped in to ensure the survival of Brazilian aeronautics. The military objective was to achieve an independent capacity in a strategically important technology. The economic objective was to use aeronautics as a beachhead for



industrial modernization across manufacturing. A key milestone in the development of the cluster was the foundation in 1953 of the Aeronautics Technical Center, the CTA (*Centro Técnico de Aeronáutica*, later *Comando-Geral de Tecnologia Aeroespacial*). CTA initially consisted of two units – the engineering school *Instituto Tecnológico de Aeronáutica* (ITA) established in 1947 and the IPD (Institute of Research and Development) set up in 1953. The IPD employed most of the engineers trained at ITA. Sao José dos Campos was chosen because of its location on the banks of the old Rio-São Paulo road between the two main centers of economic activity in Latin America (São Paulo and Rio de Janeiro), a topography and climate favorable to aviation, easy access to energy, its distance from urban centers, proximity to the Port of São Sebastião, access to the related industries, and the IPT (*Institute of Technological Research*), in São Paulo city (Rodrigues, 2008).

**2.3.2 Embraer (Cluster Anchor) and the role of government** Embraer, however, was not the first Brazilian company to succeed in serially manufacturing Brazilian-aircraft. Neiva, launched

in 1954, produced six different models of light aircraft, becoming a supplier to Embraer in 1975, and eventually being swallowed by its biggest customer in 1980. Aerotec was a spin-off from CTA started in 1962 that built the relatively successful 2-seater *Uirapuru* and the less celebrated *Tangara*, that

**Timeline of the evolution of the cluster 1946 -2000**

- 1946 – OCATC (Organizational Commission of the Aeronautics Technical Centre) of the Aeronautics Ministry, established
  - 1950 – ITA (Aeronautic Technological Institute) transferred from Rio de Janeiro to São José dos Campos.
  - 1953 - CTA formally established
  - 1954 – The Institute of Research and Development (IPD) is set up
  - 1954 - Convertplano project set up.
  - 1969 – Embraer set up.
  - 1970 – Embraer starts manufacturing activities.
  - 1971 – The Ipanema and Xavante are launched.
  - 1973 - The Bandeirante is launched.
  - 1974 – Cooperative agreement with the US PIPER Aircraft Company is signed.
  - 1978 –Xingu and Tucano aircrafts are launched.
  - 1980 – Development of the AMX program begins.
  - 1981 – The Brasilia aircraft project is re-launched.
  - 1989 – Development of the12-X project (Brazil-Argentina’s Cooperative Agreement) begins.
  - 1989 – Studies for the development for ERJ-145, (first jet produced by Embraer) begin.
  - 1994 – Embraer is privatized
  - 1997 - Development of a new regional jet, the ERJ-135 for 37 passengers, begins.
  - 1998 – Development of a new regional jet, the ERJ-140 for 40 passengers, begins.
  - 1999:- Development of a new family of regional jets, the ERJ-170/190, begins.
  - 2000 – Trade dispute with Bombardier
- Source: Cassiolato (2002)

apart from a few exported to Bolivia, never received an order. The company later became a

manufacturer for Embraer, which in 1987 acquired it. The eventual creation of Embraer was linked with a change in the demand conditions for air travel. A trend towards a reduction in the number of cities served by airlines had become evident: 120 cities in Brazil by 1960, down from 360 at its height during the previous decade (Source). The main reason was that aircraft were becoming bigger and now required tarmac to land safely.

**Embraer – Empresa Brasileira de Aeronáutica S.A.** – was created by decree of the then ruling military dictatorship on August 19<sup>th</sup> 1969 to take advantage of the commercial opportunities represented by the Bandeirante airplane designed at CTA which had made its maiden flight the previous year. About 150 engineers were recruited from the IPD with the blue-collar workforce coming mainly from the car industry (Vertesy and Szirmai, 2010).

The creation of a state-owned enterprise as a national champion in a key sector was a strategy that had been followed in other areas e.g. Petrobras in oil (Cassiolato, 2002). The Government provided launch support by ordering 80 Bandeirante and, was to buy a third of all those produced before 1980 (Goldstein, 2002). The skilled labor created through ITA and the R&D developed at IPD were effectively commercialized through Embraer, which had its first three aircraft models designed and developed at IPD. Finally, gaps in knowledge in the local supply chain were overcome through access to foreign designers (e.g. long-term Embraer collaborator Joseph Kovacs), foreign universities (MIT) and subsequently through partnerships with foreign firms (Piper, Aermacchi, Northrop, etc).

The Government used protectionist policies to support the Brazilian industry, with a 50% tariff on commuter-type aircraft and “law of similar” which prevented the public sector from purchasing any aircraft when a locally equivalent was available for less than 15% above the import price. Military offset policies – whereby any procurement above a \$1 million –

necessitated a transfer of production by the contractor to Brazil have also played an important part in the development of the cluster. The 1981 agreement with Aeritalia and Aermacchi to co-design and produce the AMX fighter was essential for the cluster in terms of expertise development on project management, systems integration, manufacturing, middle size jet's pressurization and design (Miranda, 2003; Goldstein, 2002). Another major source of Government support was the PDTI (Industrial Technology Development Program) system of tax breaks for private investment in R&D. Embraer paid no production or trade taxes, and any Brazilian company investing in its non-voting shares was entitled to a 1% corporate tax rebate.

**2.3.3 Privatization of Embraer** The early 1990s brought on a strong crisis in the history of Brazilian aeronautics. While the global recession, together with the end of the Cold War caused value added for the aerospace industry worldwide to decline by 30%, in Brazil the industry experienced a fall of 70%. Exports plummeted by 80% compared to their 1990 figure, and no new models were introduced in this period. The primary reason was the collapse in financing. Embraer incurred a loss of \$310m in 1994 on sales of just \$177m. The strategic response was to sell the company to a consortium of Brazilian and Foreign investors. This led to an injection of private capital that made it easier to engage in risk-sharing arrangements with foreign component suppliers, reducing Embraer's own R&D costs from 30% of revenue to an average of 5% (Vertesy and Szirmai, 2010b). A secondary effect of the privatization, and the entrepreneurial culture it unleashed, was the creation of spinouts by former Embraer employees that comprise part of the aeronautics cluster.

**2.3.4 Drivers of Brazilian Aeronautics Cluster Development** Brazil was the only developing and tropical country in the 20<sup>th</sup> century to have successfully developed an indigenous aircraft industry. Among the failed attempts there are India, South Korea, Indonesia, Turkey and,

Argentina. In regards to Brazil's neighbor below there are some similarities and key diversions:

**Table 4**

	Founded	Imported Engineering	French Designer of 1 <sup>s</sup> in house project	Privatization	Demand Conditions MKT Scale	Credit Support	Risk Sharing Partners Strategy
Embraer	1969	German + American Eng.	Yes	1994	Yes	Yes	Yes
FMA	1929	German Engineers	Yes	1995	No	No	No

The over-riding reasons that allowed for privatization to spark Embraer's development were **(1) Demand Conditions** which nurtured the company and cluster to develop expertise on its regional jets, its historical opportunity in the international market, due to the characteristics of the Brazilian Air-transportation market and the country's size; **(2) Specific Credit Programs** from Banco do Brasil, the National Treasure and fundamentally, BNDES' Proex-Equalization which incurred the cost of Brazilian Credit Spread compared to competitor countries on Government to allow financing competitiveness for Embraer (USD 1.5 million for each USD 17 million Air-plane; Miranda, 2003) in the international market even becoming a matter of contestation by Bombardier in the WTO and, **(3) the Risk Sharing Foreign Partners Strategy** which has been granting access to more competitive sources of credit outside Brasil and most importantly escalated the rate of the company's technological updating by engaging Embraer with many of the former or current suppliers of its competitors. Political and Economic stability in the last 19 years also played a key role in Brazil as well as military procurement for the now internationally successful Super-tucano, but the **(4) key choice to endeavor on the regional jet market while controlling the design and decision making** of the value chain of air-craft making were the key factors that allowed for Embraer to exponentially gain market share from Bombardier in the last decade and to control its network of high-tech suppliers.



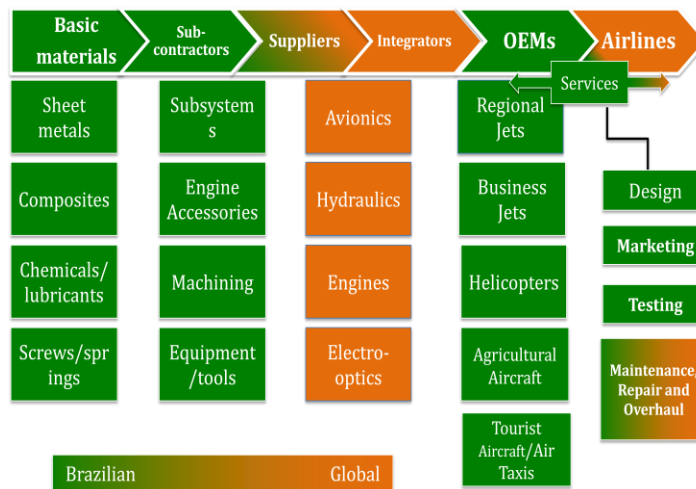
US Commerce Department 2010

together employ around 23,000 workers. Of these just five are involved in the final production of aircraft, the biggest of which, Embraer, the cluster anchor, is responsible for 90% of sector revenues in total, and around 80% of total employment. champion, is

## 2.4. Description and mapping of the cluster

While as many as 350 Brazilian companies play some role in aeronautics production and services, the core of the cluster is represented by some 50 final manufacturers and first-tier supplier companies which

Figure 2: Value Chain of the Cluster



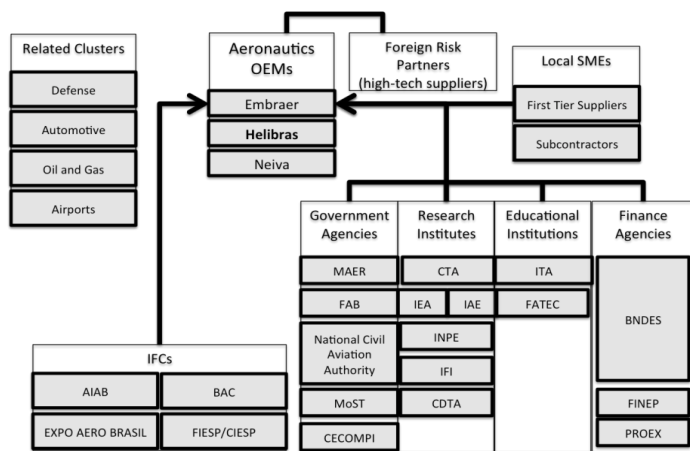
Most of the cluster companies (e.g. Cemic, Akros, Elebra, Eleb, ETA, Mectron, Neuron-Eletrônica, Fibra Forte, Aeroserv, Qualitas, N&N, Tectlecom and Alltec) are spin-out companies founded by former employees of Embraer (usually ITA graduates) with about 30 located close to the company in Sao Jose dos Campos or the Paraíba Valley, but some based in other parts of Sao Paulo State or in other Brazilian regions e.g. GE/Celma (Petrópolis – RJ), Aeronaut and Aeroeletrônica (Porto Alegre – Rio Grande do Sul) and Rolls Royce (São Bernardo do Campo-SP; Goldstein, 2002). Other key companies include Aeromot, a maintenance, repair and overhaul (MRO) provider for regional jets and Helibras, the only helicopter manufacturer in Latin America. There are also a number of Embraer subsidiaries: Neiva, a manufacturer of light aircraft and ELEB, a global exporter of landing gear, hydraulics and electro-mechanical

equipment. Another 100 lower tier suppliers are based in Sao Jose dos Campos and the surrounding Paraiba Valley. Overall, the local supply chain is fragmented and consists of a mixture of expertise provided by high-technology firms like design houses and consultancies and relatively undifferentiated second and third tier suppliers that provide basic milling, chemical treatment, coating and other low-tech services. The “missing middle” (see Figure X) of first tier suppliers of sophisticated systems tend to be globally located: 98% of Embraer’s first-tier supplier are located abroad and less than a fifth of the cluster’s leading firms are part or wholly foreign owned, e.g. Aeronnova of Spain and Latecoere of France.

The main umbrella public body involved in the cluster is the CTA, the military/civilian Aeronautics Technological Center managed as part of the Aeronautics Ministry, which is itself a division of the Ministry of Defense. CTA today provides technical support services to the industry and has also given rise to a large number of specialist institutions, which collectively employ thousands of technical experts in Sao Jose dos Campos. These include: the Institute of Advanced Studies (IEA – responsible for basic research), Institute of Aeronautics and Space (focused on research and development), Aeronautic Technology Institute (ITA – an educational institute which has to date trained some 5,000 aeronautical engineers, including most of Embraer’s CEOs; and, the Industrial Foment Institute (IFI – which plays a major role in providing consultancy and encouraging industry networking).

The National Institute for Space Research (INPE) is also located in San Jose Dos Campos? and has provided post-graduate training for some 1000 researchers and engineers since it was established in 1968 (Miranda, 2003). On a smaller scale other local training provision includes a local branch of SENAI (National Industrial Learning Service) which trains young apprentices in the aeronautics industry, and courses in aeronautics engineering offered by the Mechanical

Engineering School of University of São Paulo - São Carlos (USP), the University Vale do Paraíba (UNIVAP), the Federal University of Minas Gerais and the Escola Politécnica. Embraer's success would not have been possible without key support from publicly owned financial institutions: BNDES (the Brazilian development bank), and FINEP (Finance Fund for Studies and Projects, part of the Ministry of Science and Technology), for example, were responsible for 22% of the funding for the ERJ-135-145 family of jets and 100% of the AL-X light aircraft jet fighter (Goldstein, 2002).



**Figure 3: Cluster Map**

The export promotion program, Proex-Equalization, managed by the Government controlled Banco do Brasil, provides low interest loans to exporters, a practice which the Canadian Government challenged in 2000 in the biggest dispute in the cluster has had in the WTO but which continues as a result of the agreement negotiated at the time. Proex is essentially an interest rate equalization program, providing a rebate of up to 3.5% on loans to purchasers of Brazilian exported aircraft because of the so-called *Custo Brasil*, the putative higher due to the credit spread. Regionally, SP state FAPESP (R&D Foundation) is a key R&D funder for SMEs.

## 2.5 Cluster performance

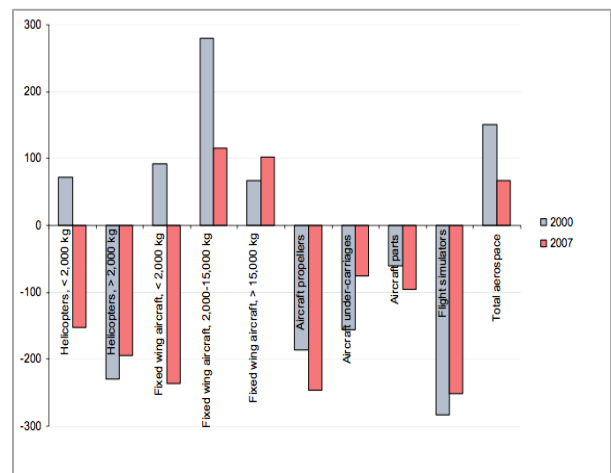
### 2.5.1 Comparative advantage



Embraer's recent performance has been phenomenal. Embraer overtook its rival in the regional jets duopoly, Bombardier, to become world leader with its two families the ERJ 135-140-145 (<50 seats) and ERJ (EMB)-170-175-190-195 (<120 seats), and is now third in the executive jets market having only entered the segment in 2005.

Today the Brazilian aeronautics industry is the largest in the southern hemisphere and the fifth largest by volume in the world, being during the last decade one of the fastest growing exporters. Trade surplus has grown from EUR 300 million in 1998 to EUR 2,4 billion in 2007. Yet, as figure x shows, it is only in regional aircraft and in business jets that Brazil has a relative comparative advantage. Moreover its relative comparative advantage overall has decreased over the period 2000 to 2007 (Ecorys, 2009).

**Figure 4: Brazil's Relative Comparative Advantage**



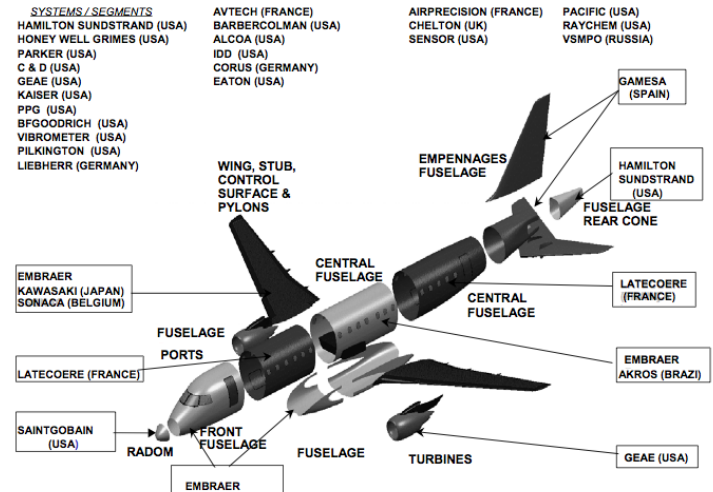
The cluster is rebounding from a tough challenge, a decrease in sector productivity as due in great part to the devaluation of local currency during the first half of the last decade. The period between 2002 and 2007 saw employment increase by 110%, total wages increase by 60% while value-added decreased by 50%. Sales per employee in Embraer, for example, was \$30,000 in 1999/2000 but fell to \$12,000 by 2009, even after a 30% cut in the workforce to reflect the effect of the economic crisis. Perversely employment among the SME sector began to rise in 2003 when sales started to shrink, and remained high despite a 60% fall in sales in the three years leading up to 2007 (Vertesy and Szirmai, 2010a).

## 2.5.2 Key Competitiveness Issues

Part of the explanation for the dramatic drop in productivity in this period also lies in the rigidity of the local labor laws. It reflects the changing structural composition of the cluster, and the dangers which flow from the over-reliance on an anchor firm. The success of the ERJ-135-145 family strengthened the local supply chain as new businesses were spun out of Embraer: 111 in 2002 up from 76 in 1996. Between 2002 and 2005 value added shrunk by 50% and gross output by 20%. This was the period in which the production focus began to shift from the ERJ134-145 to the new E-170-E-190 family. These larger jets' development costs were estimated at \$300 million, three times as high, as the smaller version –while the public budget for aeronautics research was just \$8 million. Embraer's solution was to rely on foreign risk partners to share the development costs, and, in order to better coordinate its logistics, slashed its supplier base from 350 to 38 (Aerostrategy, 2009).

Embraer has thus increasingly concentrated on its role in project design, and in production and final assembly rather than component technology *per se*. The consequence of this “horizontalization” strategy was a downfall in the local content of the final aircraft – to just 10%, compared to some 30% in the 1970s. Embraer, encouraged by the Brazilian government, made it a stipulation that its foreign suppliers sourced at least some of their production within Brazil. The Program for Expansion of the Brazilian Aerospace Industry (PEIAB), set up by Embraer itself to increase the level of local content to 50 per cent of value added has been inefficient. The level of

Figure 5: Embraer and its ERJ-145 risk

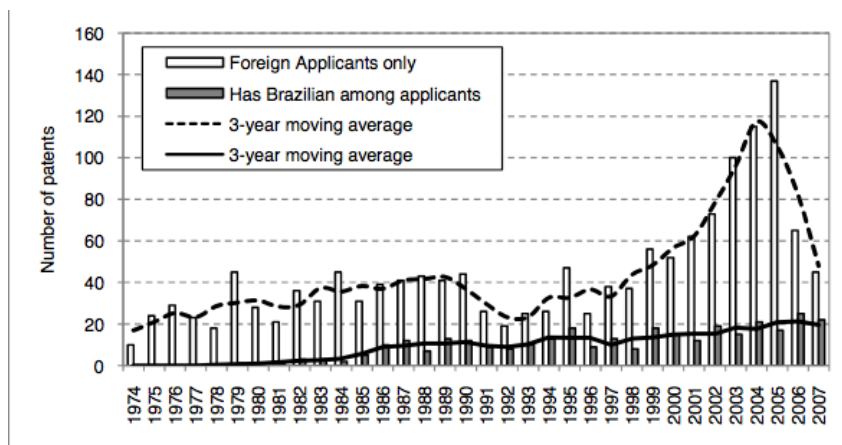


value added overall in the Brazilian aeronautics industry overall fell by a third to \$2 billion between 2003 and 2007 (Vertesy and Szmirnai, 2010b).

The challenge of the cluster is thus a challenge for its SMEs. The lack of sufficient credit lines and venture capital in particular make it difficult for local SMEs to become competitive at the same scale as global risk sharing partners. Brazilian SMEs are also not well integrated into international supply chains partly because of their distance from the major industrial centers. Yet policies to date have tended to be aimed at securing the success of Embraer rather than the

cluster as a whole (Goldstein,

**Figure 6:**  
**Patent applications within the aerospace sector, Brazil**



Source: Vertesy and Szirmnai (2010b)

2002). Foreign companies are also weakly represented in Brazil compared to the Canadian cluster, limiting the internationalization of the cluster.

The hollowing out of the

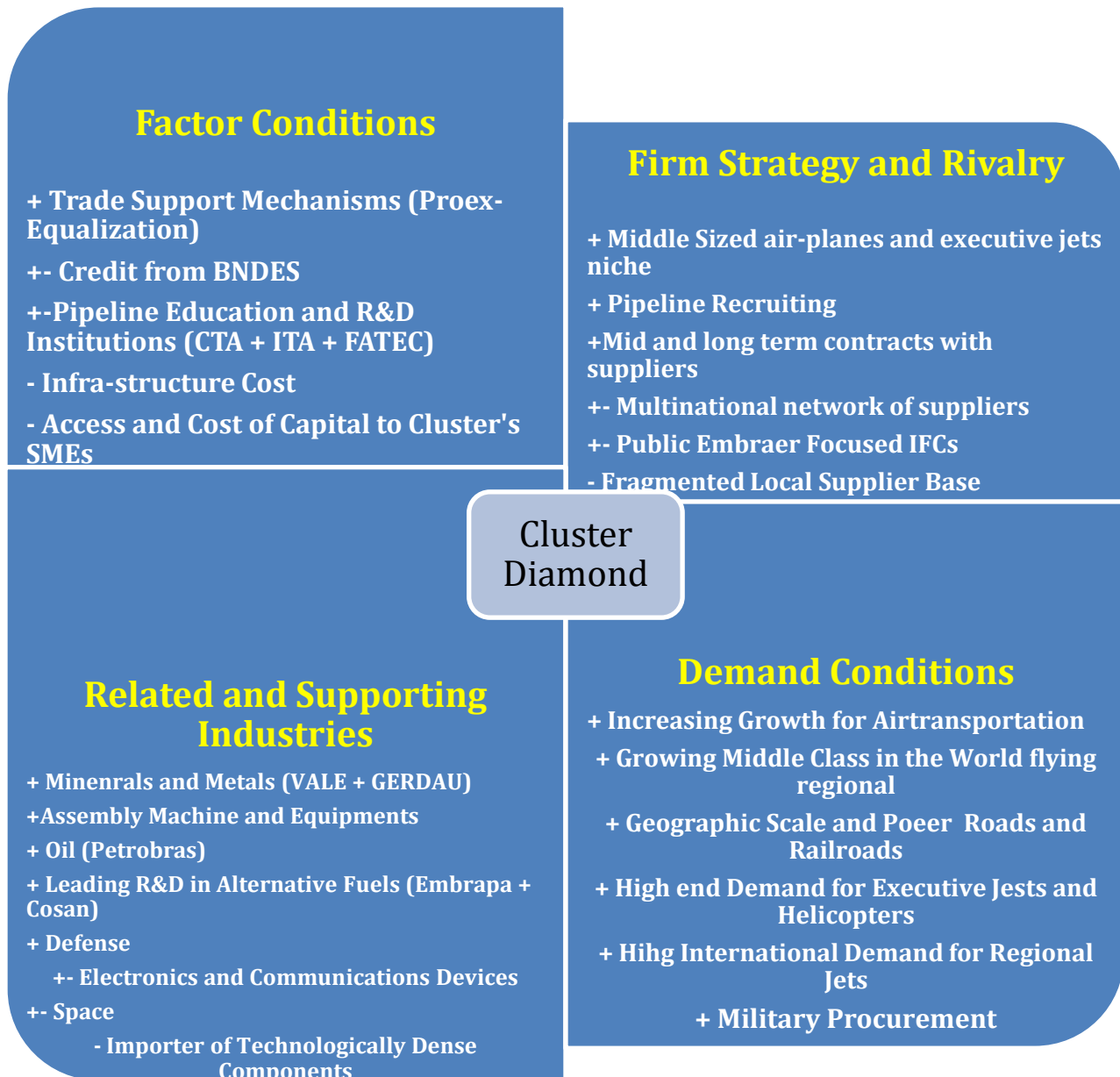
local R&D infrastructure is also

a worry as demonstrated by the low level of indigenous patents above. From its pioneering work in the 1960s, IPD did not carry out any significant research for two decades (Cassiolato, 2002).

Embraer is increasingly looking to foreign firms and institutions for technology updating. The links between the cluster and educational institutions have also become weaker as Embraer has begun to develop what amounts to an in-house corporate university because of its frustration with the quality and quantity of engineers being produced by the higher education system (except from ITA). Concern about the education system is much broader than worries about the

availability of graduate-level engineers. Embraer, for example, only achieved a fully literate workforce by 1997 when 150 of its employees passed the Brazilian secondary school certificate after a program of adult education (Goldstein, 2002).

## 2.6 Cluster Diamond



## 2.7 Recommendations

I. The primary challenge for the cluster is to increase the participation of local SMEs in the

overall value of the final product. In this context Embraer must lead the effort as an intermediary between SMEs and the development bank BNDES. The many lines of credit allocated to Embraer are all focused at making the exportation of its products competitive in the international market (e.g, Proex) or to enable it to engage in the capital intensive high-risk investment represented by air-plane design and development. This has paid important dividends for the sector but BNDES must now amend its domestic credit lines to attune them to the task of financially empowering local suppliers.

II. Promoting the development of the other OEMs within the cluster such as HELIBRAS is essential since supplier SMEs will then be able to diversify their customer base while also enlarging their access to related technologies.

III. The Maintenance Repair and Overhaul segment within the cluster has been growing – and contains a number of foreign owned companies. Making Brazil the MRO hub for the Americas on Regional and Executive Jets should become an explicit policy goal.

IV. In order to improve R&D within the local SME sector, specific efforts are needed to improve SME/university/public R&D institution linkages.

V. In order to improve the technological upgrading of the SME sector, and make them internationally competitive, IFCs, Embraer and BNDES must provide financial support and general encouragement for mergers within the SME sector among firms with strong overlapping. This should enable a greater proportion of SMEs to graduate to direct supplier status as systems integrators and manufacturers of technologically dense components to Embraer.

VI. Public authorities (through credit and deregulation) and the IFCS should support a two-way internationalization strategy: SMEs should be encouraged to internationalize: attending trade fair abroad, opening foreign sales and service operations, and also acquiring foreign companies.

In the opposite direction specific efforts should be devoted to attracting more foreign first tier suppliers into the cluster towards increasing the intensity of technology updating e.g. Mitsubishi.

VII. A unified strategy needs to be created involving all the stakeholders in the cluster: Embraer and SMEs, national and regional government, universities and public research institutions.

VIII. Finally though 90% of the sector's output is exported, local demand conditions must not be neglected. To this end investment in upgrading the airport infrastructure which is poor by international standards– through privatization – should be prioritized in the run-up to the Olympics and the World Cup in order to drive local demand for aviation.

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