Politics, Institutions and Firms:

A Multilevel Analysis of the Regional Jet Industry

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Abstract

Not far from the titanic battle for market dominance in the large commercial aircraft industry between Boeing and Airbus there is another battle for leadership within the regional jet industry. Early leadership by a Canadian firm, Bombardier, has been rolled back by Bombardier's Brazilian competitor, Embraer. This paper seeks to explain the story of industrial leadership in regional jets over time, by examining the interactions between firms, national innovation systems and national politics. By understanding how these separate action arenas work, and how they hang together, it will be possible not only to explain past performance in the industry, but will provide a window through which to analyze prospective changes in the future.

Introduction

Beginning in the late 1980's, a newcomer to the aerospace industry was able to become the world's third-largest aircraft producer (with a virtual monopoly in regional jets) overnight. After a brief period without significant international challengers, a second firm emerged as a viable competitor for the burgeoning market. The former firm, Bombardier, is a Canadian firm, while the latter firm is Embraer, a Brazilian firm. This demonstrates that small, and in the Brazilian case, underdeveloped countries can not only play a large role in strategic high-technology industries, but can even dominate them. Contained therein is an important question: what are the sources of industrial leadership in the regional jet industry?

The literature addressing leadership in the regional jet industry has, unfortunately, largely been limited to myopic matters surrounding the Bombardier-Embraer trade dispute, and the question of subsidization.[1] While surely the state has played an overt role in the development of a regional jet industry in both Canada and Brazil, through Technology Partnerships Canada in the former and the Brazilian Development Bank in the latter, a deeper story is being missed. Many countries offer subsidies to their aerospace industry, but only Brazil and Canada have parlayed government support into a successful regional jet industry.

There is a much richer approach to explaining industrial evolution that focuses on how institutions co-evolve with firms to produce competitive advantages for some firms and some countries. For instance, Jeffrey Hart in *Rival Capitalists* explores the steel, semiconductor and automobile industry, developing the thesis that the state-society bargain between business, labor and the state underlying

[1] Abdelal, Rawi, Alfaro, Laura and Laschinger, Brett. "Bombardier: Canada *versus* Brazil at the WTO" in *Harvard Business School Case Study* 9-703-022 May 8, 2003; Goldstein, Andrea "From National Champion to Global Player: Explaining the Success of Embraer" in *University of Oxford Brazilian Studies Series* (Working Paper) 2001

national institutions offers the best explanation for variance in industrial leadership.[2] However, regional aerospace presents a snag in broader application of such a model, in that state-society arrangements in Brazil and Canada are more about regional interests than they are about class. Alternately, Johann Murmann in *Knowledge and Competitive Advantage* focuses on the particular institutions that helped foster leadership in the synthetic dye industry in the late 19th century.[3] These approaches, while they might describe institutions key to the success of a particular industry, may miss the goings-on of a higher level political game. For instance, Murmann focuses on patent laws in Germany, without discussing *why* patent laws emerged and evolved as they did. National and sub-national institutions, while they may have a functional interest in improving the lot of a particular industry, do not necessarily have a political interest in doing so.

Success in the aerospace industry is driven by the ability of firms to extract support from governments, but in a manner that goes much deeper than mere export subsidies – it is the creation of supporting institutions that lead to industrial success. In explaining the existence of supporting institutions one must turn to the nature and evolution of political institutions, and their interactions with the aerospace innovation system. This means looking nor merely at subsidies, but also at the role of political institutions at fostering appropriate industrial policies, a good system of education, an effective national research and development system and establishing each in ways that are complementary to each other. Both Canadian and Brazilian success in aerospace have resulted from a specialization of labor between sub-national governments providing goods of long-term necessity (eg. education), and national governments providing more near-term goods (eg. subsidies). This division of labor is both sustainable and beneficial, and thus plays a key role in explaining the success of Bombardier and Embraer in the industry. At the same time the innovation systems in Brazil and Canada are fundamentally different. The interaction of those systems with other intervening variables – fuel prices, for instance, has been determinative of change in the past, and will continue to offer a model for prediction future change in the industry.

This paper will begin with a brief history of regional jets, and of the main players in the industry. Next it will explore some of the industry-specific characteristics of the aerospace industry that make it different from most others. Following this, it will turn to an exploration of national politics behind aerospace in Brazil and Canada. With that established, the paper will go on to address the relationship between political institutions and support for the aerospace industry – stressing the particular advantages inherent in the Canadian and Brazilian system. It will then be possible to link this holistic national system with the particular firm-level characteristics of Embraer and Bombardier. It will also be necessary to

[2] Hart, Jeffrey. *Rival Capitalists* (Ithaca: Cornell University Press, 1992) pp. 1-35
[3] Murmann, John. *Knowledge and Competitive Advantage* (Cambridge: Cambridge University Press, 2003)

address some of the shortcomings of the model. Finally, an integrated picture of politics, institutions and firms can be developed, providing a model for explanation and future prediction of how this model will interact with exogenous factors.

A Brief history of the Regional Jet, Bombardier and Embraer

In many respects, the regional aircraft industry has a long history. After all, early planes lacked a sufficient fuel capacity to travel very far and were, by nature, regional. However, at the time, the market for air travel was fairly small, and dominated by concerns about mail (much of the early development of the American aircraft industry was funded by a postal subsidy) and the military.[4] Following the Second World War, it was large jets that came to dominate the market. Regulated or nationalized airlines stuck to profitable routes (some profitable only through government subsidization) and large planes. While some shorter-range, smaller and more specialized planes existed for corporate executives and odd jobs (for instance crop-dusting or fighting fires), these represented market niches.[5]

In the United States, the largest market for aircraft, the Civil Aeronautics board (the FAA after 1958) controlled the pricing of routes, in order to ensure that airlines would be able to receive good returns.[6] Competition on routes was largely discouraged by the existing regime – airlines were treated as natural monopolies, regulated by the government. However, in 1978 that regime was eliminated with the passage of the Airline Deregulation Act. Following on the heels of this, fare regulations as well as entry/exit restrictions were abolished in the early 1980's. Similar deregulations occurred later in the decade elsewhere – most notably in Canada, the United Kingdom and Japan.[7] The allowances for entry by new firms, especially in the United States, created a new breed of regional aircraft carriers, and later discount airlines. The success of regional carriers like Skywest Airlines, for instance – emerging after deregulation and enlarging the market for regional aircraft**.**[8]

Small-range airlines (many owned by flagship airlines) have existed since the 1950's. The first class of "feederliner" aircraft typically had a capacity of fewer than 60 seats.[9] Range capacity often

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[4] Muelen, Jacob. *The Politics of Aircraft: Building of an American Industry.* (University Press of Kansas, 1991) pp. 83-116

[5] Chan, Daniel. "The Development of the Airline Industry from 1978 to 1998" *Journal of Management Development* vol 19 issue 6, 2000

[6] Morrison, Steven and Winston, Clifford. *The Evolution of the Airline Industry.* (Washington DC: The Brookings Institute, 1995) pp. 3-39

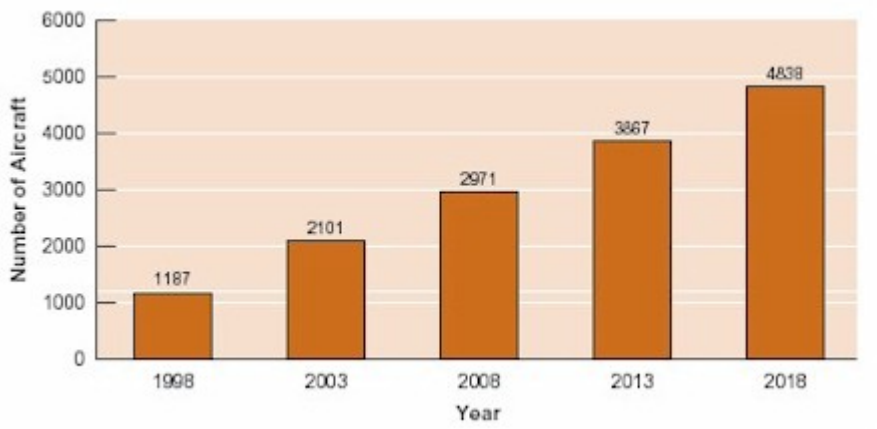
[7] Morrison, Steven. "International Comparison of Deregulation Between the USA, the UK and Japan: Volume III Airline and Trucking" in *The Kunzai Buseki* (English The Economic Analysis) (Tokyo: The Economic Planning Agency, 1995)

[8] Morrison, Steven. *The Evolution of the Airline Industry.* p. 29

[9] Borenstein, Severin. "The Evolution of US Airline Competition" in *Journal of Economic Perspectives* vol. 6 no. 2 Spring, 1992

exceeded the task for which these planes were used, perhaps since it was unclear to manufacturers that feederliners represented a particularly large industry at the time. In the 1970's, a second generation of feederliners emerged, this time much more custom-tailored to such tasks. Throughout this early period, production of aircraft was conducted by a wide range of firms with considerable national diversity. However, in the early 1980's, British Aerospace (initially through its Canadian subsidiary, Avro) managed a considerable innovation with its launch of the BAE 146. This jet offered added comfort, range and speed to potential customers, filling a considerable economic niche. However, the BAE 146, while technically successful, was not economically successful. With four engines it was not fuel efficient, and did not sell well.[10]

Figure 1: Number of Regional jets over time[11]



Rather, it was a new entrant to the market, Bombardier, having consolidated four economically unsuccessful aerospace firms (De Havilland, Learjet, Canadair and Shorts) that came to dominate the regional jet market. With the launch of the CRJ-100, and rapid expansion to offer a full family of regional jets, Bombardier emerged as the clear market leader in regional aircraft (with a 42% share in 1992), and the third-largest player worldwide.[12] The Canadian share of world aircraft exports doubled from 1980 to 2001 from 3.5% to 7%, largely driven by Bombardier's success.[13] However, Bombardier was not the only firm in the market, and is presently receiving a spirited challenge from unexpected quarters.

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[10]Barrett, Sean "Market Entry into the Full-Service Airline Market" *Journal of Air Transport Management* vol. 7 Spring, 2001

[11] "Civil Aviation" in *Transport Canada* http://www.tc.gc.ca/civilaviation/AerodromeAirNav/Standards/WildlifeControl/tp13549/Images/Chapter5d7.jpg (accessed April, 2007)

[12] Macdonald, Larry. *The Bombardier Story: Planes, Trains and Snowmobiles* (Etobicoke: Wiley, 2002) pp. 159-185

[13] "Science and Engineering Indicators 2006" in *NSF.gov* http://www.nsf.gov/statistics/seind06/tables.htm#c6 Accessed April, 2007

Embraer was initially created by the Brazilian military government, in order to develop domestic expertise in aircraft production so as to reduce reliance on others for a valuable strategic asset.[14] However, resources were also employed in order to develop Embraer as a major exporter of civilian aircraft. With the airline deregulation of 1978, new regional carriers provided a growing (but still small) market for small turboprop commuters. Embraer was able to eventually lead this market by the mid 1980's, but faced disaster in the wake of broader Brazilian economic troubles.[15] By its privatization in 1994, Embraer had only a few turbo-prop planes on the market, (namely the Brasilia) which faced declining sales, and another regional jet in production. However deep cuts to operating costs, an alliance with Dassault, and arguably some help from Pro-Ex (a Brazilian export subsidy bank) as well as other factors enabled Embraer to recover its market share. Formerly a prohibitively expensive state-run corporation, Embraer is now one of the few positive high-technology sources of the Brazilian balance of payments surplus.[16] The Brazilian share in world aircraft exports has increased from under half a percent to over 3% **(see chart 1 below)**.

Chart 1 Global Shares of Aircraft Production 1980-2003[17]

	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001	2002	2003	% change
United States	54.51	45.03	46.11	37.37	43.68	45.42	48.37	46.77	39.17	39.54	37.57	35.75	-34.43
France	6.46	7.19	9.69	18.98	13.74	13.76	11.70	14.50	17.12	16.60	17.39	18.10	180.18
Germany	4.85	11.58	10.28	11.88	9.99	11.21	11.12	13.06	14.13	15.03	15.46	15.61	221.81
Canada	3.53	3.92	4.17	4.50	4.78	4.21	4.51	5.01	5.95	6.89	6.96	7.15	102.37
United Kingdom	18.44	17.88	13.87	9.14	11.12	10.46	7.95	4.77	5.49	5.34	5.51	5.68	-69.18
Brazil	0.47	0.25	0.97	0.43	0.65	0.87	1.31	1.84	3.37	3.09	3.11	3.20	574.79
Italy	1.84	3.80	4.11	2.33	2.42	1.81	2.45	2.58	3.29	2.27	2.31	2.32	25.58
Japan	0.42	0.46	0.71	0.83	1.13	1.47	1.61	1.65	1.31	1.45	1.45	1.44	245.78
Spain	0.25	0.38	1.37	1.36	1.65	1.22	0.90	1.28	1.34	1.10	1.17	1.27	405.69

The Bombardier-Embraer battle resembles that of Boeing and Airbus in many respects, most notably in its trade dispute. Bombardier and the Canadian government contend that Brazilian subsidies have enabled the production and sale of aircraft that would otherwise be too expensive. Brazilian officials and Embraer counter, pointing to Canadian subsidies through Technology Partnerships Canada, which

[14] Ramamurti, Ravi. *State-Owned Enterprises in High Technology Industries: Studies in India and Brazil* (New York: Praeger, 1987) pp. 175-207

[15] Ghemawat, Pankaj, Herrero, Gustavo and Monteiro, Felipe. "Embraer: The Global Leader in Regional Jets" in *Harvard Business School Case Study* 9-701-006 October, 2000

[16] Bernardes, Roberto and de Oliveira,Luis "Building up complex production systems in developing countries: the Embraer experience." In ed. Cassiolata, Jose, Lastres, Helena, and Maciel, Maria *Systems of Innovation and Development* (Cheltenham: Edward Elgar Press, 2003) pp. 499-525

[17] "Science and Engineering Indicators 2006" in *NSF.gov* http://www.nsf.gov/statistics/seind06/tables.htm#c6 Accessed April, 2007

has helped fund research of new aircraft. A 2003 WTO resolution has succeeded in altering Canadian administration of TPC, while Brazil has refocused its own efforts towards attracting new firms and partners to its aerospace cluster in Sao Paulo.[18]

Industry-Level Characteristics

The above history has ended with the debate about subsidization and fair trade practices because it is that question which has characterized the majority of the literature on the regional aerospace industry.[19] In answer to the question of how leadership in aerospace is attained, the answer of this school of thought is fairly simple: government subsidies for one side or the other, coupled with favorable treatment in defense contracts and a whole host of other goodies, largely explains leadership in the industry. The argument as to the inefficiency of this approach is best captured by conventional economic theory. For instance, in the Heckscher-Ohlin model Different countries have comparative advantages in the production of various goods, depending upon their relative factor endowments.[20] Brazil, a labor-rich country should produce what it produces best, while Canada, a capital-rich country does the same – this approach should maximize the aggregate production of goods in the world (were it not for pesky government subsidies). These broad ideas have been reflected at the policy level in a number of countries – for instance, laissez-faire aerospace regimes existed in the United States prior to the Second World War, and also, briefly in the early 90's – with little success.[21]

However, the aerospace industry defies the rules of mainstream economics for a number of reasons, which make some level of subsidization the legitimate pursuit of a public good. Secondly, even if this is true, national institutions, and their co-evolution with firms, provide a far better explanation of leadership in the regional aerospace industry.[22] To the first point, there are a number of ways in which the aerospace industry is radically different from most other industries. Typically, models of pure competition represent the average cost curve facing a firm as a parabola – going down initially, as the sunk costs of development are averaged, but eventually rising due to decreasing returns to scale (**See figure 1**). Because of the substantial learning economies, increasing returns to scope and the considerable cost of new aircraft development, aerospace firms face a decreasing average cost curve (it has been estimated that a doubling

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[18] Bernardes, Roberto and de Oliveira,Luis "Building up complex production systems in developing countries: the Embraer experience." In ed. Cassiolata, Jose, Lastres, Helena, and Maciel, Maria *Systems of Innovation and Development* (Cheltenham: Edward Elgar Press, 2003) pp. 499-525

[19] Goldstein, Andrea. "The Political Economy of Strategic Trade Policy and the Brazil-Canada Export Saga" in *The World Economy* issue 27 vol. 4 April, 2004

[20] Kaempfer, William; Markusen, James; Maskus, Keith and Markusen, James. International Trade: Theory and Evidence. (McGraw-Hill, Boston: 1995) pp. 98-126

[21] Muelen, Jacob. *The Politics of Aircraft: Building of an American Industry.* pp. 41-83

[22] Tyson, Laura. *Who's Bashing Whom: Trade Conflict in High-Technology Industries.* (Washington DC: Institute for International Economies, 1992) pp. 155-176

of the production run of a model of aircraft typically reduces the cost of production per unit by 20%).[23] In the first case, subsidization will lead to a dead-weight loss as resources are wasted – facing increasing marginal costs. In the second case, however, there is an additional surplus from a subsidization policy (**see figure 2**).[24]

Figure 2: subsidies under pure competition[25]

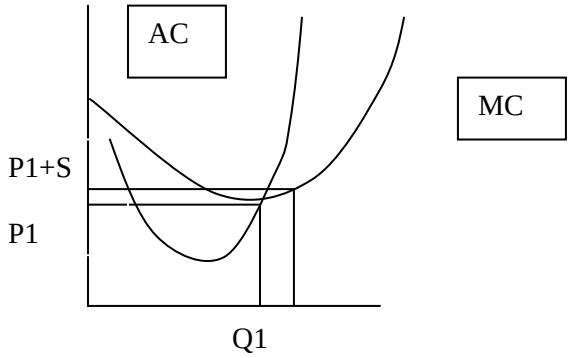
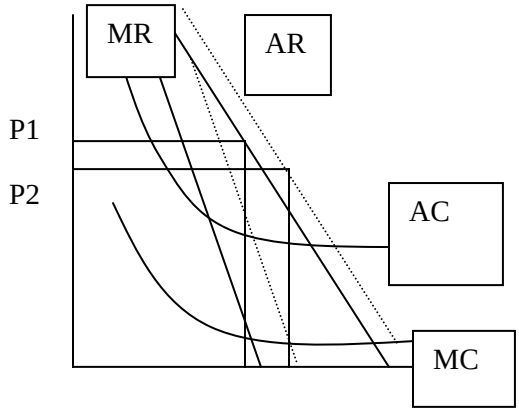


Figure 3: subsidies under a natural monopoly[26]



In addition to the aforementioned benefits, the aerospace industry has much to recommend it as the subject of a national industrial policy. There are considerable spillover effects from aerospace

[23] Busch, Mark. *Trade Warriors.* (Cambridge: Cambridge University Press, 2001) pp. 32-62
[24] Bagwell, K. and Staiger, R. W. "Strategic Export Subsidies and Reciprocal Trade Agreements" in *NBER Working Paper* (No. W5574) 1996
[25] Pindyck, Robert. And Rubinfeld, Daniel. *Microeconomics: 5th edition* (New Jersey: Prentice Hall, 2001) P. 270
[26] Ibid. p. 350

research and production, raising the productivity of related industries as well.[27] Building aircraft improves the skills of engineers and workers that may go on to work in other fields, while also feeding a host of downstream firms as well. On top of this, the development of an aerospace industry may represent a legitimate aspect of national defense policy, given the dual-use nature of technology, and the prospect of turning manufacturing capital and skill towards the production of military aircraft in a time of war.[28] The reaction of Boeing to the proposal of subsidies from the US government in the early 90's reflects quite dramatically the public good nature of aerospace production: Boeing push *against* its own subsidization, fearing reciprocation in Europe, while the government pushed *for* it. Positive externalities from aerospace make it ripe for some sort of industrial policy.[29]

Thinking about the actual case itself, this view has cropped up largely in reference to the Airbus story. After 1978, with considerable assistance from a number of governments, Airbus was able to emerge in the 1990's as a successful competitor to Boeing which had been the market leader in civil aeronautics.[30] This kind of analysis, however, reliance on the confluence of the success of Airbus (and Embraer) and the existence of subsidies represents selection on the dependent variable of the worst sort. Why have other states with considerable subsidies to their aerospace industries – for instance, Indonesia, not emerged as major competitors in any particular sphere of the industry?[31] Why did Brazilian success emerge only in the mid-1990's, *after* decades of state support (and initially, ownership)? The story of subsidies on its own tells very little about industrial leadership in the regional jet industry, without at least looking at the political basis behind government support for aerospace of one sort or another.

Clusters and Domestic Politics

While subsidies do not tell the entire story, government support for the aerospace industry (which goes beyond mere subsidization) can play an important role. Explaining the ability of the aerospace industry to lobby for government support (and variations within different countries), however, represents a more valuable approach, able to account for variations in support over time. In this regard, it is necessary to account for the evolution of the role of government in Canada – from being an investor of last resort (Canadair was nationalized twice, after failing financially), to an active subsidizer of the industry through TPC and now the Strategic Aerospace and Defence Initiative.[32] In the Brazilian case as

[27] Hayward, Keith. *The World Aerospace Industry.* (Duckworth, 1994)
[28] Tyson, Laura. *Who's Bashing Whom: Trade Conflict in High-Technology Industries.* pp. 155-176
[29] Busch, Mark. *Trade Warriors.* (Cambridge: Cambridge University Press, 2001) pp. 32-62
[30] Ibid. pp. 155-176
[31] Goldstein, Andrea. "The Political Economy of Aerospace in developing countries: Brazil, Indonesia and South Africa." In *Cambridge Journal of Economics* issue 26 (2000)
[32] Macdonald, Larry. *The Bombardier Story: Planes, Trains and Snowmobiles* pp. 127-159

well, the government's initially direct role has evolved to the provision of subsidies through the Brazilian Development Bank (BNDES) and Pro-Ex and supporting institutions.[33] The focus here will be on the role of political institutions, as opposed to partisanship, which has not influenced attitudes towards aerospace policy considerably, in keeping with predictions of median voter theory.

Efficient aerospace industries tend to develop in clusters, making political victory within a region heavily reliant upon the industry.[34] In both Brazil and Canada, a highly decentralized political system gives particular power to regional governments, which, by virtue of their lower degrees of economic diversification (relative to the country as a whole) will be likely to support their aerospace industries. The question as to whether aerospace investments represent a public good as far less ambiguous for the regional governments that are able to capture much of the benefits themselves – as opposed to national politicians, which are faced with tradeoffs between regional and national interests. At the same time, the tax base of Brazilian (in Sao Paulo) and Canadian (in Ontario and Quebec) regional governments is sufficient to support a range of initiatives.[35] Most importantly, the delivery of social services (especially education) can be tailored to benefit the particular industrial competencies of the region. However, it is at the federal level in both countries that change can be accounted for. The tendency for the Liberals to sweep Quebec, and the centralized control of the military dictatorship, removed political incentives for special support to the industry beyond any inherent utility. Rather, it was only the emergence of multiparty competition in Quebec, (as a result of political entrepreneurship by the Progressive-Conservatives and later the Bloc Quebecois) and a competitive democracy with Sao Paulo playing a key role that the respective aerospace industries of Brazil and Canada could be appropriately nurtured.

It is in the institutional structure of Canadian parliament that one can see the germ of interactions between politics and aerospace policy. Canada is a parliamentary democracy in the Westminster tradition, in which the Prime Minister sits in the lower house. While it possesses a senate, that body is appointed by the Prime Minister, and lacks both the power and legitimacy to effectively block bills coming from the house of Commons (Canada's lower house). Within parliament, the Prime Minister reigns supreme – controlling the power of appointments to cabinet, and typically commanding the loyalty of members.[36] In such a state of affairs, in which the party and not individual members are the most important actors,

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[33] Abdelal, Rawi, Alfaro, Laura and Laschinger, Brett. "Bombardier: Canada *versus* Brazil at the WTO" in *Harvard Business School Case Study* 9-703-022 May 8, 2003

[34] Niosi, Jorge. "Regional Systems of Innovation: Market Pull and Government Push" (Presentation: Canadian Research Network on Regional Innovation Systems) Montreal, 2000

[35] Suzigan, Wilson. "Local Production and Innovation systems in Sao Paulo, Brazil" in (Presentation: ERSA) Finland, 2003

[36] McGillivray, Fiona. "Party Discipline and Endogenous Tariffs" in *American Journal of Political Science* vol. 41 no. 2 (April, 1997)

marginal constituencies become of increasing importance with respect to lobbying. This stands in contrast to systems such as the American congress, in which party direction is comparatively loose, and seniority plays a larger role. Where seniority reigns, safe incumbents will be most powerful – where party discipline is central, it is marginal constituencies that governments will favor. Through much of Canadian history, this has worked to the disadvantage of the Canadian aerospace industry – the Liberal Party of Canada would typically sweep Quebec with little difficulty. A smaller aerospace cluster around Toronto was similarly made up of initially safe seats for the Progressive –Conservative party. With Quebec not in play electorally, it did not figure in Liberal electoral calculations, which were directed much more at swing ridings in southern Ontario.

Chart 2 Aerospace Clusters in Canada[37]

Variable	Montreal	Toronto	Winnipeg	Vancouver	Halifax	Ottawa	Calgary
Firms	8	9	3	2	2	2	3
Employment	18595	11943	2300	1325	1160	1135	375
Employment %	50.4	32.4	6.2	3.6	3.1	3.1	1.1
jobs per firm	2324	1327	766	663	580	568	135

However, changes at both the federal level have altered the political calculus of supporting aerospace. Firstly, on the provincial scene, there has been the rise of a separatist political party, the Parti Quebecois. The PQ has been able to win elections (it served in government from 1976-1985 and 1994-2003), and has initiated two referenda on sovereignty. Thus, even discounting the electoral calculus, the specter of separatism provides a powerful national interest reason to invest in Canadian aerospace (ie. diminishing the economic grievances of Quebec separatists). Secondly, at the federal level, the Progressive-Conservatives (in the 1984 and 1988 elections), through the political entrepreneurship of Brian Mulroney adopted decentralist positions amenable to Quebec nationalists, enabling a breakthrough in Quebec. Later, the Bloc Quebecois (from the 1993 election onward) followed suit by creating a separatist option in Quebec federal elections enabling breakthroughs in Quebec, and more importantly for aerospace, in Montreal. In 2006, the newly elected Conservative government managed to win the second-most votes in Quebec, tripling their support within the province. In spite of a number of statements critical of Bombardier made while in opposition, the Conservative government has continued to support the aerospace industry, launching a new program worth 900 million dollars over four years, demonstrating that aerospace policy is about more than mere ideology.

[37] Niosi, Jorge. "Regional Systems of Innovation: Market Pull and Government Push" (Presentation: Canadian Research Network on Regional Innovation Systems) Montreal, 2000

Chart 3 Federal Election Results in Quebec 1968-2006 (% of Popular vote)[38]

year	Liberal	Prog. Con/Con	Soc. Cred.	NDP	BQ	CA/Ref	gap w/ leader
2006	21	25		8	42		17
2004	34	9		5	49		15
2000	44	6		2	40	6	4
1997	37	22		2	38		1
1993	33	14		2	49		16
1988	30	53		14			23
1984	35	50		9			15
1980	68	13	6	9			55
1979	62	14	16	5			46
1974	54	21	17	7			33
1972	49	17	24	7			25
1968	54	21	16	8			33

The Brazilian case, to the casual observer, seems incredibly far removed from that of Canada. From 1964 till 1985, Brazil was ruled by an authoritarian government backed by the military. Brazil's military government, while repressive, aggressively sought to develop the Brazilian economy, dreaming of a future in which Brazil was a great power.[39] The economic retooling by the military government was largely successful (although substantial amounts of debt were accrued in the process), achieving real GDP per capita growth rates of 3.3%/annum.[40] These high rates of growth were accomplished through a targeted industrial policy enacted by the state, with large state-owned enterprises dominating Brazilian industry. Contemporary writers investigating the Brazilian economy have classified Brazil as a developmentalist state – one in which the state plays an active role in the pursuit of economic growth, as opposed to the redistribution of wealth.[41] Under the military junta, support for the aerospace industry was forthcoming, but largely driven by military concerns.[42] The junta feared the security prospects of being cut off from outside supplies of planes, and so fostered a domestic capacity capable of producing military

[38] "History of Federal Ridings since 1867" Parliament of Canada http://www.parl.gc.ca/information/about/process/house/hfer/hfer.asp?Language=E (accessed April, 2007)
[39] Roett, Riordan. *Brazil: Politics in a Patrimonial Society* (Westport: Praeger, 1999) pp. 1-28
[40] Maddisson, Angus. "World Population, GDP and GDP per Capita, 1-2003 AD" in *Angus Maddison Faculty Page* http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_03-2007.xls (Accessed April, 2007)
[41] Sikkink, Kathryn. *Ideas and Institutions: Developmentalism in Brazil and Argentina* (Ithaca: Cornell University Press, 1991 pp. 122-171
[42] Ramamurti, Ravi. *State-Owned Enterprises in High Technology Industries: Studies in India and Brazil* pp. 175-207

aircraft. At the same time, some effort was also made to develop smaller civilian aircraft, as such a program was deemed achievable and beneficial at least for Brazil's balance of trade (as well, despite being relatively small, as late as in the 1980's, Brazil represented the world's third-largest market for regional aircraft behind the United States and Canada).[43]

However, in 1985, the opposition party won the elections in Brazil, and the military relinquished its direct role in Brazilian politics. Brazil's democratic political institutions were able to exert influence over government policy. In theory, Brazil's constitution would lead one to assume it is a strong presidential system, however, in practice this is not the case. Regional party bosses are among the most influential actors within Brazil's federal system of government.[44] Because Brazil has a weak party system, it is difficult for presidents to control even legislatures dominated by members of their own party. Further, elections are typically personality-driven – candidates changing parties bring their base with them. Regional governors, on the other hand, do tend to have much more considerable coat-tail effects, enabling them to enact policies. It is the endorsement of regional governors that enables deputies (and presidents) to win or lose elections.[45] Thus, while Brazil is a weak party system, because of the crucial role played by regional governors, it operates similarly to a strong party system: the endorsement of regional governors will have a much greater impact in marginal districts than in safe districts – even if deputies from safe districts will tend to develop more seniority and power. Within Brazil, Sao Paulo has typically been fairly close in congressional elections between the Workers Party (PT) and the Social Democratic Party (PDSB). Additionally, though underrepresented, Sao Paulo is the largest state with 14% of all deputies, as well as being the wealthiest state.

[43] Ramamurti, Ravi. *State-Owned Enterprises in High Technology Industries: Studies in India and Brazil* pp. 175-207

[44] Samuels, David. "The Gubernatorial Coat-tails effect: Federalism and Congressional Elections in Brazil". In *Journal of Politics.* Vol 62 no. 1 (February, 2000)

[45] Ames, Barry. "Election rules, constituency pressures and pork barrel: the basis of voting in the Brazilian congress." In *Journal of Politics* Vol. 57 no. 2 (May, 1995)

Chart 4: Winning Margin and number of Deputies

in Brazilian Congressional Elections 1998-2006 by state[46]

year	Sao Paulo	Bahia	Ceara	Goias	Maranhao	M. Gerais
2006	1.1	15.1	0.9	6.8	9.9	1.7
2002	7.3	22.5	12.3	6.3	16.4	8
1998	0.8	33.2	19.3	33	14.5	7.8
win margin	3.1	23.6	10.8	15.4	13.6	5.8
deputies	70	39	22	17	18	53

	Para	Parana	Pernambuco	R. de Jan.	RGDS	S. Cataranina
2006	10.1	9.7	0.3	8.9	2.1	8.5
2002	9	1.4	0.7	0.3	6.7	0.3
1998	0.6	7.6	0.9	1.1	3.2	2.1
win margin	6.6	6.2	0.6	3.4	4	3.6
deputies	17	30	25	46	31	16

[46] Alvarez, Rivera. "Federal Elections in Brazil" in *Election resources on the net* http://www.electionresources.org/br/index_en.html (Accessed April, 2007)

Figure 4: Canadian Politics and Aerospace Policy

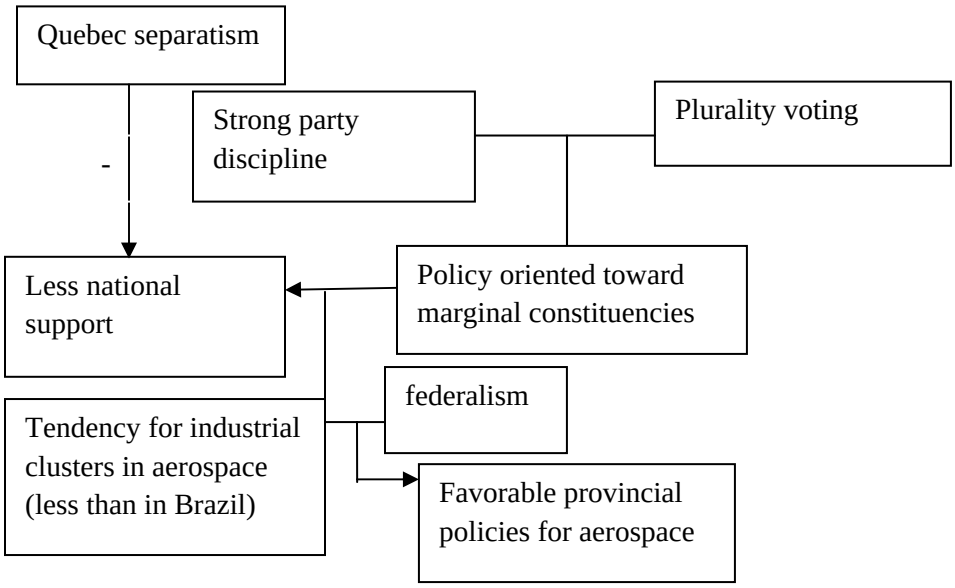
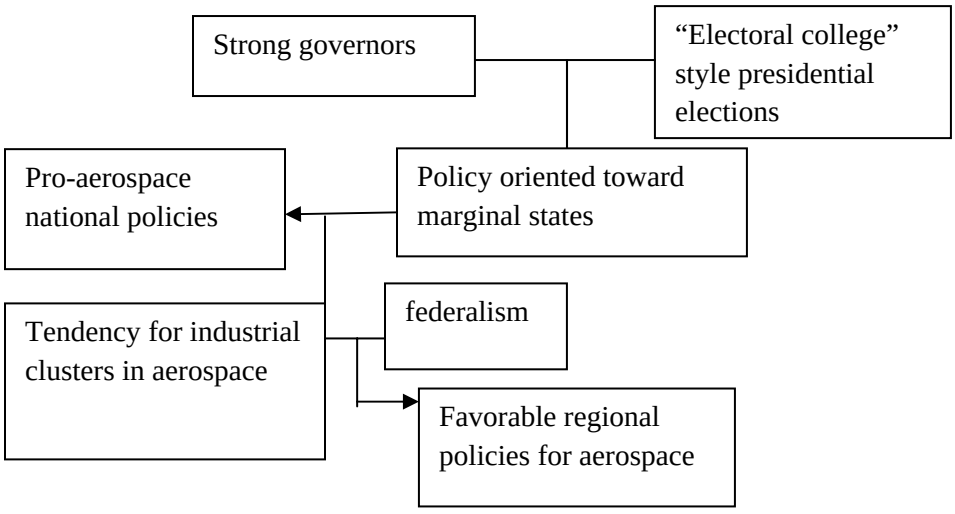


Figure 5: Brazilian Politics and Aerospace Policy



National Institutions and Complementarities

Since at least the 1980's, a number of scholars have heralded the triumph of a globalized world in which the nation state had withered away into nothingness.[47] With rapid reductions in transportation costs, comparative advantage (or competitive advantage in some accounts) had come to rule the day. Different economic models were no longer sustainable, apart from one of limited government and open borders – a particular policy mix towards which most states would converge. This argument, however, fails to consider the role of different national institutions (not all of which involve limited government) in enabling the production of particular goods, and secondly, the complementarities that may exist between those institutions.

Jeffrey Hart in *Rival Capitalists* offers as his basis the fundamental state-society bargain underlying national institutions as forming the core of his explanation of leadership in the steel, automobile and semiconductor industries.[48] He establishes a triad of orientations: state, business and labor, and places the countries he examines accordingly. Some, like Germany, have mixed strategies (business and labor), while others have pure arrangements (for instance, the United States had a strong business orientation).[49] US leadership in all three industries was supplanted by the other countries, whose state-society arrangements were better at stimulating productivity growth and competitiveness in particular industries. For instance, the preeminence of both labor and business interests in Germany fostered an industrial policy focused on human capital. With highly trained workers, German firms have been able to confidently adopt new technologies in the workplace. Hart is correct in pointing out that national institutions may be ill-suited to producing certain goods, and well-suited to producing others. For instance, a disinclination to intervene in the economy may harm industries requiring government capital to attain economies of scale (such as aerospace). On the other hand, high degrees of intervention in the economy may shield non-innovating firms and stunt growth in high innovation sectors such as in information technology. Global changes, such as decreasing transport costs and increased openness may open countries up to higher degrees of competition, but it does not necessarily force their reaction in one direction or another.

Where this study differs with Hart is in his particular definition of state-society agreements. While the traditional politics model may apply reasonably well to Europe, the United States and Japan,

[47] Held, David and McGrew, Anthony. *The Global Transformations Reader* (Cambridge, Polity Press, 2003)
[48] Hart, Jeffrey. *Rival Capitalists* pp. 1-35
[49] Ibid. pp. 181-223

other states have a political system that is founded upon *regional* political coalitions that can often defy class (though sometimes regional cleavages capture class politics as well). This characterization fits the Canadian situation well – Conservative governments, once in power, have in fact traditionally tended to expand the size of government, while the Liberal record has, if anything been the reverse (contrary to the class basis of either party – see chart 6). Rather than an ideological or class coalition, they and the Liberal party represent a set of regional interests (the socialist NDP does not fit into this classification very well). Similarly, the structure of Brazilian politics, with strong governors, whose endorsements can make or break the careers of presidents and deputies, that same element of politics as being founded on a state-society agreement between regions better captures the Brazilian story.

Chart 5 Changes in Government Spending as a share of GDP 1873-1993[50]

	change in gov. spending/GDP	Party
Alexander Mackenzie (1873-1878	51.10%	Liberal
John A Macdonald (1878-1892	-18.90%	Conservative
Abbot/Thompson/Bowell/Tupper (1892-1896	19.1	Conservative
Wilfrid Laurier (1896-1911	7.50%	Liberal
Borden/Meighen (1911-1921	58.90%	Conservative
WLM King (1921-1930	-25.40%	Liberal
Bennett: (1930-1935	17.10%	Conservative
WLM King (1935-1948	-9.70%	Liberal
Louis St. Laurent (1948-1957	45.30%	Liberal
John Diefenbaker (1957-1963	9.60%	Progressive-Conservative
Lester B. Pearson (1963-1968	15.60%	Liberal
Pierre Trudeau (1968-1979	13.70%	Liberal
Joe Clark (1979-1980	0.90%	Progressive-Conservative
Pierre Trudeau/Turner (1980-1984	5.30%	Liberal
Brian Mulroney (1984-1993	6.90%	Progressive-Conservative

In order to understand the nature of the regional aerospace industry, it may be instructive to turn to Bruno Amable's model of institutional complementarities.[51] Amable sought to tease out the way in which different institutional arrangements supported each other at the macro-level, identifying four

[50] "Historical Canadian Macroeconomic Dataset 1871-1994" in Queen's University Library http://stauffer.queensu.ca/webdoc/ssdc/cdbksnew/HistoricalMacroEconomicData/index.htm (accessed April, 2007)

[51] Amable, Bruno. "Institutional Complementarity and Diversity of Social Systems of Production and Innovation" in *Review of International Political Economy* vol 7 iss. 4 (2000)

essential paradigms (market-based, meso-corporatist, social democratic and European integration), based on differing mixes of education systems, research and development systems, financial structures and labor negotiation systems. In aerospace, the role of financial systems can be replaced by the role of governments in subsidizing aerospace firms, since private capital is typically insufficient to fund major projects.

For the regional aerospace industry, a number of aspects of government policy are critical to the competitiveness of aerospace firms. Firstly, investments in research and development are necessary for both increased productivity and improved aircraft. New research projects in aerospace are often prohibitively expensive, and difficult even for established firms to afford. Secondly, an aerospace industry requires an abundance of specialized engineers and skilled workers. Ambitious attempts by some states to develop a domestic aerospace industry with a deficit of these (Indonesia, for instance), have typically met with failure.[52] Thirdly, the organization of the industry is of critical value. There are considerable complementarities to be extracted from developing clusters of aerospace firms in a single area.[53] This enables convenient collaboration with local and provincial/state-level institutions, and ease of communication between upstream and downstream firms. Fourthly, the state can subsidize exports and protect the industry from foreign competition in its earlier stages.

Canada

Research and Development Policy

For a country with its wealth and economic size, Canada has historically been a laggard in investment in research and development, in particular at the level of the private sector.[54] Indeed, a quick look at the top sources of investment in R&D from the Canadian private sector will reveal that many of the major investors are the subsidiaries of foreign firms (as was the case in aerospace until the 1980's). As a result, complementarities between innovations are weak, since the bulk of invested capital for most decision-makers exists elsewhere.[55] Canada has long been an outlier, in studies relating patents per capita to economic growth because it benefits from considerable technological transfers from the United States. However, a sustained effort (increases running at near 13%/annum from 1974 to 1995) by private firms in the 80's and 90's enabled Canada to catch up with the other leading OECD economies **(see chart 8)**. The

[52] Goldstein, Andrea. "The Political Economy of Aerospace in developing countries: Brazil, Indonesia and South Africa." In *Cambridge Journal of Economics* issue 26 (2000)
[53] Porter, Michael. "Location, Competition and Economic Development" in *Economic Development Quarterly* vol. 15 iss. 14 (2000)
[54] Niosi, Jorge. *Canada's National System of Innovation* (Montreal: McGill-Queen's Press, 2000) pp. 98-112
[55] McFetridge, Donald. "The Canadian System of Industrial Innovation." In ed. Nelson, Richard *National Innovation Systems* (New York: Oxford University Press, 1993)

private sector now accounts for about half of all Canadian R&D spending, while governments and universities account for the other half.[56] Governments and universities provided the bulk of basic research, while firms themselves focused on algorithms/software, internal reports and prototypes (**see chart 9)**.

Chart 6: R&D Spending As a % of GDP[57]

	1981	1985	1990	1995	2000	2004
Canada	1.24	1.44	1.53	1.72	1.94	1.99
France	1.9	2.15	2.33	2.29	2.15	2.16
Germany [1]	2.43	2.68	2.67	2.19	2.45	2.49
Italy	0.86	1.1	1.25	0.97	1.05	..
Japan [2]	2.12	2.56	2.79	2.69	2.99	3.13
Korea [3]	..	..	..	2.37	2.39	2.85
UK	2.38	2.24	2.15	1.95	1.86	..
US	2.34	2.75	2.65	2.51	2.74	2.68
EU 15 total	1.65	1.83	1.91	1.77	1.86	..
OECD total	1.92	2.22	2.27	2.07	2.23	2.26
Brazil [7]	..	..	..	..	1.01	0.91

Chart 7: Research Activity By Area (percent devoting >20% of effort to area)[58]

Activity	industry	government	universities
Pub. Articles	2	45	67
Patents, lic.	2	7	5
algor, software	37	9	20
reports	36	27	20
prototypes	39	14	7
sem. Papers	0	11	15
demonstr.	14	14	2
other	19	18	7

Education

[56] Ibid. pp. 31-98
[57] "Main Science and Technology indicators" in *OECD* www.**oecd**.org/document/26/0,2340,en_2649_34451_1901082_1_1_1_1,00.htm (accessed April, 2007)
[58] Niosi, Jorge. *Canada's National System of Innovation* pp. 83

While Canada historically lagged behind most other large OECD economies with respect to education, it has dramatically caught up, and even exceeded most other countries since the 1980's.[59] Canadian students typically perform well on standardized OECD tests – behind only a few East Asian countries with respect to mathematics and science (**see chart 10**). In addition to eliminating Canada's formerly high rate of secondary school dropouts, Canada now has the highest percentage of tertiary graduates in the OECD. This is in part the result of institutions in Ontario and Quebec at the provincial level, largely designed to improve the skills of the median worker. Education minister and later Premier, Bill Davis, considerable increased education spending, increased the length of post-secondary education (until 2003 the Ontario education system had 13 grades instead of the typical 12), and launched a new stream of post-secondary institutions called colleges.[60] Colleges typically provide more practical training to students, and do not conduct research. In Quebec, the provincial government made post-secondary education more accessible both by heavily subsidizing the cost of tuition, and by creating a junior college system (CEGEP).[61] CEGEPs also contain a technical track, and so offer training for those seeking to enter into the trades. Thus in Ontario and Quebec, aerospace firms have ready access to skilled labor and engineers due to effective integration of the education system with the main industries within Ontario and Quebec. Amable's distinction between polarized and apolar education systems may not apply very well in Canada – at the lower end, large numbers of students (relative to other OECD countries) still do not complete high school, but the median worker is still fairly well-educated.[62] At the higher end, however, over 40% of Canadians has post-secondary degrees – with a greater focus on industry and technical applications for those degrees (through the College and CEGEP system).

[59] McFetridge, Donald. "The Canadian System of Industrial Innovation." In ed. Nelson, Richard *National Innovation Systems* (New York: Oxford University Press, 1993) pp. 299-324

[60] Wolfe, David and Gertler, Meric. "Ontario: Industrial Heartland or New Learning Region" in *European Planning Studies* vol. 9 iss. 5 (2001)

[61] Milner, Henry. *The Long Road to Reform* (Montreal: McGill-Queen's Press, 1986)

[62] Amable, Bruno. "Institutional Complementarity and Diversity of Social Systems of Production and Innovation" in *Review of International Political Economy* vol 7 iss. 4 (2000)

Chart 8: PISA Scores of students in OECD countries (mathematics)[63]

	Proficiency levels							
	Below Level 1 (below 358 score points)	Level 1 (from 358 to 420 score points)	Level 2 (from 421 to 482 score points)	Level 3 (from 483 to 544 score points)	Level 4 (from 545 to 606 score points)	Level 5 (from 607 to 668 score points)	Level 6 (above 668 score points)	% > Level 3
	%	%	%	%	%	%	%	
OECD countries								
Korea	2.5	7.1	16.6	24.1	25.0	16.7	8.1	49.7
Finland	1.5	5.3	16.0	27.7	26.1	16.7	6.7	49.5
Netherlands	2.6	8.4	18.0	23.0	22.6	18.2	7.3	48.1
Japan	4.7	8.6	16.3	22.4	23.6	16.1	8.2	47.9
Belgium	7.2	9.3	15.9	20.1	21.0	17.5	9.0	47.5
Canada	2.4	7.7	18.3	26.2	25.1	14.8	5.5	45.4
Switzerland	4.9	9.6	17.5	24.3	22.5	14.2	7.0	43.7
Australia	4.3	10.0	18.6	24.0	23.3	14.0	5.8	43.1
New Zealand	4.9	10.1	19.2	23.2	21.9	14.1	6.6	42.5
Czech Republic	5.0	11.6	20.1	24.3	20.8	12.9	5.3	39.1
Iceland	4.5	10.5	20.2	26.1	23.2	11.7	3.7	38.7
Denmark	4.7	10.7	20.6	26.2	21.9	11.8	4.1	37.8
France	5.6	11.0	20.2	25.9	22.1	11.6	3.5	37.2
Germany	9.2	12.4	19.0	22.6	20.6	12.2	4.1	36.8
Sweden	5.6	11.7	21.7	25.5	19.8	11.6	4.1	35.6
Austria	5.6	13.2	21.6	24.9	20.5	10.5	3.7	34.8
OECD average	***8.2***	***13.2***	***21.1***	***23.7***	***19.1***	***10.6***	***4.0***	33.8
Slovak Republic	6.7	13.2	23.5	24.9	18.9	9.8	2.9	31.6
Ireland	4.7	12.1	23.6	28.0	20.2	9.1	2.2	31.6
OECD total	***11.0***	***14.6***	***21.2***	***22.4***	***17.6***	***9.6***	***3.5***	30.7
Norway	6.9	13.9	23.7	25.2	18.9	8.7	2.7	30.3
Luxembourg	7.4	14.3	22.9	25.9	18.7	8.5	2.4	29.5
Hungary	7.8	15.2	23.8	24.3	18.2	8.2	2.5	28.9
Poland	6.8	15.2	24.8	25.3	17.7	7.8	2.3	27.8
United States	10.2	15.5	23.9	23.8	16.6	8.0	2.0	26.6
Spain	8.1	14.9	24.7	26.7	17.7	6.5	1.4	25.6
Italy	13.2	18.7	24.7	22.9	13.4	5.5	1.5	20.5
Portugal	11.3	18.8	27.1	24.0	13.4	4.6	0.8	18.8
Greece	17.8	21.2	26.3	20.2	10.6	3.4	0.6	14.6
Turkey	27.7	24.6	22.1	13.5	6.8	3.1	2.4	12.2
Mexico	38.1	27.9	20.8	10.1	2.7	0.4	0.0	3.1

Source: OECD PISA 2003 database. See Annex 3 for notes (*www.oecd.org/edu/eag2005*).

[63] OECD PISA 2003 database. See Annex 3 for notes (*www.oecd.org/edu/eag2005*) (accessed April 2007)

Chart 9: Tertiary Education by age group[64]

	1991	1995	2000	2004
Canada	29.9	34.9	40	44.6
France	15.2	18.6	22	23.9
Germany	20.5	22.2	23.5	24.9
Italy	6.1	7.9	9.4	11.4
Japan [2]	..	..	33.4	37.4
UK	16.3	21.9	25.7	29
US	30.1	33.3	36.5	39.1
OECD avg.	17.9	19.3	21.9	25.2

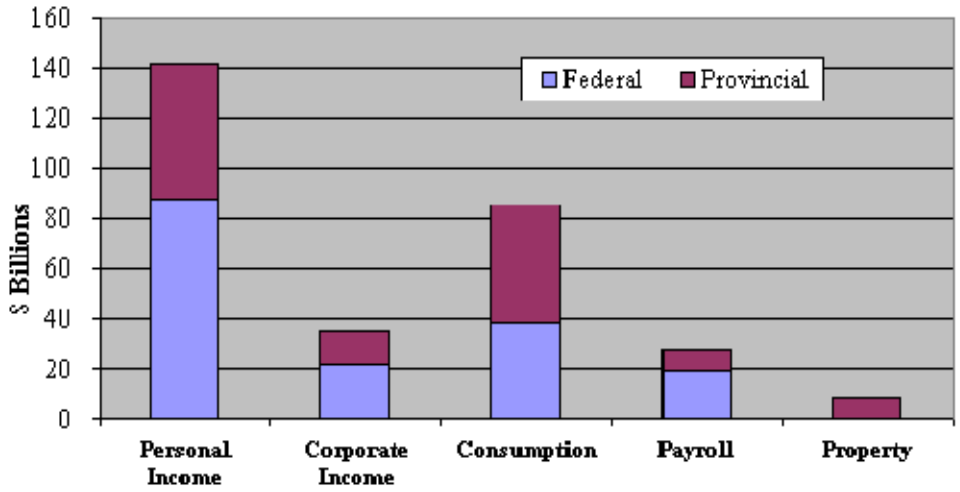
In any political discussion of social service spending it is also necessary to discuss the role of taxation. Canadian provinces, while possessing a high level of discretion over spending, do not have commensurate taxation powers. The federal government collects a larger percentage of income taxes and a smaller percentage of consumption taxes – but transfers large amounts of money to the provinces each year (**see chart 12**).[65] Additionally, equalization payments exist, acting as a regional redistribution program – offering a greater share of funds to the poorer provinces, so as to ensure relatively equal quality of services across the country. This means that for the provinces, a large share of education spending is covered through transfers to the federal government, reducing the degree to which it must be funded by politically unpopular taxes. Thus premiers have a wide latitude to invest in education, since they need not pay the full political costs of greater spending. Additionally, because responsibility for spending is not shared with the federal government, the political rewards of education spending are fully captured by the provinces (this is not the case for other services – for instance welfare).However, the flipside of this arrangement is that the tax collecting capacity of provinces is limited, capping the degree to which expenditure can be raised.

[64] "Education and Training" in *OECD* http://www.oecd.org/dataoecd/47/47/37363506.xls (accessed April, 2007)

Chart 10: Federal and Provincial Government Revenues by major area 2000-2001[66]

	Federal		*Provincial*	
	Amount $ Billions	% of Total Revenue	Amount $ Billions	% of Total Revenue
Personal Income Taxes	88.2	46.3	53.3	25
Corporate Income Taxes	27.6	14.5	14	6.5
GST/PST/HST	27.7	14.5	27.5	12.9
Other Consumption Taxes	11.1	5.8	19.1	9
Property and Related Taxes	0	0	8.7	4.1
Other Taxes	0.5	0.3	15	7
Social Insurance/Payroll	19.1	10	8.8	4.1
Total Tax Revenues	**174.2**	**91.5**	**146.3**	**68.6**
Sales of Goods/Services	4.3	2.2	7.6	3.5
Investments and Royalties	6.6	3.5	26.8	12.6
Federal Transfers	0	0	31.7	14.9
Total Revenues	**190.4**	**100**	**213.4**	**100**

Figure 6: Federal and Provincial Tax Revenues[67]



[66] "Canada's Fiscal (im)balance" in *Government of Canada website* http://dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/EB/prb0235-e.htm (accessed April, 2007)
[67] "Depository services program" in *Government of Canada website* http://dsp-psd.pwgsc.gc.ca/Collection-R/LoPBdP/images/prb0235e-1.gif (accessed April, 2007)

Industrial Policy and Location

While less averse to industrial policy than the United States, Canada's small size ultimately limits it from the development of industrial clusters at the broadest level. Additionally, attempts to do so have proven costly to governments in the past (the Mulroney government's decision to grant production of CF-18's to a Quebec-based firm instead of the low-cost bidder from Winnipeg, most famously, contributed to the rise of the populist western Canadian Reform Party, and the near-obliteration of the Progressive-Conservatives in the 1993 election).[68] Within the aerospace industry, only limited efforts at industrial policy have been attempted, through the construction of government research laboratories in Ottawa and Montreal (however, Winnipeg and Halifax also have government laboratories). Throughout Canadian history, even while most domestic industries were protected from outside competition, foreign investment and R&D has driven Canadian growth.[69] Within aerospace, this has been quite dramatically the case – De Havilland, a British company (then owned by the government, then Boeing and then Bombardier) located in Toronto, with a cluster emerging around Toronto. Further east, Pratt & Whitney, a foreign-owned engine company, set up shop in Montreal.[70] Canadair, the largest and original player began as a Vickers factory in Montreal, but, like De Havilland, changed hands, till its sale from the Canadian government to Bombardier. Thus, for many years, different Canadian firms in different locations were mere stops along the value chains of foreign firms. The decision of Bombardier to purchase De Havilland and Canadair demonstrates the considerable gains that could be had by combining the knowledge base of those two firms. De Havilland, a producer of bush planes, and Canadair, a producer of business jets, gave Bombardier both the expert labor and technological designs to produce the regional jet – in keeping with Canada's relative (to Brazil) free market orientation then, it seems fitting that private entrepreneurship was necessary to foster this arrangement.

Government Support

Like the United States, Canada has provided support for its aerospace industry largely through indirect means – in a stark contrast to the Brazilian fondness for export subsidies. This may be partly result of Canadian domestic politics, since the allocation of funds directly towards one aerospace firm and not others runs the risk of backlash from Canadian voters, and is only worth the cost if one is trading reduced margins in safe seats for increased margins in marginal seats (though the political calculus has shifted in favor of Quebec since the 1984 election). In place of more direct subsidies, the government has

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[68] Flanagan, Thomas. "From Riel to Reform: Politics in Western Canada" in *American Review of Canadian Studies* vol. 31 iss. 4 (2001)

[69] Niosi, Jorge. "Regional Systems of Innovation: Market Pull and Government Push" (Presentation: Canadian Research Network on Regional Innovation Systems) Montreal, 2000

[70] Pickler, Ron and Milberry, Larry. *Canadair: the first 50 years* (CANAV Press, 1995) pp. 7-120

proceeded by subsidizing research and development.[71] Not only does the government have general subsidies of this sort that are among the most generous in the world (aerospace firms are among the larger beneficiaries of this, being some of the largest innovators in Canada), but it also provides more directed subsidies through Technology Partnerships Canada (until the WTO ruled TPC illegal) and the Strategic Aerospace and Defence Initiative.[72] Additionally, the Canadian space agency and Canadian military provides funding for a number of projects that have positive spillovers for the aerospace industry.

Putting it Together

Canada in 1980 lacked a cohesive national innovation system. Research was largely driven foreign, private firms, minimizing its positive impact upon Canada, and the prospect for complementarities in its direction. The Canadian education system was poor, with high numbers of high school dropouts providing a dearth of skills. Additionally the aerospace industry was divided regionally and received comparatively little support from the government. Efforts at the provincial level to craft an education system able to compete in the automobile and aerospace industry were well-served by a federal push towards generous subsidies, and improved quality in Canadian universities. The regime of indirect subsidization of aerospace firms makes cost competition difficult and limits the degree to which Bombardier can expand production to achieve the necessary economies of scale to undercut Embraer. However, skilled industrial workers and indirect subsidization provides Bombardier with substantially greater flexibility in implementing new techniques and putting together new products. Ultimately, the changes in the Canadian innovation system in the past 25 years have taken away large negatives for Canadian high-technology industries; however, looking solely at Canadian institutions, it does not seem overwhelmingly abundant that national provision of public goods has been less effective than that by the relevant provincial governments.

Canada is fortunate that there were considerable complementarities inherent in its main aerospace firms. This, in itself, stems partly from luck, but also reflects the nature of the Canadian market for aircraft.[73] In a large, sparsely populated, country like Canada, commuter aircraft, business jets and bush planes make economic sense, whereas trains are more suited to densely populated, smaller countries like those in Europe. As a result, no overt industrial policy was necessary in order to ensure that the

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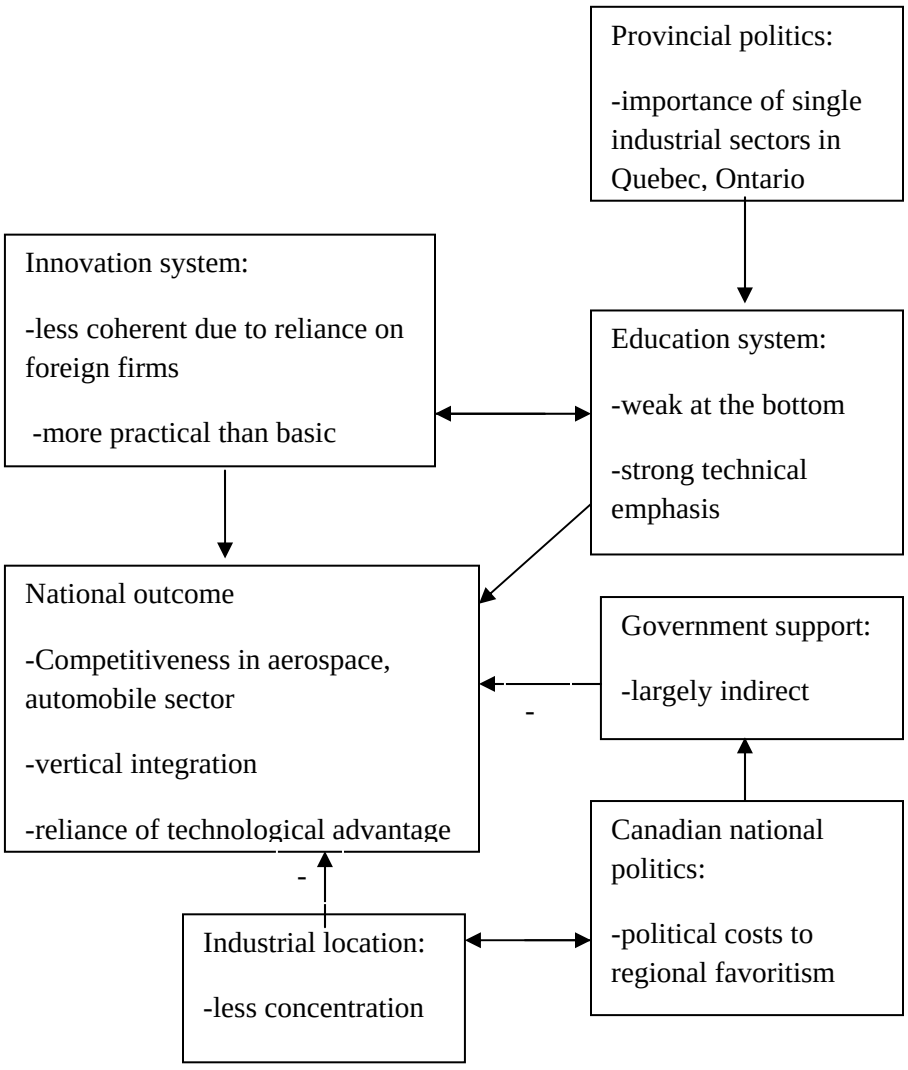
[71] Mansfield, Edward. "The R&D Tax Credit and Other Technology Issues" in *American Economic Review* vol 76 iss. 2 (1986)
[72] "Strategic Aerospace and Defence Initiative Application Guide" in *Industry Canada* http://ito.gc.ca/epic/site/ito-oti.nsf/en/h_00090e.html (Accessed April 2007)
[73] Ramamurti, Ravi. *State-Owned Enterprises in High Technology Industries: Studies in India and Brazil* pp. 175-207

development of aerospace firms was such that they contained complementarities. At the same time, government defense procurement procedures likely helped push development in this direction. Furthermore, the integration of Canadian firms with outside parent companies ensured that they were oriented towards export markets. This is a crucial factor for competitiveness, since producing for export markets helps achieve the economies of scale that define the aerospace industry. Thus, while Canadian industrial policy allowed some deconcentration of the industry, private entrepreneurship and the nature of the Canadian market enabled the eventual emergence of a strong aerospace industry. The comparative failure of national institutions to centralize aerospace in Canada through its history has fostered an industry reliant more on innovation than on economies of scale.

Indeed, here some reference to firm-level characteristics is relevant: of the many failed firms in Canadian aerospace, none were family firms, but rather were share-holder driven divisions of foreign companies. Bombardier, however, as a family firm, has a long time-horizon, and so is much more willing and able to endure the short-term losses necessary to playing a long-term game than would a firm run by managers beholden to stockholders.[74] Additionally, Bombardier's vertically integrated structure (which results from its legacy as a producer of related goods – snowmobiles and subways – and the positive externalities of owning component producers able to support both) is well-suited to the Canadian innovation system.[75] Because R&D funding is less focused, while the Canadian supply of skilled labor is sufficient to produce related goods, a vertically integrated structure was much more likely to emerge.

[74] Daily, C. M. "An Empirical Examination of Ownership Structure in Family and Professionally Managed Firms" in *Family Business Review* vol 5 iss.. 2 (1992)
[75] Abdelal, Rawi, Alfaro, Laura and Laschinger, Brett. "Bombardier: Canada *versus* Brazil at the WTO" in *Harvard Business School Case Study* 9-703-022 May 8, 2003

Figure 7: Canadian National Innovation System



Brazil

Research and Development Policy

Under military rule, Brazilian development proceeded at a rapid pace, directed heavily by the government through successive plans. After achieving macroeconomic stability, the government turned to the development of high-technology industries with three successive national 'plans' between 1973 to 1985.[76] The first plan increased the volume of resources for science and technology, through the National Fund for Scientific and Technological Development (FNDCT). The second plan directed those funds towards national priorities: alternatives to fossil fuels, space and oceanography. Key to accomplishing this was human capital development through the National Graduate Education Plan. Finally, the third plan of the military government returned to the job of expanding overall research and development funds, while also strengthening national firms in their research capacity. However, Brazil's development strategy was exceedingly debt-intensive, resulting in severe problems since the early 1980's. Per capita GDP growth fell from 3.3%/annum in the 1964-1985 period to below .7%/annum from 1985 to 2003.[77] By the mid-1980's manufactured goods in Brazil had lost their competitive edge abroad – Brazil's import-substitution policies had lead to highly diversified industry, in spite of relatively focused R&D policy.

Through the National Institute of Industrial Policy, Brazil has tried to regulate technological transfers since 1970. The aim of the institute is to protect less efficient Brazilian firms from predatory activities by foreign firms, but ultimately provides substantial obstacles for technology to diffuse to Brazil. On top of this, Brazil has fairly weak intellectual property laws, further reducing the incentive of firms to transfer technology to Brazilian subsidiaries at all. Brazil's government is the main source of investment within Brazil in technological development, however, in aggregate Brazil lags most developed countries in terms of its investment in R&D, with less than 1% of GDP.[78] This, nonetheless, represents a doubling of Brazilian R&D outlays since the mid 1980's, and, because of the smaller degree of research conducted by foreign firms, Brazilian R&D is much more heavily focused (especially since increased economic openness has eliminated less efficient firms). This, coupled with the size of Brazil's economy

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[76] Dahlman, Carl and Frischtak, Claudio. "National Systems Supporting Technical Advance in Industry: The Brazilian Experience" in In ed. Nelson, Richard *National Innovation Systems* (New York: Oxford University Press, 1993) pp. 414-451

[77] Maddisson, Angus. "World Population, GDP and GDP per Capita, 1-2003 AD" in *Angus Maddison Faculty Page* http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_03-2007.xls (Accessed April, 2007)

[78] "Main Science and Technology indicators" in *OECD* www.**oecd**.org/document/26/0,2340,en_2649_34451_1901082_1_1_1_1,00.htm (accessed April, 2007)

(about 40% larger than that of Canada) provides relatively equal footing for the national R&D systems of each country.[79]

Chart 11: Brazilian Technological Capability, by number of firms[80]

Technological Capability	Level / period											
	Advanced			Intermediate			Pre-Intermediate			Basic		
	1970 - 1980	*1981 - 1994*	*1995 - 2002*	*1970 - 1980*	*1981 - 1994*	*1995 - 2002*	*1970 - 1980*	***1981 - 1994***	***1995 - 2002***	***1970 - 1980***	***1981 - 1994***	***1995 - 2002***
Product	-	-	1	-	2	1	1		1	**2**	**7**	**9**
Production					-							
Process	-	-	-	-	-	1	-	2	3	**3**	**7**	**8**
Equipment related	-	-	-	-	-	1	-	1	1	**3**	**8**	**10**
Organisational processes												
Project management	-	-	-	-	-	1	-	1	-	**3**	**8**	**11**
Design procedures	-	-	-	-	-	1	-	-	-	**3**	**9**	**11**

[79] Maddisson, Angus. "World Population, GDP and GDP per Capita, 1-2003 AD" in *Angus Maddison Faculty Page* http://www.ggdc.net/maddison/Historical_Statistics/horizontal-file_03-2007.xls (Accessed April, 2007)

[80] Marques, Rosane and Oliveira, L. "Sectoral System of Innovation in Brazil: Reflections about the accumulation of technological capabilities in the aeronautic sector" (working paper)

Education

Today Brazilian federalism divides responsibility for education between three levels of government: municipal governments mainly address primary education; state governments hold responsibility for secondary schooling, while tertiary education is the responsibility of the national government, since the draft of the 1988 constitution.[81] Prior to that, under military rule, power was highly centralized by the central government – in part of a longstanding oscillation through Brazilian history between centralization and decentralization. This specialization of labor has coincided with an increase in the average years of schooling overall from 5.4 in the early 80's to 6.8 by the late 90's. The most rapid growth has come in the upper secondary school graduate region, which has increased by about 67% since the early 80's.[82] However, the bottom end remains fairly large due to a high dropout rate. As the returns to an additional year of schooling have decreased substantially for all but tertiary degrees, suggesting that the latter has been the greatest area of underinvestment (unsurprising because it is largely the domain of the national government, and not state governments that are the principle beneficiaries of good performance in a few high-technology industries). This should strike a dour tone for Brazil, which, as it stands has a relatively poor education system, even among developing countries. However, the education gap, while wide between regions, is relatively small in Sao Paulo, home to much of Brazil's industry. As the wealthiest region in Brazil, with its well-being tied to industry, like Quebec and Ontario, it maintains a strong incentive for investment in education – although this effect is somewhat mitigated by the fact that state governments must rely upon consumption taxes (consumption taxes are somewhat regressive, and will likely yield less income in wealthier areas because wealthier people spend less of a percentage of their incomes). Despite these efforts, expansion for Embraer may require the development of offshore facilities, as is already beginning to be the case.

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[81] "Estatísticas populacionais, sociais, políticas e culturais" in *Brazilian Institute of Statistics and Geography* http://www.ibge.gov.br/seculoxx/arquivos/educacao.xls (Accessed April 2007)

[82] Blom, Andreas. "Education, Earnings and Inequality in Brazil 1982-1998" in *World Bank* http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079934475/Education_earnings_inequality_Brazil_EN00.pdf (accessed April, 2007)

Chart 12: Brazilian Education system 1980-1998 (% of workforce by level of schooling)[83]

	1980	1990	1998	80 to 90	90 to 98	80 to 98
no degree	36.7	27.7	21.5	-24.80%	-22.10%	-41.40%
Primary	32.7	34.2	34.3	4.60%	0.30%	4.90%
low sec	11.9	13.2	15.1	10.90%	14.40%	26.90%
up sec	11.2	15.5	18.8	38.40%	21.30%	67.90%
Tertiary	7.5	9.5	10.3	26.70%	8.40%	37.30%
Sum	100	100	100	-	-	-
yrs of school	5.4	6.2	6.8	14.80%	9.90%	26.20%

Government Support

While Brazilian overall institutions have been fairly weak at providing a basis for the evolution of an aerospace industry, more specific institutions have allowed the emergence of Embraer as a leader. The Aeronautics Technology Institute was created in 1946 to train workers with the skills necessary to work in the aerospace industry.[84] Additionally, the military orientation of Embraer enabled it to tap a fair share of the research money available in general (space being one of the main priorities for development under the military government). Furthermore, Brazil's state-run airline industry was initially developed in such a manner as to provide a market for Embraer – through the creation of four regional airlines. Military contracts have further bolstered Embraer's development into a leading aerospace firm. As well, a series of Brazilian institutions have provided Embraer with export subsidies, enabling larger production runs and greater economies of scale. Relative to the Canadian case, Brazil's national government has provided considerable *direct* support for Embraer, in order to foster the development of a world-class firm. Since Brazil's transition away from import-substitution policies, and the WTO case against its export subsidies, government support for Embraer has been reduced considerably and, in contrast to the subsidy argument, this has been the period of greatest success for the firm.[85]

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[83] Blom, Andreas. "Education, Earnings and Inequality in Brazil 1982-1998" in *World Bank* http://siteresources.worldbank.org/EDUCATION/Resources/278200-1099079877269/547664-1099079934475/Education_earnings_inequality_Brazil_EN00.pdf (accessed April, 2007)

[84] Dahlman, Carl and Frischtak, Claudio. "National Systems Supporting Technical Advance in Industry: The Brazilian Experience" in In ed. Nelson, Richard *National Innovation Systems* (New York: Oxford University Press, 1993) pp. 414-451

[85] Abdelal, Rawi, Alfaro, Laura and Laschinger, Brett. "Bombardier: Canada *versus* Brazil at the WTO" in *Harvard Business School Case Study* 9-703-022 May 8, 2003

Industrial Policy and Location

In contrast to the Canadian case, in Brazil Embraer was both the only aircraft firm (there were downstream firms specialized in aerospace as well), and was owned by the government. Brazil's military government had no qualms about engaging in industrial policy, and, given the concentration of educated workers in Sao Paulo likely had little option but to centre Embraer in Sao Paulo. The main limitation on the evolution of a Brazilian cluster lay in the continuing reliance of Embraer on imported parts. The development of an aerospace cluster in Sau Jose dos Campos has enabled the Brazilian government to focus the location of supporting institutions (eg. INPE and CTA).[86] Furthermore, an important aspect of assigning responsibilities for policy areas lies in assigning responsibility to the lowest level able to do the task.[87] Thus ensures that the body providing the good is both able, and more exclusively committed, since increased size is associated with a greater diversity of interests. In Canada, provincial governments in Manitoba, Alberta and Nova Scotia must trade off the interests of their aerospace industries with other substantial groups competing for a hearing. In Sau Paulo, on the other hand, the degree of employment (both direct and indirect) diminishes the degree to which the regional government needs to make such tradeoffs in designing policy.

In additional to concentration, Brazilian industrial policy stressed specialization and export orientation. Realizing that Brazil would be unable to compete in the production of large commercial aircraft, Embraer focused on building smaller military craft (especially training planes) and shorter range jets.[88] The government created four regional airlines in order to ensure that there would be a natural marketplace for Embraer's civilian aircraft – banking on the existence of dual-use technologies that could also strengthen the Brazilian air force.[89] A similar approach was taken to a range of other industries in Brazil (for instance, the production of computers), but those industries were generally not internationally competitive, and survived largely because of high tariffs.[90] However, Brazilian aircraft were constructed with the intent of exports – making larger economies of scale possible, and opening up the industry to competition in export markets (though the home market was relatively safe for Embraer).

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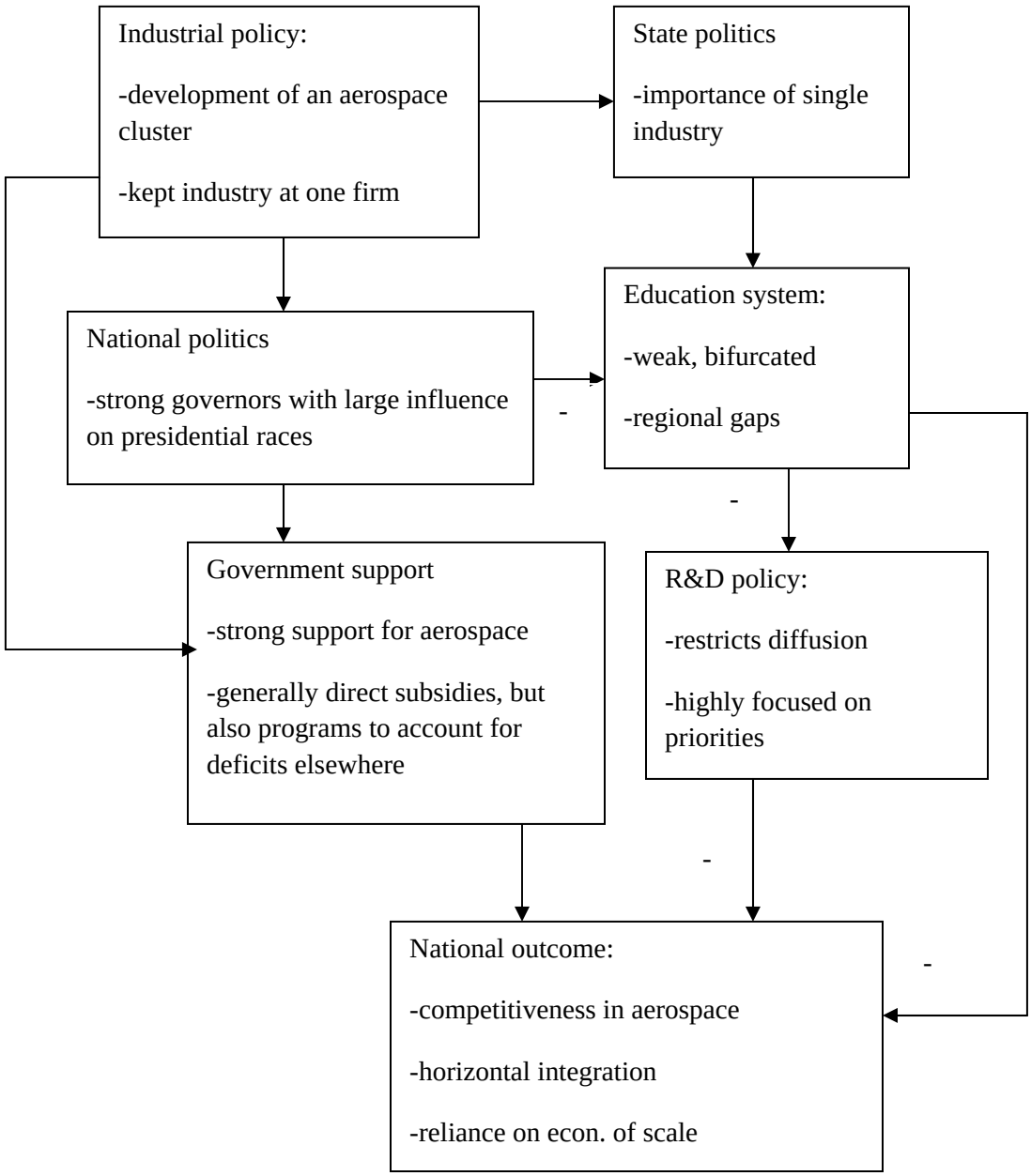
[86] Goldstein, Andrea. "The Political Economy of Aerospace in developing countries: Brazil, Indonesia and South Africa." In *Cambridge Journal of Economics* issue 26 (2000)
[87] Ostrom, Elinor. Understanding Institutional Diversity (Princeton: Princeton University Press, 2005) pp. 281-287
[88] Bernardes, Roberto and de Oliveira,Luis "Building up complex production systems in developing countries: the Embraer experience." In ed. Cassiolata, Jose, Lastres, Helena, and Maciel, Maria *Systems of Innovation and Development* (Cheltenham: Edward Elgar Press, 2003) pp. 499-525
[89] Ramamurti, Ravi. *State-Owned Enterprises in High Technology Industries: Studies in India and Brazil* pp. 175-207
[90] Ibid. pp. 212-248

Brazilian Summary

The political constituency for aerospace in Brazil is stronger, even as Brazilian resources for the industry are lacking. Embraer was fortunate during the period of import substitution in that its mandate fell within the goals of Brazil's military government, ensuring the necessary specific support that the industry needed in order to grow and reach effective economies of scale. Brazil's political system of decentralization and strong governors has enabled this to take place at both the national and state levels. On the one hand, greater autonomy for Sao Paulo enables the state to maintain much of its considerable wealth, and tend to its own interest, albeit only at the secondary level. By comparison, performance in tertiary education has been worse and, as suggested by the increase in the overall returns to tertiary education, it has likely faced underinvestment. While Brazilian R&D policy is more focused, to the benefit of Embraer, it is also less well-funded and burdened with institutional obstacles. Relative to Canada, aerospace in Brazil has developed much more as a result of national policy direction – bolstered by positive political incentives to develop in such a fashion. The conduct of industrial policy by the Brazilian military government aided in the creation of a strong domestic constituency for aerospace on Sao Paulo – ensuring governmental support at the national and state level.

Additionally, Embraer is able to succeed more because of aerospace-specific policies in Brazil (and their legacy), and not because of inherent strengths within the national innovation system. The net result is a firm reliant upon economies of scale, and not a broader research capacity. If the Brazilian retrenchment of subsidization continues, expansion in order to obtain economies of scale will be difficult – on top of the general lack of specialized labor within Brazil. Thus, the success of Embraer hinges very much on the weight of Sao Paulo's political relevance, to maintain the broad set of aerospace-related institutions that bolster Embraer. Without government capital it may be necessary for off-shoring – a strategy likely to cause problems in the future, given the importance of Embraer's industrial cluster in fostering a political environment favorable to its interests.

Chart 13: Brazilian National Innovation System



Strengths and Weaknesses of this Approach

With a degree of humility uncharacteristic in academia, this paper must stress the limitations of the model developed herein. There are a number of factors that have been left exogenous to the model, which it does not explain. Some major omissions are firm-level characteristics, oil prices, the aerospace business cycle, it is uncertain that this model will apply to other industries and it selects on the dependent variable by only discussing successes. With regard to the first, it is necessary to turn to Murmann's

Knowledge and Competitive Advantage. Murmann, looking at the synthetic dye industry, puts forth an evolutionary model rooted in evolutionary theory. Social science can benefit from producing models that establish the systemic constraints upon firms, as does Murmann.[91] While this may miss the rich story of Laurent Beaudoin, or the typo that turned the "ski-dog" into the "ski-doo", individual and firm-level actors may not be able to comprehend the system around them that moulds their long-term form. Because this model does not account for individual behaviors, it will be prone to mistakes – but in the long run the systemic logic of favorable national political institutions will hold.

Secondly, there are a number of aspects of the industry that tend to create aerospace business cycles. While this model cannot predict their occurrence, it can predict how these effects will interact with the Brazilian and Canadian innovation systems. Rising oil prices create increased scrutiny over fuel economy, since they decrease considerably the percentage of the lifetime cost associated with the purchase of the aircraft itself. This will tend to favor higher quality, more expensive aircraft, of the sort more akin to Bombardier aircraft.[92] On the other hand, low fuel prices will tend to favor low-cost aircraft. At the same time, there may be a second-order shock because oil prices will have different effects upon different regions – at least in Canada where some regions of the country are oil producers and others are net consumers. As for the business cycle in the aerospace industry, this is largely connected with war, and the demand for air travel. In the former case of increased conflict (and demand for military jets), Embraer's military production stands to benefit.[93] However, military conflicts may also have long-term affects either by changing domestic political cleavages or forcing a reassessment of particular national institutions. Thus, while the model is imperfect, it can offer more nuanced explanations of various events than would otherwise be possible.

Thirdly, applications of this model to other industries may be dangerous. To begin with, there are many aerospace-specific aspects in play that would not matter in studies of lettuce-farming. Presumably the economies of scale in such enterprises are fairly limited, and the scope for technological improvement similarly minimal (at the very least the cost of innovation is comparatively affordable). The other benefit of having few firms (eg. greater simplicity for repair) fails to apply for lettuce, or any other generic product. Other products may lack the tendency to produce clusters of related firms, which would substantially reduce the applicability of the political aspect of this model to such industries. However, in general, this model does apply to high technology industries, and some future study of its applicability to others is in order.

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[91] Murmann, John. *Knowledge and Competitive Advantage*
[92] Tyson, Laura. *Who's Bashing Whom: Trade Conflict in High-Technology Industries.* pp. 155-176
[93] Ferreri, Domenico. *Marketing and Management in the High-Technology Sector* (Westport: Praeger, 2003)

Fourthly, this model was constructed from the successes in the industry, with relatively little discussion of the other regional aerospace firms that failed to survive in the regional jet industry. This is partly unavoidable due to a lack of data on those unsuccessful firms. Perhaps in time such information will become available. As well, the study compares two currently successful firms that had periods of relatively less success, minimizing, but not eliminating the problem.

Explaining the Past

The co-evolution of firm, industry and the national level largely explain industrial evolution in aerospace. Without centralization or common direction (for which there was little political incentive, given that the industry was located primarily in non-marginal seats), Canada's aerospace industry was principally made up of links on foreign-owned value chains. This link, however, included downstream firms (such as Pratt and Whitney), and was oriented towards serving Canada's large market for smaller aircraft. The Airline Deregulation Act in the United States and similar deregulations elsewhere in the world created a vastly increased opening for commuter airlines, which proceeded to set up shop in the United States and elsewhere. Institutional entrepreneurship is ultimately about creating the *conditions* wherein private entrepreneurship is possible.

While British Aerospace was an early entrant to the regional jet market, its plane was overly costly, and a larger family was not constructed. Bombardier was able to obtain an early lead in the market, capitalizing on a number of factors. Firstly, Canada's massive buildup of R&D spending and considerable increases in the availability of skilled workers gave Bombardier a particular edge. Secondly, the specter of Quebec separatism gave the Canadian government an overwhelming incentive in supporting the Quebec-centered industry. Thirdly, Bombardier was able to capture considerable complementarities by purchasing similar firms (all producing smaller planes), that had not been previously realized. As a family firm with a long time-horizon, it was better able to make concessions in this regard, and so was able to beat out other firms, that had to answer to stockholders. Embraer was not able to make inroads during the same period, as Brazil's debt crisis forced the government to cut back on research and development programs – not to mention doubt over the future of Embraer.

However, after being privatized by the Brazilian government, Embraer was able to mount a considerable challenge to Bombardier, dramatically turning the tables. Brazilian industrial policy ensured that the Brazilian aerospace cluster was more efficiently allocated – centered in a single city. This, coupled with Brazil's political system of strong governors has given Sao Paulo influence beyond the large number of deputies it elects – ensuring a strong pro-aerospace constituency in the presidency (Sao Paulo is a swing state) and in congress. Additionally, Embraer had a long history of specialization in the

production of similar products to those of regional jets. While Canada had a better system of education, and more R&D spending, focused institutions enabled Embraer to compete, while its horizontally integrated structure gave Embraer more room to seek partnerships (such as its partnership with Dassault).[94] Low oil prices in the mid-to-late 90's focused purchasers on the price of the aircraft, a strongpoint for Embraer.[95] Finally, the end of import substitution was a boon to Embraer. Manufacturing firms in other industries, producing uncompetitive goods were priced out of the market, providing Embraer with cheaper labor and raw materials. Finally, as a latecomer firm, research was less expensive for Embraer, simply needed to mimic existing technologies.

Thus Bombardier and Embraer have been locked into a titanic struggle for domination of the industry. In spite of the early focus on subsidies, the re-tooling of both TPC and Pro-Ex mean that the battleground will lie within national institutions. Material changes around the world will interact with firms and national institutions and ultimately determine the course of the industry. For instance, the lifetime cost of most aircraft is exceeded by the cost of fuel for that aircraft. In a period of high fuel costs, Bombardier's higher cost approach will likely pay off, as purchasers can get better fuel economy (or at least greater customer comfort with the same amount of fuel economy). The onset of a major war would give Embraer something of an edge, as it would be able to pick up additional contracts, and possibly gain valuable technologies and skills through the production of military aircraft. Apart from material shocks to the industry, it is unlikely that either firm will die off, in that both represent valuable aspects of the industry. Bombardier's long focus and better research linkages make it likely that Bombardier will be the main innovator within the industry. However, Embraer's ability to produce lower cost aircraft will enable it to prevent Bombardier from winning a monopoly over any particular segment of the regional jet market.

Conclusion

It is impossible to simply talk about industrial leadership in the regional jet industry as stemming from political support, subsidies, national innovation structures, or enlightened corporate governance. Rather, it is far more useful to throw parsimony to the winds, and look for all relevant linkages that drive leadership in the industry – separating out the causal from the merely correlative. Key to success in aerospace for Brazil and Canada have been polycentric structures of governance, with each providing appropriate public goods (from the perspective of the industry – it is entirely possible that subsidies to the

[94] Ghemawat, Pankaj, Herrero, Gustavo and Monteiro, Felipe. "Embraer: The Global Leader in Regional Jets" in *Harvard Business School Case Study* 9-701-006 October, 2000
[95] Tyson, Laura. *Who's Bashing Whom: Trade Conflict in High-Technology Industries.* pp. 155-176

industry are not justified by the opportunity cost of such spending). However, it is necessary to go beyond endogenous tariff theory, and to examine how each level of government, driven by politics, intermeshes itself with the national aerospace innovation system – both in deep ways, and fickle ways. Unfortunately the newness of the subject matter prevents further quantitative and empirical testing, which will have to be conducted later.

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