

# **Project Report**

# Brazil: An economy in transition

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#### **Executive Summary**

Brazil is a very unique country in a number of different ways. They are an emerging economic power with a focus on technology and are pioneering the way in several technological areas. According to the World Economic Forum, Brazil is one of the most improved countries in terms of economic competitiveness in 2009, but is still an efficiency driven economy instead of an innovation driven economy. [1] This paper focuses on how the legislative branch of the Brazilian government can use technology management through specific technological policies to help the country transition from a Stage 2 (efficiency driven) to a stage 3 (innovation driven) economy. Or, in other words, raise the level of GDP per capita and increase non-mineral exports.

Our paper looks at legislative polices that have shaped specific areas of the Brazilian economy. Our five part investigation begins with the Portuguese rule of the country; evaluates the importance of technology transfer, Institutional Act, and the "Plano Real". Next we investigate the ethanol industry, looking at the Proalcool program, ethanol vehicles, EMBRAPA, and efficiency. Our third area of investigation, Aviation, investigates the government founded Aerospace Technical Center, and the Institute of Aeronautical Technology. We looked at how the government financed, marketed, and provided regulation for the support of the aviation industry. Our fourth area of investigation, investigation, investment, evaluates economic policy towards reformation, education, imports, and exports. The final section, comparative analysis, evaluates the food vs. fuel debate, China's vs. Brazil's aviation, and Korea vs. Brazil's patterns in education, technological acquisition, and outcomes of the national economic efforts.

We will investigate some of the policies implemented by the Brazilian government in order to better understand how technology management in the government impacts economic growth. We will investigate how technology management can drive efficiency, lowers costs, increase foreign investment, and drive innovation. [2] This transition to increased innovation will be the deciding factor in the continued growth of the economy in Brazil.

#### Introduction

As we look into technology management, it is important to define what we mean by technology management.

"Technological management is the management of innovation, whether it be a product, a process or an organization, from its conception to its diffusion, and therefore to its implementation within the company, including the consequences, advantages and disadvantages for all the variables and actors involved in running the company." [3]

In other words, technology management is set of management tools used to create value through increasing competitive advantage, generating new markets, improving efficiency, or reducing costs. Below is a graph showing the relationship regarding the Technological Management of R&D specifically.



Figure 1 - Technology Management [3]

As we can see, Technology is the foundation, Management is the implementation of the technology in the marketplace and R&D is the scientific optimization of the technology. All three are interconnected as shown in the figure above. Economists suggest that technology and innovation should be managed as scientifically as possible, since they claim to synthesize the specific concepts, tools, methods and processes of the both.

As a country improves its economic situation and become more competitive on a global scale, the country's priorities for development change as it passes through different stages of economic development. The stages of economic development as outlined in The Global Competitiveness Report published by the World Economic Forum are Factor-Driven, Investment-Driven (also known as an efficiency driven economy) and Innovation-Driven economies. [1]



Figure 2 - Economic Stages [1]

# Below are some of the major characteristics of each stage:

# Factor-driven economies

- Economies primarily compete on low prices and natural resources.
- Enterprises are mainly involved in primary production and occupy a small part of the value chain.
- The economy is particularly susceptible to fluctuations in the world economic cycle, commodity prices, and exchange rates.

# Investment-driven stage

- Companies produce standard products and services.
- Productivity is improved through increased investment in infrastructure and a business-friendly environment.
- Enterprises move up the value chain beyond basic manufacturing towards product design, distribution, and marketing.
- Financial crises and external, sector-specific demand shocks can still impact the economy

# Innovation-driven stage

- Economies produce unique goods and services for the global market, driving advances in technology and business methods.
- Service industries play an increasingly important role and contribute significantly to GDP.
- Economies at this stage of development are more resilient in a volatile global economy. [1]

#### History

To understand how Brazil's legislative branch may act as a catalyst in the countries transformation into a stage three economy, we must first understand the historical ramifications of government policies which have lead Brazil to where they are today. Brazil's economy has been driven by both external and internal governmental policies from its colonial period into the modern day.

Blessed by the king Manuel of Portugal, thirteen ships lead by Pedro Alvares Cabral, a Portugal navigator, discovered what is now the state of Bahia In April 23<sup>rd</sup> 1500. [4] [5] [6] Rather than subjugate the indigenous population of brazil politically, the Portugal government choose to create a network of trading posts. This network was the beginning of Brazil's colonial economy.

In the 1530's the policy of non subjugation was forced to change due to the incursion of the French and Spanish. To thwart their incursion, the Portuguese government established a semi feudal system, land grants, or captaincies. The Nobles who received these lands choose sugar as their principal crop. Sugar, a side affect of the new policy, drove Brazils export earnings for more than a century. In the 17<sup>th</sup> century sugar exports began to die down, but remained an important material resource into the twentieth century. [7]

Gold, the ultimate currency in Europe in the 17<sup>th</sup> security, was actively sought by the Portuguese to compete with the Spaniards luck of finding vast supplies of the rare metal. Once discovered, Brazil became the world's greatest gold producer, built upon the backs of slaves imported from Africa. These mineral riches went to Portugal, and then were used to rescue the kingdom from its deficit with England. Due to the flow of riches Portugal was able to ignore the economic transition into an industrialize world taking place in West Europe and England. The Portugal Crown mismanaged these new funds which lead to Portugal back into a significant amount of deficit. (pg30 refine) In 1755 Marquis de Pombal, the de facto prime minister of Portugal, took two major actions upon brazil to recover from this new deficit. First Pombal restructured Brazil's economic administrative structure, resulting in Brazils laws to be changed by judges "sympathetic to the mercantilist view of a colony's economic function." The second action was to create three monopolies to exploit exports. These actions helped Portugal prosper but caused Brazil to miss the industrial revolution.

While the enlightenment age began impacting Brazil in the 18<sup>th</sup> century, higher taxes were being imposed upon the colonists of Brazil, with the pressure to generate gold from "Worked-out mines" lead to the beginning of a social revolution in 1798. In 1822 Brazil proclaimed its independence. [5]

Sugar, Cocoa, Mate, Tobacco, Cotton, Coffee, Rubber, skins, and hides were the primary exports for Brazil in the eighteen hundreds. But from 1830 to 1930 it was the Coffee export boom which helped shape Brazil by facilitating modernization, urbanization, and

industrialization to fuel change. [6] As Gilberto Freyre stated "The Coffee boom represents the transition from the patriarchal to the industrial economy." The traditional "Patriarchal" or old republic of Brazil began to erode in 1889 and continued until the rebellion of 1930 which placed Getulio Vargas into power.

Getulio Vargas was Joano Pessoa running mate from the presidential campaign of 1929. When Pessoa was assassinated the opposition took up arms and led Vargas into power. Vargas dissolved congress, instituted an emergency regime, and assumed full policy making authority by a federal decree of power. During this political transition, the real GDP fell 4 percent in 1930 and fell another 5 percent in 1931. In 1937 Vargas lead a military Coup on the government he helped create, and Brazil became a full-fledged dictatorship.

During WWII the allies needed two assets which Brazil had an abundance of: minerals, and raw materials. Brazil government agreed to supply the needed materials. In return the United States gave military equipment, technical assistance, and financing for a Brazilian Steel Mill in Volta Redonda. [7] The world war greatly accelerated governmental centralization. Vargas had new power to ration essentials such as petroleum. The War also created a surge in inflationary demand. In Rio the cost of doubled from 1939 to 1945. When the war ended the emergency powers Vargas claimed would not be allowed by the Brazilian people. The anti-Vargistas doubted that he would ever surrender his power, but all Brazilians could see a contradiction, Brazil was fighting against a dictatorship, Germeny, but it had a dictatorial regime itself. In 1945 the army command served Bargas with an ultimatum, "Unless he resigned immediately, the army would besiege the palace, cutting off all water, power, and other supplies". Vegas resigned in the bloodless coup. Eurico Gaspar Dutra won the presidential election shortly after.

In 1945 Brazil had accumulated significant foreign exchange reserves from the war. After the war the government was hopping the economy would pick back up where it left off in 1930, by relying on the sales of primary products such as coffee. However, President Dutra's policy makers bought up foreign-owned public utilities and imported consumer goods which drained Brazil's foreign reserves. In addition the Government chose a policy to promote coffee sales vs. promoting industrialization. These policies stifled innovation. Then in 1950 Vargas returned from "Exile" and ran for president, receiving 48.7 percent of the vote he reclaimed his power.

In 1952 Vegas created the National Bank for Economic Development. Vargas with a joint US-Brazil commission on economic development produced an analysis of Brazil's primary economic needs. The government created state enterprises in oil and electricity. This Monopoly ultimately failed; instead Vargas opponents outflank him and established a total state monopoly. This Monopoly caused Vargas to loose control over the legislative process.

In 1953 World coffee prices began to decline shrinking Brazil's foreign exchange earnings resulting in a growing payment deficit. To stabilize this deficit Oswaldo Aranha, minister of finance, "precluded" economic growth for the rest of his term. Oswaldo also restricted credit and held down wages. In 1950 Vargas supporters saw him as dispensable. Vargas recognized that the military was looking for an opportunity for a coup, and unrest was developing. He gave a one hundred percent rage increase to the military, and labor. But employers saw this as a confirmation of the militaries suspensions of Vargas trying to create a radical populist strategy. In 1954 Vargas was impeached.

In the 1945's a long standing public health campaign against disease began to pay off. By the 1960's 6.28 children were being produced per mother. This resulted in a huge population growth. This new population moved from the rural cities into urban centers.

In the 1940's only 31% of Brazil's inhabitants resided in towns and cities. By 1991 75.5 % lived in cities. [7] Healthcare and school system were inadequate for this large population boom. Sao Paulo and Rio De Janeiro were the prime recipients of this new population.

In 1964 military units seized the government and created the "Institutional Act", which gave the military the power to do anything it wished. The military ruled Brazil for 21 years under a repressive control. In 1973 an oil shock occurred when market prices for oil drastically increased. Brazil covered this by increasing its international borrowing. In 1979 a second oil shock occurred but Brazil had more difficulties raising funds needed to cover this. As a result in 1981 the country was in an economic crisis. During this time the military was slowly easing planning their transition out of power, and in 1985 a Civilian rule was reestablished.

Shortly their after inflation became rampant, as shown within the Annual Rate of Inflation for 1986-1997, and in 1994 Brazil was the sole Latin American country that had failed to control its inflation. This failure was not due to economic issues or disease; rather it was due to Brazil poor Political leadership. [7]

In 1994 Itamar Franco addressed the issue of inflation by appointing Fernando Henrique Cardoso as the finance minister. Cardoso brought together a team to create a five part strategy to fight inflation. Cardoso began by eliminating the shock treatment, such as price or wage freezes. Next the team created a balanced budget which was passed by congress, and put into effect March 1994. The third action was to create the URV (Unit of Real Value), which was used to eliminate all of its pervious values. The forth action was to eliminated the Cruzeiro (existing currency) and introduce the new currency (the real) July 1<sup>st</sup> 1994. The final stage of Cardoso's approach was to implement an overvalued exchange rate and imposed a high real interest rate. The overvalued exchange rate was to fight inflation and create cheap imports. The high real interest rate was to prevent a consumer boom that occurred under the Cruzado plan.[7]

The plan brought stability and enabled Brazil to sustain economic growth over the global economy for the next decade. The Real serves as the year zero for economic policy, growth has picked up to a reasonable rate three times. [8] The Asian Financial Crisis in 1998, Argentina's bond default in 2001, and rapid rise in inflation in 2005. [8]

Year	Inflation Rate (%)
1986	65
1987	416
1988	1038
1989	1783
1990	1477
1991	480
1992	1158
1993	2489
1994	929
1995	22
1996	11
1997	4

Table 1 - Annual Rate of Inflation, 1986-97

Source: 1986-1992: Werner Baier, The Brazilian Economy, 4<sup>th</sup> ed. (Westport 1005), p 393. 1992-1997: Economic Commission for Latin America. [7]

In 2006 the real lost 11% of its value in a matter of a few weeks, at the same time exchange rates reduced government liabilities. This has driven foreign a strong interest in foreign direct investment into the country. As a result Brazil holds more dollars than it owes. [8] Brazil's headline real interest rate sits a just below 7%, this would tip most countries into recession, but is low by Brazilian standards. [8]

As Mentioned above during World War II the policy of technology transfer had a positive impact on Brazil's technological development. As a comparative analysis, Japan, an isolated country before and during World War II), had spectacular economic growth based upon borrowed technology after WWII. Japan embraced a scientific policy that gave rise to Japan's massive store of technology. [9]

Now, Brazil, one of the new growing economic powers, is known for many different industries including aircraft, software, fiber optics, electric appliances, automobile and ethanol production.

# **Ethanol Industry**

Brazil is the world's second largest producer of ethanol, with only the USA surpassing Brazil in ethanol production (see table 2). Developing a new industry can be a long process that often requires government interaction. The ethanol industry in Brazil is over 30 years old and the government has played a key role throughout.

Table 2 - 2008 world fuel ethanol production

Country	Millions of	
	Gallons	
USA	9000.0	
Brazil	6472.2	
European	733.6	
Union		
China	501.9	
Canada	237.7	
Other	128.4	
Thailand	89.8	
Colombia	79.29	
India	66.0	
Australia	26.4	
Total	17,335.2	
Source: RFA, F.C	D. Licht 2008 Estima	ites
http://www.etha	nolrfa.org/industry/	statistics/#E

In 1975, during the oil crisis, the government created the Brazilian Ethanol Program – PROÁLCOOL. This was an effort to reduce the country's dependence on oil imports, balance payment deficits and help balance the unstable sugar market by encouraging special ethanol distilleries next to the sugar mills which could be used when needed and turned off when not needed. [10] This would provide a beneficial product of the sugar even when there was an excess supply of raw sugar itself.

Not all were in favor of the PROÁLCOOL program in Brazil in the beginning. In 1981, a well known Brazilian environmentalist said the following in an interview with Herman Daily,

"In its current conception PROALCOOL threatens to extend this process of displacing people from the land and displacing food crops with more profitable, but less necessary, fuel crops. Of course, it all has a kind of diabolical logic to it and it is all so rigged with subsidies, fiscal privileges, and free credit that it is difficult for normal folk to see through it." [11]

Nevertheless, the government was set on supporting the PROÁLCOOL program and passed a law which mandated that a certain amount of ethanol, made from sugar cane, must be substituted for part of conventional gasoline. The program started out by requiring at least a 10-22% ethanol blend, and by 1993, all gasoline was required to be E22 which meant that it had to be 22% ethanol. More recently, in 2007, the government increased this percentage to 25% (E25). [12]

Besides the required percentage of ethanol in the gasoline used by cars and trucks, the Brazilian government also guaranteed that the state-owned oil company, Petrobas, would purchase the ethanol produced. In addition, the government provided lowinterest loans for agro- industrial ethanol firms, and fixed the ethanol prices at 59 cents on the dollar compared to gasoline. These incentives made ethanol production competitive and were major drivers of the ethanol industry in Brazil as a whole. [13]

The graph below shows a comparison between the production of gasoline and ethanol at the end of the 20<sup>th</sup> century. One can see an increasing ethanol production trend starting with the oil crisis in the 70's.



Figure 3 - Gasoline vs. Ethanol Production [10]

As is shown, PROALCOOL caused the production of ethanol (alcohol) to increase dramatically at the beginning of the program. As prices of gasoline began to drop in the late 1980's, ethanol production slowed. In 1989, Brazil actually had to import ethanol due to ethanol shortages and the government considered ending the program altogether until the Gulf War cemented the importance of energy independence through sugarcane based ethanol production. [10]

Through regulation and policy making, the Brazilian government was able to create a large demand for ethanol in Brazil, and in 1991, the large number of ethanol-only vehicles, created a demand which Brazil could not provide internally. [12] The Brazilian government began importing ethanol in 1991 and continued importing ethanol until 2001, but since then, ethanol production has grown faster than the country's demand for it.



Figure 4 - Ethanol Trade (www.distill.com)

Ethanol exports have continued to increase, making Brazil the current largest ethanol exporter in the world who exports over 90% of the total global export market. "According to industry sources, Brazil's ethanol exports reached 86,000 bbl/d in 2008, with 13,000 bbl/d going to the United States." [www.eia.doe.gov]

In addition to the direct driving forces instituted by the government for ethanol production through the PROALCOOL program, another key aspect for the development of the ethanol industry in Brazil was the investment in agricultural research and development by both the public and private sector. [12] One of the main ways the Brazilian government supports the bioethanol industry is through the Brazilian Enterprise for Research on Farming and Cattle Raising or EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária). EMBRAPA is a company owned by the government and associated closely with the Ministry of Agriculture. According to EMBRAPA's website, "The Brazilian Agricultural Research Corporation's mission is to provide feasible solutions for the sustainable development of Brazilian agribusiness through knowledge and technology generation and transfer." [14] As part of EMBRAPA's agro-energy plan for 2006-2011, ethanol production from sugarcane is a major focus. Some of the priorities include using biotechnology to develop sugarcane with larger energy content and more resilient strains of sugarcane, improving ethanol production processes, investigating agricultural zoning, developing techniques involving plant hormones in sugarcane production, and innovating new products and processes related to sugarcane biomass and alcohol chemistry. [14] In fact, there are public research programs devoted specifically to further genetic improvement of the sugarcane, and ongoing research

pertaining to sugarcane biological nitrogen fixation. Through EMBRAPA, the government has focused on creating collaboration and innovation for the ethanol industry. They help provide the structure, organization, direction, and encouragement necessary to grow the agro-energy industry and maintain its leadership position in ethanol production. Through investments into process improvement like this, Brazil's ethanol yield per land area has improved 3.77% on average each year since 1975, making Brazil have the most efficient agricultural technology for sugarcane to ethanol production in the world. [15]



Figure 5 - Ethanol Production Efficiency [15]

One debated topic, however, is whether ethanol is really environmentally friendly once you consider all the energy intensive manufacturing steps required to produce the ethanol from sugarcane. After raw sugarcane production, ethanol distillation and distribution of the alcohol, it can be argued that the ethanol is worse for the environment than oil. [11] In regards to the efficiency of ethanol, or energy balance, studies have been conducted regarding specifically the sugarcane ethanol production in Brazil, and these studies point to the ethanol fuel having a positive energy balance. One study, conducted by the state of Sao Paulo, showed that the energy balance can vary between 8.3-10.2 (1 energy unit into the process provides 8.3-10.2 energy units from the final product). [16] This information has been confirmed by others reports and seem to prove, that, at least in Brazil, they are making good use of their energy. Either way, it is important to note that the energy efficiency was not one of the main reasons for the government to promote ethanol production; it was, instead, to avoid dependence on foreign oil, and help stabilize the turbulent sugar market. [10] One consistent theme throughout the reports, however, is that Brazilian sugarcane ethanol is the most favorable biofuel in the world in terms of cost, energy balance, and greenhouse gas balance.



As mentioned previously, the government created laws requiring certain minimum percentages of ethanol in all gasoline fuel sold. This policy is tied in closely with the advent of the flexible fuel automobile industry. The first car to run on pure ethanol was introduced in Brazil in 1979, the Fiat 147. [18] It wasn't until March of 2003, with the help of government subsidies, that the first flexible fuel car was introduced into the Brazilian market – the Gol 1.6 Total Flex. These cars which can run off some or all ethanol (thus the term "flexible fuel") really enabled the ethanol industry in Brazil. Now many car manufacturers make them, including General Motors, Fiat, Ford, Peugeot, Renault, Volkswagen. Honda, Mitsubishi, Toyota, Citröen and Nissan. In recent years there has been a growing trend in Brazil toward using flexible fuel cars. Currently, the vast majority of car sales are flexible fuel cars; in fact, in 2009, 94% of all car sales in Brazil were flexible fuel cars. [19]



A major reason for the success of flexible fuel cars in Brazil was the existence of a wide far-reaching infrastructure designed to support the flexible fuel vehicle industry. This infrastructure involves the bioethanol production as discussed in detail previously, but it also involves the distribution network required to get the ethanol to the public. By 2006, there were 33,000 filling stations in Brazil which had at least one ethanol pump. This infrastructure is a necessary and important aspect to the development of the ethanol industry, but creating a new infrastructure like this is not an easy task. The Brazilian government has been building the countries ethanol infrastructure since the PROALCOOL program in the 1970's, and the 33,000 filling stations are a representation of the money and time invested by the government in the focused development of this specific industry.

This infrastructure also made Brazil a prime candidate for a new program supported by the European Union - BioEthanol for Sustainable Transport (BEST). From the website for the program, comes the following definition:

"BEST (Bioethanol for Sustainable Transport) is a joint effort between ten strategically chosen sites in Europe and the rest of the world, as well as a number of important market participants, to stimulate an extensive substitution of petrol and diesel by bioethanol. It is supported by the European Union, and coordinated by the City of Stockholm, Sweden. [20]

Out of the ten cities involved in the BEST program, eight of the cities are in Europe. Nanyang, China and São Paulo, Brazil are the only cities outside of the EU to be involved with this program. The fact that Brazil was chosen as one of the cities for BEST, highlights Brazil's prominence in this industry and establishes São Paulo as a leader in bioethanol transportation systems. In fact, São Paulo, one of the largest cities in the world, was the first city to begin implementation of the BEST program.



Figure 8 - BEST Partners and Supporters [20]

Under BEST, São Paulo will test and evaluate a set of buses running on a special E95 hydrous alcohol fuel for one year. The objective of the BEST project is to analyze and demonstrate the fact that the use of ethanol in public transport has major air quality as well as environmental benefits. The E95 fuel as trialed in Sweden reduces carbon monoxide by 60% and particulate matter emissions by up to 90%. When made from highly efficient Brazilian bioethanol it reduces GHG emissions by around 90%. [20]





Figure 9 - Ethanol - Wheel to Well [20]

The fact that São Paulo was chosen as the first city to implement this program, is in part due to the already developed infrastructure developed by the Brazilian government. This recognition could not have hindered the country's ability to attract some of the largest and most coveted events in the world. With the 2014 world cup being hosted in São Paulo (and other cities in Brazil) and the 2016 summer Olympics being held in Rio de Janeiro, it is impossible to avoid the connection between the global push for renewable, sustainable, energy efficient technology and Brazil's recognized leadership in this area.

#### Aerospace Industry

One of the vital industries in Brazil is aerospace industry. The table below proves that Brazil can make a plenty of income from the aircraft industry. This paper presents the aircraft and airport section in the industry as the samples of government role to make Brazil across from Stage 2 to Stage 3.



Aircraft and associated equipment Exports (in billion dollar)

Figure 10 - Aircraft Exports (International Trade Center - UNCTAD/WTO)

The aircraft industry started getting attention from the Brazilian government since the Second World War (1935-1945). Brazil is an ally of the United States so that the United States trained Brazilian engineers to help in producing fighter aircrafts [21]. At that time the aircraft industry in Brazil still did not famous because of the shortage of technology and engineers to design and manufacture aircrafts. Therefore, the government established the Ministry of Aeronautics (MAER), which later became the Aeronautical Command (COMAER). Later, the Ministry of Aeronautics decided to create the Aerospace Technical Center (CTA) with the support of MIT and NASA to develop, expand and coordinate the economic and technical activities of the domestic aviation [21]. The government also established two institutions devoted to technical training Institute of Aeronautical Technology (ITA) and aerospace research Instituto de Pesquisas Espaciais (INPE)[22]. The main research project at the CTA was to design and produce a 19-seater aircraft. The Brazilian Ministry of Aeronautics contracted an entire research group from Germany to work with Brazilian engineers from ITA to develop this aircraft. The first prototype flew in 1959, but further improvements were necessary. In 1969, the project finished with the production of the first aircraft, the Bandeirante [21].

In 1960s, the government directed efforts toward science and technology. The group of public technicians and the support from the Ministry of Aeronautics led to found Embraer - Empresa Brasileira de Aeronautica S.A.- to be the first state-owned aircraft manufacturer in Sao Paulo, which is privatized in 1994 [23]. The original goal for the company is to produce aircrafts to support Brazilian Air Force with parts, components, and training and fighter aircraft [21]. As the production cost was so high, the

government designed to reduce the unit costs by expanding the scale of production [24]. This was the starting point for Brazil to be an aircraft exporter and research on this industry had been directed towards the sector's competitiveness.

Although the Ministry of Defense had heavily invested in the creation of a national aircraft supply chain, the majority of its aircraft systems, structural parts, components, and sub-systems are imported [21]. The company cooperated with foreign partners under an agreement whereby they had to provide the kits to assemble the final product in Brazil. As a result, the company increased market share at the expense of its competitors [22].

The government gave strong support to the company not only manipulated the domestic market to Embraer's advantage, but it also helped in finance, market, regulation to favor Embraer. The government financed through a State development bank (BNDES) which gave a chance for the company to provide customers with alternate financing, Fundo de Financiamento à Exportação – Export Finance Fund (FINEX). The company was exempted from duties on the import of inputs and did not pay trade (ICM) and production (IPI) taxes. Furthermore, all Brazilian companies buying non-voting shares in Embraer could obtain a 1% rebate on corporate income tax [22].

The graph below shows that the aircraft export of Brazil was gradually increased in the first part. It was declined in 1989 because the government forced Embraer to enter into unprofitable projects such as the CBA 123, a joint venture with Argentina's FAMA, which was great opportunity to improve manufacturing technology but not practical for commerce [24]. The worsening economic situation since 1990 and a loss of US\$310m on sales of US\$253m of Embraer the government decided to sell the company to private investors [22].



After privation, Embraer was lack of financial resources and market-driven technical solutions which preventing it from surviving from the crisis. Embraer implemented the new management, which injected a new corporate strategy to ensure alignment between the company's core competences and market signals. Embraer also believed that there was a transformation of the commuter airline industry from turboprops to jets [22]. The company's strategy had been to focus its R&D funds on key technologies that it could effectively produce in house. It had outsourced the production of components that other companies could manufacture more efficiently. The company invested in producing jets and came up with the most important products were the ERJ 145 and ERJ 170 jetliners. The ERJ145 jetliner has the basic platform of the 30-seater advanced turbo propeller aircraft but incorporates new technologies in avionics, propulsion, and aerodynamics, and was launched in 1995. The ERJ 170 jetliner was first "rolled-out" in November 2001, with the first flight in 2002 [21]. By the support from the government, new management of the company and foreign partners sustained the company to recover and come back to be an export market leader.

The government remained involved in Embraer's development and actively supported the company's transition to a producer of regional commercial aircraft for export. Embraer had a support from the program of the state of Sao Paulo which has the ultimate goal to turn the state to be Brazil's high –tech pole. The program, which was run under the Sao Paulo industrial federation (FIESP/CIESP), the national support program for micro- and small enterprises of Brazilian Enterprise Support Service, and the local business association, tried to improve the linkage between different private and public sectors. The government helped the company in both finance and research parts. The Ministry for Science and Technology continued support the company by providing a large fund and tax holidays. The CTA helped the company to do research in mechanical analysis, thermal tests, electro-magnetic compatibility tests and vacuum simulations. Moreover, the government tried to enhance partnership between business and the academic world by financing the company through FAPESP, Research Support Foundation of the State of Sao Paulo. Therefore, the company and ITA launched a number of projects together (table 3) [22].

	Partner	Total budget (US\$)	Embraer share (per cent)	Time frame
Development of a DGPS system for real time aircraft positioning	INPE	218,117	0	March 2002- August 2003
Advanced applications of computational fluid mechanics to high-performance aircraft	ΙΤΑ	1,255,000	8	January 2002- December 2004
Identification of aerospace stability and control derivatives	ПА	195,525	0	January 2002- June 2003
Development of aerodynamics testing technology for high-performance aircraft	ПА	948,479	0	June 2001- May 2004

#### Table 3-Embraer joint projects financed by FAPESP

Source: Fundação de Amparo a Pesquisa do Estado de São Paulo - Research Support Foundation of the State of São Paulo (FAPESP).

Foreign partners also played a major role in developing Embraer from the crisis. The company decided to sign a risk-sharing partner with United Technologies Sikorsky for the development and production of the fuel system, fuel tank and landing gear of the S-92 19-seat, twin-engine, turbine-powered civilian helicopter. This deal gave the company access to important technological advances in the field of new material and virtual design, using Computer Aided Three-Dimensional Interactive Application to reengineer aircraft. Embraer also created a joint venture with foreign partners with headquarters outside of Brazil; however, as Embraer kept expand, many of foreign partners set up the manufacturer in Brazil which reduced development costs and risk for Embraer [22]. The graph presents the Annual Evolution of Net Income of Embraer in US\$ million. This states that the company was correct to change the direction from producing turboprops to jets and could make a lot of profit from them.



#### Figure 12 - Net Income of Embraer in US\$ million (EMBRAER)

The Brazilian government gave strong supports not only to Embraer but also others small airplane companies by investing in educational and research facilities to develop production and technological capabilities to manufacture aircrafts [24]. After the companies were able to produce an aircraft, the Brazilian Foreign Relations certified their aircrafts to protect confliction with foreign companies. The government created the Regional Aviation to establish the market for the company's planes to export without the conflicts with foreign countries. Moreover, the government supported and financed the company's exports, so that it could operate with an efficient scale and competitive unit costs for example, the government financed through a State development bank (BNDES), Fundo de Financiadora de e Projetos –Finance Fund for Studies and Projects (FINEP), Programa de Desenvolvimiento Tecnológico Industrial – Industrial Technology Development Programmeand (PDTI) and tax exemption [22].

The aerospace sector registered a turnover of 7.55 US\$ billion in 2008. Aeronautics accounted for 89.13% of the sector, followed by Defense (8.79%) and Space (0.57%). More than 90% of production was exported, which represented 3% of the total Brazilian exports [25].

Table 4 – Aerospace Industry performance

	2005	2006	2007	2008
Annual Turnover (US\$ bi.)	4.3	4.3	6.2	7.55
Participation in industrial GNP (%)	1.5	1.5	1.9	2.02
Exports (US\$ bi.)	3.7	3.9	5.6	6.74

Source: Aerospace Industries Association of Brazil - AIAB

Another example of the government played an important role in economy. As we know from above section, the oil crisis emphasized Brazil to innovate alternative fuel which is ethanol. Brazilian government interested in using ethanol with not only cars but also aircraft. According to José, in 1970s the government gave funds to the Institute Command of Aerospace Technology (CTA) to do research with Professor Stumpf in alternative fuel. The project succeeded and was able to test with a Bandeirante aircraft of the Brazilian Air Force, in 1984. This initiated the research program for the use of ethanol with the alcohol-powered aircraft for Embraer [26].

According to the executive of Embraer, the company implemented the first ethanolpowered fixed-wing aircraft called Ipanema in 2004 with the help from CTA and Professor Stumpf. As ethanol has a neutral carbon emission balance and has no lead in its composition, therefore, the Ipanema aircraft is an environment friendly aircraft, less pollutant. Moreover, the Ipanema engine had 20% lower maintenance and operational costs. These advantages make the Ipanema popular in the country, having market share of about 80%, and the 1,000th delivery was completed on March 15, 2005 [27].

Due to the vast size of the country, the air transportation plays the important role in the country. The air transportation links inhabited areas with major economic centers and has influenced both domestic and international markets [25]. The civil airlines of Brazil are private owned of Vasp, practically all of the capital of which is held by the State and municipal governments of Sao Paulo. Airport construction in Brazil was given a strong impetus by military requirements in World War II. Many small airports operate in the country and are used by both military and commercial airplanes [28].

There were 70 million passengers flown in 2003 and about 110 million passengers flown in 2008. This represented a growth rate of approximately 60% in five years. The Brazilian government gives priority to improve the Brazilian air transport industry by developing the government policy and regulatory. Start from 1973 until present, the government introduces a regulation with Industrial policy which the government controls the fare price and the number of newcomers entry into the market [29]. The government also limits foreign investment in domestic airline companies to a maximum of 20 percent and private enterprises will not be able to purchase the airports outright [30].



#### Brazilian airports traffic 2003-2008 Annual passengers (millions)

righte 15 Drazman an ports traine (based on infracto data)

The civil air transport industry regulator (ANAC) began functioning in 2006 with a mandate to increase competition within Brazil's civil aviation industry. ANAC has begun to take steps to liberalize the Brazilian market for example; the United States and Brazil liberalized cargo and passenger services in June 2008 and committed to further liberalization discussions by 2010. Two countries agreed to increase the number of weekly cargo flights allowed from 24 to 35 in the year 2008 and to 42 in the year 2010, increase the number of cargo charter flights from 750 to 1000 in 2008 and to 1250 by 2010 and provide for a nearly 50 percent increase in passenger flights between the two countries and eliminate a number of restrictions on U.S.-Brazil air service [31]. Furthermore, the Brazilian government and the International Air Transport Association decided to cut the PIS/COFINS tax on jet fuel which collected US\$100 million annually to support Brazilian aviation and even more liberalized air fares to improve the competitiveness of Brazilian aviation as Brazil prepares to host the 2014 FIFA World Cup [32].

#### Investment

The transformation of the Brazil economy since the late 80s has been impressive in its intensity and shows little sign of slowing. Brazil has embarked on the path of progressive integration into the global economy starting with the economic reform and investment policy.

In regards to the economic policy reform the government has played a key role. By 1989, at the end of President Sarney's term, it was widely known within the political and economic elites that the past policies that associated with import substitution industrialization (ISI) were no longer sustainable. A strategic decision was made to break from the past inward-orientated legacy to seek out the more open, liberal and foreign investor friendly strategy. In 1990 with the first directly elected president, Fernando Collor de Melo, this strategic change has become an ambitious national economic reform in which the main elements are remained in place today, again credited much to the economic transformation. The keys features embarked the growing economic competitiveness included trade liberalization, privatization, and market deregulation. [33]

In regards to trade liberalization, President Collor's 4 year rolling program of trade reform has more than halved the average tariff from 32% to 14% from 1990 to 1994. Furthermore within this decade Brazil saw the significant abolition of the majority of non-tariff barriers (NTBs) in which the Brazilian industry has seek as a protective shelter. The disappearance has caused an enormous increase in the competitiveness pressure on Brazilian business.

The process of privatization has increased its pace substantially from Sarney's presidency to Collor's. By 1992 most of state owned steel and petrochemical sectors been transferred to the private sectors. As started by Collor's administration the ambitious program known as National State Divestment Programme, the privatization expanded further to other sectors like telecommunication and electrical energy, banking and mining with the help of the passage of constitutional amendments allowing the entry of private investors both foreign and domestic.

Collor's administration commitment to a far reaching market deregulation was intended to increase the competitiveness of domestic markets and to attract much needed foreign investment. Under President Cardoso in 1992 the pace of market deregulation has much increased. During his tenure President Cardoso has succeeded in securing the passage of legislation to open up the oil, gas, and mining sectors to both domestic and foreign private sectors investors. Legislation allowed for the entry of new market competitors to challenge the privatized incumbents. With well run special regulatory agencies in place, and whose functions were to ensure fair practice for all regardless of nationality, the barriers to foreign investment in almost all ranges of sectors including oil exploration and production, telecommunication, and electricity generation and distribution has become fraction of what they were at the beginning of the 1990s.

These were the primary elements within the economic platform that the Brazilian government has recognized as change factors in order to help its effort in growing with other global economies. Today Brazil is more deeply integrated with the global economy than ever before. The government policy favoring increase in foreign direct investment and internationalization has resulted in a steady growth in national income. Trade now accounts for 25 to 30 percent of Brazil's national income, up significantly from the 15 to 20 percent share of previous decades. [34] [35].

As discussed in earlier sections, the advancement in Brazil's mature industrial sectors, notably in alternative energy and aerospace industries, was a direct result of sound government economic policy started in the 1960s and 1970s. Its policy in increase investment in researches and agriculture products has played key role in the country's current growth in national income, through export of agriculture products to rapidly growing countries such as China and India, as well becoming more self reliant in the oil consuming by way of using alternative such as ethanol fueled energy. For Brazil to sustain the current growth and be able to catapult itself into one of leading economic power, the government would have to put in place a growth centric policy, putting investment in education, infrastructure and technology on a national scale that would create a sustainable and more wide-spread growth across all business sectors.

### *Comparative Examples* Food vs. Fuel

As mentioned earlier, not all were in favor of the government's investments into ethanol from biomass. Some of the arguments against the government's promotion of ethanol production include the idea that it could potentially cause the cost of food to go up (food vs. fuel). It is a fact that the poor spend a major portion of their income on food, while the middle and upper class spend a small portion on food and a higher portion on fuel. Because of this, an increase in the price of food made from crops such as corn or sugar would affect the poor much more than the rich, and cause the gap between the two to widen. This is a debate that is also taking place in the U.S., where ethanol production made from agriculture traditionally used for food has often been cited as a reason for the increase in price of many different food goods. This variety of goods are said to be affected in one way or another by the lower supply of corn and other agriculture for foodstuffs. Many articles have been published on this, however, with so many factors affecting the prices of foodstuffs, it is hard to prove that ethanol production causes an increase in food price or even that there are in direct competition. Taking a look at the big picture, it can be shown that, in general, since the emergence of bioethanol in the 1970's, food prices have continued to decrease as is shown by the graph below:



Figure 14 - Global Food Trends [36]

While this debate has continued for a number of years, just recently, as the US has subsidized more bioethanol production, the debate has been revived. In April 2008, Robert Zoellick, the President of World Bank, said that "While many worry about filling their gas tanks, many others around the world are struggling to fill their stomachs. And it's getting more and more difficult every day." [37] In contrast, the president of Brazil, Luiz Inacio Lula da Silva, strongly disagrees and claims that Brazil's sugar cane based ethanol industry has not contributed to the food crisis. Instead, he believes it is due to the subsidies for bioethanol put in place by the U.S. and European governments. [37] These subsidies can offset the free market supply and demand for agricultural products and could result in the increase of food products derived from the same raw material as the ethanol. Currently the ethanol in the U.S. is subsidized at 0.45/gallon (as a tax

credit) while there is no subsidy for ethanol in Brazil, instead the government has supported the infrastructure, regulated the auto industry and invested in the research and development of more efficient ethanol production in order to encourage its use. Brazil's sugar cane-based industry is more efficient than the U.S. corn-based industry. Sugar cane ethanol has an energy balance seven times greater than ethanol produced from corn. [38]



Figure 15 - Ethanol Energy Balance by Feedstock (www.ambientediritoo.it)

#### Brazilian vs. Chinese Air Transportation

Brazil and China have the same need of air transportation due to the vast size of both countries. The governments of two countries play the significant role in developing air transport system and control over the domestic airlines (including aircraft purchases, air fares, and route structures), airports, and jet fuel. [39]

In 1980s, China started aviation industry by reverse engineering of the Boeing 707, the Ministry of Aerospace Industries built a large civilian airliner, the Y-10, while Xi'an Aircraft Corporation (XAC) developed its own 60-seat turbo-prop regional aircraft, the Y-7. All aviation industry is controlled by Aviation Industries of China (AVIC) with the aim of creating an ultra-large industrial group, combining military and civil aviation and capable of competing globally. [40] However, the Y-10 aircraft was not competitive with other aircraft available at the time, and the program was halted after only two were produced. The next effort was a successful joint venture with McDonnell Douglas in 1985 that produced MD-80 series aircraft totally for China's domestic market. [39] This is different from the early stage of Brazil aviation that the Brazilian government invested a lot of resources for research and development to learn how to produce an aircraft. After privatization, Brazil also opened more for the foreign investment. The aviation companies have joint venture with foreign companies which gave a lot of opportunity for Brazilian companies to have more funds to do some research and development. Moreover, Brazilian companies had benefits from the transfer of technology and knowhow to manufacture aircrafts more efficiency. [21]

Brazil found a company called EMBRAER to produce aircrafts and sell to domestic market. China also founded 10 state-owned companies and the largest company was AVIC which subsequently split into two companies (AVIC-I and AVIC-II) with similar capabilities to server different markets. [39]

According to Goldstein, Brazil and China are the same that they need to utilize foreign imports for the most crucial subsystems such as propulsion, avionics and fire-control. Due to cheap labor China has more advantage to supply parts of system instead of producing the whole system. This make China increase export sharply.

Embraer has signed an agreement to build a production unit in China through a joint venture with Harbin Aircraft Industry and Hafei Aviation Industry, both companies controlled by China Aviation Industry Corp II (AVIC II). The new Company--Harbin Embraer Aircraft Industry Co Ltd--represents Embraer's first industrial initiative outside Brazil. EMBRAER holds a 51 percent share of this joint venture, investing \$25 million to build a new factory for manufacturing, assembly, sales and after-sales support for the ERJ 135/140/145 family. [40]

The graph below shows how China and Brazil export Aircraft and parts of aircrafts. Even Brazil has more export; China has been increasing the number of export. In a future, China trends to be in the same level as Brazil. [41]



Aircraft and associated equipment Exports (in USD thousands)

Figure 16 - Brazil vs. China Aircraft Exports [42]

#### Investment in Brazil vs. South Korea

As mentioned earlier, it is important for Brazil to invest in education, infrastructure and technology on a national scale to create a sustainable and more wide-spread growth across all business sectors. A comparative study shall be discussed focusing on the

National Learning Systems (NLSs) between the two countries, Brazil and Korea to demonstrate that important aspect of having a government based policy in promoting an active learning system. A widespread system that would result in the kind of growth that promotes a transformation economy from a level two (efficiency based) to a level three (innovation based).

Following are some specific patterns reflective of two countries commitment on the national scale: national patterns in education, national patterns of technological acquisition, national patterns of commitment of resources to technological learning, and the outcomes of the national technological efforts

The country has to be fully committed in the promotion of an effective education system that is accountable for active learning. This started with a government policy that enforces and encourages its people to embrace learning. Table 5 captures selected indicators of the difference between two countries in variety of levels of the labor force education and training. A good example is a large difference in first university degree in engineering where Korea gathered twice as many as Brazil's, 18 % to 9%. A work force that is well educated will play a crucial role in the process of absorption of foreign technology, making it operational, and further improving it. This is an important starting point of an active learning system, a necessary seed for transitioning from diffusion to innovation.

Indicator	Brazil	South Korea
Adult illiteracy (1995)	16.7	2.0
Percentage of age group in secondary education (1993)	43	93
Performance of secondary students in 1991	Among the world's	The world's
international standardized tests in science and mathematics	worst scores	best scores
Percentage of age group in tertiary education (1993)	11.5	48.2
Number of tertiary students per 100.000 inhabitants (1992)	1079	4253
Percentage of first university degrees in engineering (1992)	7	18
Tertiary students abroad (as % of those at home) (1985–1992)	0.1	2.7
Percentage of the population at working age enrolled in vocational training	1.83 (1985)	3.06 (1986)

#### Table 5 – Labor Force Education and Training

NLSs of Brazil and South Korea-selected indicators on labor force education and training

Source: Viotti [1, Tables 2, 3 and 4, and pp. 184-185, 187-188, 186 and 192-193].

Table 6 would demonstrate the effect of having a well educated work force as a result from a systematic stress in higher education, in which the ability for the country to acquire technology is demonstrated. Technology acquisitions in Korea to Brazil were \$287 million to \$7 million respectively. This 1993 figure indicated that Korea is well capable of handling new technologies as contrast to Brazil in its lacking of such capability. It is worth noting that Korea was only second to Japan, an advance industrialized nation, in this category. Furthermore, another indicator was in the foreign direct investment where Brazil garnered a large sum of \$27.4 billion as contrasting to Korea's minute amount of \$3.6 billion. Brazil attracted more foreign funds particularly in its manufacturing sector, whereas Korea attracted much less. This is primary due to Korea's ability to acquire the needed technology and use it to produce innovative products. In doing so, Korea is at great advantage of reaping long term growth then Brazil.

NLSs of Brazil and South Korea—selected indicators on technology acquisition					
Indicator	Brazil	South Korea			
Imports of capital goods as a ratio of the GDI (1987)	0.259	1.066			
Foreign direct investment up to 1986	US\$27.4 billion	US\$3.6 billion			
Direct purchase of technology	(1984 - 1988)	(1982–1986)			
	US\$827.8 million	US\$1517 million			
Imports of US industrial processes (1993)	US\$7 million	US\$287 million (second only to Japan)			
Imports of Japanese technology (1993)	_a	¥53 billion (second only to US)			

# Table 6 – Technology Acquisition

Source: Viotti [1, Tables 6, 7, 8, 9, 10 and 11, and p. 215].

GDI stands for Gross Domestic Investment. Numbers between parentheses indicate the years to which the data corresponds.

<sup>a</sup> Brazilian imports of technology from Japan in 1993 were not remarkable enough to be shown in the table of Japanese exports of technology.

National commitment of resources to technological learning basically bridges the two previously discussed patterns, a well educated work force and technological acquisitions. The commitment has to be on the national scale in order to transform the national economy to the next level. The commitments of resources such as in table 6 below show the essence of Korea's further facilitating the technological efforts through committing resources, especially in Research and Development as shown South Korea's expenditure at 2.1% of Gross national product vs. Brazil's at 0.4%, a 5 to 1 ratio.

Indicator	Brazil	South Korea
Expenditure for R&D as percentage of GNP	0.4 (1994)	2.1 (1992)
Expenditure in R&D by source of funds (%)	(1994)	(1992)
Government	81.9	17.2
Productive enterprise	18.1	82.4
Other	_	0.4
Government preferential financing for	US\$810 million	US\$848 million
industry's R&D	(1973 - 1989)	(1987)
Scientists and engineers engaged in R&D (per million inhabitants)	235 (1993)	1990 (1992)
Researchers according to place of activity (%)	(1986)	(1987)
Government institutions	26.16	17.40
Universities	68.51	33.15
Private sector	5.33	49.46

Table 7 – Commitment of Resources to technological effort	
NLSs of Brazil and South Korea—selected indicators on the commitment of resources to the technologica	l effort

Source: Viotti [1, Tables 13 and 14, and p. 226].

Numbers between parentheses indicate the years to which the data corresponds.

The difference in the scale of national commitments between Korea and Brazil shows the remarkable corresponding difference in advancement between two nations, of which the return of investment follows the footprint that Korea is employing. Take a look at the particular indicator in the table 8 below, exports of advanced technology product with US (1994): Korea exporting a ghastly amount of \$6.6 billion by far leaving Brazil behind at \$115 million.

Indicator	Brazil	South Korea	
National patents			
National patents granted by the national bureau (1991)	2479	3741	
Patents granted by the national bureau to residents (1991) (%)	14	69	
US patents			
US patents granted to residents in each country (1993)	57	779	
Percentage of US patents granted to nonresidents (1963-1993)	0.09	0.31	
Percentage of US patents granted to nonresidents (1993)	0.13	1.73	
Trade in high-tech products with the US			
Exports of advanced technology products (1994) (US\$ million)	115.8	6658.4	
Diffusion of new productive technologies			
Robots per million in employment	52 (1987)	1060 (1987)	
CAD <sup>a</sup> per million in employment	422 (1987)	1437 (1986)	
NCMT <sup>b</sup> per million in employment	2298 (1987)	5176 (1985)	

Table 8 –	Outcomes	of the	national	techno	logical	efforts
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NLSs of Brazil and South Korea-selected indicators on the outcomes of the national technological efforts

Source: Viotti [1, Tables 13, 15, 17 and 18].

<sup>a</sup> CAD stands for computer aid design workstations.

<sup>b</sup> NCMT stands for numerically controlled machine tools. Numbers between parentheses indicate the years to which the data corresponds.

The success of state supported policy stemming from the 1960s up to current resulted out of necessity (national security, self reliant in oil) in which come the success in cases such as Embraer (aerospace) and Petrobras (oil) as discussed earlier, as well as in agriculture products for the rising consumption needed out of the fast growing countries such as China and India. Nevertheless a strong government policy supporting a national commitment to education, infrastructure and technology is essential to Brazil in order to transforming it to the same economic levels of such industrialized nations like the United States, and Japan. Brazil should be looking Korea as it has cultivated and confidently carried out the patterns (blue prints) to ensure its success, elevating its own economy from level 2 (efficiency based) to level 3 (innovation) that resembles that of its great rivalry, Japan. [42]

# **Critical Analysis**

Brazil has followed a program of both direct intervention and public policy to encourage technology innovation. In the preceding sections we've examined three sectors of the Brazilian economy: Aviation, Ethanol and Investment. Now we will see what common policies the Brazilian government has used in these areas.

Historically Brazil's government has played a significant role in directing technology policy. Starting in the 1930's and increasingly in the 1950's the government policy of Import Substitution Industrialization was state directed policy with strong state participation in the economy. This policy changed in the 1980's with the shift to Neoliberalism to a less direct government involvement.

The three main areas of government policy are research (both scientific and technology), supply creation and demand creation. We'll look at each of the three areas and examine how the policies we've discussed in the three business sectors fit into these areas.

#### Research

The government participated directly and indirectly in research to support the areas we've examined. Directly the government has created agencies to fund research into targeted areas. In aviation the General Command for Aerospace Technology (CTA) was created, which developed aviation technology. The CTA also opened an engineering school, ITA - Institute for Aerospace Technology. In the Ethanol sector the government created the Brazilian Enterprise for Research on Farming and Cattle Raising or EMBRAPA (Empresa Brasileira de Pesquisa Agropecuária) to fund research into crops and production improvements. The CTA was also instrumental in developing ethanol-based auto engines [43].

Indirectly the government has enacted tax reforms to encourage private industry to invest in R&D and jointly fund research with universities. The federal Innovation Law supports alliances between universities and the business community, and provides incentives to boost innovation and investments for public and private enterprises to share resources raise capital and support intellectual property rights. The Positive Law established a set of fiscal incentives, such as significant reductions in taxes and contributions for companies that invest R&D. These laws encouraged research in all three sectors examined.

# Supply

The government also directly and indirectly encouraged production in targeted sectors. Directly the government created government programs or ministries to direct development in targeted industrial areas. In Aviation they established the Ministry of Aeronautics (MAER), which later became the Aeronautical Command (COMAER) while in Ethanol they created the Brazilian Ethanol Program (PROÁLCOOL). During the period of Import Industrial Substitution they founded state owned companies such as Embraer, the Brazilian aerospace manufacturer, to develop production in targeted industries. Later during the shift to Neoliberalism these public corporations were privatized. This privatization became important because it gave the companies access to additional sources of private capital, which had not been available to state owned companies, and allowed them to raise funds for critical technology development [44]. The government also directly provided financing to provide cheap and available credit for industry expansion in key technology areas. The government provided low interest loans to agro- industrial ethanol firms for ethanol development. Aviation benefited from government financing support mechanisms and from FINEX (Fundo de Financiamento à Exportação – Export Finance Fund).

Government indirectly encouraged investment in Embraer when it was privatized by providing a 1% rebate on corporate income tax for Brazilian companies buying non-voting shares. It also indirectly encouraged the Aviation industry by granting very generous tax holidays, and it did not pay trade (ICM) and production (IPI) taxes. Foreign investment was encouraged by the lifting of investment restrictions under the Plano Real.

#### Demand

The government directly encouraged demand for products in key industries by purchasing products. The government guaranteed that the state-owned oil company, Petrobas, would purchase the ethanol produced. In Aviation it favored Embraer in public procurement. Military purchase programs such as the BRL 2.26 billion "National Defense Strategy - END" also encourage the domestic Aviation industry. Although much of the equipment will be purchased from foreign firms, the industry will be encouraged both by some domestic purchases and benefit from technology transfers. The government also directly encouraged Aviation purchases by provide customers with alternate financing through BNDES (a State development bank).

Indirectly the government encourages demand through pricing policies. In Ethanol it initially fixed the ethanol prices at 59 cents on the dollar compared to gasoline and subsidized production to keep the price low and encourage consumption. More recently it has ended subsidies on production but it has maintained a 20% tariff on imports to discourage importation. The government has also indirectly increased demand for Ethanol by mandating though regulation the minimum percentage of Ethanol in gasoline. The program began in 1976 by requiring at least a 10-22% ethanol blend, and by 1993, all gasoline was required to be 22% ethanol. Recently, in 2007, the government increased this to 25% (E25). Through tax policy the government indirectly encouraged the purchase of Ethanol and flex-fuel vehicles with a 2% sales tax discount, thus increasing demand for Ethanol. To improve Brazilian aviation, the government cut the tax on jet fuel and liberalized air fares to improve the competitiveness of Brazilian aviation – thus increasing the demand for airplanes and equipment. The civil air transport industry regulator (ANAC) has begun to liberalize the Brazilian market. For example Brazil and the United State have agreed to increase the number of weekly

cargo flights from 24 to 35 in the 2008 and to 42 in the year 2010, and provide for a nearly 50 percent increase in passenger flights between the two countries.

Demand for foreign investment was increased by the lowering of import tariffs. Multinational companies were able to import needed components at competitive prices to product products in Brazil. Since the implementation of the Plano Real imports have steadily increased. Those industrial sectors where imports have grown to the greatest percentage of the completed products are also the sectors that are the most competitive and have had the largest increase in exports.

# **Critical Analysis Summary**

The government has encouraged technology development through both direct and indirect means in the targeted industrial sectors. The government policies are summarized in the table below.

Area	Method	Aviation	Ethanol	Investment		
Research	Direct	Found CTA, ITA	Founded EMBRAPA			
	Indirect	Innovation Law Positive Law				
Supply Creation	Direct	COMAER, Embraer	PROÁLCOOL			
	Indirect	financing FINEX	loans invest rebate Tax Breaks	Plano Real		
Demand Creation	Direct	Favored Embraer BRL, Customer Loans	Purchases			
	Indirect	Cut Fuel Tax Liberalized Market	Mandate % Pricing Import tariffs Flex Fuel Discount	Tariff Reduction		

Table 9 – Summary of Government Policies

The government has pursued similar policies in all the focused technology sectors. It did create the state owed aviation company in the Aviation sector while relying on cheap loans to expand the Ethanol industry. For Aviation demand creation it focused on the direct means of direct purchase and providing loans to customers while in Ethanol it mandated minimum percentages while keeping prices low and guaranteeing production would be purchased. The government has pursued similar strategies in both sectors – tuning the strategy to the more consumer focused Ethanol market and the more business oriented Aviation market. In the more global investment sectors it's relied on indirect methods for influencing progress.

#### Conclusion

Our paper looked at legislative polices that have shaped specific areas of the Brazilian economy. Our five part investigation began with the Portuguese rule of the country; evaluated the importance of technology transfer, Institutional Act, and the "Plano Real". Next we investigated the ethanol industry, looked at the Proalcool program, ethanol vehicles, EMBRAPA, and efficiency. Our third area of investigation, Aviation, investigated the government founded Aerospace Technical Center, and the Institute of Aeronautical Technology. We looked at how the government financed, marketed, and provided regulation for the support of the aviation industry. Our fourth area of investigation, investigation, investment, evaluated economic policy towards reformation, education, imports, and exports. The final section, comparative analysis, evaluated the food vs. fuel debate, China's vs. Brazil's aviation, and Korea vs. Brazil's patterns in education, technological acquisition, and outcomes of the national economic efforts.

Resulting from this five part investigation we found that Brazil is moving in the right direction. We have described both in the historical section and in the aviation section how technology transfer has propelled the Brazilian economy. The government created legislative policies which have encouraged the people of Brazil to use local resources to their maximum potential. Within the Ethanol industry the availability of sugarcane became scarce when the policy of Proalcool was implemented. This regulation forced the Brazilian people to be innovative, resulting in their dominance in the sugar market.

Brazil's embark on the path of progressive integration into the global economy has lead to great influx of foreign investment, and internationalization of domestic businesses. The government economic reform policy has effectively influenced all business sectors. National income level has increased as a result, however commitment on national educational system is needed in order to sustain a capable workforce that understands technology, innovation and innovation process capability.

Our paper focused on how the legislative branch of the Brazilian government can use technology management through specific technological policies to help the country transition from a Stage 2 (efficiency driven) to a stage 3 (innovation driven) economy.

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