GDP Forecast for Australia

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How high will the Kangaroos jump?

Ravi Saraogi

5/26/2008
Australia: An Introduction

The Commonwealth of Australia is a country in the southern hemisphere comprising the mainland of the world’s smallest continent, the major island of Tasmania, and a number of other islands in the Indian and Pacific Oceans. The neighbouring countries are Indonesia, East Timor, and Papua New Guinea to the north, the Solomon Islands, Vanuatu, and New Caledonia to the north-east, and New Zealand to the south-east. Australia is the only country that is also a continent.

Australia has a prosperous, Western-style mixed economy, with a per capita GDP slightly higher than that of the UK, Germany, and France in terms of purchasing power parity. The country was ranked third in the United Nations’ 2007 Human Development Index and sixth in The Economist worldwide quality-of-life index 2005. The absence of an export-oriented manufacturing industry has been considered a key weakness of the Australian economy. More recently, rising prices for Australia’s commodity exports and increasing tourism have made this criticism less relevant. Nevertheless, Australia has the world’s fourth largest current account deficit in absolute terms (in relative terms it is more than 7% of GDP). This is considered problematic by some economists, especially as it has coincided with the high terms of trade and low interest rates that make the cost of servicing the foreign debt low.

The Hawke Government started the process of economic reform by floating the Australian dollar in 1983, and partially deregulating the financial system. The Howard government continued the process of microeconomic reform, including a partial deregulation of the labour market and the privatisation of state-owned businesses, most notably in the telecommunications industry. The indirect tax system was substantially reformed in July 2000 with the introduction of a 10% Goods and Services Tax (GST), which has slightly reduced the heavy reliance on personal and company income tax that characterises Australia’s tax system.

At January 2007, there were 10,033,480 people employed, with an unemployment rate of 4.6%. Over the past decade, inflation has typically been 2–3% and the base interest rate 5–6%. The service sector of the economy, including tourism, education and financial services, constitutes 69% of GDP. Agriculture and natural resources constitute 3% and 5% of GDP but contribute substantially to export performance. Australia’s largest export markets include Japan, China, the US, South Korea and New Zealand.

The snapshot given below should get the reader acquainted with the Australian economy.
Australia: Fact Sheet

General information:

- Capital: Canberra
- Surface area: 7,692 thousand sq km
- Official language: English
- Exchange rate: AUD = US$ 0.9131 (Feb 2008)
- Head of State: H.M. Queen Elizabeth II, represented by the Governor-General Major General Michael Jeffery
- Head of Government: Prime Minister The Hon Mr Kevin Rudd

Recent economic indicators:

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007(a)</th>
<th>2008(b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP (US$bn) (current prices):</td>
<td>527.7</td>
<td>640.3</td>
<td>713.0</td>
<td>757.5</td>
<td>910.9</td>
<td>1,046.8</td>
</tr>
<tr>
<td>GDP PPP (US$bn) (c):</td>
<td>600.1</td>
<td>636.3</td>
<td>672.5</td>
<td>713.1</td>
<td>760.8</td>
<td>801.0</td>
</tr>
<tr>
<td>GDP per capita ($)</td>
<td>20,364</td>
<td>31,610</td>
<td>34,741</td>
<td>36,325</td>
<td>36,478</td>
<td>40,900</td>
</tr>
<tr>
<td>GDP per capita PPP ($) (c)</td>
<td>30,112</td>
<td>31,551</td>
<td>32,698</td>
<td>34,375</td>
<td>36,258</td>
<td>37,701</td>
</tr>
<tr>
<td>Real GDP growth (% change YOY):</td>
<td>3.4</td>
<td>3.4</td>
<td>3.0</td>
<td>2.6</td>
<td>4.1</td>
<td>3.2</td>
</tr>
<tr>
<td>Current account balance (US$m):</td>
<td>-28,585</td>
<td>-38,905</td>
<td>-41,050</td>
<td>-41,470</td>
<td>-56,517</td>
<td>-65,574</td>
</tr>
<tr>
<td>Current account balance (% GDP):</td>
<td>-5.2</td>
<td>-6.1</td>
<td>-5.8</td>
<td>-5.5</td>
<td>-6.2</td>
<td>-6.0</td>
</tr>
<tr>
<td>Goods &amp; services exports (% GDP):</td>
<td>17.6</td>
<td>19.1</td>
<td>19.4</td>
<td>20.8</td>
<td>20.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Inflation (% change YOY):</td>
<td>2.4</td>
<td>2.6</td>
<td>2.8</td>
<td>3.3</td>
<td>3.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Australia’s merchandise trade

<table>
<thead>
<tr>
<th>Year</th>
<th>Exports (A$m)</th>
<th>Imports (A$m)</th>
<th>Exports - Imports (A$m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>168,055</td>
<td>187,796</td>
<td>20,735</td>
</tr>
</tbody>
</table>

Australia’s trade and investment relationships:

Australia’s main export destinations, 2007:

- 1. Japan: 18.9%
- 2. China: 14.1%
- 3. Republic of Korea: 8.0%
- 4. United States: 6.0%
- 5. New Zealand: 5.6%

Australia’s main import sources, 2007:

- 1. China: 15.5%
- 2. United States: 12.9%
- 3. Japan: 9.8%
- 4. Singapore: 5.6%
- 5. Germany: 5.2%

Australia’s trade in services, 2007:

- Exports of services (A$m): 48,042
- Imports of services (A$m): 46,054
- Services trade surplus (A$m): 1,988

Australia’s investment links, as at 31 Dec 2007:

- Level of Australian investment abroad (A$m): 884,365
- Level of foreign investment in Australia (A$m): 1,621,192

Source: Compiled by the Market Information and Analysis Section, DFAT, using the latest data from ABS, the IMF and various international sources.
(a) All recent data subject to revision  (b) IMF forecast  (c) PPP is purchasing power parity  (d) Total may not add due to rounding  (e) Merchandise Trade
Australian Economy: A Graphical Tour

Source: Reserve Bank of Australia

GDP
Contribution to year-ended growth, December quarter 2007

Consumer Price Inflation*

Employment

State Budget Balances*

The Model

We are estimating a Vector Auto Regressive (VAR) model to forecast the quarterly growth rates in the GDP (at constant 2000 USD) of Australia\(^1\), which has some obvious benefits over a pure simultaneous equation system. In the case of simultaneous equation systems, some variables are treated as endogenous and some as exogenous or predetermined (exogenous plus lagged endogenous). Before we estimate such models, we have to make sure that the equations in the system are identified (either exactly or over-). This identification is often achieved by assuming that some of the predetermined variables are present only in some equations. This decision is often subjective and has been severely criticized by Christopher Sims\(^2\). According to Sims, if there is true simultaneity among a set of variables, they should all be treated on an equal footing; there should not be any a priori distinction between endogenous and exogenous variables. It is in this spirit that Sims developed his VAR model which we use for our purpose.

All the variables in a VAR model are endogenous and we can apply the usual OLS procedure\(^3\). The model which we will be using is,

\[
Y_t = \alpha + \beta HCI_{t-i} + \gamma PCI_{t-i} + \eta BI_{t-i} + \theta ESI_{t-i} + \epsilon_t
\]

where, \(Y_t\) = Quarterly growth rate in GDP (at constant 2000 US$)

\(\alpha\) = Intercept term

\(HCI_{t-i}\) = Human capital index with \(i^{th}\) time period lag

\(PCI_{t-i}\) = Physical capital index with \(i^{th}\) time period lag

\(BI_{t-i}\) = Banking index with \(i^{th}\) time period lag

\(ESI_{t-i}\) = External sector index with \(i^{th}\) time period lag

\(\beta, \gamma, \eta, \theta\) = Regression coefficients

\(\epsilon_t\) = Error term

In the above model, we estimate human capital index, physical capital index, banking index and external sector index with the help of 16 variables\(^4\) as described below-

**Human Capital Index**

\(HCI_t = a (PG) + b (DR) + c (Edu)\)

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\(^1\) Sample data is from 1960:1 to 2006:4 and the forecast is up to 2050:4


\(^3\) Gujarati, “Time Series Econometrics: Forecasting”, *Basic Econometrics*, pp 853

\(^4\) For the WDI definitions of the variables used in the model, refer Appendix A
Where,
\( a, b, c \) are weights (\( a + b + c = 1 \) and \( a = b = c \))

\( PG \) = Quarterly population growth rates in per cent

\( DR \) = Quarterly dependency ratio

\( Edu \) = Quarterly govt. expenditure on education as a per cent of quarterly GDP (at current US$)

**Physical Capital Index**

\[ PCI_t = d \cdot (GFCF_{t-1}) + e \cdot (FDI_{t-1}) + f \cdot (M\ Cap) \]

Where,
\( d, e, f \) are weights (\( d + e + f = 1 \) and \( d = e = f \))

\( GFCF_{t-1} \) = Quarterly gross fixed capital formation as a per cent of quarterly GDP (at current US$) with one time period lag

\( FDI_{t-1} \) = Quarterly net foreign direct investment as a per cent of quarterly GDP (at current US$) with one time period lag

\( M\ Cap \) = Quarterly stock market capitalization as a per cent of quarterly GDP (at current US$)

**Banking Index**

\[ BI_t = g \cdot (I) + h \cdot (RR) + i \cdot (L) + j \cdot (CR) \]

g, h, i, j are weights (\( g + h + i + j = 1 \) and \( g = h = i = j \))

\( I \) = Quarterly prime lending rate

\( RR \) = Quarterly bank liquid reserves to bank assets ratio (ratio)

\( L \) = Quarterly banks non performing loans to total loans (ratio)

\( CR \) = Quarterly bank capital to asset ratios

**External Sector Index**

\[ ESI_t = k \cdot (REER) + l \cdot (CA) + m \cdot (T) + n \cdot (F) \]

Where,
\( k, l, m, n \) are weights (\( k + l + m + n = 1 \) and \( k = l = m = n \))

\( REER \) = Quarterly Real Effective Exchange Rate (REER)

\( CA \) = Quarterly capital account balance as a per cent of quarterly GDP (at current US$)

\( T \) = Quarterly trade balance in goods and services as a per cent of quarterly GDP (at current US$)

\( F \) = Quarterly forex reserves as a per cent of quarterly GDP (at current US$)
The Variables

<table>
<thead>
<tr>
<th>S.No</th>
<th>Variable Name</th>
<th>Variable Symbol</th>
<th>Units</th>
<th>Frequency</th>
<th>Actual Series From</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GDP Growth Rate (in constant 2000 US$)</td>
<td>Y</td>
<td>%</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
<tr>
<td>2</td>
<td>Population Growth Rate</td>
<td>PG</td>
<td>%</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
<tr>
<td>3</td>
<td>Dependency Ratio</td>
<td>DR</td>
<td>Ratio</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
<tr>
<td>4</td>
<td>Education on Expenditure (% of current GDP)</td>
<td>Edu</td>
<td>%</td>
<td>Quarterly</td>
<td>1973:3 to 1994:4</td>
</tr>
<tr>
<td>5</td>
<td>Gross Fixed Capital Formation (% of current GDP)</td>
<td>GFCF</td>
<td>%</td>
<td>Quarterly</td>
<td>1971:1 to 2005:4</td>
</tr>
<tr>
<td>6</td>
<td>Net Foreign Direct Investment (% of current GDP)</td>
<td>FDI</td>
<td>%</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
<tr>
<td>7</td>
<td>Market Capitalization (% of current GDP)</td>
<td>M cap</td>
<td>%</td>
<td>Quarterly</td>
<td>1988:1 to 2006:4</td>
</tr>
<tr>
<td>8</td>
<td>Prime Lending Rate</td>
<td>I</td>
<td>%</td>
<td>Quarterly</td>
<td>1975:1 to 2006:4</td>
</tr>
<tr>
<td>9</td>
<td>Bank Liquid Reserves to Bank Assets Ratio</td>
<td>RR</td>
<td>Ratio</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
<tr>
<td>10</td>
<td>Banks Non Performing Loans to Total Loans</td>
<td>L</td>
<td>Ratio</td>
<td>Quarterly</td>
<td>2000:1 to 2006:4</td>
</tr>
<tr>
<td>11</td>
<td>Bank Capital to Asset Ratio</td>
<td>CR</td>
<td>Ratio</td>
<td>Quarterly</td>
<td>2000:2 to 2006:4</td>
</tr>
<tr>
<td>12</td>
<td>Real Effective Exchange Rate</td>
<td>REER</td>
<td>Index</td>
<td>Quarterly</td>
<td>1980:2 to 2006:4</td>
</tr>
<tr>
<td>13</td>
<td>Capital Account Balance (% of current GDP)</td>
<td>CA</td>
<td>%</td>
<td>Quarterly</td>
<td>1961:1 to 2006:4</td>
</tr>
<tr>
<td>14</td>
<td>Trade Balance in Goods and Services (% of current GDP)</td>
<td>T</td>
<td>%</td>
<td>Quarterly</td>
<td>1961:1 to 2006:4</td>
</tr>
<tr>
<td>15</td>
<td>Forex Reserves (% of current GDP)</td>
<td>F</td>
<td>%</td>
<td>Quarterly</td>
<td>1960:1 to 2006:4</td>
</tr>
</tbody>
</table>

![Graphs of PG, DR, EDU, and GFCF]
The following graphs are for the initial indices that were constructed with the use of appropriate weights (equal weights have been given to each variable within an index). As a visual examination would suggest, apart from the series for GDP and perhaps HCI, none of the series appear to be stationary.
For further information about the stationarity of the series, the augmented dickey fuller test was applied to each of the five series to and appropriate transformation was used to convert non stationary data into stationary data.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Data Series</th>
<th>Stationary</th>
<th>Transformation Used for Stationarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GDP</td>
<td>Yes</td>
<td>Already stationary</td>
</tr>
<tr>
<td>2</td>
<td>HCI</td>
<td>Yes</td>
<td>Already stationary</td>
</tr>
<tr>
<td>3</td>
<td>PCI</td>
<td>No</td>
<td>First difference transformation</td>
</tr>
<tr>
<td>4</td>
<td>ESI</td>
<td>No</td>
<td>First difference transformation</td>
</tr>
<tr>
<td>5</td>
<td>BI</td>
<td>No</td>
<td>First difference transformation</td>
</tr>
</tbody>
</table>

BI= Banking Index (Non Stationary)
ESI=External Sector Index (Non Stationary)
PCI=Physical Capital Index (Non Stationary)
DBI = First difference of BI (Stationary)
DESIE=First difference of ESI (Stationary)
DPCI=First difference of PCI (Stationary)
After making the data stationary, we estimated an unrestricted VAR type with 3 lag intervals. The lag interval was selected based on the following criterion-

**VAR Lag Order Selection Criteria**

Endogenous variables: DBI DESI DPCI GDP HCI
Exogenous variables: C
Sample: 1960:3 2006:4
Included observations: 183

<table>
<thead>
<tr>
<th>Lag</th>
<th>LogL</th>
<th>LR</th>
<th>FPE</th>
<th>AIC</th>
<th>SC</th>
<th>HQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>-1107.402</td>
<td>NA</td>
<td>0.131074</td>
<td>12.15739</td>
<td>12.24509</td>
<td>12.19294</td>
</tr>
<tr>
<td>1</td>
<td>-673.0682</td>
<td>840.1859</td>
<td>0.001495</td>
<td>7.683805</td>
<td>8.209951</td>
<td>7.897078</td>
</tr>
<tr>
<td>2</td>
<td>-484.3979</td>
<td>354.6589</td>
<td>0.000250</td>
<td>5.895059</td>
<td>6.859659</td>
<td>6.286058</td>
</tr>
<tr>
<td>3</td>
<td>-368.0067</td>
<td>212.4297*</td>
<td>9.23E-05*</td>
<td>4.896249*</td>
<td>6.299303*</td>
<td>5.464975*</td>
</tr>
</tbody>
</table>

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

The VAR model has been outlined below-

\[ \begin{align*}
\text{Eq1: } & \quad \text{dbi} = F(\text{dbi, desi, dpci, gdp, hci}) \\
\text{Eq2: } & \quad \text{desi} = F(\text{dbi, desi, dpci, gdp, hci}) \\
\text{Eq3: } & \quad \text{dpci} = F(\text{dbi, desi, dpci, gdp, hci}) \\
\text{Eq4: } & \quad \text{gdp} = F(\text{dbi, desi, dpci, gdp, hci}) \\
\text{Eq5: } & \quad \text{hci} = F(\text{dbi, desi, dpci, gdp, hci})
\end{align*} \]

The quarterly estimates were obtained up to 2050:4 with the following results

![Actual GDP Growth Rate (Quarterly) up to 2006:4](image1)
![Forecasted GDP Growth Rate (Quarterly) up to 2050:4](image2)

As we can see, the growth rate in quarterly GDP (at constant 2000 US$) stabilises in the range of 0.5 to 1 per cent. The above model was also estimated with the quarterly growth rate of GDP at current prices with the following results-
The growth rate for quarterly GDP at current prices stabilizes at around 1.9 per cent with minor fluctuations on either side. The above result however should be accepted with the several caveats. The data has not been checked for problems of autocorrelation, multicolinearity and heteroscedasticity. The accuracy of the estimate may have been compromised due to part availability of some data series and the indexation technique adopted in such cases. The weights used for indexation were assumed to be equal. This can however be challenged on theoretical grounds.

Appendix A – Variable Description

Population growth (quarterly %): Quarterly Annual population growth rate. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, which are generally considered part of the population of the country of origin.

Dependency Ratio (dependents to working-age population): Dependency ratio is the ratio of dependents--people younger than 15 or older than 64--to the working-age population--those ages 15-64. For example, 0.7 means there are 7 dependents for every 10 working-age people.

Gross fixed capital formation (% of GDP at current US$): Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial

Data for the below mentioned variables was collected for the time period 1960:1 to 2006:4 from www.economy.com (Moody’s Economy)
buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.

**Net Foreign direct investment, net inflows (% of GDP at current US$):** Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows in the reporting economy and is divided by GDP.

**Market capitalization of listed companies (% of GDP at current US$):** Market capitalization (also known as market value) is the share price times the number of shares outstanding. Listed domestic companies are the domestically incorporated companies listed on the country's stock exchanges at the end of the year. Listed companies do not include investment companies, mutual funds, or other collective investment vehicles.

**Prime lending rate (in %):** Prime lending interest rate is the rate charged by banks on loans to prime customers.

**Bank liquid reserves to bank assets ratio:** Ratio of bank liquid reserves to bank assets is the ratio of domestic currency holdings and deposits with the monetary authorities to claims on other governments, nonfinancial public enterprises, the private sector, and other banking institutions.

**Bank nonperforming loans to total loans (ratio):** Bank nonperforming loans to total gross loans are the value of nonperforming loans divided by the total value of the loan portfolio (including nonperforming loans before the deduction of specific loan-loss provisions). The loan amount recorded as nonperforming should be the gross value of the loan as recorded on the balance sheet, not just the amount that is overdue.

**Bank capital to assets (ratio):** Bank capital to assets is the ratio of bank capital and reserves to total assets. Capital and reserves include funds contributed by owners, retained earnings, general and special reserves, provisions, and valuation adjustments. Capital includes tier 1 capital (paid-up shares and common stock), which is a common feature in all countries' banking systems, and total regulatory capital, which includes several specified types of subordinated debt instruments that need not be repaid if the funds are required to maintain minimum capital levels (these comprise tier 2 and tier 3 capital). Total assets include all nonfinancial and financial assets.
Real effective exchange rate index (2000 = 100): Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

Net capital account (% of GDP at current US$): Net capital account includes government debt forgiveness, investment grants in cash or in kind by a government entity, and taxes on capital transfers. Also included are migrants' capital transfers and debt forgiveness and investment grants by nongovernmental entities. Data are in current U.S. dollars.

Net trade in goods and services (% of GDP at current US$): Net trade in goods and services is derived by offsetting imports of goods and services against exports of goods and services. Exports and imports of goods and services comprise all transactions involving a change of ownership of goods and services between residents of one country and the rest of the world. Data are in current U.S. dollars.

Forex reserves (excluding gold, % of GDP at current US$): Total reserves comprise holdings of monetary gold, special drawing rights, reserves of IMF members held by the IMF, and holdings of foreign exchange under the control of monetary authorities.

Expenditure on Education (% of GDP at current US$): To capture the skill base, government expenditure on education as a percentage of current US$ GDP has been computed.