The convergence process of Argentina with Australia and Canada: 1875–2000

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Abstract

This paper uses time series techniques to estimate the points in time when Argentina started to lose ground with Australia, Canada and the OECD. Based on my estimates Argentina started to fall behind Australia in 1899 and behind Canada in 1896, earlier than the dates maintained by previous scholars.

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1. Introduction

Argentina today is a nation emerging from deep economic crisis. Periodic crises coupled with economic stagnation have been characteristics of the Argentine economy for decades. But this picture contrasts sharply with the “golden years”

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of Argentine economic development around the turn of the century. At that time Argentina boasted one of the highest growth rates of per capita income in the world and its economic future, compared with other “settler economies” such as Australia and Canada, and more broadly, with that of Europe, seemed secure (Duncan and Fogarty, 1984; Fogarty, 1979; Korol, 1991; Platt and Di Tella, 1985).

At some point the Argentine economy diverged from the path that seemed so secure at the turn of the century, and became an economy beset by recurring crises. But when was the turning point? Although previous work has attempted to answer this question, there is still a lack of consensus as to the precise timing (Cortés Conde, 1997; D’iaz Alejandro, 1983; Taylor, 1994). Getting the timing right is important because it helps identify “shocks” that may have been responsible for the divergence.

This paper uses new and extensive data on per capita income developed by Cortés Conde and Harriague (1996) for Argentine and Maddison (1997, 2002) for several other countries to explore Argentina’s absolute and relative growth performance. Relative comparisons are undertaken with respect to Canada and Australia, because these have been central to the previous literature. As a sensitivity analysis I also present some broader comparisons with the OECD experience. The econometric analysis makes use of recent developments in the detection of “structural breaks” in univariate time series and in comparisons across time series, specifically the methodology proposed by Greasley and Oxley (1998).

The results obtained are at variance in certain respects with the previous literature. I demonstrate, for example, that Argentina never converged strictly speaking with Australia. On the other hand, I find that Argentina caught up to Canada at a rapid pace over certain periods and, indeed, on certain occasions, Argentina’s per capita income surpassed that of Canada. But this process lost intensity after 1897, coinciding with Canada’s “so-called” wheat boom. Lastly, I demonstrate econometrically that Argentina stopped catching up with the OECD countries in 1913.

2. Historiography

There are two closely related debates that are relevant to this paper. The first concerns when Argentina’s “export-led” growth came to an end. According to Di Tella and Zymelman (1967), Cortés Conde (1997), and Taylor (1994) this occurred in 1913 as a consequence of the First World War, but others (D’iaz Alejandro, 1983; Ferrer, 1996) argue that 1929 is a more appropriate date.

The other important debate concentrates on determining at what point in time Argentina started diverging from the developed countries. In this debate comparisons have been made with Australia and Canada. According to Taylor (1994), the relative decline of the Argentine economy took place after 1913, coinciding with the end of Argentina’s expansive phase. Cortés Conde (1997) argues that at some point around the middle of the twentieth century Argentina started falling behind
When did Argentina stop its convergence process with Australia and Canada? Table 1 provides some insight into this question.

In 1913 differences in income per capita levels between Argentina, Australia, and Canada were smaller than in 1870. However at some point between 1929 and 1950 Argentina began to diverge. According to the data in Table 1, in 1929 the product per capita of Argentina was 86% of that of Australia and 90% of that of Canada. In 1950 these percentages were 66 and 67%, respectively. However, these results are not conclusive enough to fix the exact date when the Argentinean economy took a separate path from that followed by Australia and Canada.

### 3. Convergence: two different approaches

Much recent work on convergence uses cointegration techniques or univariate analysis of GDP per capita series of the countries under consideration (Bernard and Durlauf (1995) and Greasley and Oxley (1998), respectively). Of particular relevance to this paper is the study of Greasley and Oxley (1998), who apply techniques developed by Perron (1989) and especially by Zivot and Andrews (1992) to relative GDP series. If the relative series is non-stationary, the strict definition of conver-

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1 Cortés Conde’s study is not very conclusive given that he reaches this conclusion based on GDP per capita levels for Argentina, Australia, Canada, Great Britain, USA, and Italy between 1875 and 1929 whereas he presents growth rates for subperiods from 1875 to 1973 for Argentina, France, Germany, USA, and Great Britain and not for Australia and Canada, as we would have expected. See Cortés Conde (1997, pp. 26–29).

2 These differences are not only maintained but even increase for the following period. Using the same data source we observe that in 1973 the GDP per capita in Argentina was 62% that of Australia and 57% that of Canada. In 1990 these percentages were 38 and 34%, respectively, and in 1998 they rose to 45 and 44%.
gence cannot hold. If the relative series shows a segmented trend we can infer a process of “catching-up” but not of strict convergence.

Our data set includes the GDP per capita time series estimated by Maddison (1997, 2002) expressed in 1990 International Dollars. For Argentina up to 1935 we will use Cortés Conde’s GDP estimates converted to 1990 International dollars in order to make it strictly comparable to the data for Australia and Canada and the OECD group. This conversion has been made by extrapolating the levels given by Maddison for some benchmarks between 1875 and 1935 according to the growth rates calculated from Cortés Conde’s estimates during this period.

In order to determine the potential breaks which allow our series to become stationary I generally follow the methodology of Perron (1989), who developed a test for unit roots that extends the standard Dickey-Fuller procedure by adding dummy variables for different intercepts and slopes, assuming that the break dates are known a priori and choosing just one exogenous break. The equation used is:

$$\Delta Y_t = a_0 + \lambda \cdot Y_{t-1} + a_2 t + a_3 \cdot duT_i + a_4 \cdot dtT_i + \sum_{i=2}^{p} \beta_i \Delta Y_{t-i+1} + \epsilon_t,$$

where $Y$ is, for example, the log of output per capita and $\Delta Y$ is the first difference. The period at which the change in the parameters of the trend function occurs will be referred to as the time of break or $T_i$. The break dummy variables have the following values: $duT_i = 1$ if $t > T_i$, 0 otherwise; $dtT_i = (t - T_i)$ if $t > T_i$, 0 otherwise.

Perron’s method has been criticized by some scholars who argue that the break should be inferred endogenously from the data (see Banerjee et al., 1992; Christiano, 1992; Vogelsang, 1997; Zivot and Andrews, 1992) while others have proposed extending Perron’s original approach to allow for multiple breaks (Bai and Perron, 1998; Ben David and Papell, 2000; Lumsdaine and Papell, 1997; Wang and Zivot, 2000). In light of these criticisms and extensions, I adopt an eclectic approach, mixing visual inspection of the data to look for breaks with formal tests based on Augmented Dickey–Fuller (ADF) statistics in which critical values are obtained using Monte Carlo simulations (see Inwood and Stengos, 1991).

Before proceeding to study the relative series, however, it is important to study the time series properties of each county separately. The underlying idea is to identify different structural breaks for each of the series and verify the extent to which these breaks favoured or impeded convergence between Argentina and the other two economies.

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3 The GDP for the OECD group was constructed as the average of the GDP per head from a set of countries including Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Norway, Sweden, Switzerland, UK, Australia, New Zealand, Canada, and USA. This information also comes from Maddison (1997, 2002).

4 For selecting the value of the lag length $p$ we can follow the procedure suggested by Campbell and Perron (1991) and Ng and Perron (1995) by starting with an upper bound of $p_{\text{max}}$ on $p$. If the last lag included in the equation is significant (with a t-ratio > 1.6), then the choice of $p$ is $p_{\text{max}}$. If the lag is not significant, then $p$ is reduced by 1.

5 The analysis of the GDP per head series for Australia and Canada is included in the appendix.
3.1. Univariate Analysis of GDP per capita series Argentinean GDP per capita analysis, 1875–2000

The Argentinean series shown in Fig. 1 is not stationary given that the ADF values are \(-3.03\) compared to the critical values of \(-4.03\), \(-3.44\), and \(-3.14\) at significance levels of 1, 5, and 10% respectively. Nevertheless the series becomes stationary when modelling its trend with a set of structural breaks fixed at 1913, 1929, and 1974. As can be observed in the following estimation, two negative changes in level in 1913 and 1929 and two negative changes in trend in 1913 and 1974 increase the significance of the lagged variable above the corresponding critical values at levels of 1, 5, and 10%, calculated with Monte Carlo experiments.\(^6\)

The results in Table 2 support those who assert that 1913 was the first structural break (Cortés Conde, 1997; Di Tella and Zymelman, 1967, 1973; Taylor, 1994). From then on and up to 1974 the Argentinean economy went through a new phase characterised by an annual average growth rate of 1.55% compared to that of 3.25% registered between 1875 and 1913.

Di Tella and Zymelman (1967, 1973) define the phase between 1913 and 1933 as the “great delay” which they attribute to the obstinacy of wanting to continue with

\(^6\) The critical values for all variables of this model have been tabulated using the Monte Carlo experiment with 2000 repetitions and a sample size of 126 observations. The data generating process is the result of considering the model under the unit root null hypothesis and with level changes in 1913 and 1929. The value is \(-5.57\) at a 1%, \(-5.09\) at a 5%, and \(-4.82\) at a 10% level for the lagged dependent variable. All of the incorporated breaks are significant at a 5% level, as we have assumed, given that they exceed the reference values, which in absolute values are 2.78 for \(du1913\), 2.75 for \(du1929\), 3.44 for \(dt1913\), and 2.80 for \(dt1975\).
the previous growth model even though the key factor, the opening of new range, was coming to an end around 1913 and did in fact end around 1933. This view is shared by Corte’s Conde (1997) who cites the reduction of trade, the fall in public spending, construction and transport, and market intervention as additional factors which explain the slow-down of the economy which occurred after 1913.

However, the most important forces for the change in trend observed around 1913 were the slowing down of immigration and the reduction of capital flows. As Taylor (1992) showed, the rate at which foreign capital flowed into Argentina slowed down markedly after the First World War. The increase in internal savings could not compensate for this, given that this increase represented only a small percentage of income (5% in Argentina opposed to 13.4% in Australia and 16.5% in Canada between 1914 and 1929). Moreover, the theory that the import substitution industrialisation (ISI) process commenced as a consequence of the First World War supports the break founded in 1913 (Lewis, 1990; Randall, 1978; Villanueva, 1972).

The ISI process progressed over time, after 1929 and especially during the Peronist regime and this could explain why the new pattern of growth, which started in 1914, did not change until 1974. The change of level we observe in 1929 can be explained by the fact that Argentinean exports lost their leading role at that time. On the one hand this produced an important reduction in foreign exchange inflow, which was vital for buying capital goods and continuing the ISI process. On the other hand, Taylor (1998a,b) argues that the Argentinean economy isolated itself more and more from the outside world causing a sharp increase in the price of capital goods and making the economy less capital intensive than it should have been.

This pattern of growth put Argentina on an unsustainable path, a situation which became manifest during the 1973 oil crisis and our analysis shows this with a negative change in the trend of the series, delimiting the last phase. From 1975 to 2000 the economy grew at an annual average rate of 0.58%.

### Table 2

Univariate analysis of argentina’s GDP per capita series ADF: $\Delta Y_{t-1} = a_0 + \lambda * Y_{t-1} + a_2t + a_1 * duT_i + a_3 * dtT_i + \epsilon_t$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cte</td>
<td>-23.223</td>
<td>-5.571</td>
</tr>
<tr>
<td>$Y_{t-1}$</td>
<td>-0.385</td>
<td>-6.165</td>
</tr>
<tr>
<td>$t$</td>
<td>0.013</td>
<td>5.696</td>
</tr>
<tr>
<td>$du1913$</td>
<td>-0.179</td>
<td>-5.274</td>
</tr>
<tr>
<td>$dt1913$</td>
<td>-0.006</td>
<td>-4.101</td>
</tr>
<tr>
<td>$du1929$</td>
<td>-0.069</td>
<td>-2.929</td>
</tr>
<tr>
<td>$dt1974$</td>
<td>-0.006</td>
<td>-3.559</td>
</tr>
</tbody>
</table>

Adj $R^2 = 0.23$

DW = 1.806

AIC = 2.60

$F = 7.39$

For which $duT_i = 1$ if $t > T_i$ ($T_i = 1913, 1929, and 1974$) and is zero for all other cases, and $dtT_i = (t - T_i)$ if $t > T_i$ and is zero for all other cases. Therefore $duT_i$ represents level changes in the corresponding series for the years indicated in parentheses and $dtT_i$ represents changes in trend.
Another shock affected the Argentine economy, an event which, when added to the unsustainable internal conditions, put the economy in a very complicated situation (Di Tella, 1989, p. 213). The crisis aggravated the deficit in the balance of payments and contributed to an increase in the inflation rate which reached a peak in 1975. In fact, from then on the economy became immersed in a hyperinflationary process which lasted until the end of the 1980s.

In addition, the increase in the world interest rate as a consequence of the oil crisis helped to generate the external debt crisis which also affected this economy.

In an attempt to deal with the situation some short-term measures were implemented such as a reduction in wages, meaning a contraction in the real income of wage-earners, and a process aimed at liberalising foreign trade. In the end, these measures did not produce the expected results. Firstly, the reduction in wages, in conjunction with a massive flight of capital, led to a drop in consumption and, obviously, internal demand. On the supply side, the industrial sector was the most affected and began to become less competitive at the beginning of the 1980s.

Secondly, the external trade liberalisation measures, despite the subsequent rise in exports, also had counterproductive results. On one hand, the use of devaluation to make exports more competitive helped to maintain the inflationary process. On the other hand, the reduction in tariffs, part of this set of measures, implied a reduction in the price of imports perpetuating the imbalance in the external accounts (Torre and De Riz, 1993).

In 1983 the famous Plan Austral was introduced with the main purpose of stopping inflation and reducing the public deficit. Nevertheless, the Plan started to fail at the beginning of 1987 and it was not until 1990, with the introduction of the Convertibility Law, which fixed the peso with the dollar, and the associated economic reforms, that inflation was finally brought under control and the economy initiated an upward movement. Moreover, the continuation of the privatisation process, initiated with the Plan Austral, helped to balance the public sector accounts. From then on, and as we can see in Fig. 1, GDP per head started to grow more quickly. However, this jump represented only a cyclical movement within a trend that had remained unaltered since 1975.

3.2. Analysis of the relative series

3.2.1. Argentina versus Australia and Canada

For how long did the Argentine economy converge with the economies of Australia and Canada? I start with the Argentina/Australia comparative series and continue with the Argentina/Canada comparison. The graphs for both are shown in Figs. 2 and 3.

As we can observe in the first of the two graphs, Argentina never reached the per capita product of Australia even though there was a closing of the gap between the two countries up to the beginning of the 20th century. However the gap remained the same until the early 1970s when, after more or less seventy years of relative stability, Argentina’s relative position declines.
The second graph shows the comparison between Argentina and Canada and is somewhat different. Here, we see the Argentine economy gathering pace after 1875, reaching the same level as Canada around 1890 and actually overtaking the Canadian economy at certain points up to 1936.

A simple analysis of the graphs seriously questions the theses put forward by historians and economists concerning the moment when Argentina stopped converging with the other two economies. We can guess that the key moment was not 1929, as argued by Díaz Alejandro, because Argentina and Australia stopped converging much earlier than this and Argentina never attained Australia’s level whereas Argen-
tina did reach the same level as Canada and even overtook it later on. We can see also that 1950 was not a turning point as Cortés Conde has asserted. The catching-up process between Argentina and Canada slowed down before the Second World War. It would seem that the turning point should be closer to 1913, as maintained by Taylor. Nevertheless this reasoning is purely intuitive and it is important to investigate the matter econometrically.

The relative series for Argentina and Australia is clearly non-stationary given that the value of its ADF statistic is \( /C0 2.84 \) (the critical values are \( /C0 4.036 \), \( /C0 3.447 \), and \( /C0 3.148 \) at 1, 5, and 10% levels of significance, respectively). But this series can be transformed into a stationary series by introducing different structural breaks. The results are shown in Table 3.

From Table 3, we can observe that the most suitable break points which convert the relative series for Argentina–Australia into a stationary series are 1899 and 1974. Both breaks are significant and are also those that maximise the statistic for the lagged GDP per capita variable. The negative sign of the parameter for the first break indicates that Argentina’s rapid catching-up process with respect to Australia from 1875 (at an average annual speed of 2.3%) started slowing down from 1899 onwards and even turned negative (an annual average of –0.09%). After 1975, we can observe a clear process of divergence at an annual rate of –0.7%.

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7 The years when Argentina’s GDP per capita levels overtake or equal those of Canada are the periods between 1892 and 1899 and 1904, 1905, 1908, 1909, 1912, and 1935.

8 In this case the reference values for \( Y_{t-1} \), taking into account the data generating process assuming the unit root null hypothesis and the change of level after 1899, are \( –4.853 \) at 1%, \( –3.733 \) at 5%, and \( –3.624 \) at 10% levels. The structural breaks are significant at a 5% level with critical values of 2.421 for \( dtT_{1899} \) and 2.859 for \( dtT_{1974} \).

9 These speeds of closing and widening of the gap between the two economies have been calculated with an equation which relates the relative GDP per capita series and the modelled segmented trend taking into account the trend breaks obtained and fixed in 1899 and 1974.
From our results we are able to estimate more precisely when Argentina catching up with Australia; this seems to be 1899. The growth of the Australian economy after 1892 led to a relative worsening of Argentina’s situation which was reinforced by the later negative break in its growth trend after 1913. As we can see in the first table of Appendix A, which shows the univariate analysis of the Australian GDP per capita series, in 1892 the growth trend of this economy showed a downward change in level but an upward change in trend. The question whether or not the Australian economy suffered a climacteric in the last decade of the nineteenth century has been scrutinised in recent historical literature. Many interpretations confirm this view and argue that this was an immediate consequence of the Baring crisis, which caused the flow of loans from Great Britain to cease (Boehm, 1979; Greasley and Oxley, 1998, p. 309).

Greasley and Oxley (1998, p. 304), following previous work by Butlin (1970), suggest the origin of the climacteric can be found at an earlier date, somewhere in the eighties, when investments in railways, cattle and farming produced very low returns. This fact, according to Butlin, jeopardised the foreign debt service payments and the effects were to be felt in the 1990s (Greasley and Oxley, 1998, p. 304). Australia began to register lower growth rates after 1890, both in total product and in product per capita but the fall in GDP was far less pronounced than that in population which produced some increase in product per capita. For Butlin a sustained growth in GDP per capita and a degree of stability similar to that reached between 1860 and 1890 was not be obtained until after the Second World War (Butlin, 1970, p. 282).

Other authors, such as Maddock and Jackson, propose a different sequence of events. For them it was not until 1890 that Australia initiated an era of intense economic growth, which, for Maddock, can be observed in its GDP per capita series. Jackson also maintains 1890 as the point at which Australia’s economic development pattern changed (Greasley and Oxley, 1998, p. 304).

In the light of our results both interpretations are plausible. On the one hand, the Baring crisis or the low returns on investments in the eighties caused the low levels of GDP which we observe after 1892. On the other hand, after 1892 we perceive a period of intense growth of Australia’s economy in per capita terms. Both changes can be reconciled as we can see in the plotted series in the first graph of Appendix A and can be supported by the fact that the average annual growth rate for Australia’s GDP per capita is 0.85% from 1875 to 1892 and 1.76% from 1892 to the present. Therefore, based on Maddison’s data, the results we have obtained do not support Butlin’s view. We must stress, however, that this analysis distinguishes between

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10 Obviously there is an interval of years between 1890 and 1903 that are potential breaks with power enough to reject the null hypothesis that maintains the existence of unit root. For example, the absolute value of the t-statistics for the dependent retarded variable in the ADF test vary from 4.06 for 1890 to 4.14 for the year 1903. Nevertheless, and I said in Section 4, we are interesting in choosing the year for which this t-ratio is maximised and in this case that is 1899 which displays a t-ratio of 4.88. In combination with the break 1974 this t-ratio is higher, of 5.88, as we can see in Table 3.

11 Also according to Boehm (1993) from 1895 to 1900 there were a number of droughts and according to Greasley and Oxley (1998, p. 309), this coincided with a fall in the terms of trade. Both circumstances may have had an impact on the level of Australian GDP too.
changes in levels and trends and that we also found that although the Australian economy can be represented with a sharper trend from 1892 onwards, the analysis also perceives a fall in the product per capita level for that same year. This suggests that the economy began a period of more intense growth even though it started off from a lower level than previously attained.

Following the results obtained in Table 2 and observing Graph 2, we can also see that even though Argentina never reached Australia’s GDP per capita levels, during an intermediate phase—1899 to 1975—both economies evolved almost in parallel. Nevertheless, after 1975 Argentina lost any opportunity of reducing the gap and its economy entered the least satisfactory phase of its history whereas Australia, in the long run, maintained the rhythm of growth initiated in 1892. This series does not show the impact of the First World War.

If we continue with the convergence analysis we can verify that the relative series for Argentina and Canada is also non-stationary; it shows an ADF value of −3.07.\textsuperscript{12} This series becomes stationary if we introduce a structural break in its trend in 1896 and a change of level in 1918.\textsuperscript{13} (Table 4)

The first structural break occurs in 1896 and has a negative sign, which indicates a break in the catching-up trend between the two economies. This process, which was advancing until that moment at an annual average speed of 1.22%, started to become

\begin{table}[h]
\centering
\caption{Univariate analysis of relative GDP p.c. Argentina versus Canada ADF: ΔY_{t-1} = a_0 + \lambda \cdot Y_{t-1} + a_1 \cdot t + a_2 \cdot duT_i + a_3 \cdot drT_i + \epsilon_t}
\begin{tabular}{lccc}
\hline
Variable & Parameter & $t$-ratio \\
\hline
Constant & −20.490 & −2.587 \\
$Y_{t-1}$ & −0.853 & −7.051 \\
t & 0.010 & 2.585 \\
dr1896 & −0.015 & −3.314 \\
du1918 & 0.101 & 3.225 \\
AR(1) & 0.699 & 6.846 \\
\hline
\end{tabular}
\end{table}

where $duT_i = 1$ if $t > T_i$ ($T_i = 1896$ and 1918) and is zero for the contrary, and $drT_i = (t-T_i)$ if $t > T_i$ and is zero for the contrary. Therefore, $duT_i$ represents level changes in the corresponding series for the years indicated in parenthesis and $drT_i$ represents changes in trend. The AR(1) term has been introduced to correct autocorrelation problems.

\textsuperscript{12} The critical values according to Dickey–Fuller are −4.0361 at a 1%, −3.4472 at a 5%, and −3.1487 at a 10%. I obtained a statistical value for the $Y_{t-1}$ variable of −3.07, less than any of the reference values from which we deduce that the series has a unit root and therefore is not stationary.

\textsuperscript{13} In this case the reference values for $Y_{t-1}$, taking into account the data generating process assuming the unit root null hypothesis and the change of level in 1896 and 1918, are −4.318 at a 1%, −4.003 at a 5%, and −3.735 at a 10% level. The structural breaks are significant at a 5% level with critical values of 2.421 for dr1896 and 2.864 for du1918.
a gap-widening process given that from that time on, and up to 2000, the growth trend of the relative series became negative. This is confirmed by the growth trend which shows an annual average of $-0.51\%$ for that period.

The gap between the economies of Argentina and Canada was decreasing rapidly for a short period, from 1875 to 1896, but that was more than sufficient for Argentina to overtake Canada around 1892. After 1896, and even though Argentina showed higher levels per capita at some moments of time until 1936, this process of reducing the gap, pulling even and overtaking Canada started to change and eventually reversed direction. The differences in the growth trends of GDP per capita began to increase in Canada’s favour in 1896 and the following years when its economy moved into a phase of higher economic growth due to the country’s wheat boom. Although there is some dispute among Canadian economic historians regarding the impact of the wheat boom (see Chambers and Gordon, 1996; Greasley and Oxley, 1998; Inwood and Stengos, 1995) my results suggest that the wheat boom had an impact on product per capita levels.14

The positive change in the level of the relative series after 1918, shown in Table 3, would reflect the lesser impact of the First World War on Argentina’s GDP per capita. This is what pushed its GDP levels above Canada’s at certain times up to 1936, although it does not affect the trend initiated in 1896 when Argentina lost its relative position.

3.2.2. A final proof: Argentina versus OECD

To achieve our objective and in order not to influence the main conclusions by choosing only Australia and Canada as the comparative sample, we continue with the study of the relative GDP per head series for Argentina and the OECD group which, at the same time, will allow us to check the accuracy of Taylor’s hypothesis more thoroughly. In this case too we find that the relative series is not stationary due to the fact that its ADF is below the critical values at the 1, 5, and 10% levels of significance ($-2.733$ versus $-4.036$, $-3.447$, and $-3.148$, respectively). However, as usual, it can be converted into a stationary one once we introduce one change to the level in 1913 and what is more important, two changes to the trend after 1913 and 1950.15 In reality, all these changes adopt a negative sign in 1913 and 1950 and again, these breaks clearly agree with those obtained in the analysis of the individual series. More specifically, the first one is due to the slow-down in growth experienced by the Argentinean economy in 1913 which has been broadly commented on

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14 Population also grew as a consequence of the wheat boom but not at such a high rate as to find important differences between Inwood and Stengos's analysis, in terms of GDP, and mine, in terms of GDP per capita. According to the data taken from Maddison the average population growth rate was 1.2% from 1875 to 1896 and 1.6% after that year.

15 In this case the reference values for $Y_{1-1}$ obtained from a Monte Carlo experiment are $-5.042$, $-4.729$, and $-4.590$ at a 1, 5, and 10%, respectively. So, as the statistical value for this variable in the estimation taking into account the breaks in the trend is greater than those reference values (that is of $-5.191$), we can conclude that once we control for breaks the series became stationary. The structural breaks are significant at a 5% level with critical values of $-2.209$ and $-3.395$ for $d{t}1913$ and $d{t}1913$ and of 3.165 for $d{t}1950$. 

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before. In fact, this result supports Taylor’s thesis, which locates the end of Argentina’s catching-up process in relation to the OCDE countries in this particular year. The second break, found in 1950, is related to the higher rate of growth achieved by the OECD group after the Second World War (see Fig. 4 and Table 5).

4. Conclusions

The objective of this article has been to provide a more accurate estimate of when Argentina started to diverge from the economies of Australia and Canada. From the
analysis carried out we conclude that Argentina’s rapid catching up process with Australia came to an end around 1899. Between that year and 1975, these two economies evolved in parallel, although Australia maintained a higher level of income. After 1975, this parallel evolution changed and the gap between the two economies widened.

In the case of Argentina and Canada we can observe a process of catching-up, drawing level and overtaking in the GDP per capita levels. The situation started to change after 1896, even though Argentina’s product per capita levels surpassed those of Canada at some moments until 1936. After 1896, the trend marking the higher rate of progress in the Argentinean economy became negative, which indicates a loss of relative position in terms of growth rates.

Undertaking the same analysis comparing Argentina’s evolution with that followed by the OECD area I reach the same conclusion as Taylor because our results indicate 1913 as being the year in which Argentina stopped catching up with this group of countries.

From these results it has been argued that there were some structural breaks which favoured, and others that hindered the process of catching-up and convergence between these economies. In this case, the higher growth rate which Australia registered after 1892, the wheat boom which Canada experienced after 1896 and the recovery of the OECD countries after the Second World War were events which affected their relative positions with Argentina and made it difficult for that country to continue closing the gap at the same pace. This explanation is reinforced by the negative change in trend observed after 1913, which marked the end of Argentina’s golden era of economic growth. This last outcome is in line with the view put forward by Cortés Conde (1997) using the results obtained by analysing the evolution of the Argentine economy on its own, and with those maintained by Di Tella and Zymelman (1967) and Taylor (1994). The break which occurred in 1975 initiated the period of Argentina’s lowest economic growth until 2000.

Appendix A. Analysis of Australia’s GDP per capita series: 1875–2000

In the case of Australia we observe that the statistic obtained for the lagged dependent variable is $-1.96$, which is less than the reference values at a 1, 5, and 10% level, from which we deduce that this series is not stationary. Similar to the case of Argentina we can obtain a stationary series by introducing certain structural breaks in the Australian GDP series (Fig. 5).

A downward change in level and a positive change in trend after 1892 and two additional downward changes in level after 1914 and 1928 allow us to reject the unit root hypothesis for this series. The results are shown below:

\[\text{The reference values which have been tabulated by Dickey and Fuller for a sample size of 126 observations and a regression which includes a constant and a trend are } -4.036 \text{ at a 1%, } -3.447 \text{ at a 5%, and } -3.148 \text{ at a 10% level.} \]
Univariate analysis of Australia’s GDP per capita series ADF: $\Delta Y_{t-1} = a_0 + \lambda * Y_{t-1} + a_1 * t + a_2 * du_{T_i} + a_3 * dt_{T_i} + \epsilon_t$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_{t-1}$</td>
<td>-0.438</td>
<td>-8.467</td>
</tr>
<tr>
<td>$t$</td>
<td>0.002</td>
<td>8.482</td>
</tr>
<tr>
<td>du1892</td>
<td>-0.137</td>
<td>-6.949</td>
</tr>
<tr>
<td>dt1892</td>
<td>0.007</td>
<td>8.513</td>
</tr>
<tr>
<td>du1914</td>
<td>-0.108</td>
<td>-6.455</td>
</tr>
<tr>
<td>du1928</td>
<td>-0.109</td>
<td>-5.586</td>
</tr>
</tbody>
</table>

Adj. $R^2 = 0.372$

DW = 1.811

AIC = -6.628

$F = 15.718$

where $du_{T_i} = 1$ if $t > T_i$ ($T_i = 1892, 1914, and 1928$) and is zero for the contrary, and $dt_{T_i} = (t - T_i)$ if $t > T_i$ and is zero for the contrary. Therefore, $du_{T_i}$ represents level changes in the corresponding series for the years indicated in parenthesis and $dt_{T_i}$ represents changes in trend.

Performing Monte Carlo experiments for the Australian GDP per capita series, we can contrast the fact that the breaks we have identified are significant and that the $t$-ratios for the lagged dependent variable are greater than the reference values.\(^{17}\)

\(^{17}\) The critical values found via Monte Carlo for the lagged dependent variable in the ADF contrast are $-4.792$, $-4.425$, and $-3.979$ at a 1, 5, and 10% level of significance. For the different breaks this represents an absolute value at a 5% level, of 2.806 for $du_{1896}$, of 2.632 for $du_{1914}$ and of 2.362 for $du_{1931}$. We have considered a data generating process, assuming a unit root hypothesis, with a change in level after 1892.
A key difference between my study and Greasley and Oxley (1998) is that these authors consider that the structural change after 1891 was only a change in GDP per capita level. Also their analysis shows a negative change in level and positive change in trend after 1925. 18

Appendix B. Univariate analysis of Canada’s GDP per capita series

The graph of Canadian GDP per capita is shown in Fig. 6. Just as in the case of Argentina and Australia, if we perform an ADF test of the Canadian GDP per capita series we find that the series is not stationary given that the lagged dependent variable shows a significance which is lower than the critical values tabulated by Dickey and Fuller. The ADF value is $-2.622$ opposed to the critical values of $4.036$, $3.447$, and $3.148$ at a 1, 5, and 10% level respectively.

Again as in the previous cases the Canadian GDP per capita series has significant breaks in its trend that convert it in stationary. These structural breaks take place in 1896, 1914, and 1931 and are more than sufficient to reject the non stationary hypothesis as the lagged dependent variable becomes greater than the reference values at all levels of significance. 19 The results are shown below:

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18 I have introduced both breaks in the ADF test in order to compare their analysis with that presented in this paper obtaining a reduction in significance of the lagged GDP per capita variable in absolute terms (5.045 opposed to 8.467 obtained in our analysis). Greasley and Oxley (1998) fail to use the Monte Carlo method to calculate the critical values of reference and therefore we can consider the analysis we present here as more precise.

19 Considering a data generating process assuming unit root hypothesis and a change in level after 1897, the Monte Carlo experiment gives us critical values for $Y_{t-1}$ of $-5.210$, $-4.652$, and $-4.369$ at a 1, 5, and 10% level. For the different structural breaks and at a 5% level of significance these are in absolute values 2.690 for $du1892$ variable, 2.637 for $dr1892$, 2.493 for $du1914$ and 2.638 for $du1928$. 

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Univariate analysis of Canada’s GDP per capita series ADF: $\Delta Y_{t-1} = a_0 + \lambda Y_{t-1} + a_1 t + a_2 duT_i + a_3 dtT_i + \epsilon_t$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y_{t-1}$</td>
<td>-0.730</td>
<td>-7.605</td>
</tr>
<tr>
<td>$t$</td>
<td>0.003</td>
<td>7.464</td>
</tr>
<tr>
<td>$du1896$</td>
<td>0.015</td>
<td>7.953</td>
</tr>
<tr>
<td>$du1914$</td>
<td>-0.116</td>
<td>-2.551</td>
</tr>
<tr>
<td>$du1931$</td>
<td>-0.177</td>
<td>-3.837</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.876</td>
<td>16.27</td>
</tr>
</tbody>
</table>

Adj. $R^2 = 0.245$
DW = 1.984
AIC = -6.133
$F = 8.885$

where $duT_i = 1$ if $t > T_i$ ($T_i = 1897, 1914, \text{and } 1931$) and is zero for the contrary, and $dtT_i = (t-T_i)$ if $t > T_i$ and is zero for the contrary. Therefore, $duT_i$ represents level changes in the corresponding series for the years indicated in parenthesis and $dtT_i$ represents changes in trend. The AR(1) term has been introduced to correct autocorrelation problems.

Appendix C. Univariate analysis of OCDE’s GDP per capita series

That series is not stationary given that the ADF value is $-1.408$ opposed to the critical values before mentioned but some structural breaks places in 1930 and

Fig. 7. OCDE’s GDP per capita series: 1875–2000 (logarithms). Sources: Maddison (1997, 2002).
1945 (the first one just in the level and the second in both, level and trend) are enough to convert it in stationary as we can see in the next table.\textsuperscript{20} (Fig. 7)

Univariate analysis of OCDE’s GDP per capita series ADF: \( \Delta Y_{t-1} = a_0 + \lambda \cdot Y_{t-1} + a_1 \cdot t + a_2 \cdot d_u T_i + a_3 \cdot d_t T_i + \varepsilon_t \)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Parameter</th>
<th>( t )-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-7.303</td>
<td>-4.497</td>
</tr>
<tr>
<td>( Y_{t-1} )</td>
<td>-0.583</td>
<td>-6.474</td>
</tr>
<tr>
<td>( t )</td>
<td>0.005</td>
<td>5.063</td>
</tr>
<tr>
<td>( d_u 1930 )</td>
<td>-0.034</td>
<td>-2.797</td>
</tr>
<tr>
<td>( d_u 1945 )</td>
<td>-0.049</td>
<td>-3.849</td>
</tr>
<tr>
<td>( d_t 1945 )</td>
<td>0.003</td>
<td>2.573</td>
</tr>
<tr>
<td>AR(1)</td>
<td>0.866</td>
<td>13.645</td>
</tr>
</tbody>
</table>

Adj. \( R^2 = 0.338 \)

\( DW = 2.070 \)

\( AIC = -8.852 \)

\( F = 11.487 \)

where \( d_u T_i = 1 \) if \( t > T_i \) (\( T_i = 1930 \) and 1945) and is zero for the contrary, and \( d_t T_i = (t - T_i) \) if \( t > T_i \) and is zero for the contrary. Therefore, \( d_t T_i \) represents changes in trend in the corresponding series for the years indicated in parenthesis and \( d_u T_i \) represents a level change in 1930. The AR(1) term has been introduced to correct autocorrelation problems.

References


\textsuperscript{20} The Monte Carlo experiment, assuming unit root hypothesis and two changes in level after 1930 and 1945, displays a critical values for \( Y_{t-1} \) of -5.459, -4.989, and -4.654 at a 1, 5, and 10\% level. For the different structural breaks and at a 5\% level of significance these are in absolute values 2.473 for \( d_u 1930 \) variable, 2.123 for \( d_u 1945 \), and 2.076 for \( d_t 1945 \).