

Understanding the Prosperity Gap between Australia and Canada

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LESSONS FOR CANADA FROM DOWN UNDER

Essay Series

CHAPTER 1

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By Stephen Kirchner

Key points

- Despite many similarities, the Canadian economy has under-performed Australia's since the mid-1990s.
- This under-performance is evident in measures of economic growth, growth in average living standards, and productivity.
- In 2021, whereas Canada's average standard of living was 78 percent that of the United States, Australia enjoyed average living standards that were 82 percent of the US level, a four percentage point difference in Australia's favour.
- Australian output per hour worked (labour productivity) is around 80 percent of the US level, whereas in Canada it is 76 percent of the US level.
- Australia's outperformance is due to extensive economic reforms since the early 1980s that have been widely credited with a productivity surge in the 1990s, although Australia's productivity growth has slowed more recently in line with global trends.
- Australia's superior productivity performance is also due to historically higher rates of investment spending as a share of the economy. Business investment spending is one of the main channels for the adoption of new technology and innovations.
- The key role played by investment spending in explaining the outperformance of the Australian economy suggests Canada needs to pay more attention to policies that may be inhibiting domestic capital formation.
- Australia's economic reforms have also facilitated the reallocation of labour and capital to more productive sectors of the economy.

Introduction

Australia and Canada have much in common, perhaps more so than any other two industrialized countries. They have a common political and cultural heritage deriving from British colonization, giving both countries a similar set of institutions such as a federal system of government, bicameral parliament, and the rule of law. The Australian and Canadian economies are similar in terms of population, industry composition, and their status as relatively open, commodity-exporting countries. They both enjoy a close economic, diplomatic, and security relationship with the world's leading economy, the United States.

The relative performance of the two economies has varied over time. Since the early 19th century, the Canadian economy has experienced episodes of both outperformance and underperformance relative to the Australian economy in both productivity growth and average living standards. Productivity growth is the main determinant of growth in average living standards over the long-run.

This paper focuses on two main measures of productivity growth. Labour productivity measures output per hour worked and reflects contributions from both labour and capital inputs. At the level of the economy as a whole, labour productivity reflects a wide-range of factors, including labour use rates and changes in the relative size of different sectors of the economy that may have different levels of productivity. Ideally, public policy should facilitate rather than hinder the movement of capital and labour to where it is most productive.

Total or multifactor productivity (T/MFP) is referred to interchangeably as the ratio of output to the combined input of labour and capital. It is generally considered to be a more comprehensive measure of technological change and efficiency improvements than labour productivity. Usually, the growth in labour productivity exceeds the growth in multifactor productivity. The difference between the two is the contribution from “capital deepening,” or the capital-to-labour ratio. The accumulation of more and better capital equipment over time helps to make workers more productive (Productivity Commission, 2020). While MFP is a conceptually superior measure of productivity, it is also more difficult to measure because of difficulties in measuring the flow of capital services from a given capital stock. In particular, it is difficult to make reliable cross-country comparisons. This paper will reference measures taken from well-established databases that seek to estimate the level of productivity and related measures on a consistent basis over long periods of time.

This study reviews the relative productivity performance of the Canadian and Australian economies over time. Since the mid-1990s, the Aus-

tralian economy has outperformed Canada's in terms of average growth in both productivity and living standards. Given the similarities in many of the structural characteristics of the two economies, Canada's underperformance must be attributable, at least in part, to the economic institutions and policies put in place by successive Canadian governments relative to those pursued in Australia. The paper considers the extent to which the two economies are converging on the global frontier of productivity and living standards represented by the United States. It then looks at the composition of economic and productivity growth in the two economies in order to identify some of the factors behind Canada's underperformance.

Australia has enjoyed faster growth in per capita income, at least until the most recent decade, even with faster population growth. Australia's economic growth has benefited from larger contributions from both labour and capital inputs, though the growth contribution from capital inputs explains most of the difference in economic growth since the mid-1990s. The growth contribution made by the quality of labour inputs, or human capital, has been broadly similar.

Australia's relatively high rates of investment spending have increased the capital intensity of the Australian economy. This capital deepening largely accounts for Australia's superior productivity performance and is reflected in a consistently higher investment share of GDP relative to Canada. Investment spending is the main channel through which the new innovations and technology that drive productivity growth are adopted by the business sector. New investment has facilitated the reallocation of labour to higher productivity industries, most notably the mining and oil and gas sectors. Previous goods and labour market reforms have also facilitated these sectoral reallocations.

Canada also undertook extensive economic reforms in the 1990s similar to those in Australia, although it lags Australia in the Fraser Institute's latest Economic Freedom ranking at 14th place versus Australia's 9th place (Gwartney, Lawson, Hall, and Murphy, 2021). Canada's past reforms appear to have yielded a smaller pay-off in measured economic freedom and productivity growth. Some analysts have attributed Canada's weak productivity growth relative to that of the US to the fact that "the Canadian economy faced two major shocks in the form of rising commodity prices and a rising Canadian dollar" (Arsenault and Sharpe, 2008). However, Australia faced the same shock to commodity prices and its exchange rate over the same period. Like New Zealand, Canada's economic underperformance, despite past market-oriented reforms, is sometimes portrayed as a paradox (Sharpe, 2008). Sharpe suggests that "the low-hanging fruit of market reform has been harvested in the decades well before 2000"

(Sharpe, 2008: 158). But this claim is equally true of Australia and does not explain Australia's subsequent outperformance.

Historically, proximity to the US economy has been a structural strength for Canada and a weakness for Australia. More recently, however, Australia has benefited from its smaller exposure to cyclical developments in the US economy and greater exposure to the rapidly growing Chinese economy. The 2008 financial crisis and slow recovery from the recession in the United States from 2007 to 2009 weighed more heavily on the Canadian than the Australia economy. Australia avoided the technical definition of a recession (two consecutive quarters of negative growth) in 2008-09, although still experienced a significant downturn at that time. Whereas the Australian economy previously had a very close relationship with the US business cycle, this relationship has broken down since the 2001 global recession, which also bypassed Australia, at least in terms of the technical definition of a recession.

The key role that investment spending has played in explaining the Australian economy's outperformance suggests that Canada needs to pay more attention to policies that may be inhibiting domestic capital formation. It should be noted that investment spending in Australia as a share of GDP has weakened since 2013 and has converged with that of Canada. Both Australia and Canada have participated in the global slowdown in productivity growth seen since the 2008 financial crisis and productivity growth differentials between the two economies have narrowed more recently. Both countries therefore face challenges in maintaining investment and productivity growth in their economies, but Canada's underperformance since the mid-1990s suggests that it faces the more serious challenge and requires an even bigger lift in terms of future economic reform.

Future papers in this series will consider the role of changes in the industry composition of the two economies as a driver of productivity outcomes, and will compare institutional arrangements and policies that may help explain Canada's underperformance relative to Australia.

Relative living standards and productivity in historical perspective

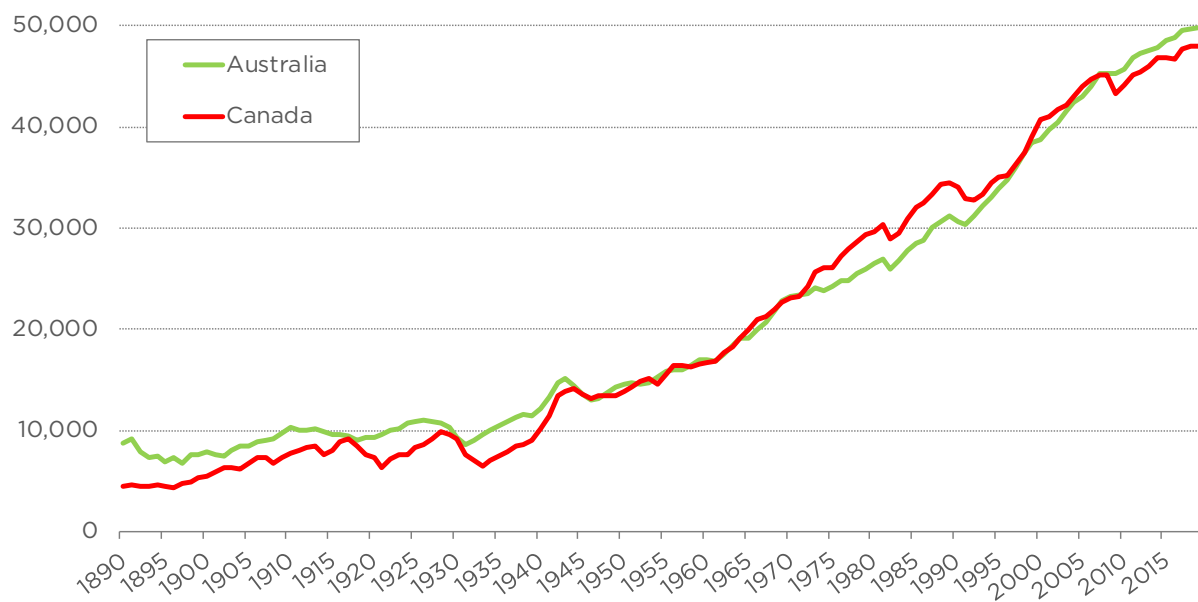
The relative performance of the Canadian and Australian economies has varied over time as shown in figures 1 and 2.

For much of the nineteenth century, the Australian economy enjoyed the world's highest standard of living due to high levels of productivity and labour force participation. Between 1870 and 1890, Australia's income per capita was 40 to 50 percent above the level of the United States (Ir-

win, 2007). Canadian living standards were less than half Australian levels before the 1890s. The period of “Australian exceptionalism” in the nineteenth century reflected Australia’s openness and integration into a rapidly globalizing world economy, despite its distance from world markets. The Australian economy in the nineteenth century was more open than it was for much of the 20th century, with a trade share around 50 percent of GDP (McLean, 2013: 101). But the aftermath of the 1891 depression in Australia and its embrace of tariff protection, centralized wage fixing, and more restrictive immigration policies around the time of Federation in 1901 increasingly weighed on Australia’s absolute and relative economic performance in the early twentieth century.

By contrast, the Canadian economy’s greater openness and proximity to the United States saw its economy outperform Australia’s in the early twentieth century (Pomfret, 2000). Canadian living standards improved in relative terms and showed mostly faster growth, although the catching-up process was interrupted in the years immediately after the First World War and in the 1930s. Canada caught up to Australia by the end of the Second World War and the two countries enjoyed a similar standard of living until the early 1970s, when the Australian economy began to underperform once again. By the 1980s, Canadian GDP per capita was 25

Figure 1: GDP Per Capita (2010 PPP-adjusted Dollars)



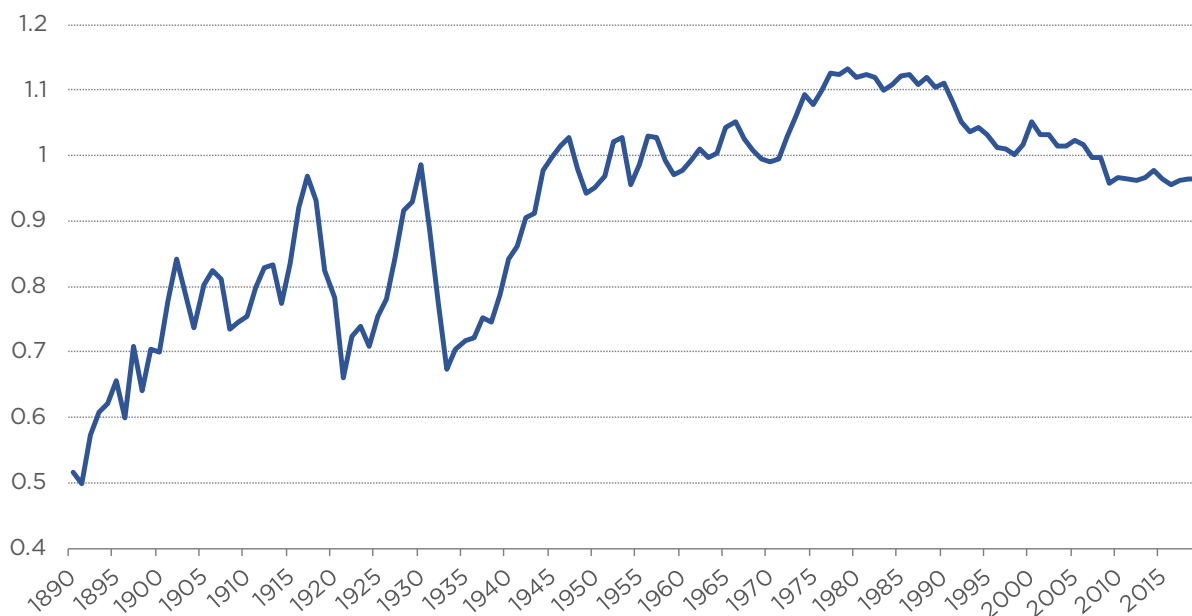
Source: Bergeaud, Cette, and Lecat (2016), BCL long-term productivity database, as updated by the authors at <http://www.longtermproductivity.com>.

percent above Australia's on some measures and Canada's income gap with the United States fell to less than 10 percent (Greasley and Oxley, 1998).

Australia embarked on a major program of economic reform in the early 1980s, deregulating financial and product markets and lowering tariff protection. A review of some of those reforms can be found in my 2013 Fraser Institute report, *Policy Reforms in Australia and What they Mean for Canada*. The reforms that re-internationalized the Australian economy starting in 1983 have been widely credited as the basis for a productivity surge in the 1990s, pointing to lags between economic reforms and their productivity benefits (Parham, 2004).

It is Australia's 1990s productivity surge that largely accounts for Australia's current outperformance of the Canadian economy. Many of these reforms focused on opening up the Australian economy—in particular, reductions in tariff protection and greater openness to foreign capital, which in turn increased export competitiveness. The liberalization of merchandise trade alone between 1986 and 2016 is estimated to have raised Australia's real GDP per capita by \$A3,506, representing a lower bound on the gains from broader trade and other forms of liberalization (Centre for International Economics, 2017). The income gains from the terms of trade

Figure 2: Canada's GDP Per Capita Relative to Australia's



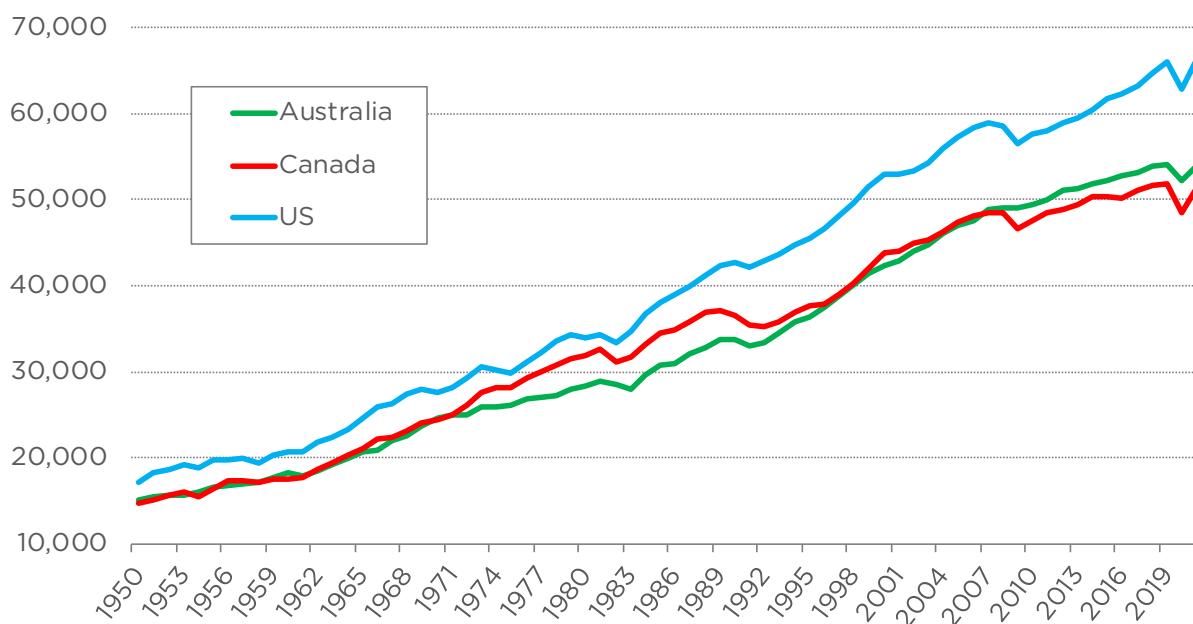
Source: Bergeaud, Cette, and Lecat (2016), BCL long-term productivity database, as updated by the authors at <http://www.longtermproductivity.com>.

boom from the mid-2000s would have bypassed Australia were it not for its increased openness to trade relative to earlier decades. The estimated 7.4 percent increase in real wages due to merchandise trade liberalization points to economy-wide productivity gains given the long-run relationship between productivity and average compensation of employees (Kirchner, 2019). By the mid-1990s, Australian living standards had caught up with Canada's once again as these reforms delivered an acceleration in productivity growth (Bergeaud, Cette, and Lecat, 2016).

Since the financial crisis of 2008, Australian living standards have consistently exceeded those in Canada (figure 3), partly reflecting Australia's relatively smaller exposure to cyclical developments in the United States economy. In 2021, whereas Canada had an average standard of living 78 percent that of the United States, Australia enjoys average living standards 82 percent of the US level, a four percentage point difference in Australia's favour based on Conference Board data (see figure 3).

Productivity is the main determinant of living standards over the long-run and the trends in living standards described above are reflected in productivity differentials between the two economies. Figure 4 shows the labour and total factor productivity differential between Canada and Australia since 1890.

Figure 3: Australian and Canadian Per Capita Income, 2016 PPP-adjusted Dollars



Source: Conference Board, 2021.

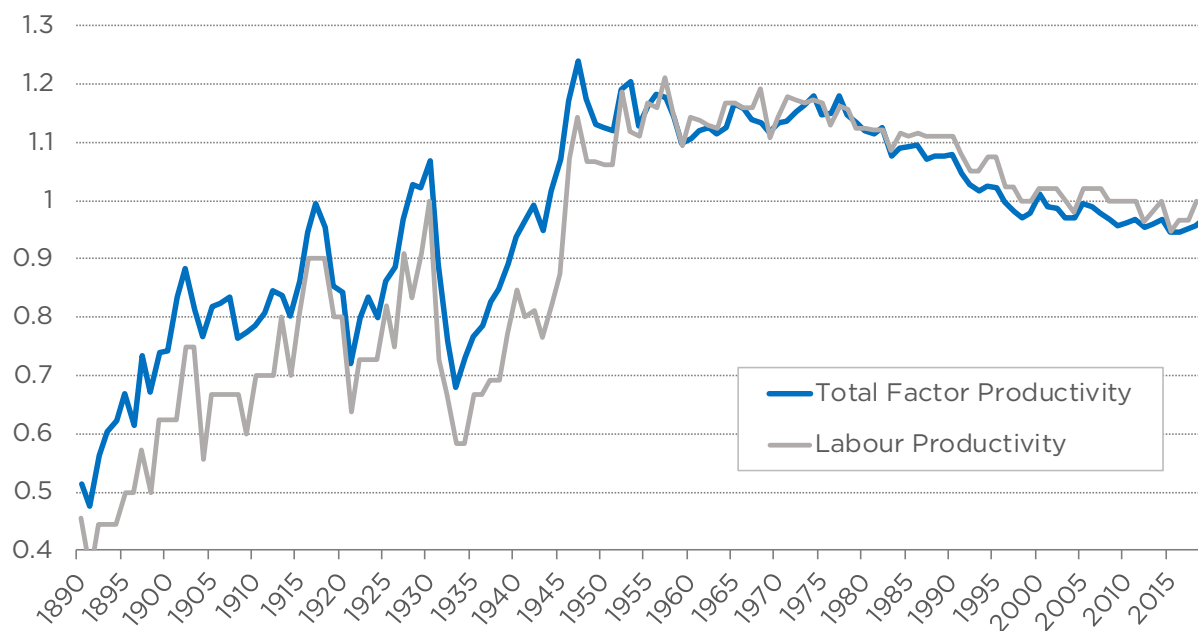
Whereas Canada lagged Australian productivity levels for much of the nineteenth century, it caught up during the twentieth century to enjoy a productivity lead of as much as 20 percent until the late 1970s. But Canada's productivity declined in relative terms to be somewhat below Australia's for most of the period since the mid-1990s, at least in terms of total or multifactor productivity. According to the Bergeaud, Cette, and Lecat (BCL) long-term productivity database, Australia enjoyed a four percentage-point lead in total factor productivity in 2019 prior to the onset of the COVID pandemic. The Canada-Australia productivity differential largely accounts for the difference in living standards shown above.

Conference Board data shows that Canada has underperformed in measured labour productivity growth, that is, output per hour worked, relative both Australia and the United States (figure 5).

In 2021, Australian output per hour worked (labour productivity) on the Conference Board measure was around 80 percent of the US level, whereas in Canada, it was 76 percent of the US level, a four percentage point gap similar to that shown by BCL for total factor productivity.

Canada's underperformance is particularly troubling given the geographic penalty Australia faces due to its distance from global markets.

Figure 4: Labour and Total Factor Productivity, Canada Relative to Australia, Ratio in 2010, PPP-adjusted dollars

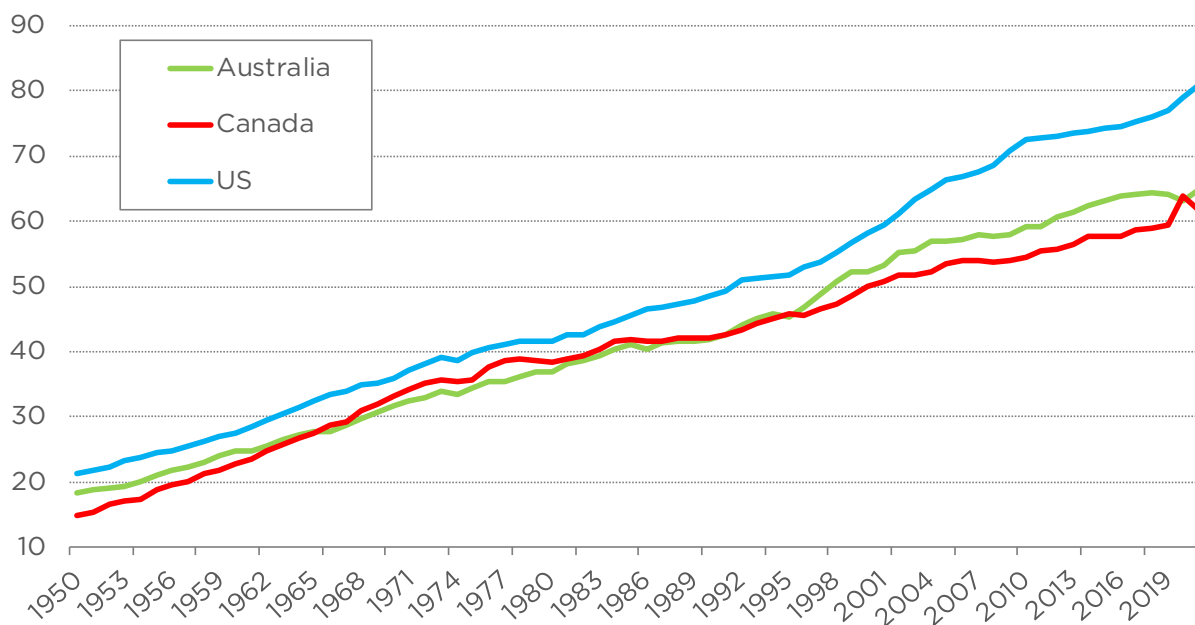


Source: Bergeaud, Cette, and Lecat (2016), BCL long-term productivity database, as updated by the authors at <http://www.longtermp productivity.com>.

By contrast, Canada shares a land border with the United States, one of the world's largest and most productive economies. Distance has been estimated to account for as much as 40 percent of Australia's productivity shortfall relative to the US (Battersby, 2006), which implies that Canada's productivity performance is even poorer than the data indicate given that it does not suffer this structural impediment. Whereas Canada's proximity to the US is a structural advantage, in recent years it has also given Canada a greater exposure to cyclical developments in the US economy, in particular, the negative shock from the financial crisis of 2008. The previously very close relationship between the Australian and US business cycles broke down after the early 2000s (Beechey, Bharucha, Cagliarini, et al., 2000). The relationship of the Canadian and Australian economies to the US economy has thus had mixed implications for the relative performance of the Australian and Canadian economies. Australia has benefited from its trade exposure to China, although distance remains an issue even there; Berlin is closer to Beijing than is Sydney.

In the late 2000s, analysts noted the underperformance of Canadian productivity growth relative to the United States, but argued that “much of the increased Canada-US productivity gap since 2000 relates to develop-

Figure 5: Labour Productivity—Output per Hour Worked, 2016 PPP-Adjusted Dollars



Source: Conference Board, 2021.

ments south of the 49th parallel and not to developments in this country [Canada]” (Arsenault and Sharpe, 2008: 37). Given this underperformance, analysts argued that “productivity growth in Canada has the potential to exceed that in the United States” because “the current widening opens more room for convergence” (Arsenault and Sharpe, 2008: 135). In the event, this convergence did not eventuate.

Long-Run Convergence in Living Standards and Productivity Relative to the United States

Economic theory predicts that economies should in the long-run converge on a similar average standard of living. Over time, capital should flow to those economies with low capital-labour ratios where the returns to capital are higher, raising productivity and living standards. In particular, living standards for advanced economies should in the long-run converge on those of the United States given its position near the frontier of global productivity and living standards. This prediction has an empirically testable implication. Forecasts of per capita income differences between Canada and the United States should converge to zero in expected value as the forecast horizon becomes arbitrarily long, regardless of initial capital stock, given that Canada is near its long-run equilibrium and has similar technology and preferences to the US (Bernard and Durlauf, 1996).

In the Appendix, I test the long-run convergence hypothesis for Canadian and Australian per capita income with respect to the United States from 1950 to 2021 using Conference Board data and find that neither Canadian or Australian per capita incomes are converging on the US. While Australia shows some evidence of converging on US productivity levels, this is not the case for Canada, which appears caught in a low productivity trap relative to the US and Australia. This lack of convergence points to structural impediments to realizing higher levels of productivity. Some of these impediments may reflect economic institutions and policies that are amenable to change.

Accounting for Canadian and Australian Economic Growth and Per Capita Income

The performance of the Canadian and Australian economies can be compared in terms of the rates of GDP and per capita income growth, as well as the contributions to economic growth from labour and capital inputs (table 1). The Australian economy and average living standards have grown consistently faster than those of Canada since the mid-1990s. Australia’s

Table 1: Economic Growth and Related Measures, Average Growth Rates

Country	1990s	2000s	2010-21	1990-2021
Contribution of Labor Quantity to GDP Growth				
Australia	0.5	1.2	0.8	0.8
Canada	0.6	0.6	0.5	0.6
Contribution of Labor Quality to GDP Growth				
Australia	0.0	0.3	0.3	0.2
Canada	0.2	0.2	0.2	0.2
Contribution of Total Capital Services to GDP Growth				
Australia	1.7	2.5	1.6	1.9
Canada	1.3	1.9	1.2	1.4
Contribution of Capital Services provided by ICT Assets to GDP Growth				
Australia	0.9	1.0	0.3	0.7
Canada	0.6	0.7	0.3	0.5
Contribution of Capital Services provided by Non-ICT Assets to GDP Growth				
Australia	0.8	1.6	1.3	1.2
Canada	0.7	1.1	0.8	0.9
GDP Growth				
Australia	3.3	3.1	2.4	2.9
Canada	2.4	2.1	1.9	2.1
Population Growth				
Australia	1.1	1.4	1.5	1.4
Canada	1.1	1.0	1.1	1.1
GDP Per Capita Growth				
Australia	2.1	1.7	0.8	1.5
Canada	1.3	1.1	0.8	1.0

Source: Conference Board (2021), Total Economy Database.

population growth rate has also been faster. While Australia's per capita income growth slowed to equal that of Canada's between 2010 and 2021, this is due in part to Australia's faster population growth rate.

Australia's faster economic growth rate reflects larger growth contributions from labour and capital inputs. Australian population growth has been consistently faster than Canada's since the early 1990s, largely driven by immigration, and this has been reflected in growth in the labour force. Australia's unemployment rate has been consistently below Canada's since the mid-1980s, which suggests the Australian labour market is somewhat more flexible than Canada's.

Canada and Australia show remarkably similar growth contributions from the quality of labour inputs to GDP growth. Whereas the level of educational attainment was a drag on Australia's productivity and living standards historically (Greasley and Oxley, 1998), in more recent decades Australia's levels of educational attainment have converged on economies like the US and are no longer considered a major source of productivity shortfall with respect to peer economies. The quality of labour inputs has generally been improving through both the 1990s and 2000s and labour quality has made a positive contribution to TFP growth in Australia (Connolly and Gustafsson, 2013). Human capital accumulation is unlikely to be the source of recent underperformance in the Canadian economy relative to Australia, at least in aggregate.

In terms of the growth contribution from capital services, the Australian economy has consistently outperformed the Canadian economy for each of the decades since 1990. This contribution can be decomposed into contributions from information and communications technology (ICT) assets and non-ICT assets. Australia leads Canada in both categories, although this lead is more pronounced in the case of non-ICT assets. The comparative investment performance of the two economies is discussed in more detail below.

Accounting for Canadian and Australian Labour Productivity Growth

The decomposition of economic growth into contributions from labour and capital inputs does not in itself tell us about the productivity of those inputs, although greater capital intensity contributes to the productivity of labour. It is always possible to obtain additional output through additional labour and capital inputs, but the efficiency with which the economy produces goods and services is a function of the amount of output per unit of labour and capital.

Table 2 shows compound annual growth rates for labour productivity (LP), capital productivity (CP), multifactor productivity (MFP), value-added (VA) or GDP, hours worked (HW), and capital services (CS) for Australia and Canada for 1994 to 2019 and various sub-periods. The 1994 start date reflects limited data availability for Australia prior to that date.

Australia's outperformance in value-added (economic growth), labour, and multifactor productivity is most pronounced during the 1990s and first decade of the 2000s. In the most recent decade, Canada outperforms on labour productivity and MFP, although this is largely due to Australia's stronger growth in capital services having a negative effect on capital productivity. The terms-of-trade boom from 2003-2011 contrib-

Table 2: Productivity Growth and Related Measures, Compound Annual Growth Rates

Canada						
	LP	CP	MFP	VA	HW	CS
1994-1999	1.9%	-0.3%	0.7%	3.7%	2.5%	4.7%
2000-2009	0.7%	-2.2%	-0.8%	2.0%	0.6%	3.4%
2010-2019	1.2%	0.1%	0.6%	1.8%	1.1%	2.2%
1994-2019	1.3%	-0.7%	0.2%	2.4%	1.3%	3.2%
Australia						
	LP	CP	MFP	VA	HW	CS
1995-1999	3.2%	0.2%	2.0%	4.8%	3.8%	4.6%
2000-2009	1.4%	-1.7%	0.1%	3.3%	1.8%	4.9%
2010-2019	1.0%	-0.5%	0.4%	2.7%	1.6%	3.2%
1995-2019	1.6%	-0.9%	0.6%	3.3%	2.1%	4.1%
Differential (percentage points)						
	LP	CP	MFP	VA	HW	CS
1995-1999	-1.4	-0.5	-1.4	-1.1	-1.2	0.1
2000-2009	-0.7	-0.5	-0.9	-1.2	-1.3	-1.5
2010-2019	0.2	0.6	0.2	-0.9	-0.5	-0.9
1995-2019	-0.3	0.2	-0.3	-0.9	-0.8	-0.9

Source: Australian Bureau of Statistics, 5260.0.55.002; Statistics Canada, Table 36-10-0208-01; author's calculations. Estimates are for the market sector in Australia and the business sector in Canada. This table updates similar estimates for different periods found in Capeluck (2016).

uted to a boom in mining investment, which dramatically increased the Australian capital stock and capital per worker. However, it also contributed to a slump in capital productivity, with a long lag before the increased investment turned into increased mining output. Capital deepening has improved labour productivity, but MFP growth during and after the terms of trade boom has been weak. Although led by the mining industry, weakness in MFP growth has also been broad-based, suggesting economy-wide factors are at work. Australia's MFP growth in recent years has been similar to that of Canada.

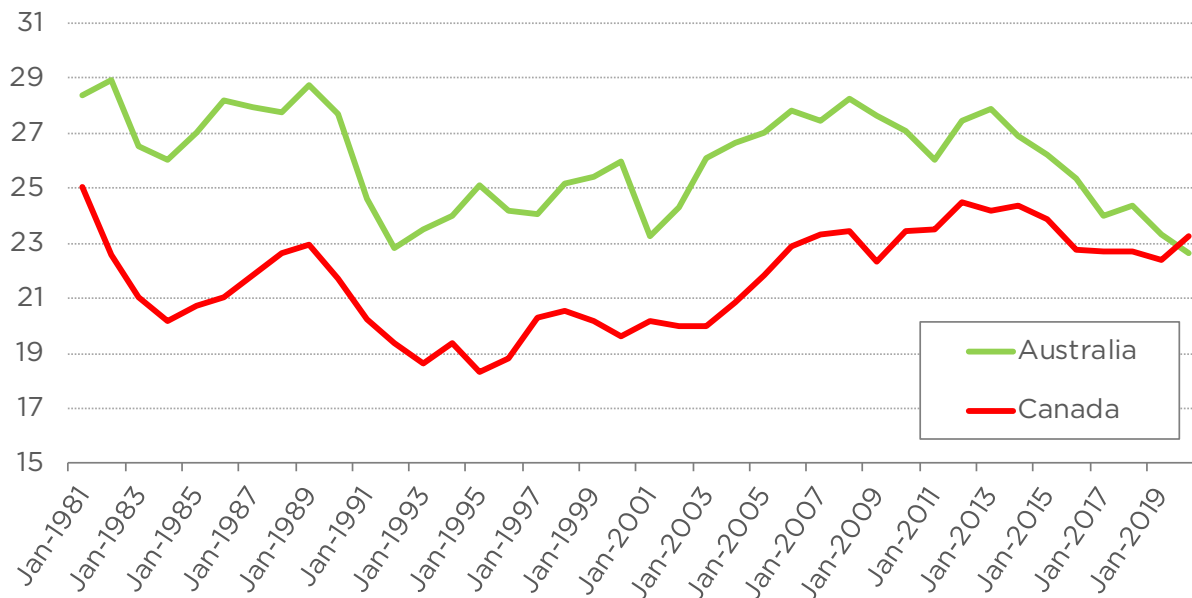
Australia also saw much stronger growth in hours worked than did Canada. This was a drag on capital intensity, which is measured by capital services divided by hours worked, but growth in capital intensity still explains Australia's superior long-run labour productivity performance.

Productivity can be affected by changes in the industry composition of an economy, as output shifts between sectors that are more or less productive. Sharpe found that most of the slowdown in Canada's productivity performance was attributable to within-sector declines in productivity, particularly in the manufacturing sector, rather than due to the reallocation of labour to less productive sectors (Sharpe, 2010). Relative to Australia, however, Capeluck found that inter-industry shifts explain 32 percent of the labour productivity growth differential between Australia and Canada between 1994 and 2013. Australia allocated more labour to mining, and oil and gas, accounting for 17 percent of the gap. Australia's share of hours worked in mining, and oil and gas increased by 2.5 percentage points, while Canada's increased by only 0.6 percentage points (Capeluck, 2016).

It is likely that relative weakness in investment spending and these industry composition effects are closely related. The lack of investment spending inhibited the reallocation of output and labour to the mining and the oil and gas sectors, reducing the ability of the Canadian economy to capitalize on strong growth in demand for commodities. Australia's product and labour market reforms have also facilitated great mobility in factors of production.

Comparing Investment Performance of Canada and Australia

Capital deepening has made an important contribution to Australia's labour productivity growth, even though it has weighed on MFP growth more recently. The stronger contribution of capital inputs to Australian economic and productivity growth relative to Canada highlights Australia's

Figure 6: Gross Fixed Capital Formation (%) Current Price GDP

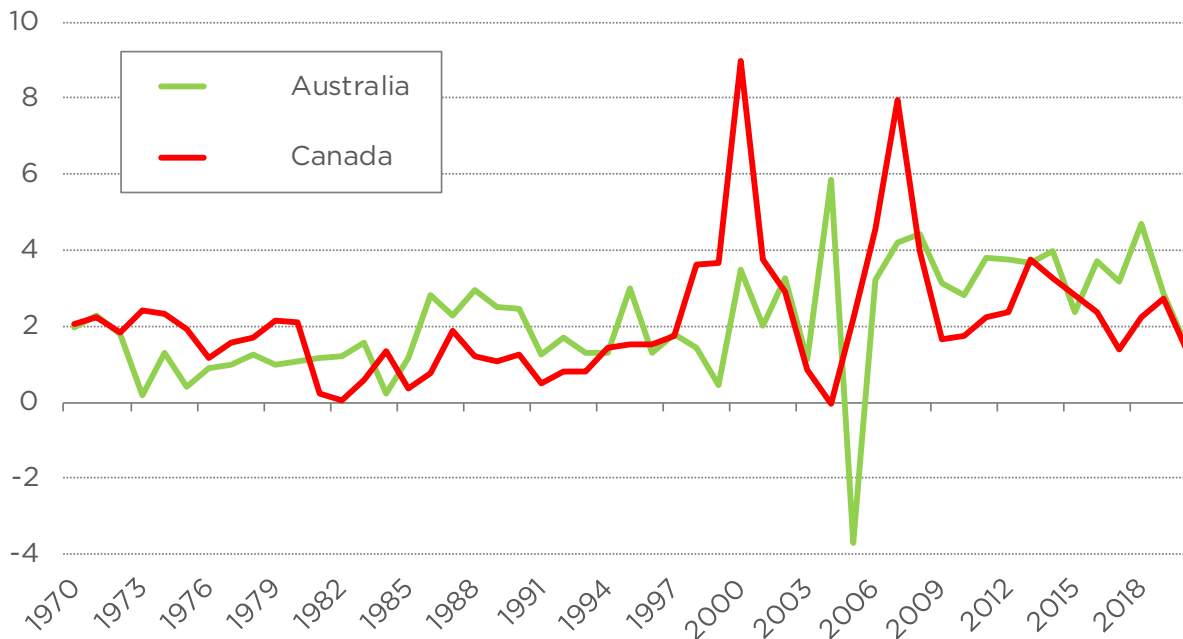
Sources: Australian Bureau of Statistics, 5206 – Australian National Accounts; Statistics Canada, Table 36-10-0222-01; author's calculations.

outperformance in investment spending. This in turn suggests that Canada has pursued policies relatively less friendly to domestic and foreign investment. Foreign-owned firms account for around 20 percent of capital expenditure in Australia (Kirchner, 2021).

Figure 6 shows investment spending in Canada and Australia as a share of their economies.

Australia has consistently devoted a larger share of output to new investment spending, although the investment share has weakened since 2013 and is now broadly in line with Canada's.

The shock from the information and communications technology revolution was an important element of Australia's productivity surge in the 1990s. Australia is one of the few advanced economies to generate significant productivity benefits from the use of ICT, accounting for around one-third of Australian labour productivity growth in the 1990s (Shahiduzzaman, Layton, and Alam, 2015). Because Australia is a net consumer and importer of ICT equipment rather than a producer and exporter,

Figure 7: Inward FDI Flows (% GDP)

Sources: UNCTAD (Undated).

Australia experienced the ICT revolution as a form of capital deepening. This contributed to labour productivity, as well as multifactor productivity from user-based innovations based on ICT. Australia was only able to capitalize on these labour productivity gains because of its openness to imports of ICT capital equipment, which facilitated a high take-up rate for new technology, as did product and labour market reforms. The declining relative price of imported ICT capital goods reduces the relative price of investment in Australia and induces capital accumulation, boosting productivity through capital deepening. Lower imported ICT prices also assisted income growth through Australia's terms of trade.

Australia has also outperformed Canada in attracting foreign direct investment (FDI) in recent years (figure 7). Although FDI inflows as a share of GDP have been similar on average since 1970, since the financial crisis of 2008 Australia has enjoyed stronger FDI inflows as a share of GDP than Canada. FDI is an important driver of productivity growth through knowledge transfers and productivity spillovers. However, while FDI has added to the capital intensity of the Australian economy in recent years, increasing labour productivity, it has likely also weighed on capital productivity, as previously discussed.

Conclusion

Australia's economy has outperformed Canada's in growth in productivity and living standards since the mid-1990s. This largely reflects a productivity surge in the 1990s that followed extensive product and factor market reforms in the Australian economy beginning in the early 1980s, as well as capital market deregulation. Productivity growth has slowed more recently as part of a global trend towards slower productivity growth. The pace of economic reform has also slowed relative to earlier decades.

Both economies have struggled to keep pace with the global frontier of productivity and living standards represented by the United States, but Australia shows stronger statistical evidence of converging on US productivity levels. While Australia faces challenges in maintaining its economic outperformance of previous decades, Canada faces a much larger reform task in catching up to Australia, much less the US.

A decomposition of economic and productivity growth shows that Australia has generally outperformed Canada in both labour and capital inputs, but also in the efficiency with which those inputs have been used. In particular, Australia has dramatically increased the capital intensity of its economy, adding to the productivity of labour. This reflects an investment share of GDP that has been much higher than Canada's, at least until very recently.

Around one-third of the labour productivity differential between 1994 and 2013 can be explained by shifts in the industry composition of the two economies. In particular, Australia re-allocated more labour to the mining sector than did Canada over this period. While this sector has experienced weak productivity growth in both Canada and Australia, in level terms, it is highly productive. It is likely that relative weakness in investment spending inhibited the ability of Canadian firms to reallocate output and labour to higher productivity uses and to capitalize on the strong demand for commodities over this period. New business investment is the main channel through which new technology and innovations are adopted and raise productivity. This suggests that policies more friendly to domestic and foreign investment would have improved Canada's absolute and relative economic performance in recent decades.

Future essays in this series will update these sectoral composition effects and compare institutional and policy settings in the two economies with a view to identifying the sources of Australia's economic outperformance and reforms that could improve Canada's relative performance.

Appendix 1: Long-Run Convergence in Living Standards and Productivity Relative to the United States

Economic theory predicts that in the long-run, economies should converge on a similar average standard of living. In particular, in the long-run, living standards for advanced economies should converge on those of the United States given its position at the frontier of global productivity and living standards. This prediction has an empirically testable implication. Forecasts of per capita income differences between Canada and the United States should converge to zero in expected value as the forecast horizon becomes arbitrarily long, regardless of initial capital stock, given that Canada is near its long-run equilibrium and has similar technology and preferences to the US (Bernard and Durlauf, 1996). In statistical terms, long-run convergence implies the absence of either a stochastic or deterministic trend in the (log) difference between Canadian and US real income per capita.

In addition to long-run convergence in per capita incomes, the theory of economic growth also suggests the possibility of catch-up growth for economies that are out of long-run equilibrium, over a fixed period of time. Catch-up growth implies the absence of a stochastic but not a deterministic trend in the (log) per capita income differential. Oxley and Greasley (1995), for example, find evidence of a historical catch-up relationship between Australian and US per capita incomes for the period 1882 to 1992, but not long-run convergence.

Following Oxley and Greasley, I perform unit root tests that allow for structural breaks in the trend for US-Canada, US-Australia, and Australia-Canada income and productivity differentials. The tests include an intercept and trend term for both the trend and break specification. Using more recent Conference Board data, I test the long-run convergence hypothesis for Canadian and Australian per capita income with respect to the United States from 1950 to 2021. The results reported in table A1 find that neither Canadian or Australian per capita incomes are converging on the US given the presence of a stochastic trend in their income differentials with the US.

The same test can be applied to labour productivity and total factor productivity differentials. There is evidence for catch-up growth in labour productivity between Australia and the US (no stochastic trend in the labour productivity differential, but a statistically significant deterministic trend). For the TFP differential between Australia and the US, the test rejects the presence of a stochastic trend at the 10 percent level of statistical significance. This is consistent with catch-up growth in Australia's TFP

Table A1: Unit root tests for US-Canada, US-Australia and Australia-Canada income and productivity differentials

Differential	ADF t-stat	Trend term	Break year	Adjusted sample period
US-Aus GDP/Capita	-4.56	0	1982	1952-2021
US-Aus labour productivity (LP)	-6.37***	0.00***	2007	1957-2021
US-Aus total factor productivity (TFP)	-5.11*	0.00**	2000	1957-2019
US-Can GDP/Capita	-3.44	0.00*	1988	1952-2021
US-Can LP	-4.18	0.00**	1967	1951-2021
US-Can TFP	-4.17	0	1968	1951-2019
Aus-Can GDP/Capita	-4.91***	0	1971	1951-2021
Aus-Can LP	-4.63	-0.01***	1965	1951-2021
Aus-Can TFP	-4.44	0.00***	1990	1951-2019

Notes: GDP per capita and labour productivity from the Conference Board database. TFP from the BCL database. ***, **, * denote the 1, 5, and 10 percent significance levels respectively.

The ADF t-statistics are for the null hypothesis of a unit root in the differential, while the associated p -values are based on the non-standard critical values for the rejection of this hypothesis. Rejection of the hypothesis indicates long-run convergence in the expected value of the differential.

The trend term and associated p -value tests for a deterministic trend in the differential. Long-run convergence implies the trend term should be equal to zero. A statistically significant non-zero trend term, together with the absence of a stochastic trend, would imply catch-up growth and a narrowing in the differential over time.

The break year is the observation that minimizes the ADF t-statistic. I do not report significance levels for the break coefficients.

differential with the US, notwithstanding falling narrowly short of conventional levels of statistical significance.

In the case of the US-Canada labour and total productivity differentials, a stochastic trend cannot be rejected, implying the absence of long-run convergence in productivity levels. This result is confirmed by the Australia-Canada labour productivity and TFP differentials, which also show an absence of long-run convergence, although Australian and Canadian living standards would appear to converge in the long-run given the absence of a stochastic trend in their differential.

These results highlight the long-term underperformance of Canadian relative to Australian productivity growth. While Australia shows evidence of converging on US productivity levels, this is not the case for Canada, which appears caught in a low productivity trap relative to the US and Australia. In related work, I find evidence for a long-run equilibrium relationship between US and Australian living standards and labour productivity differentials conditional on other variables and using earlier data and sample periods to those use here (Kirchner, 2020). Given the potential sensitivity of these results to model specification and sample period, the above results should be interpreted with caution, but are nonetheless suggestive.

Box 1: Glossary

Productivity: A measure of the rate at which the output of goods and services are produced per unit of input, most notably labour and capital. It is calculated as the ratio of the quantity of output produced to some measure of the quantity of inputs used. Many factors can affect productivity growth. These include technological improvements, economies of scale and scope, workforce skills, management practices, changes in other inputs (such as capital), competitive pressures, and the stage of the business cycle.

Labour productivity: The ratio of output to hours worked. Over the long term, wages generally grow in line with labour productivity. Labour productivity is a key determinant of income growth.

Multifactor or total factor productivity (MFP/TFP): The ratio of output to combined input of labour and capital. It is generally considered to be a more comprehensive measure of technological change and efficiency improvements than labour productivity. Usually the growth in labour productivity exceeds the growth in multifactor productivity. The difference between the two is the contribution from “capital deepening” or the capital-labour ratio. That is, the accumulation of more and better capital equipment over time helps to make workers more productive.

Source: Adapted from Productivity Commission (2020).

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