Infrastructure, Trade Driven Growth Potential and Economic Development in Two Dominions: Canada and Australia Compared, 1917-1975 [*]

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Carl Mosk [**]
Department of Economics
University of Victoria

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** **e-mail: mosk@uvic.ca**

homepage: web.uvic.ca/~mosk/mosk-hp.html

Abstract

The ability to sustain long-run economic growth has been variously attributed to institutions, human capital accumulation, international integration through trade, and the constraints imposed by geography. In this paper I argue that the main impact of institutions upon economic growth lies in the social capacity to invest in infrastructure in response to improvements in income. In addition I argue that geography matters mainly through its impact on international integration. Comparing the development experience of two former British Dominions – Canada and Australia – that share a common British institutional heritage, I show that both countries responded to rising income by improving infrastructure, but infrastructure alone does not explain growth in these countries. I create a summary growth potential measure by equally weighting together three domestic infrastructure variables – for educational achievement, for health, and for physical (transportation/communications) infrastructure per capita – with a trade based variable, trade driven growth potential, computed by multiplying trade openness by the (trade weighted) relative income per capita of major trading partners. Generating annual time series in this measure – for Australia, between 1917 and 1975; for Canada, between 1926 and 1975 – I explain why each country grew at the rate it did, and I explain why Canada grew faster than Australia. The ultimate reason for Canada's relative success is rooted in geography. Located next to the high per capita income United States, Canada enjoyed greater trade driven growth potential than did Australia.

I Institutions, Human Development, Trade Openness and Geography

The ability to sustain long-run economic growth has been variously attributed to institutions, human capital accumulation, international integration through trade and the constraints imposed by geography. This conclusion comes from a reading of recent contributions to the literatures in economic history, economic development, international trade and aggregate growth theory. [1] In this paper I argue that institutions mainly matter because they either discourage or encourage private and public investment in infrastructure, and that the impact of geography is most strongly felt in its impact upon the trading partners to which a land is attracted through gravitational pull.

It is important to be clear about the role that geography plays in this argument. Geography *per se* does not matter. International institutions governing the cluster of countries with which a nation trades *may* trump geography. Historically, there are cases where it has. The experience of pre-World War II Australia and New Zealand in integrating with the British Empire is a case in point. Still, as the Canadian case demonstrates, geographic distance does exercise a strong gravitational pull on trade. In this sense it shapes long-run development.

To restate the thesis of this paper in slightly different language: a nation's long-run economic growth depends upon the social capacity to import and adapt technology from foreign countries with which it integrates. [2] Integration mainly comes through bilateral trade and the associated flows of capital and people that lubricate the wheels of this trade. Social capacity ultimately depends upon levels of physical, human capital enhancing and financial infrastructure. [3] Societies failing to channel additional resources that accrue to them - as their economies grow or they tap into the largess of international

agencies or the coffers of multinational corporations by taxing their activities - into infrastructure enhancement limit their ability to extract long-run growth benefits from international trade. Social capacity interacts with the international opportunities dropping into a county's lap, the resulting interaction shaping its long-run growth path.

The role of institutions in conditioning the way income improvements are channeled into public and private investments in infrastructure is crucial to the argument developed here. For instance, both Easterly (2001) and Sokoloff and Engerman (2000) argue that substantial diversity – religious and cultural - may discourage investment in infrastructure, partly because social divisiveness encourages decentralized rent seeking corruption that impedes business, partly because it discourages the spread of education and democracy to all ranks of society.

Given the potential importance of infrastructure in conditioning the relationship between income improvement and infrastructure investments, and therefore the impact of trade upon growth, it is useful to control for institutional variation in carrying out analysis of long-run growth. To this end I have selected Canada and Australia for study. [4] While it would be an exaggeration to claim that Canadian and Australian institutions are identical, they are not very dissimilar. Both countries slowly emerged as independent nation states out of the nexus of the British Empire, confederating out of colonies, becoming Dominions in the Empire, and eventually securing complete control over their foreign policies and legal systems during the 1930s. Both countries have parliamentary systems modeled on the British system; both adhere to the Common law (Quebec in Canada is an exception); both are confederations, federal powers being strongly limited

by the devolution of power to provinces in Canada and states in Australia; both continue to exercise salient political voice within the British Commonwealth.

An additional reason for focusing on the Australia and Canada in explaining long-run growth lies in the "crisscrossing" of levels of income per capita highlighted by Greasley and Oxley (1998.) In the early twentieth century Australian per capita income outstripped Canadian; by the 1960s, Canadian outstripped Australian. Both countries experienced substantial long-run growth but Canada's growth rate was greater than Australia's. Why?

II Infrastructure Expansion in Australia and Canada, 1911-1975

As income per capita rose in Australia and Canada between the 1910 and the mid-1970s, infrastructure deepened in both jurisdictions, in a remarkably parallel fashion. Still, it deepened more in Canada than in Australia, offering an important reason why Canadian income per capita grew more quickly than did Australian income.

In constructing estimates for infrastructure I aimed at generating measures that are comprehensive and plausible for the purposes of my analysis. I am well aware that selecting any set of variables to weight together in fashioning an overall index of infrastructure is arbitrary to a degree.

But what is to be done? Empirical analysis is never free from the criticism that it is arbitrary to some extent. In any event there is a rationale for my choices. My measures include both physical and human capital enhancing infrastructure. These two components of infrastructure tend to reinforce each other (endnote 2 illustrates this point); at the same time they do not mirror each other exactly. They are not mere surrogates for one another.

For instance, as can be seen from the estimates discussed in this section the infant mortality rate that I use in estimating health was quite high in Canada during the early twentieth century despite Canada's relatively advanced educational attainment. [5]

Consider the figures assembled in Table 1 for Australia for three components of infrastructure: physical infrastructure represented by various facets of transportation (motor vehicles registered) or communications per capita (telegrams, radios, televisions); and two components of human capital enhancing infrastructure, educational attainment (captured with estimates of attendance rates for primary and secondary schooling) and health (containing the infant mortality rate.) [Table 1 about here.] Summing per capita transportation and communications yields a summary variable TC; summing TC with the proxy for school attendance (PSAR) and health (H), and dividing the resulting sum by three yields an overall summary measure for domestic infrastructure (DINF) that appears in the right hand column of the table. Note that DINF has almost tripled in value over the period 1911/15 to 1971/75.

For Canada the multiplication rate by which DINF expanded between 1911/15 and 1971/75 is considerably larger. This is apparent from the estimates assembled in Table 2. [Table 2 about here.] Indeed between 1916/20 and 1971/75, Canadian DINF increased tenfold. To be sure, Canada's superior growth in infrastructure is exaggerated to a degree by the absence of figures on radio licenses and/or radios purchased prior to the mid-1950s. For instance if we assign a figure of 20 per 100 persons for Canadian radio ownership in 1916-20 (a figure that errs on the high side), we still only get a figure of 20 for the overall value of DINF, yielding a fivefold expansion of the summary infrastructure variable over the period 1916/20 to 1971/75.While we might quibble over

the precise number whereby Canadian infrastructure expansion exceeds that of Australia, that it did so is not in question.

To be sure there is potential circularity in claiming that Canadian superiority in the growth of infrastructure explains *why* Canadian per capita income grew more rapidly than Australian. [6] One can argue the converse: the very fact that Canadian per capita income grew more rapidly than Australian can itself explain why Canadian infrastructure improved at more vigorous pace than did Australian infrastructure. As income levels improve, the ability of households to pay for goods and services including health enhancement and education is enhanced. As well the taxation base that local and national governments can tap into for the funding of public investment in infrastructure is enhanced as per capita income rises.

Against the argument that income improvements automatically translate into greater expenditure devoted to infrastructure improvement and expansion are the multiplicity of particular examples offered by Easterly (2001) suggesting that bad policies and bad politics, corruption, an inadequate judicial system, and other ills have impeded exactly the translation of income improvement into infrastructure upgrading apparent for Australia and Canada. Could institutional constraints independently explain the outstripping of Australian infrastructure expansion by Canadian?

This is unlikely. Consider the most likely candidate. Diversity. Studies of Australian and Canadian education suggest that both countries struggled with issues of religious diversity in developing their educational infrastructures (the realm of infrastructure most sensitively impacted by cultural differences.) [7] Interestingly, both countries solved the problem in the same way, by initially allowing limited

denominational control over local education that was acceptable to both Protestants and Catholics, then promoting secularization in schooling. Indeed, Australia moved more rapidly to secularize compulsory education than did Canada, the secularization movement making important regional gains almost a half century prior to formal confederation in 1901 (Tasmania colony taking the first step, followed by Victoria and Queensland colonies in the 1870s.) And this is precisely because Canada struggled with an issue that Australia could and did avoid. Coping with a significant Francophone minority, especially one concentrated in a single province of Canada, in Quebec, made working out an approach for public education politically contentious. In Canada school boards divided along both linguistic *and* religious lines in the two provinces of Ontario and Quebec where the bulk of Canadian population was concentrated historically. In short, if either country was at an institutional disadvantage in developing infrastructure it was Canada, not Australia.

Geography may have played some role in Canada's infrastructure surge. Situated next to the United States that aggressively embraced automobile ownership, communications and education at the turn of the twentieth century gave a fillip to Canadian infrastructure development. Cross-border spillover and emulation is a powerful engine for international diffusion of infrastructure particularly that transmitted through the air. Most Canadians lived (and continue to live) near the border with the United States, within a one hundred mile band of the border. Armed with a radio or television, they could pick up broadcasting from their southern neighbor. The richer the programming menu one can tap into with a radio or television set, the greater the incentive to purchase a receiving device. [8] The rapid and early development of

communications in American behemoth encouraged the diffusion of communications in Canada.

Similar logic applies to the diffusion of vehicles. Canadians owning automobiles or trucks could, did, drive them on the paved roads of the United States. Early diffusion of automobile ownership in Canada encouraged relatively early construction of a paved road network in Canada, thereby giving an additional impetus to automobile assembly within the country.

Again, Canadians seeking an advanced education could and did apply to American schools. Canadian teachers could and did enroll in education programs and normal schools in the United States, which – as Goldin (1998) argues – was a pioneer in promoting secondary school expansion during the period 1910-40. The pressure of American educational models, the existence of American textbooks produced for a huge domestic market that were sold throughout North America, and the natural force of diffusion flowing across a common border largely populated by speakers of a common language on both sides was felt by the Canadian educational system with an intensity that was not felt by geographically isolated Australia. For instance, the junior college movement spearheaded by California in the 1950s was rapidly emulated in Canada, especially in west coast British Columbia.

Returning to a comparison of Tables 1 and Table 2, we can draw some general conclusions about infrastructure development in the two countries. Canadian infrastructure was less well developed than Australian around World War I. In part because it started at a lower base, it expanded more rapidly than its Australian counterpart. But, reflecting its more vigorous growth, it also reached a higher level by the

early1960s. There is crisscrossing in the infrastructure series paralleling crisscrossing in the income per capita series. In Figure 1 based upon ratios of income per capita and ratios of the DINF variable for the two countries (with Canadian figures in the numerator and Australian figures in the denominator) the crisscrossing of the two series is clearly evident. [Figure 1 about here.]

It is unlikely that institutional differences account for the superiority of Canada's record. Geography (propinquity with the United States) working through diffusion may explain some of this superiority. What about our third candidate: income per capita? Assume a factor other than domestic infrastructure raises Canadian per capita income more vigorously than it does Australian. This could account for more rapid growth in Canadian infrastructure.

That income per capita and infrastructure are closed linked for these two countries, causation potentially running backward and forward between the logarithms for the two variables through feedback, is evident from the Figure 2 scatter diagram. [Figure 2 about here.] The data paired in the scatter diagram are logarithms of five-year averages for infrastructure and for income per capita for 1911-1975, the observations for both countries pooled.

Income per head and infrastructure move together for these two countries in a remarkably similar way. But as has been stressed the two variables are not identical. From the crisscrossing pattern evidenced in Figure 1 it is apparent that the crisscrossing in infrastructure lags the crisscrossing in income per capita by a decade or slightly more (the income series cross around 1945 but the infrastructure series cross around 1959.) Moreover Canadian relative income levels fall precipitously during the mid-1930s. The

suspicion is that the pull of the American economy upon the Canadian, working through demand for imports from Canada, is driving both phenomena: the downswing of the 1930s, and the relatively early income per capita crisscrossing.

In making this interpretation from Figure 1 it is important to emphasize the fact this argument assumes that the Canadian income decline of the1930s is largely explicable in terms of a sustained falloff in aggregate demand not supply, income per capita falling far short of the potential level of income per capita that would have obtained had full employment of labor and capital been secured. Indeed, the thrust of my argument is that a variable that combines infrastructure with trade driven growth potential tracks well the path of potential income per capita (aggregate supply per capita), which may or may not equal actual income per head depending on the state of aggregate demand.

It is to the trade growth potential variable that we now turn our attention.

III Trade Driven Growth Potential

Repetitive contact between the firms and households of two countries is an important agent through which ideas flow from one country to the other. Migration, especially two way or "U-turn" return migration, from one country to the other is one source of repetitive contact. Another is trade. A third is investment flowing between the two countries. Often, but not always, these three flows reinforce one another, moving together.

Countries that actively trade with one another exchange ideas because competing in each other markets forces companies selling in both markets to adjust to the market

standards of both nations. This stimulates emulation whereby innovations spread from country to country through imitation.

Producers in lower income per capita countries that actively trade with higher income per capita countries are encouraged, are under pressure, to upgrade their technologies and performance standards under the pressure of this type of trade, to jettison their comparative advantage. To keep their share of the domestic market they feel constrained to imitate lest they lose out to firms based in higher income countries; to build a market base in the higher income country they must find a way to compete where standards are likely to be higher.

It is important to emphasize that this argument hinges on the assumption that the two countries are producing the same goods, they are engaging in intra-industry trade. If firms in the higher income land produce goods that few if any companies in the lower income country are struggling to fashion and bring to market, how much knowledge spillover can there be between the two trading partners? Can Peruvian or Indonesian villagers carving dolls and trinkets expect to secure major market share in the United States where most toys are constructed from plastic and designed to be battery operated?

In principle, the greater the gap in income per capita between a country and its major trading partners, the greater the opportunity, the greater the pressure, to imitate. If a low-income country concentrates on producing raw materials that its partner does not produce in abundance, the pressure to upgrade is muted. The existence of trade between economies with radically different economic structures limits the universality of this argument.

There is another limiting factor: differentials in infrastructure between the trade partners. Whether firms can effectively imitate or not depends heavily on the infrastructure environment within which they operate. In low income lands with poorly developed infrastructure – for instance high levels of illiteracy, poor roads and ramshackle telecommunications, inadequate banking and financial regulatory and monitoring institutions – firms may find it difficult to imitate.

In short, trade adds opportunities for imitation and emulation to those generated by domestic infrastructure thereby fashioning long-run growth potential from an amalgam of domestic and international forces acting upon a national economy.

Using this logic I construct the variable DINFTDGP expressing the potential income per capita supply supporting sum of potential trade spillovers with domestic infrastructure as follows:

- I compute trade driven growth potential (TDGP) for a country by multiplying the level its trade openness (the ratio of merchandise imports plus exports to gross domestic product, all variables measured nominally) by the ratio of its income per capita relative to the (average trade weighted) income per head of its major trade partners (the trade weights are computed for the trade with major trading partners only.) Let "To" represent trade openness and "rympt" the relative income of a country compared to its major trading partners. Then,

  TDGP = (To)*(rympt).

- I compute the sum of trade driven growth potential TDGP and domestic infrastructure DINF by adding the two variables together and computing the average. That is,

DINFTDGP = (DINF + TDGP)/2.

My estimates for Australia and Canada appear in Table 3. [Table 3 about here.] Note that because the figures from which trade openness is computed are not available for all the years between 1911 and 1975, the TDGP and DINFTDGP series are not computed for all of the five-year periods for which I computed DINF.

The key point to draw from Table 3 is that Canada was blessed with greater trade driven growth potential than was Australia. The primary reason – indeed, basically the only reason for this advantage – lies in the fact that Canada traded (and continues to trade) extensively with the United States and Australia does not. Geography is not destiny. But under the appropriate circumstances it can be decisive.

That the DINFTDGP variable can be used to explain the path of per capita income development in the two countries is the message of Figures 3 and 4 that display indices for income per capita and for DINFTDGP for each nation taken separately. [Figures 3 and 4 about here.] That relative levels of DINFTDGP can better explain relative levels of income per capita than can DINF alone is the message of Figure 5. [Figure 5 about here.] Figure 6 parallels Figure 2. [Figure 2 about here.]

Canada's income per capita grew because its domestic infrastructure was substantially upgraded, and because it traded extensively with countries that had a higher per capita income than it had. While the same forces were at work in Australia, the advantage attributable to trade was far less than it was for Canada. Hence Australia's per capita income grew more slowly than did Canada's. And because gains in infrastructure investment mirror gains in levels of income per capita, the crisscross in income per capita attributable to Canada's trade ultimately translated into a crisscross in infrastructure.

IV Conclusions

In this paper I argue that long-run growth for nations is the resultant of domestic infrastructure improvement and opportunities due to international trade. Using data on Australia and Canada I demonstrate the validity of this thesis.

In general the argument I make can be used to support a variety of views on the determinants of growth at the global level. It supports the view that institutions can and do matter since a poor institutional environment tends to depress incremental investment in infrastructure flowing from increments to income per capita. It supports the view that geography may, but does not, *automatically* matter. Trade can play a role in stimulating growth. In particular the view advanced here places strong weight on the interaction of geography with trade. What matters is not trade openness *per se* but rather trade openness adjusted for the countries that a nation trades with, which in turn may reflect geography. This last argument is consistent with recent findings concerning the globalization that suggest regional economic integration has been more important than globalization. Regions that have strong growth engines – Western Europe during the 1950s and 1960s with its French and German growth engine, North America with its United States engine, East Asia in the 1960s and 1970s with its Japanese growth engine – generally have done well as regions. Nations situated within these blessed regions have experienced better than expected growth prospects due to the regional trade growth associated with regional income expansion. [9]

These are the principal arguments flowing from the comparative analysis of Australian and Canadian twentieth century development undertaken here. It is hoped that

exploring and elaborating the implications of the arguments advanced here for other countries will form the basis for future research.

Table 1: Computing a Summary Measure of Domestic Infrastructure (DINF) for Australia, 1911-1975

Years	Per Capita Transportation and Communications [a]					School Attendance Rates		100-imr [d] (H)	Summary Measure (DINF)
	Telegrams	Radios	Televisions	Motor Vehicles	Sum (TC)	Primary & Secondary (PSAR) [b]	University [c]		
1911-15	2.9	-	-	-	-	68.9	0.4	29.7	33.8
1916-20	3.1	-	-	-	-	72.0	-	35.4	37.0
1921-25	2.9	-	-	4.3	7.5	75.4	0.9	42.1	41.6
1926-30	2.7	3.9	-	9.4	15.9	79.1	-	48.0	47.7
1931-35	2.1	7.5	-	9.9	19.5	80.5	0.8	58.8	52.9
1936-40	2.5	14.9	-	12.2	29.6	83.5	-	61.2	58.1
1941-45	4.3	18.8	-	10.9	34.0	85.8	0.9	71.2	63.7
1946-50	4.8	21.7	-	14.6	41.0	87.6	-	73.6	67.4
1951-55	3.3	22.5	-	21.0	46.8	90.0	2.5	76.6	71.1
1956-60	2.4	22.1	-	25.5	53.8	97.1	3.2	78.9	76.6
1961-65	2.1	20.9	15.0	30.3	68.2	108.8	4.2	80.6	85.9
1966-70	2.0	21.5	20.8	35.7	80.0	112.9	5.0	82.0	91.6
1971-75	1.5	20.8	22.1	41.9	86.4	116.4	5.9	83.8	95.6

Notes: [a] Per 100 persons.

[b] Estimated from annual figures on attendance – in primary, secondary, junior technical or correspondence school (but excluding senior technical collage, evening school or continuation classes) – and census figures on persons aged 5 to 14 for 1911, 1921, 1931 and 1941 extrapolated to yield annual figures prior to 1950. For the post-1950 period based upon annual attendance and/or enrolment figures and annual estimates of population aged 5 to 14.

[c] Enrolled in university as a percentage of those aged 15 to 24. For the pre-1950 figure estimates for 1911, 1921, 1931 and 1941 only.

Table 1 [Continued]

Notes [Continued]:

[d] imr = infant mortality rate (deaths to children under age 1 per 1,000 live births.)

[e] DINF = (TC + PSAR + H)/3.

Sources: Australian Bureau of Statistics (various years): various tables.

Table 2: Computing a Summary Measure of Domestic Infrastructure (DINF) for Canada, 1911-1975 [a]

Years	Per Capita Transportation and Communications [b]					School Attendance Rates: Primary & Secondary (PSAR) [c]	100 – imr (H)	Summary Measure (DINF)
	Telegrams	Radios	Televisions	Motor Vehicles	Sum (TC)			
1911-15	14.5	-	-	0.8	12.2	64.1	-65.6	6.2
1916-20	16.3	-	-	3.2	19.5	69.3	-48.8	13.3
1921-25	16.8	-	-	6.3	23.1	75.5	1.2	33.3
1926-30	14.3	n.a.	-	10.4	24.6	82.5	5.8	37.7
1931-35	9.4	n.a.	-	10.5	19.9	85.9	24.0	43.3
1936-40	10.5	n.a.	-	12.0	22.5	86.6	34.4	47.8
1941-45	12.9	n.a.	-	12.6	25.4	86	44.2	51.9
1946-50	13.5	n.a.	-	15.7	29.2	86.1	55.4	56.9
1951-55	13.4	n.a.	8.9	23.0	41.7	89.0	64.8	65.2
1956-60	10.0	43.0	18.2	27.8	81.8	91.7	70.4	81.3
1961-65	7.6	52.7	25.2	32.8	118.3	92.8	74.0	95.0
1966-70	5.1	62.7	30.3	37.8	135.9	93.0	79.2	102.7
1971-75	2.8	81.1	36.2	45.8	165.8	93.0	84.0	114.3

Notes: [a] For some periods, the data is not available for all five years; n.a. = not available; n.e. = not estimated. For acronyms and definitions of variables, see notes to Table 1.

[b] Rate per 100 persons.

[c] Annual estimates obtained by extrapolating data for 1915, 1920, 1930, 1935, 1940, 1945, 1950, 1955, and 1958-62 (the value for 1962 is assumed to hold for 1963-1975.)

Sources: Various tables in Leacy (1983) and in Urquhart and Buckley (1965.)

Table 3: Computing Trade Driven Growth Potential (TDGP) and the Composite Domestic Infrastructure plus Trade Driven Growth Potential Variable (DINFTDGP): Australia and Canada, 1911-1975 [a]

Years	Australia				Canada			
	TDGP Calculations [b]			DINFTDGP [c]	TDGP Calculations [b]			DINFTDGP [c]
	To	rymtp	TDGP		To	rymtp	TDGP	
1911-15	36.4	0.97	35.9	n.e.	n.a.	n.e.	n.e.	n.e.
1916-20	36.4	1.05	37.9	37.5	n.a.	n.e.	n.e.	n.e.
1921-25	34.2	0.87	29.9	39.0	n.a.	n.e.	n.e.	n.e.
1926-30	30.4	1.00	30.1	43.1	32.0	1.29	41.3	38.6
1931-35	26.6	0.98	26.7	45.2	28.7	1.44	41.3	42.8
1936-40	26.6	1.03	26.7	48.2	30.8	1.42	43.8	46.8
1941-45	n.a.	1.27	n.e.	n.e.	27.1	1.44	39.2	48.7
1946-50	n.a.	1.06	n.e	n.e	26.1	1.27	33.0	50.9
1951-55	30.0	1.01	30.4	60.4	24.1	1.30	31.4	56.7
1956-60	32.6	0.98	32.0	65.6	23.4	1.22	28.7	68.2
1961-65	32.7	1.03	33.7	73.0	23.4	1.20	28.0	78.3
1966-70	31.2	1.04	32.6	76.8	28.9	1.23	35.5	85.9
1970-75	30.3	1.00	30.3	79.4	32.9	1.14	37.6	95.1

Notes: [a] n.a. = not available; n.e. = not estimated.

[b] "To" computed by adding merchandise imports to merchandise exports, dividing the sum by national income and expressing trade as a percentage of income. The "rymtp" variable measures the relative income per capita of a country compared to the (trade weighted) income per capita of its major trading partners. TDGP = (To)*(rymtp).

[c] DINFTDGP = (DINF + TDGP)/2 [see Tables 1 and 2 for definition of DINF.]

Sources: See sources to Tables 1 and 2.

Figure 1: Relative Level of Domestic Infrastructure Variable (DINF) and Relative Level of Income per Capita, Canada/Australia, 1912-1975

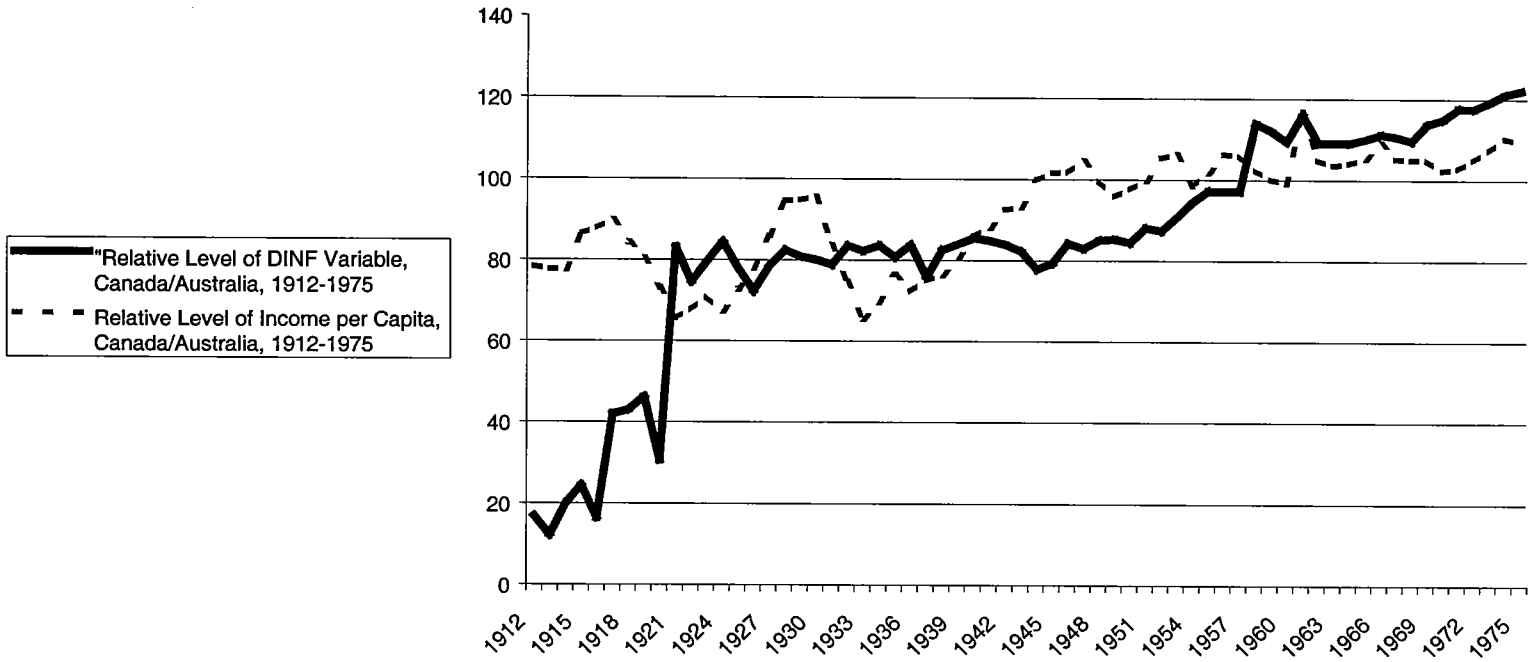


Figure 2: Domestic Infrastructure and Income per Capita, Scatter Diagram for Five Year Periods, 1911-15 to 1971-75, Australia and Canada

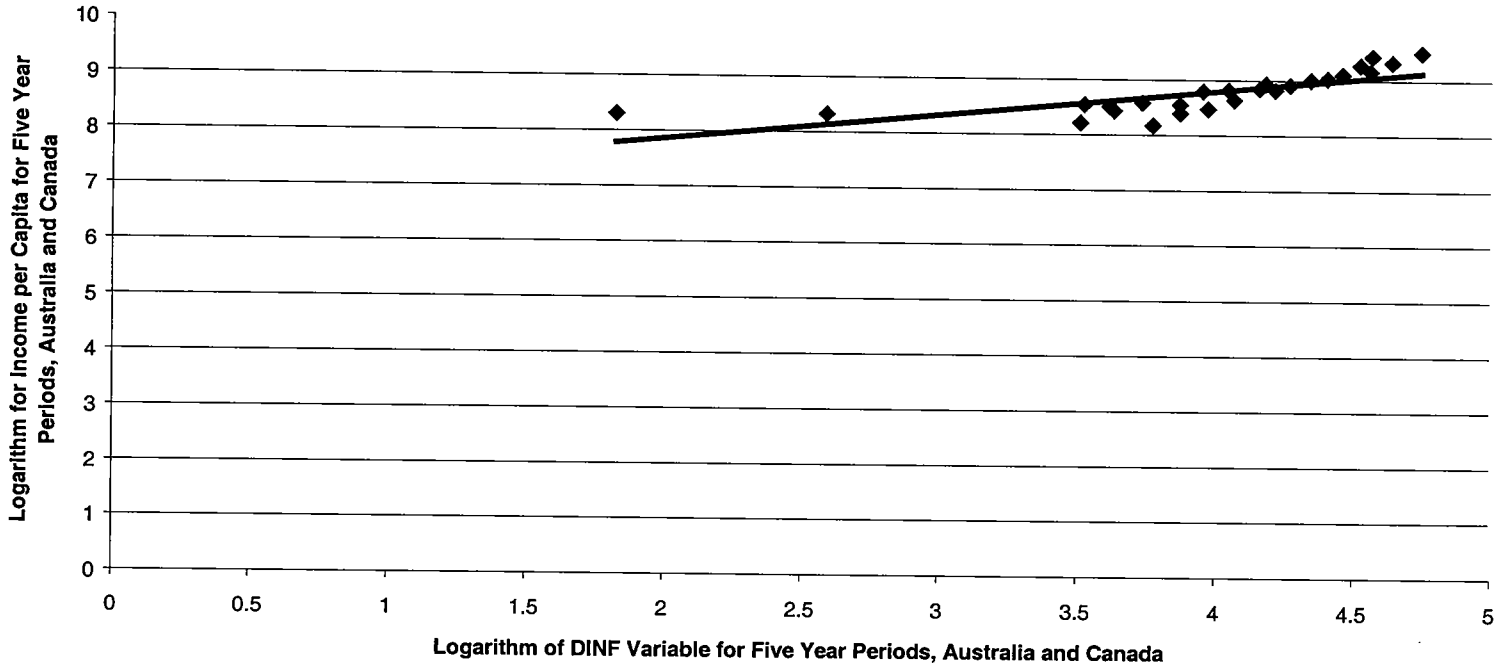


Figure 3: Indices for Composite Domestic Infrastructure plus Trade Driven Growth Potential Variable (DINFTDGP) and for Income per Capita, Australia (1950=100), 1917-1975

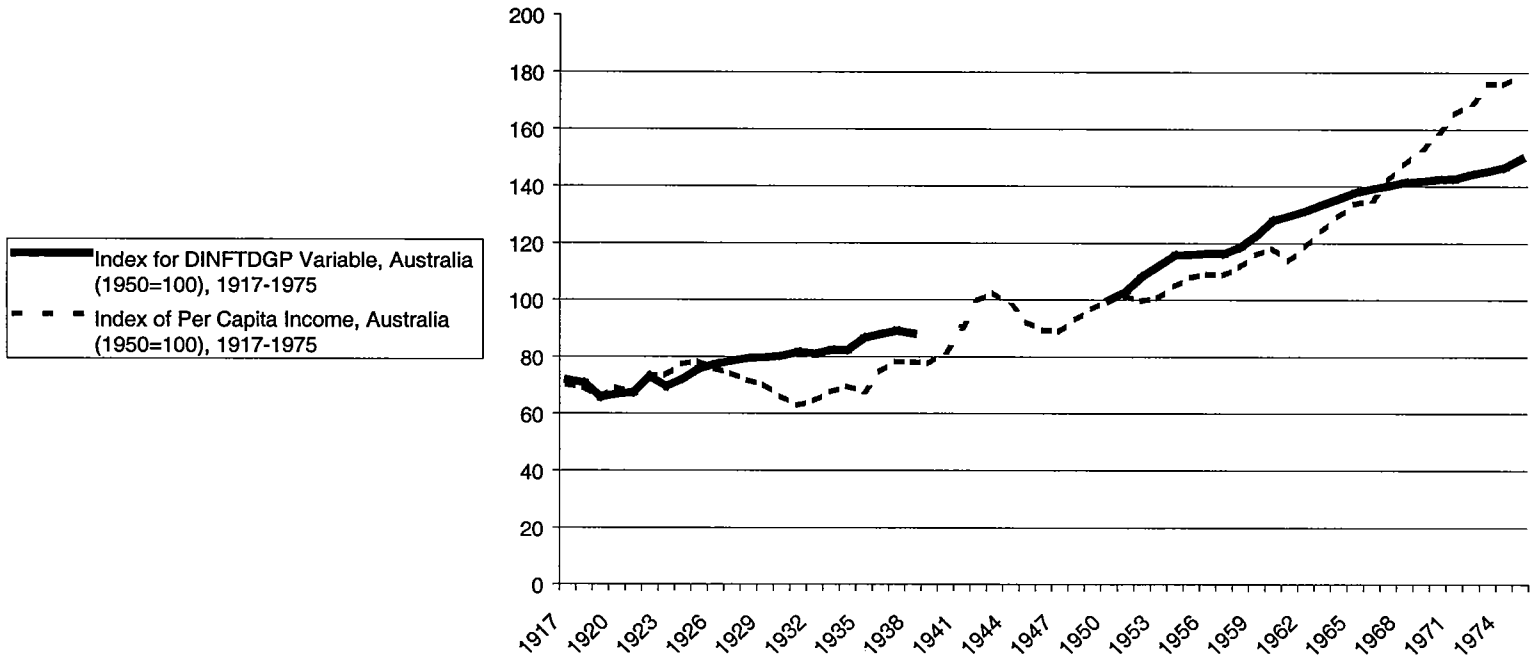


Figure 4: Indices for Composite Domestic Infrastructure plus Trade Driven Growth Potential and for Income per Capita, Canada (1950=100), 1926-1975

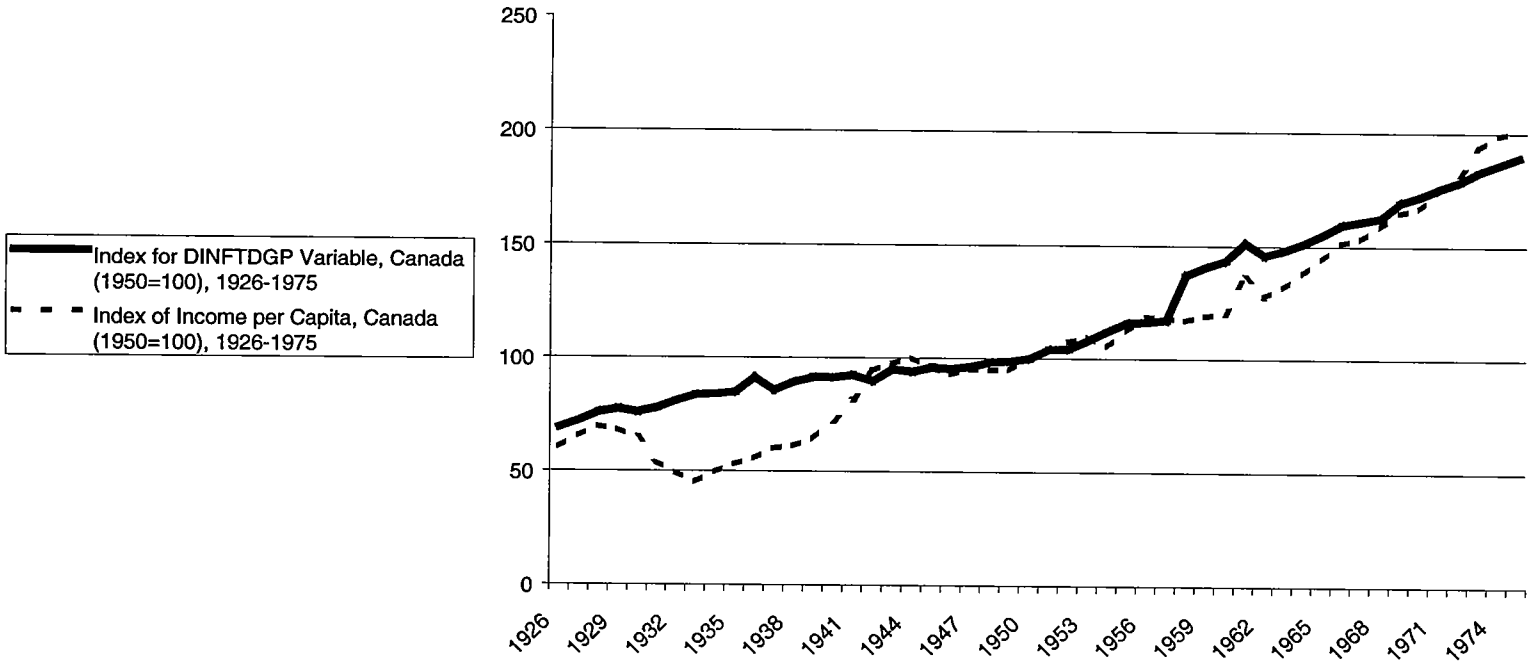


Figure 5: Relative Level of Composite Domestic Infrastructure plus Trade Driven Growth Potential Variable (DINFTDGP) and Relative Level of Income per Capita, Canada/Australia, 1926-1975

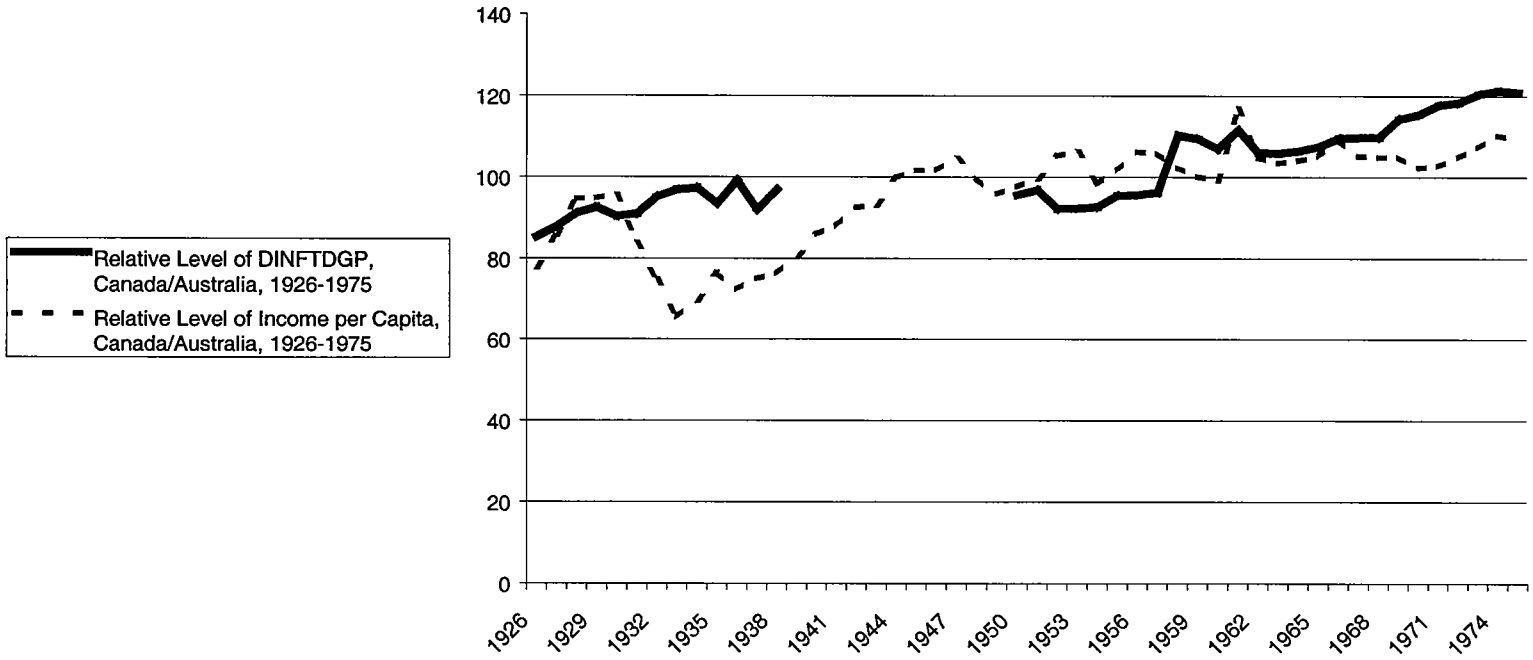
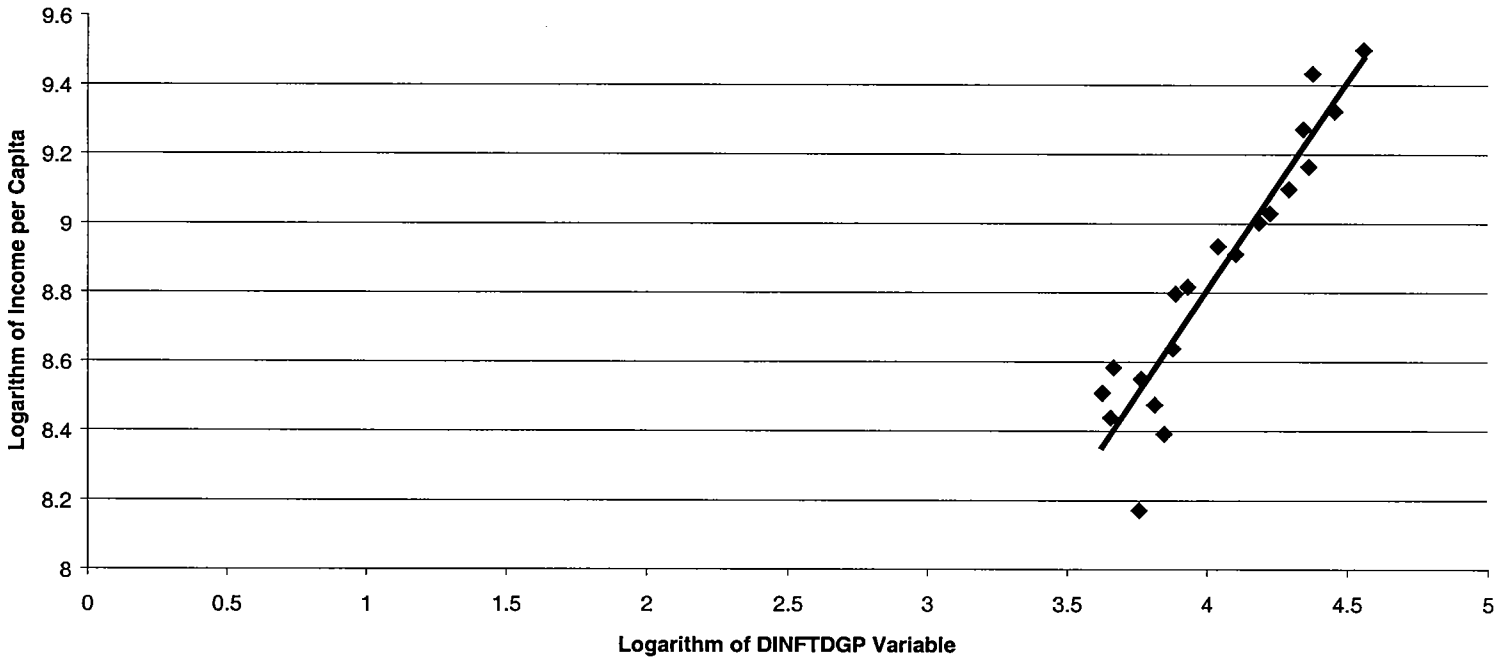


Figure 6: Composite Domestic Infrastructure plus Trade Driven Growth Potential (DINFTDGP) Variable and Income per Capita, Scatter Diagram of Logarithms for Five Year Period Averages, 1916-1920 to 1970-75, Australia and Canada



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[1] See contributions emphasizing the role of institutions, see Acemoglu, Johnson and Robinson (2001); Easterly (2001); Rodrik, Subramanian and Trebbi (2002) and Sokoloff and Engerman (2000). Rodrik, Subramanian and Trebbi (2002) provide a good – albeit critical – review of the literatures emphasizing geography (exemplified by the writings of Jared Diamond and Jeffrey Sachs), human development (stressed by Robert Barro), and international trade (stressed by Jeffrey Frankel amongst others.)

[2] The social capacity to import and adapt foreign technology is a concept first introduced by Ohkawa and Rosovsky (1973) in a study of miracle growth in Japan that was part of a larger publishing project concerning post-1950 economic growth under the general editorship of Moses Abramovitz and Simon Kuznets. For recent discussion of the concept see Abramovitz (1995) and Broadberry and Ghosal (2002). The latter study argues education improvement was crucial to

social capacity in the United States. It draws upon the emphasis given to the expansion of secondary schooling in the United States by Claudia Goldin in explaining American productivity advance in the post-1910 era, especially productivity advance in managing the flow of information in business offices. For Goldin's work, see *inter alia*, Goldin (1998.) It is worth noting that Goldin (1998) shows that physical infrastructure was important for educational expansion. For instance, Goldin (1998: pg. 368) writes "The automobile, the school bus, and improved roads were of critical importance to secondary school education in America and may account for why the movement took off so rapidly in the 1910s and 1920s." In this paper I argue that all forms of infrastructure investment – in health care, in education and in the transport/communications fields – positively interact. Reducing mortality risks for children encourages more investment in education. Likewise reductions in the cost of commuting to schools or engaging in distance education through radio/television delivery and the telephone promote attendance in schools. In the rural districts frontier countries like Australia and Canada, transport infrastructure was particularly important for the diffusion of public schooling.

[3] For the importance of infrastructure in general, see Easterly (2001), Hall and Jones (1997, 1999) and World Bank (1994.) Mosk (2001) develops an "infrastructure-driven" theory of long-run Japanese economic growth, emphasizing all three forms of infrastructure: physical, human capital enhancing and financial. Mosk (forthcoming) develops a theory of resistance to diversity in international immigration rooted in a nationalism committed to successful

development of physical and human capital enhancing infrastructure, especially the education.

4 An additional reason for focusing upon these two countries is data availability. Securing usable estimates of education and other variables used in my estimates of infrastructure for the pre-1950 period is a daunting task. This is not a trivial point. One of the criticisms of the Baumol (1986) analysis showing long-run convergence in income per capita amongst a number of relatively developed economies is that long-run historical data is only available for countries that were already relatively advanced in terms of literacy and education in the nineteenth century. Not surprisingly, these very countries were well positioned to converge towards one another. The very fact that they already had substantial infrastructure reflects a deeply entrenched social capacity to make infrastructure investments out of increments to income.

5 I was unable to secure usable quantitative estimates for financial infrastructure.

6 Figures on income per capita used in this study are from Maddison (2000.)

7 See Barcan (1980), Cleverley and Lawry (1972), Johnson (1968), Mallea and Young (1984), Prentice and Houston (1975), and Wilson, Stamp and Audet (1970).

8 As can be seen from the figures on telegrams, radios and televisions assembled in Tables 1 and 2, newer forms of communication drive out earlier forms of communication over time, in an on-going process of innovation, imitation and creative destruction. Telegrams supplant letters; radios supplant telegram and

telegraph delivery; televisions supplant radios; the Internet diminishes the importance of traditional mail delivery and television. Indeed this is the one of the verities of economic history. Technological progress reshapes consumption patterns, partly because it changes relative prices for goods, the goods most strongly impacted by innovation experiencing price reductions faster than other goods. Thus any long-run overall index of prices is biased upward or downward, depending on whether the relative prices are for the initial date or the concluding date over which the index is computed.

[9] See Baldwin (2004) and Redding and Venables (2004). This argument can be used to explain the finding of Baumol (1986) that there are several distinct convergence groups prior to the 1990s: Western Europe, North America and Eastern Europe under Communism. Trade tended to develop within each of these regions between 1950 and the late 1980s. Thus the growth of smaller Communist countries of Eastern Europe like Poland and Hungary was largely limited by the rate of innovation occurring within the Soviet Union, a rate that fell short of that obtaining in Western Europe and/or North America.