Technological Progress and Economic Growth
An Australian Exposition
1965 to 2015

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Declaration

I declare that this thesis is my own account of my research and contains, as its main content, work that has not previously been submitted for a degree at any tertiary educational institution, including Murdoch University.

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Abstract

In the last 25 years or so Australia has experienced one of the longest economic booms in history, as compared with other advanced economies. As a result, Australians are enjoying one of the world’s highest living standards and per capita income. Will Australians continue to enjoy positive economic growth for the next 25 years or so? No one could predict accurately – which is not at all helpful. However, it is possible to shed further light on the long-run sustainability of Australia’s aggregate output growth by quantifying and decomposing it. The primary aim of this dissertation is to quantify the sources of economic growth in Australia covering the period 1965 to 2015. The neoclassical growth analysis (Solow 1956; Swan 1956) will be employed to decompose Australia’s economic growth into three components. The first is due to the growth of capital input, the second is due to the growth of labour input, and the third is due to technological progress as captured by an increase in both the productivity of capital and labour, which is also known in the growth literature as total factor productivity (TFP). The Solow-Swan model not only provides a razor-edge measurement method for technological progress but of more importance, the model demonstrates that technological progress (as captured by TFP) is the engine of long-run sustainable growth (Solow 1956; Swan 1956). A positive TFP value suggests that growth is sustainable and vice versa.
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Chapter 1: Introduction and Thesis Structure

1.1 Introduction

The primary aim of this thesis is to empirically estimate the impact of technological progress on Australia’s aggregate output growth covering the period 1965 to 2015. The methodological framework for conducting the study is based on the Solow (1956), Swan (1956) and Solow (1957) papers. According to the Solow (1957) growth analysis, technological progress can be captured by Total Factor Productivity (TFP). A concept whereby the productivity of capital and the productivity of labour can have a simultaneous impact on aggregate output growth. To shed further light on the impact of technological progress on Australia’s output growth for the fifty-year period, the aggregate production structure of the Australian economy is further disaggregated into the primary, secondary and tertiary sectors. In doing so, it would provide some orders of magnitude of productivity growth in these three sectors, and their contributions to the aggregate economy.

Australia’s significant structural and political change over the previous fifty years provides an empirically unique case study in the economics of growth and productivity. For over half a century, each decade has presented unique circumstances: the prosperous 1960’s made way for the turbulent 70’s and 80’s, before the booming late 90’s created a resilient 2000’s. Throughout this time, frequent changes in government have exacerbated uncertainty in the political environment – partially pushed by macroeconomic performance through the 1970’s, 80’s and early 90’s. Since
around the 1980’s, a number of complex factors have led to a clear focus on the decentralisation and liberalisation of the Australian economy. Substantial evidence suggests that the drivers of improved prosperity and resilience has been partially driven by these reforms (see Eslake 2011; Dolman 2009; Bean 2000; Banks 2003; Banks 2005; Banks 2012; Productivity Commission 1999; Parham 2002; Parham 2003). Therefore, the most general aim of the questions that follow is to more deeply enquire into the drivers of Australia’s economic success.

In summary, this paper will examine i) What have been the main drivers of growth in the Australian economy i.e. TFP or factor accumulation? ii) What patterns, if any, exist in terms of the economy’s growth composition? iii) What are the contributions of each economic sector toward the growth path of the economy? iv) Given the findings of the status quo, what is the importance of productivity in sustaining growth moving forward?

The structure of this thesis is as follows. Chapter 2 will provide a brief overview of the Solow (1956) – Swan (1956) neoclassical growth model. Here, the model assumptions will be discussed highlighting the differences between the former growth proposition by Harrod (1939) and Domar (1946). A key role of this chapter is illustrating the effects technological progress has on the production function of an economy in escaping diminishing returns of production. Following this, the respective Solow (1956) and Swan (1956) models will be mathematically derived to provide an understanding of the potential growth paths an economy may take. Lastly, the methodology used for conducting TFP estimates in chapter 5 will be presented.

Chapter 3’s purpose is to briefly examine the literature of other TFP studies. This is to provide an understanding of the measures use and interpretive value. The discussion sequence will cover various findings – from factor accumulation led growth, to its influence on employment,
whilst also highlighting the controversy surrounding measurement and interpretation issues of TFP.

The data needed to conduct the study are found in chapter 4. The discussion undertaken examines all facets of the known factors in the Solow (1956) – Swan (1956) production function i.e. output, capital, and labour. A focus of the historical discussion is the numerous policy, political, and structural change that has occurred in relation to aggregate output, capital, and labour. Putting the aggregate trends in context will be a sectoral division of the economy into the primary, secondary, and tertiary sectors. The trends seen on the sectoral level will help establish the growth path of the economy.

Chapter 5 conducts empirical estimations of TFP growth in Australia for the period 1965 to 2015. Here, using the historical data discussed in chapter 4, sectoral TFP will also be estimated. However, prior to the estimation of TFP, the capital’s share of output, $\alpha$, is determined a priori through an assessment of literature findings. Using the empirical work, TFP findings will then be compared to that of its GDP growth via the Real Business Cycle (RBC) theory. That is, to assess whether technological shocks have caused the variations witnessed in economic growth over the last fifty years. Finally, a decomposition of national and sectoral growth into three components will provide the conclusive evidence of the economy’s growth path during the study period.

Summarising the discussion of the thesis is chapter 6. The primary aim of this chapter is to perform a comprehensive review of all preceding chapters and findings. Most importantly, however, will be putting into context the historical data trends and empirical work undertaken in terms of the questions asked earlier in this chapter.
Chapter 2: Theoretical Premise of Study

2.1 Introduction

The primary aim of this chapter is to provide a brief overview of the Solow (1956) and Swan (1956) growth analysis. In doing so, it would provide a theoretical framework for the analysis of economic growth of Australia covering the period 1965 to 2015, found in the latter part of this thesis. The Solow (1956) – Swan (1956) growth proposition is considered by many (Denison 1967; Jorgenson and Griliches 1967; Taylor 2007; Krugman 1994; Harcourt 2006) to be the cutting edge of quantifying aggregate output growth.

The central proposition of the Solow (1956) – Swan (1956) growth analysis is that positive and long-run growth of per capita output rested on technological progress. Accordingly, without technological progress aggregate output growth would come to a halt as a result of diminishing returns to factor inputs i.e. capital and labour. In short, technological progress is the key for the economy to escape the constraint of diminishing returns of production. The sections following will develop the model frameworks from which my study will correspond.
2.2 The Solow-Swan Neoclassical Growth Model

Solow (1956) was dissatisfied with the growth propositions put forward by Harrod (1939) and Domar (1946), in particular with the notion of the “knife edge” equilibrium. Accordingly, the assumption of fixed proportions is the cause of this unstable equilibrium according to both Solow (1956) and Swan (1956). By allowing the ability to substitute labour for capital equilibrium growth becomes a stable state. However, as a result of diminishing returns to factor inputs, equilibrium depicts a stagnant state where capital and labour growth rates correspond and the per capita rate of growth of output is constant. This point is described by Solow (1956) and Swan (1956) as the steady-state. The notion of the steady-state entails that at any other stage where capital and labour growth rates are not equal, the economy will autonomously adjust toward equilibrium growth. Here, the main point that Solow (1956) and Swan (1956) convey is that technological progress is the driver of productivity gains that permanently increases per capita output beyond that of the current steady-state. Once this occurs, the process of adjusting toward the new higher steady-state simply reoccurs. According to Swan (1956), economists never found a way to utilise the notion of productivity growth that they were in favour of, until now. The following section will discuss the model's assumptions before the dynamics are presented later in the chapter.

2.2.1 Model Assumptions

According to Solow (1956) and Swan (1956), the single commodity of output as a whole is produced from combinations of capital and labour. The growth equation can, therefore, be summarised by the following Cobb-Douglas production function:

\[ Y(t) = f(A(t) K(t)\alpha L(t)\beta) \]
Where \( Y(t) \) is aggregate output, \( K(t) \) is the capital stock, \( L(t) \) is the labour force, and \( A(t) \) denotes technological progress. All variables are denoted with respect to time \( t \). The parameter \( \alpha \) depicts capital's share of output and is a value between 0 and 1. \( \beta \) denotes labour's share of output and is equal to \( 1 - \alpha \). Due to the assumption of constant returns to scale, the capital and labour parameters must sum to one \( (\alpha + \beta = 1) \). Thus, a factor increase in capital and labour of \( \pi \) results in an increase in output of \( \pi \). Equation 2.2 expresses this relationship,

\[
\pi Y(t) = f(\pi A(t), \pi K(t), \pi L(t))
\]

where \( \pi > 0 \)

The next assumption pertains to that of output and the capital stock. Here, the production function assumes full output capacity and that output is either saved and invested or consumed. The rate of investment is also seen as the rate of capital stock accumulation. This proposition is assumed to be funded by the constant proportion of output that is saved in each period, \( s \), where the savings rate is expressed as \( sY(t) \) (Solow 1956; Swan 1956). According to Solow (1956), the propensity to save depicts the net accumulation of capital in the current period and therefore how much of net output is saved and invested. Furthermore, the pre-existing capital stock is assumed to be fully employed and inelastically supplied at any point in time (Solow 1956). The rate of increase in capital (net investment) is shown via the following,

\[
K'(t) = sY(t)
\]

The dot above \( K(t) \) represents the rate of change in capital. It should be noted that the rate of change in capital takes into account depreciation in each period occurring at a rate of \( \delta \) (Solow 1956). As such, output is to be known as net output. For each unit of \( Y(t) \) that is utilised as \( s \), and therefore investment, one new unit of capital is yielded. Hence,
The penultimate assumption relates to the growth rates in the labour force and technology. According to Solow (1956) and Swan (1956), increases in the labour force and technology are exogenous and grow at a constant rate of $n$ and $g$ respectively,

(2.5) \[ L_{(t)} = L_0 e^{nt} \]

(2.6) \[ A_{(t)} = A_0 e^{gt} \]

The symbol $e$ in each term represents a continuous growth rate of the factor between time periods $0$ and $t$. Note that two different labour terms have been presented thus far in equation 2.1 and 2.5. Solow (1956) defines the difference between the terms as the total of employed labour (equation 2.1) and the total available labour supply (equation 2.5). Due to the assumption of full output capacity, the labour supply curve is fully inelastic and increases in $n$ shift the supply curve to the right. In the Harrod (1939) – Domar (1946) reasoning $n$ in equation 2.5 would be the economy’s natural rate of growth (Solow 1956).

The final assumption is what forms the occurrence of diminishing returns to factor inputs. This entails marginal products of factors are positive, however, adding consecutive increments will result in increases in the flow of output at a decreasing rate (Solow 1956; Swan 1956). In other words, the initial marginal product increase is positive but its additional derivative is negative. Here, diminishing returns of production is shown as follows,

(2.7) \[ F_K, F_L > 0 \]

(2.8) \[ F_{KK}, F_{LL} < 0 \]
As the assumptions of the Solow (1956) – Swan (1956) growth analysis have been highlighted, the following will graphically present an economy’s growth path from both the Solow (1956) and Swan (1956) papers. Here, the impact positive technological change has upon growth and the steady-state is made clear.

Figure 2.1: Positive Technological Change to Solow Growth Model

According to Solow (1956), positive technical change causes a “blowing up” (pg. 85) effect of the production function shown in figure 2.1 above. Each point on the productivity curve $sF(r, 1)$ is simply multiplied by the increasing scale factor of $A(t)$. Technological progress creates a shift in output equilibrium from point $r_1$ to a permanently higher equilibrium point $r_2$. Thus, any shift in the production function is caused by “technical change” (Solow 1957, pg. 312).
Figure 2.2: Positive Technological Change to Swan Growth Model

Figure 2.2 depicts the Swan (1956) growth model which displays the affect technological change has on output. The introduction of technological progress brings a shift in output from \( y \) to \( y_1 \) at the new higher equilibrium point 2. As such, equilibrium output per unit of capital has now increased from \( \dot{K}^* \) to \( \dot{K}^{**} \). Evidently, the total affect technological change has upon output growth is measured via the vertical distance between \( y \) and \( y_1 \) (A to B on the vertical axis). Swan (1956) demonstrates a permanently higher and perpetually rising output per capita as the main gain from technological progress. The natural rate of growth \( L \) (as stipulated by Harrod (1939) and Domar (1946)) now does not solely determine the equilibrium growth rate of capital and output. Rather,

Source: Swan (1956), pg. 336
it jointly determines it alongside technical change (Swan 1956). The following section will seek to determine the dynamics of each of the respective Solow (1956) and Swan (1956) models.

2.2.2 Mechanics of the Model

The forthcoming discussion will present the growth path of an economy as stipulated by Solow (1956) and Swan (1956). The rationale for doing so is to provide an understanding of the relationship between the factor inputs that suggest the potential growth paths an economy may take. Each model’s dynamics will be mathematically derived in relation to the respective graphical representations seen in figures 2.3 and 2.6 shown later in the section.

2.2.2.1 The Solow Mechanics

Initially, Solow (1956) derives the growth path of an economy without the influence of technological change. In doing so, he seeks to tell the stories of the time paths of capital accumulation and labour that are consistent between one another. Firstly, equations 2.1 and 2.3 are consolidated to form,

\[ \dot{K}(t) = s f(K(t), L(t)) \]  

Next, Solow (1956) derives the time path of capital accumulation. Substituting equation 2.5 into equation 2.9 gives the basic equation of the time path of capital accumulation, expressed by \( \dot{K} \). Hence,

\[ \dot{K}(t) = s f(K(t), L_0 e^{nt}) \]  

Equation 2.10 is a differential equation with a single variable being \( K(t) \). Its solution is the only time path of capital that employs all the available labour. According to Solow (1956), the key to determining if there is always a growth path of capital consistent with any growth rate of labour
is studying equation 2.10. This forms the foundation of providing a possible production function shape given the capital stock and labour force time paths.

Second, Solow (1956) derives the time path of labour consistent with that of the capital stock. A new variable of a capital-to-labour ratio is introduced represented by \( r = \frac{K}{L} \). Rearranging this expression for \( K \), the available labour supply expresses the capital stock to give,

(2.11) \[ K(t) = rL = rL_0e^{nt} \]

The term \( rL_0e^{nt} \) depicts the capital-to-labour ratio of the available labour supply. With respect to time, Solow (1956) differentiates equation 2.11 to receive,

(2.12) \[ \dot{K}(t) = L_0e^{nt}\dot{r} + nrL_0e^{nt} \]

The dot above \( r \) shows the rate of change in the capital-to-labour ratio. Hence, the term \( L_0e^{nt}\dot{r} \) shows the rate of change in the capital-to-labour ratio given the available labour supply; and the term \( nrL_0e^{nt} \) depicts the rate of growth of the labour supply given the capital-to-labour ratio.

Now knowing the time path capital accumulation and labour take, the corresponding time path of real output can be attained via the production function (Solow 1956). Both equations 2.10 and 2.12 express the growth path of the capital stock in terms of the labour force time path. According to Solow (1956), equation 2.12 can be substituted into equation 2.10 for \( \dot{K} \),

(2.13) \[ L_0e^{nt}\dot{r} + nrL_0e^{nt} = sF(K, L_0e^{nt}) \]

(2.14) \[ (\dot{r} + nr)L_0e^{nt} = sF(K, L_0e^{nt}) \]
Equation 2.14 is a simplification of equation 2.13 via rearranging \( L_0e^{nt}\dot{r} + nrL_0e^{nt} \). Solow (1956) states that due to constant returns to scale, as long as we multiply the function \( F \) by the same factor, we can divide both terms in \( F \) by \( L = L_0e^{nt} \),

\[
(r^* + nr)L_0e^{nt} = sL_0e^{nt}F\left(\frac{K}{L_0e^{nt}}, 1\right)
\]

Lastly, Solow (1956) divides out the common factor of \( L_0e^{nt} \) and substitutes in \( r \) for the term \( \frac{K}{L_0e^{nt}} \) to result in,

\[
\dot{r} + nr = sF(r, 1)
\]

\[
\dot{r} = sF(r, 1) - nr
\]

The explanation of equation 2.17 is straightforward. It is the final differential equation resulting from rearranging equation 2.16 to express \( \dot{r} \) – the changing ratios of capital and labour. The term \( nr \) shows the constant and exogenous growth rate in the labour force of \( n \), whereas the function \( sF(r, 1) \) is to be seen as the total product curve (output). This conveys differing amounts of capital that are employed by one unit of labour, expressed by \( r \). Thus, the story of output growth can be determined through the changes in \( \dot{r} \).
Figure 2.3: Solow Growth Model

Figure 2.3 tells the story of the growth patterns of capital and labour through time. Here, convex nature of the total product curve depicts the diminishing returns of factor inputs. The steady-state is attained at $r^*$ where $sF(r, I) = nr$ and the two growth paths of capital and labour intersect. At this point $\dot{r} = 0$ and the growth rates of the labour force and capital-to-labour ratio correspond and henceforth grow proportionately to each other.

Perhaps, what is of more interest is when the economy is in disequilibrium, at any point where $r \neq 0$, and the trends that $r$ takes. According to Solow (1956), if $r < r^*$ on the curve $sF(r, I)$, then capital stock and output levels will grow at a faster rate than that of the labour force – progressing along the curve westward. Vice versa, if $r > r^*$, then output growth rates will regress
eastward. As a result of such behaviour, the growth path of output is constantly transitioning between capital and labour levels (Solow 1956).

**Figure 2.4: Solow Growth Path Two**

An extension of growth path determination is that the stability displayed in figure 2.3 is not inevitable or a definitive growth trend. According to Solow (1956), other production function possibilities may exist as shown in figure 2.4 and 2.5. Figure 2.4 demonstrates three intersection points of $r_1$, $r_2$ and $r_3$. In this case, $r_2$ is an unstable equilibrium where $r_1$ and $r_3$ are balanced growth points (Solow 1956). Growth trends toward the stable equilibrium growth points are as follows,

i) If $0 < r < r_2$ growth moves toward $r_1$

ii) If $r_2 < r > r_3$ growth moves toward $r_3$
Lastly, figure 2.5 indicates that a balanced equilibrium growth rate may cease to exist indefinitely. Distinct observations are that possible growth lines of capital may be fully submerged beneath \( nr \) or ascend wholly above \( nr \). The ray \( sF^2(r, I) \) illustrates an economy where productivity is at such an extreme low that income per capita is infinitely diminishing at full employment (Solow 1956). Conversely, \( sF^1(r, I) \) exhibits above capacity savings and productivity whilst income and capital are perpetually increasing faster than the labour force (Solow 1956).

Figure 2.5: Solow Growth Path Three

\[
\begin{align*}
\dot{r} & \\
r & \\
\end{align*}
\]

Source: Solow (1956), pg. 72

2.2.2.2 The Swan Mechanics

Swan (1956) derived his model through an expression of the rate of growth in output. Initially, he also sought to determine the growth path of an economy without the influence of
technological change. According to Swan (1956), equations 2.1 and 2.3 can be consolidated to yield equation 2.18. Hence,

\[ y(t) = \alpha K'(t) + \beta L(t) \]  

Where \( y(t) \) denotes the annual rate of growth in output. Like Solow (1956), the \( \alpha \) and \( \beta \) values depict each factor’s share of output. Holding all other assumptions discussed in section 2.2.1 constant, Swan (1956) proceeds to articulate the model as shown in figure 2.6 below.

Figure 2.6: Swan Growth Model

The Swan (1956) growth model, gives the same commentary of an economy’s growth as Solow (1956) via a different diagrammatic representation. The growth line of capital is conveyed by \( K' \) with a slope equal to the savings ratio (Swan 1956). Where capitals contribution to output
can be seen by the line $\alpha \dot{K}$ with slope equal to $\alpha$. The constant growth of the labour force is exhibited by the horizontal line $L$ displaying a growth rate of 1% per annum. According to Swan (1956), the dotted line $y$ depicts the growth line of output, where the starting point on the vertical axis, $A$, is the point of division between the capital and labour parameters $\alpha$ and $\beta$. Like Solow (1956), Swan (1956) determines equilibrium growth at the intersection point of the capital, labour and output lines at $\dot{K}_*$. Thus, at any other point of economic growth on $y$, the economy will either progress westward or regress eastward toward 1. Here, a key observation is that the savings rate determines where the equilibrium output-to-capital ratio intersects, but crucially, the entire economy equilibrium growth rate is fully determined by $L$ (Swan 1956).

With each of the individual Solow (1956) and Swan (1956) growth dynamics derived, the following section will provide the methodology in calculating TFP. This is the method that will be used for Australia’s TFP estimations in chapter 5 of this thesis.

2.2.2.3 Calculating Total Factor Productivity

The estimation of TFP takes the following production function,

$$ Y(t) = f(A(t) \ K(t)^\alpha \ L(t)^\beta) $$

Where $Y(t)$ is real aggregate output, $K(t)$ is the capital stock, $L(t)$ is labour and $A(t)$ denotes the TFP being estimated. The parameter $\alpha$ depicts capital’s contribution to economic growth and is a value between 0 and 1. $\beta$ denotes labour’s contribution to economic growth and is equal to $1 - \alpha$. As previously discussed, the Solow (1956) – Swan (1956) model assumes constant returns to scale. Therefore, the capital and labour parameters must always sum to one ($\alpha + \beta = 1$). The capital stock in this framework is to be known as the sum of the capital stock less depreciation at a rate of $\delta$. Rearranging equation 2.23 for $A(t)$ we receive,
(2.24) \[ \hat{A}_{(t)} = Y_{(t)} - K^\alpha_{(t)} - L^\beta_{(t)} \]

The hat above \( A_{(t)} \) depicts the estimation for TFP. Output, capital, and labour are now converted to an annual percentage change and equation 2.24 can be rewritten as follows,

(2.25) \[ \hat{A}_{(t)} = \dot{Y}_{(t)} - \alpha \dot{K}_{(t)} - (1 - \alpha) \dot{L}_{(t)} \]

The dots above \( Y_{(t)}, K_{(t)} \), and \( L_{(t)} \) signify the annual percentage rate of change in output, capital and labour respectively. Once an estimate for \( \alpha \) is given, \( \hat{\alpha} \), then TFP, \( \hat{A} \), is estimated as follows,

(2.26) \[ \hat{A}_{(t)} = \dot{Y}_{(t)} - \hat{\alpha} \dot{K}_{(t)} - (1 - \hat{\alpha}) \dot{L}_{(t)} \]
2.3 Conclusion

This chapter set out to review the Solow (1956) – Swan (1956) growth proposition to provide the framework of analysis in later chapters. Here, technological progress was found to cause a blowing up effect of the production function thus preventing diminishing returns from materialising. A formalisation of the Solow (1956) – Swan (1956) growth dynamics then portrayed the time path capital and labour take that may result in one of three potential growth trends. The model dynamics emphasised the capital-to-labour ratio of workers as the means for increasing productivity. Lastly, the methodology for conducting TFP estimates was brought to light. With the model framework now determined, the following chapter will seek to provide an empirical discussion on the literature findings of other TFP studies.
Chapter 3: A Literature Review

3.1 Introduction

The purpose of this chapter is to provide a brief literature review of productivity studies. The rationale for doing so is to add depth to the significance, meaning, and interpretation of the Solow (1956; 1957) residual. Due to the measure itself being an estimation, it has been subject to various criticism from economists and researchers alike. Areas of examination will include instances where prolonged periods of growth have occurred without high rates of TFP, employment and labour productivity, the relevance of Research and Development (R&D), and the measurement and interpretation issues associated with TFP. The latter is one of the main problems with the Solow (1956; 1957) residual, as its razor-edge value is subject to various methodological sensitivities.
3.2 An Empirical Discussion

3.2.1 TFP vs Factor Accumulation Growth

The post-war period for the economies of the Newly Industrialising Countries (NIC’s) of East Asia proved a prosperous and sustainable time for economic growth. Economists had concluded that dynamic gains (i.e. TFP) were the explanation (Young 1994; Young 1995). Yet, Alwyn Young’s (1994; 1995) study of Hong Kong, Singapore, South Korea, and Taiwan for this period proved the contrary. Results showed that whilst per capita growth rates of the four nations were in the top five of 118 economies, TFP residuals were not inexplicably high, but comparable to vast international economies (Young 1994). Furthermore, the sustainable high growth in output rates was in general thanks to hasty factor accumulation and sectoral resource reallocation (Young 1994). As such, the crux of the growth was not attributable to productivity; positive TFP simply enabled the sustainability. Table 3.1 and 3.2 depict Young’s (1995) TFP growth comparisons between economies. Other works such as Krugman (1994) and Kim and Lau (1994) are seen to support Young’s (1994; 1995) findings.

Table 3.1: Young’s (1995) Estimates of NIC’s TFP

<table>
<thead>
<tr>
<th>Source: Young (1995), pg. 672</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average TFP Growth (% per annum)</strong></td>
</tr>
<tr>
<td>TFP</td>
</tr>
</tbody>
</table>
Table 3.2: Young’s (1995) Estimates of Comparative Economy TFP

<table>
<thead>
<tr>
<th>Country</th>
<th>Period</th>
<th>TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>1960-1989</td>
<td>0.5</td>
</tr>
<tr>
<td>France</td>
<td>1960-1989</td>
<td>1.5</td>
</tr>
<tr>
<td>Germany</td>
<td>1960-1989</td>
<td>1.6</td>
</tr>
<tr>
<td>Italy</td>
<td>1960-1989</td>
<td>2.0</td>
</tr>
<tr>
<td>Japan</td>
<td>1960-1989</td>
<td>2.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1960-1989</td>
<td>1.3</td>
</tr>
<tr>
<td>United States</td>
<td>1960-1989</td>
<td>0.4</td>
</tr>
<tr>
<td>Brazil</td>
<td>1950-1985</td>
<td>1.6</td>
</tr>
<tr>
<td>Chile</td>
<td>1940-1985</td>
<td>0.8</td>
</tr>
<tr>
<td>Mexico</td>
<td>1940-1985</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Source: Young (1995), pg. 673

3.2.2 Employment and Labour Productivity

A study conducted by Pissarides and Vallanti (2007) looked at the effects changes to TFP growth had on unemployment. The rationale for doing so was the belief from economists that a slowdown of TFP growth in the late 1970’s was correlated to rising unemployment in the United States and the European Union. It was shown that the rate of growth of TFP had a substantial inverse relationship with unemployment (Pissarides and Vallanti 2007).

Table 3.3: Pissarides & Vallanti (2007) TFP Growth and Unemployment

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean TFP Growth (%)</th>
<th>Mean Unemployment Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>US</td>
<td>EU</td>
</tr>
<tr>
<td>1960-1973</td>
<td>1.90</td>
<td>3.95</td>
</tr>
<tr>
<td>1974-1992</td>
<td>0.80</td>
<td>1.79</td>
</tr>
</tbody>
</table>

Source: Pissarides and Vallanti (2007), pg. 613
Table 3.3 above shows Pissarides and Vallanti’s (2007) TFP estimates and unemployment rates of the US and EU for the period 1960 to 1992. Over the thirty-two-year period, for each unit change in TFP, the change in unemployment was -1.49% and -1.31% for the US and EU respectively (Pissarides and Vallanti 2007). These findings are supported by Machin and Van Reenen (1998) who sought to provide a relationship between shifts in the labour skill structure of seven OECD countries and technical change. Using an R&D measure alternatively to TFP, the study showed that technological change increases the demand for “skill-biased technological change” i.e. higher skilled labour (Machin and Van Reenen 1998, pg. 1238).

Another labour market study is Burda and Hunt (2001) which looked at the productivity of Eastern and Western Germany during the reunification period of the 1990’s. The study showed that for the duration of 1992 to 1995 and 1996 to 1999, East German TFP fell from 4.4% to -0.8% per annum, whilst West German TFP increased from 0.0% to 1.1% (Burda and Hunt 2001). The results confirmed the presumption that East German workers would be less productive due to lower TFP. However, German TFP as a whole during both periods was consistent at 0.9% (Burda and Hunt 2001). The significantly lower TFP of Eastern Germany was shown to be due to several factors. These included labour relocation from East to West, productivity skill level gaps, and quality of inputs (Burda and Hunt 2001).

OECD (1987) findings give further grounds to the relationship between a country’s labour productivity, TFP, and output. The OECD (1987) retrieved data from three time periods of all the member nations, of which, I will compare the trends of two – Australia and the United States – against the OECD average. Table 3.4 depicts this comparison. Firstly, it is shown that TFP in all time periods across all columns decreased by more than half. This occurred most significantly between the earlier periods of Pre-1973 and 1973-1979. Secondly, labour productivity across all
groups fell also by more than half which can be attributable to the decreasing TFP values and capital-to-labour ratios of workers (OECD 1987). Lastly, as a result of falling TFP and labour productivity, the output of Australia, the United States, and the OECD average fell concurrently. It is shown that in regards to medium-term TFP and output growth, near parallel movements exist (OECD 1987).

Table 3.4: OECD (1987) Output, TFP, and Labour Productivity

Business sector: average % changes at annual rates

<table>
<thead>
<tr>
<th></th>
<th>OECD Average</th>
<th>Australia</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pre-1973</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output (%)</td>
<td>5.2</td>
<td>5.5</td>
<td>3.8</td>
</tr>
<tr>
<td>TFP (%)</td>
<td>2.9</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Labour Productivity (%)</td>
<td>4.1</td>
<td>3.2</td>
<td>2.2</td>
</tr>
<tr>
<td><strong>1973-1979</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output (%)</td>
<td>2.9</td>
<td>2.3</td>
<td>2.8</td>
</tr>
<tr>
<td>TFP (%)</td>
<td>0.7</td>
<td>0.7</td>
<td>-0.1</td>
</tr>
<tr>
<td>Labour Productivity (%)</td>
<td>1.6</td>
<td>2.0</td>
<td>0.3</td>
</tr>
<tr>
<td><strong>1979-1985</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output (%)</td>
<td>2.3</td>
<td>2.6</td>
<td>2.1</td>
</tr>
<tr>
<td>TFP (%)</td>
<td>0.6</td>
<td>0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Labour Productivity (%)</td>
<td>1.4</td>
<td>1.1</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Note: Data retrieved from OECD (1987), pg. 41

More recently Guellec and Pilat (2009) provided updated OECD figures pertaining to the mid-1990’s to mid-2000’s decade. With regards to Australia, both labour utilisation and productivity of labour decreased – both by more than half. During the same decade, it was found that TFP had also diminished by just under half from approximately 1.7% to 0.8% (Guellec and Pilat 2009). Yet, the considerable declines in labour productivity materialised after a period of
growth a decade prior. An improvement from 1.1% in 1985 (see table 3.4) to approximately 2.6% in 1995 took place. Coinciding with this trend was TFP which displayed the same behaviour.

Between the empirical studies discussed appears a commonality. What is apparent are consistent correlations between changes to TFP and other economic variables. Now, in the section following, the discussion will be focused on whether R&D, both domestic and international, has a bearing upon the productivity of an economy.

3.2.3 R&D and Productivity

Technological improvement is brought about through R&D exercises of organisations. Mendi (2007) sought to determine whether the effects of R&D were influential upon TFP. The study was conducted on sixteen OECD countries from 1971 to 1995. The motivation for doing so was to test if positive changes to TFP occurred from the trade of disembodied technology. Results showed that a positive correlation exists between imported technology and TFP in non-G7 countries (Mendi 2007). This was most prominent during the early periods of the test as these countries were initially more reliant upon international R&D. As such, the results prove the existence of technology diffusion as a net positive effect on productivity caused by foreign R&D imports (Mendi 2007). Furthermore, a key result of this study occurring in all of the sample countries, was the significant productivity gains domestic R&D yields (Mendi 2007). Such findings suggest that government policy should iterate consistent advocacy in the areas of R&D.

Goel (1996) shows that government subsidy policies for R&D may not be needed in the case of risky research. His findings discovered that patent length and risky R&D is positively correlated, whilst less risky R&D showed an inverse relationship. Therefore, in order to encourage risky R&D of firms, longer patent implementation may be sufficient. Other studies such as Kamien
and Schwartz (1974) support these claims as innovation size was found to be negatively correlated to competitive rivalry, whilst directly correlated with patent size.

3.2.4 Measurement and Interpretation of TFP

This section is a discussion pertaining to the measurement and interpretation of TFP. Predominantly, interpretations of what TFP values depict are that of technological progress. But by definition, does this best explain all unexplained values of economic growth?

Nishimizu and Page (1982) sought a more detailed explanation of TFP results through providing two interpretations of it. A flaw in conventional TFP approaches is there is no distinction of productivity gains between changes in technical efficiency and technological progress (Nishimizu and Page 1982). The original interpretation of TFP from Solow (1956) and Swan (1956) is technological progress i.e. the improvement and creation of technology that supersedes the existing in production. Technical efficiency is gains or losses in productivity attributed to such factors as labour skill levels and technological knowledge diffusion (Nishimizu and Page 1982). Their study of the Yugoslavian Social Sector from 1962 to 1978 proved that TFP growth slowdown for the period was due to both deteriorating technical efficiency and decreasing technological progress. However, the deteriorating technical efficiency change dominated the impact on TFP growth compared to the reduction in new technology acquired (Nishimizu and Page 1982). Government policy can be aided by such findings. Considerations would then revolve around whether investing in new foreign technology is required, or conversely, to provide training to workers increasing their skills in the current technology state.

The human capital element of the TFP measurement was investigated further by Maudos et al (1999). The aim was to show the effect human capital has upon fluctuations in the productivity
measure. Total TFP, technological change, and efficiency change was calculated for OECD countries covering the period 1975 to 1990. Their results indicated that the USA was consistently efficient during this time with 100% of its TFP growth attributable to technological change (Maudos et al 1999). But the outcomes of the EU, OECD total, and Japan – in particular – tell a different story. The EU and OECD total both had TFP growth of 0.96%, of which 17.7% and 16.6% respectively is attributable to efficiency change. Most significant of all was Japan who had the highest TFP growth of 1.36%. In this case, efficiency change made up 44.1% of its TFP value. According to Maudos et al (1999), efficiency change significantly affected Japan’s TFP value due to the high capital growth rate coupled with moderate human capital accumulation of the period.

A Canadian study by Sharpe and Arsenault (2009) sought to provide updated TFP values per province, that incorporated changes in labour and capital composition for the period of 1997 to 2007. The methodology has similarities to that of Maudos et al’s (1999) study. Instead of dissecting the TFP values they decomposed labour productivity totals into labour quality, capital intensity, and TFP.
Table 3.5: Canadian Productivity Measures by Province, 1997-2007

<table>
<thead>
<tr>
<th>Province</th>
<th>Labour Productivity (% per annum)</th>
<th>Capital Productivity (% per annum)</th>
<th>TFP (% per annum)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada - National Estimates</td>
<td>1.71</td>
<td>-0.57</td>
<td>0.44</td>
</tr>
<tr>
<td>Newfoundland</td>
<td>4.82</td>
<td>4.25</td>
<td>4.14</td>
</tr>
<tr>
<td>Prince Edward Island</td>
<td>1.59</td>
<td>-1.87</td>
<td>-0.18</td>
</tr>
<tr>
<td>Nova Scotia</td>
<td>1.92</td>
<td>0.26</td>
<td>1.12</td>
</tr>
<tr>
<td>New Brunswick</td>
<td>1.78</td>
<td>-1.00</td>
<td>0.37</td>
</tr>
<tr>
<td>Quebec</td>
<td>1.76</td>
<td>0.44</td>
<td>0.94</td>
</tr>
<tr>
<td>Ontario</td>
<td>1.71</td>
<td>0.24</td>
<td>0.82</td>
</tr>
<tr>
<td>Manitoba</td>
<td>2.10</td>
<td>-0.54</td>
<td>0.62</td>
</tr>
<tr>
<td>Saskatchewan</td>
<td>2.09</td>
<td>-0.62</td>
<td>0.11</td>
</tr>
<tr>
<td>Alberta</td>
<td>1.04</td>
<td>-3.40</td>
<td>-1.58</td>
</tr>
<tr>
<td>British Columbia</td>
<td>1.18</td>
<td>-0.46</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Source: Sharpe and Arsenault (2009), pg. 33

Table 3.5 above displays the findings of Sharpe and Arsenault (2009). Focusing on national labour productivity, a key finding is made through decomposing the value. This was that of the 1.7% national annual average labour productivity growth rate, 0.3%, 1.0%, and 0.4% are attributable to labour quality, capital intensity, and TFP respectively (Sharpe and Arsenault 2009). Labour productivity sources within provinces varied significantly to the national findings. An example of the variation is the labour quality contribution to labour productivity in Saskatchewan was 0.4% whilst British Columbia was 0.0% (Sharpe and Arsenault 2009). According to Sharpe and Arsenault (2009), the differences in the component contribution rates to labour productivity within each province is of importance, as it can affect the relative importance of the sources of growth. This study supports that of earlier discussions (see Nishimizu and Page 1982; Maudos et al 1999) toward the influence human capital has upon TFP and labour productivity.
Whilst TFP provides an empirical value for unexplained economic growth it is not a perfect measure and is subject to criticism. Syed et al (2015) seek to explain the considerable fall in TFP growth of the Australian mining sector during the boom period of 2000 to 2013. The study brings into question the methodology of measuring TFP and its accuracy. Three adjustments to the measurement were suggested for the mining industry,

- Input-Output lags: delays between investment, employment, and output of the mine
- Endogenous depletion: higher prices raise the incentive to extract deeper deposits lowering product quality and increasing input costs
- Exogenous depletion: high-grade surface resources diminish and mining moves down deeper using more inputs per unit of output

Once TFP is adjusted for these variables, the values differed significantly within states as seen in table 3.6.

Table 3.6: Adjusted and Unadjusted State TFP Growth Rates, 1990 to 2010

<table>
<thead>
<tr>
<th>State</th>
<th>Unadjusted TFP</th>
<th>Adjusted TFP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Australia</td>
<td>-1.48</td>
<td>0.96</td>
</tr>
<tr>
<td>Queensland</td>
<td>0.74</td>
<td>3.65</td>
</tr>
<tr>
<td>New South Wales</td>
<td>1.70</td>
<td>5.10</td>
</tr>
<tr>
<td>Victoria</td>
<td>-9.10</td>
<td>-0.60</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>2.50</td>
<td>10.30</td>
</tr>
<tr>
<td>South Australia</td>
<td>-1.87</td>
<td>n/a</td>
</tr>
<tr>
<td>Tasmania</td>
<td>1.89</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Source: Syed et al (2015), pg. 561

Syed et al (2015) show the considerable disparity in results when adjusting for mining industry specific variables between states. Building from these results, they went further to
decompose TFP into three components of technical progress (TP), technical efficiency (TE), and scale effects (SC). The results, seen in table 3.7 below, show technical efficiency as the main contributor to TFP at 82.4% whilst technical progress is statistically 0.

Table 3.7: TFP Composition, 1990 to 2010

<table>
<thead>
<tr>
<th>Sector</th>
<th>TP (%)</th>
<th>TE (%)</th>
<th>SC (%)</th>
<th>TFP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australian Mining Industry</td>
<td>-10.2</td>
<td>82.4</td>
<td>27.8</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Syed et al (2015), pg. 565

Various other studies have brought into question the validity of TFP methodology and its values accuracy (see Harper et al 2012; Roberts 2008; Productivity Commission 1992). Some of the main concerns of such stem from the estimated data sets that are employed and the top-down approach method (Harper et al 2012; Roberts 2008). According to the Productivity Commission (1992) measurement difficulties occur in TFP due to the reliance on data availability and accuracy of estimations. Therefore, in order to improve data accuracy concerns, continuing industry level growth accounting is necessary (Roberts 2008).

Sun (2005) continues the debate of the role TFP played in the NIC’s of the East Asia economic growth boom. Results of various studies investigating TFP as a source of growth in this boom are argued to be questionable as productivity values differ between research. Differences in methodology, the number of industries and industrial classification, data and sample periods, and construction and adjustment of variables used account for these mixed results (Sun 2005). According to Chen (1997), TFP is highly sensitive to the time period and the measurement type of inputs. Thus, how TFP is defined and how input data is measured reflects the significance of technical change on economic growth (Chen 1997).
3.3 Conclusion

Ongoing empirical research has added much depth to the significance, meaning, and interpretation of TFP over time. Findings depict a positive relationship between TFP and numerous macroeconomic variables. Yet, since results vary according to the application, it is shown that more than one face value interpretation of TFP is required. It was found that by including a human capital element in TFP estimations, changes in the efficiency of labour rather than technology itself can be accounted for. Further, questions of accuracy are found to be primarily influenced by the methodology used and the quality of the input data. Queries of TFP validity according to its application will continue to arise. However, the existence and importance of productivity toward economic prosperity has remained unquestioned. Before conducting TFP estimates for Australia, a brief history of the macroeconomic data is needed.
Chapter 4: Australia’s Economic Story

4.1 Introduction

The main objective of this chapter is to provide a brief overview of the macroeconomic data needed to estimate TFP growth covering the period 1965 to 2015. A focus of such is placed on the numerous policy, political, and structural change that has occurred in relation to aggregate output, capital, and labour. Putting the aggregate trends in context will be a sectoral division of the economy into the primary, secondary, and tertiary sectors. This will provide a deeper perspective of what industries have been the central drivers of growth during the study period. Currently, the nation is at the envy of competing economies having experienced almost a quarter of a century of positive growth. Mclean (2013) determines Australia’s prosperity is respective to two main features i) the interaction between potential contributing sources of growth and ii) shifting the basis of prosperity.
4.2 The Australian Economy, 1965-2015

4.2.1 Gross Domestic Product

Figure 4.1: Australia’s Gross Domestic Product, 1965-2015

Source: ABS, cat no. 5204.0

GDP is defined by the ABS (2016) as the total value of goods and services produced in a given period after subtracting the cost of production – not including the depreciation of capital. According to Solow (1956), output is to be known unambiguously in real terms. Thus, for the purpose of this thesis, GDP values are in real terms to reflect the value of production taking into account the price level.

Since 1965 it is shown that GDP has grown in a relatively linear fashion (see figure 4.1). Over the fifty-year period, the value of GDP has approximately doubled every twenty years since 1965. This occurred for the periods 1965 to 1985 and 1985 to 2005. The rise of Australia’s output value has been so consistent that GDP experienced only two periods of negative growth – both of
which occurred as a result of recessions. The first occurred from 1982 to 1984, and the second from 1990 to 1992. Such events can be seen in figure 4.2 below.

Figure 4.2: Australia’s Gross Domestic Product Growth Rate, 1965-2015

![GDP Growth Rate Graph](image)

Source: ABS, cat no. 5204.0

Australia’s annual growth rate of GDP shows a volatile history. Figure 4.2 does not reflect the same smooth growth trend as seen in figure 4.1. The highest decade average GDP growth for the study period occurred in the 1960’s at 5.3% (The Treasury 2001). For the five-year span of 1965 to 1970, growth aggressively fluctuated. A drop from 6% in 1965 to 2.4% in 1966 took place, before a peak of 7.2% in 1970. Similar patterns are apparent between 1980 to 1985 and 1990 to 1995. However, these periods both witnessed yearlong recessions. Overall, the twenty years from 1970 to 1990 proves to be the most volatile period of growth across the trend.

Brought on by the global recession of the time, the largest decline in growth occurred in the 80’s. GDP growth fell from 3.3% in 1982, to -2.2% by 1983. Yet, an equally sharp recovery a
year later saw growth reach 4.6% by June 1984. A similar fall and recovery, whilst less severe, was from 1990 to 1994. However, proceeding the mid-90’s growth volatility was moderate compared to previous decades. From 2000 to 2007 GDP averaged an annual growth rate of 3.4%. Although, this run was ended with the Global Financial Crisis (GFC) of 2008 to 2009, where growth experienced a sharp decline from 3.7% to 1.8% respectively. In recent periods following a three-year recovery, growth has steadily declined since 2012 achieving a rate of 2.3% in 2015. What will now be discussed are the key political, policy, and macroeconomic events that unfolded in each decade.

Over the course of the last half-century, Australia has witnessed an evolution in fiscal policy. According to Gruen and Sayegh (2005), the progression has been in response to two main developments in the economy,

- The emergence of a growing Current Account Deficit (CAD) in the mid-1980’s; and
- Anticipated fiscal implications of an ageing population and future public health costs

However, a study conducted by Crosby et al (1997) discovered that between 1969 to 1994 there is little evidence that partisan or political changes have affected the macro economy. Fisher et al (1996) support this claim as it was found that government investment and consumption are uncorrelated with the economy’s output cycle. Although, it is apparent that government consumption and investment decisions are influenced by the timing of elections (Crosby et al 1997). As a result of such findings, determining relationships between macroeconomic variables and output has come from analysing Australia’s business cycle.

Studies by Fisher et al (1996), Wel (1998), and Cashin and Ouliaris (2004) sought to determine relationships between output and other economic variables in Australia. It was found
that private investment is pro-cyclical with, and more volatile than output, and tends to fall several quarters prior to most recessions (Fisher et al 1996; Wel 1998). Real wages were countercyclical leading the trend by two to three quarters, whilst labour productivity is pro-cyclical and contemporaneous (Fisher et al 1996). Prices were shown to move counter-cyclically with output which suggested that output fluctuations were predominantly caused by shocks to aggregate supply (Cashin and Ouliaris 2004).

Wel’s (1998) analysis from 1970 to 1997 was directed at explaining the behaviour of macroeconomic variables in periods of expansion and recession. During expansionary phases, it was found that the economy grows by 21.4% over an average duration of five years. Furthermore, consumption, investment, and the CAD all increase by 0.84%, 1.34%, and 1% respectively in such times (Wel 1998). Conversely, in periods of recession over an average timeframe of three quarters, output and investment fall by 2.3% and 10.9% respectively (Wel 1998). The following will now aim to explore the major events of each decade.

In 1965 the Australian economy produced $308 billion of output. The post-war decade of the 1960’s saw freer international capital, technology, and people movements with reduced constraints on supply output (Banks 2003). This created the “golden age” of global economic growth as described by Banks (2003, pg. 2). According to Gruen and Sayegh (2005), the post-war period initially encountered significant government debt totalling over 100% of GDP. However, prudent fiscal policy coupled with unanticipated inflation diminished this ratio of debt-to-GDP considerably by the mid-1970’s (Gruen and Sayegh 2005).

Much of the fiscal debate in the 1970’s revolved around how to reduce the accumulating budget deficits. The difficulty in doing so was the high instability of the macroeconomic environment during the decade (Stevens 2008). Yet, the decade average growth rate achieved was
still on par with the century trend at 3.4% (The Treasury 2001). Arguably the most significant
development of the period was the rise of stagflation. Public policy was ill-equipped to deal with
the persistently high inflation and unemployment coinciding. This led to the demise of the Whitlam
government in 1975 who was overturned by the Liberal party led by Malcolm Fraser. The OPEC
oil shocks in 1973 and 1979 coupled with rising demand pressures were the cause of the prolonged
period of high inflation (Norton and McDonald 1983; The Treasury 2001). Hence, the cost of
production in the economy saw a rise as a result of the oil supply shocks (Dickman and Holloway
2004).

Perhaps what should be noted, is shifts in other major economic indicators were also large.
Growth in production and employment saw sharp declines, whereas wages, money, total spending,
and government outlays all experienced significant rises (Norton and McDonald 1983). What
seemed to exacerbate these occurrences was the two phases, in close proximity, of cyclical
weakness during the decade. These took place in 1974 to 1975 and 1977 (Stevens 2008). A
potential solution to the issue was put forth by Perkins (1979). He argued that further expansionary
policy would worsen the balance of payments and therefore strict monetary policy and adequate
tax cuts would act as a non-inflationary form of stimulus. In other words, inflationary cost-push
effects from taxes will be decreased with permanent tax cuts creating a continued deflationary
effect (Perkins 1979).

Arguably the most influential decade in terms of policy and structural change was the
1980’s. This was a time of extensive microeconomic reforms and market deregulation that set the
foundations for economic growth to accelerate in future periods. These were achievements of the
Labour government under the Bob Hawke administration. According to Kelly (2000), momentum
for reform was very much “elite driven” (pg. 223) from the government down. At the time,
inefficiencies of the Australian economy were causing an inability to respond to challenges of advancing competition, technology, and global integration (Productivity Commission 1999). This aided in facilitating the reform movement. Such a movement was essential for Australia integrating into the global economy through deregulating markets, enabling freer trade, smaller government, and lower taxes (Kelly 2000). As presented by Forsyth (2000), there were four main types of reforms,

Table 4.1: Australia’s Microeconomic Reforms in the 1980’s

<table>
<thead>
<tr>
<th>Reform Type</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Trade reforms</td>
<td>Reductions in industry protection</td>
</tr>
<tr>
<td>- Deregulation of markets</td>
<td>Decentralisation of the financial system aimed at affecting service industries</td>
</tr>
<tr>
<td>- Reforms to natural monopolies</td>
<td>Structural reforms and implementation of incentive regulation</td>
</tr>
<tr>
<td>- Public-sector reforms</td>
<td>Competitive tendering and contracting out</td>
</tr>
</tbody>
</table>

Source: Forsyth (2000), pg. 236

Financial deregulation proved to be the most influential of the reforms undertaken. According to Milbourne and Cumberworth (1991), at the turn of the decade Australia held one of the most regulated financial systems in the OECD. Regulations took four main forms,

- Restrictions on competition
- Interest rate ceilings on deposits and loans
- Portfolio restrictions; and
- Restrictions on foreign capital flows and a fixed exchange rate
As such, from 1980 to 1989 the Australian financial market was overhauled. One of the main achievements was the floating of the exchange rate in 1983. The turbulent economic and policy period of the 1970’s facilitated this outcome through a consensus that you could not choose monetary policy and exchange rate settings independently (Stevens 2008). The vast financial market reforms can be seen in table 4.2 below.

Table 4.2: Australia’s Financial Deregulation in the 1980’s

<table>
<thead>
<tr>
<th>Year</th>
<th>Deregulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>- Interest rate ceilings on all trading bank and savings bank deposits were removed</td>
</tr>
<tr>
<td>1981</td>
<td>- Minimum term on certificates was reduced to 30 days</td>
</tr>
<tr>
<td>1982</td>
<td>- Requirement of one month’s notice of withdrawal on savings bank investment accounts was removed  &lt;br&gt; - Quantitative lending guidance was ended  &lt;br&gt; - Minimum term on trading bank fixed deposits (&lt; $50,000) reduced from 30 to 14 days, and deposits &gt; $50,000 from 3 months to 30 days</td>
</tr>
<tr>
<td>1983</td>
<td>- Australian dollar was floated and most foreign exchange controls removed</td>
</tr>
<tr>
<td>1984</td>
<td>- All controls on terms of bank deposits removed  &lt;br&gt; - Savings banks permitted to offer cheque facilities</td>
</tr>
<tr>
<td>1985</td>
<td>- 16 foreign banks invited to take up banking licenses  &lt;br&gt; - Remaining ceilings on bank interest rates removed except owner-occupied housing loans under $100,000</td>
</tr>
<tr>
<td>1986</td>
<td>- Interest rate ceiling on new housing loans removed</td>
</tr>
<tr>
<td>1987</td>
<td>- Savings bank reserve asset ratio reduced to 13%</td>
</tr>
</tbody>
</table>

Source: Milbourne and Cumberworth (1991), pg. 173

What was significant about floating the exchange rate was it paved the way for continued financial market deregulation. This generated declining labour costs and strong economic growth in the second half of the decade (Banks 2005; Gruen and Sayegh 2005). Such benefits were also
brought about by product market liberalisation and tariff reforms which increased Australia’s international trade. However, a downside to increased financial freedom was the banks’ ability to give out riskier loans. This in itself caused property asset price inflation in the late 1980’s (Milbourne and Cumberworth 1991; Bell and Quiggin 2008; Gruen and Sayegh 2005). Along with financial freedom, however, also came growing interest in the share market.

Groenewold (2003) sought to examine the relationship between the share market and the economy after financial deregulation. Whilst the findings are not conclusive, the results showed that through allowing international capital flows, the link between the share market and greater economy is weakened. These results stand as evidence to the internationalisation of the Australian economy at the time. Complementing these findings is Nasir and Soliman (2014) who looked to determine the implications of macroeconomic policy for financial stability in the bond and stock markets. Their results showed that the time frames and level of stabilisation will not be optimal without a tandem use of fiscal and monetary policy (Nasir and Soliman 2014).

The second event that shaped the 1980’s was the growing level of national debt. Although after the recession growth returned to strong levels, concern surrounding the status of the balance of payments was beginning to build. Of specific concern was the growing CAD and its theorised effects on economic growth.
From 1959 to 1984 Australia’s CAD averaged 2.75% of GDP (Gruen and Sayegh 2005). Figure 4.3 shows the CAD deviating away from this trend post-1980. As such, in the decade following there was a broad consensus that the CAD was the most serious economic problem facing Australia (Gruen and Sayegh 2005). A slowing demand for exports, lacking manufacturing competitiveness, and skyrocketing foreign debt levels became the causes of the CAD crisis (Dyster and Meredith 2012). This is supported by Black (1985), who determined the balance of payments difficulties was due to a deceleration in world trade as a result of slowing economic growth following the 1982 recession. Exacerbating this fact were policy measures taken to protect external balances which only diminished trade further (Black 1985). Such attempted measures to control the rising debt was fiscal consolidation and higher interest rates (Dyster and Meredith 2012; Gruen and Sayegh 2005).
According to Anderson and Gruen (1995), with a CAD level at 4.5% of GDP, the ratio of net liabilities-to-GDP rises at 1.7% a year. This is the case as from 1984 to 2005 the CAD has averaged 4.75% of GDP (Gruen and Sayegh 2005). Additional cause for CAD concern is the impact on public sector productivity. Findings by Dalamags (1995) showed that countries with high levels of government debt will experience a major negative impact on public sector productivity.

Putting the CAD in a new perspective was Pitchford (1989) and Makin (1988). The notion was that the increasing preoccupation with foreign debt is misplaced and the negative impacts of having a CAD were misconstrued. Here, it was argued that the growth in the CAD was not a sign of adverse future economic activity. Instead, the capital account surplus should be used as a proxy for investor confidence in the Australian economy (Makin 2005). Belkar et al (2007) argue the vulnerability associated with a high CAD need not exist as the increasing attraction of foreign capital depicts a reflection of economic resilience. Furthermore, according to Fahrer (1990), following adverse shocks, the CAD will eventually correct itself over time. This leaves macroeconomic policy the ability to improve allocative efficiency in the economy (Fahrer 1990). As the decade proceeded into the 1990’s, these alternative views gained acceptance.

The 1990’s began with a sharp fall in economic growth as the economy entered a recession (see figure 4.2). Whilst in the political world, Bob Hawke’s rein as Labor leader was transferred to Paul Keating in 1991. The significance of the early 90’s was the reforms in monetary policy and the introduction of inflation targeting in 1993. Monetary policy was now utilised as a tool for inflation control within a medium-term framework (Stevens 2008). This was also a time of transitioning fiscal policy goals. During the mid-1980’s the government's agenda was to target higher national savings, whilst during the mid-1990’s asset sales and privatisation was used as a
means to reduce government debt (Banks 2005). There was also evidence for further financial market deregulation provided by Fahrer and Rohling (1994). Their findings showed that post-deregulation the bank market was still not perfectly competitive, however, there was no evidence of collusive behaviour between them.

Growth in the second half of the 1990’s was primarily driven by a productivity surge – annual average growth in TFP since 1964 was 1.4%. Whereas, for the five year period from 1993 to 1998, productivity grew at 2.4% (Parham 1999). According to Parham (2003), what propelled productivity was the combination of the increasing growth rates of capital deepening, labour productivity, and TFP. In 1996 the country witnessed a shift in political power as John Howard won office for the Liberal party. The Howard government continued on the reforms agenda from the 1980’s in the form of tax cuts, fiscal consolidation, and shifting away from centralised wage setting (Giesecke 2008). This period of deregulation followed the Council of Australian Governments (COAG’s) agreement in 1995 for the implementation of the National Competition Policy (NCP). A key progress from the NCP was the extension of anti-competitive laws toward unincorporated enterprises and government (Banks 2005). Furthermore, the series of tariff reductions across industries had fallen to five percent or less under the legislation (Banks 2005).

Other developments in the late 1990’s were the series of external shocks the Australian economy experienced. These included the Asian financial crisis in 1997 and the East Timor security crisis in 1999 (Giesecke 2008). Yet, seemingly unfazed to such events the Australian economy demonstrated resilience and amounted to a trillion-dollar value by 1999.

The 2000’s began with the Howard government’s introduction of the Goods and Services Tax (GST). Why this was so unique is it represented a major shift toward a broad-based consumption tax system rather than one primarily based on income taxes. Reasoning behind such
a movement was to remove pressure from the CAD through boosting domestic savings and
reducing the level of foreign debt (Day and Day 2010). However, the introduction of the GST
coincided with tax relief elsewhere. These included reductions in the company tax rate from 36%
in 2000, to 30% in 2002. According to Day and Day (2010), personal income taxes also saw reform
via higher income thresholds, tax rebates, and lower marginal tax rates.

Whilst economic growth was strong from 2002 to 2008 (see figure 4.2), there was concern
surrounding the wave of oil price rises taking place. The worry was that the stagflation experienced
in the 1970’s would reoccur, but this never materialised. Price rises were less of a contractionary
shock to the economy as they only increased commodity prices of exports (Rosewall et al 2008).
Therefore, the resources and mining boom had a cushioning effect on the macro economy.
According to Dickman and Holloway (2004), global demand for oil rose 5.5% in two years from
2002 to 2004. Such positive demand shocks outpacing that of global supply were largely
unanticipated and seen to have caused the price hikes (Kilian 2009; Dickman and Holloway 2004).

The significance of the resources boom is apparent during the 2008 GFC. A relatively large
commodity sector and small manufacturing sector contributed to the resilience of growth at the
time (McDonald and Morling 2011). Conversely, other OECD economies were experiencing
recessions whilst Australia continued to grow. The GFC was predominantly caused by a housing
asset bubble in the United States – a result of subprime mortgage debt accumulation creating a
credit crunch (Dyster and Meredith 2012; Mishkin and Eakins 2012). Anticipating severe adverse
effects, the government took a proactive stance by implementing a stimulus package to households.
Here, the objective was to raise growth through boosting consumption expenditure. Li and Spencer
(2016) found that the timely stimulus package coupled with monetary easing aided in escaping
recession. But what has occurred as a result of such is accelerating public debt since 2008 (Li and
Spencer 2016). Such debt accumulation has seen the government seek new revenue streams via taxes in recent times. Studies of taxation behaviour in Australia (see Stewart 1996) has shown evidence, at both state and local levels, of the flypaper effect. In other words, intergovernmental grants raise the level of public spending – and government size – more than an increase in local income of the same size (Dolley and Worthington 1995; Spahn 1979). What is concerning moving forward, given the current level of debt, is the fiscal illusion that takes place (Stewart 1996).

Since 2010, economic growth has fluctuated between 3.2% in 2012 to 2.3% in 2015. In terms of value, 2015 saw Australia’s economic output worth $1.6 trillion. The following section will now discuss the three primary, secondary, and tertiary sectors contribution to GDP. Due to data restrictions, the timeframe for each sectors data set is from 1975 to 2015.

4.2.1.1 Primary Sector GDP

Figure 4.4: Primary Sector Gross Domestic Product, 1975-2015

Source: ABS, cat no. 5204.0
The primary sector is comprised of agriculture and mining output. Figure 4.4 shows an overall increasing trend in the primary sectors output. Following world war two, agriculture declined as a share of GDP through until the late 1970’s. This was a result of the economy becoming less reliant on the land for output (The Treasury 2001). From 1975 to the mid-1980’s, primary sector GDP remained relatively stagnant. However, post-recession it is shown that output growth accelerated into the 1990’s. The domestic recession of 1990 to 1992 is seen to have not negatively affected the growth path of the primary sector. Rather, the rate of growth appears to have only slowed until 1995. Prior to the resources boom of the 2000’s, the Federal government aimed to facilitate mining expansion through the 1998 Resources Policy Statement (Goodman and Worth 2008). Such incentives included property rights, competitive tax rates, and self-regulatory environmental protection (Goodman and Worth 2008; Mercer 2000).

From the onset of the 2000’s, the mining sector saw rapid expansion as a result of resource demand growth from China. Infrastructure investment, consumer durables, and manufacturing exports increased China’s resource demand and propelled double-digit economic growth (Lenegan et al 2005; Battellino 2010). As such, the effect for Australia was strong growth during the first half of the decade (see figure 4.2). The GFC was found to have minimal impact, if any, on the primary sector’s output (see figure 4.4). This was unexpected as findings from Dunn (2009) and Bloch et al (2006) suggested the contrary. Here, it was argued that increasing commodity exports are conducive to rising vulnerability to world economic events – whilst exchange rate movements become pro-cyclical with commodity prices. China’s continued demand for exports during this period restricted the extent of such impact. As seen, the growth in the primary sectors output since 2000 has been predominantly mining driven, doubling in the last fifteen years alone. A total of 80% of primary sector output in 2015 is attributable to mining.
4.2.1.2 Secondary Sector GDP

**Figure 4.5: Secondary Sector Gross Domestic Product, 1975-2015**

Source: ABS, cat no. 5204.0

The secondary sector is comprised of manufacturing output. In the 1960’s economic growth was predominantly driven by a transition to manufacturing production (The Treasury 2001). Since such time, a gradual increase in manufacturing output took place until a sharp fall in 1982. Post-recession, a recovery occurred until the next recession of the early 1990’s. According to the Productivity Commission (2003), periods of recessions are when Australian manufacturing experiences the most structural change. Evidence shows that food and beverage industries are less affected, whereas investment-good producers are more highly sensitive to economic downturns.

Production efficiency from capital deepening in the sector has been highly discussed over the previous half century. Findings from Whiteman (1991) suggest that from 1954 to 1982 the rate of capital-augmenting technological change in Australian manufacturing was lower than that of labour-augmenting. In other words, innovations directed at labour efficiency was the cause of the
declining cost of the labour-to-output ratio in most manufacturing industries (Whiteman 1991). Conversely, Bloch (2010) provided findings that contradicted those of Whiteman’s (1991). He found that from 1962 to 2000, technological change has resulted in a clear bias to save labour over capital. History in manufacturing suggests this be the case as increasing mechanisation requiring less labour has enhanced labour productivity. Therefore, labour-saving technology has been employed across all manufacturing industries in this period (Bloch 2010). Relatively high technical progress compared to that of other sectors has seen manufacturing’s annual labour productivity average 3% a year from 1960 to 2000 (Productivity Commission 2003). Dividend payments to the economy from this productivity growth is estimated to be $400 billion over this period (Productivity Commission 2003).

Although since 1965 manufacturing’s role in the economy has lessened, the value of its output produced has not (see figure 4.5). A period of significant growth was the 1990’s where exports of manufactured goods grew strongly at an annual rate of 10% (Lowe 2011). The positive growth trend continued until a plateau in 2008 saw the sectors output value surpass $110 billion. This reflects the vital role the sector still holds in providing a diverse range of goods in the economy (Langcake 2016; Ville and Withers 2014). Moreover, manufacturing contributes strongly to exports and productivity growth, whilst having evolved into a more knowledge-intense, less labour dense sector (Ville and Withers 2014). According to Borland and Home (1996), from 1984 to 1985 it was found that the size of the firm is positively correlated to the establishment level rate of employment growth and negatively correlated to the probability of business failure.

As the economy increased its participation in export markets, exchange rate movements now influence Australian manufacturing competitiveness. As the dollar appreciated from 2000 to 2013, manufacturing competitiveness fell. This is reflected in a decline of output since the GFC of
2008. According to Lowe (2011), industries impacted from the slowdown include machinery and equipment and beverages. In recent years since 2013, the exchange rate has weakened bringing about a small recovery of exports in some manufacturing sub-industries (Department of Industry, Innovation and Science 2015; Langcake 2016).

4.2.1.3 Tertiary Sector GDP

Figure 4.6: Tertiary Sector Gross Domestic Product, 1975-2015

![Graph showing Tertiary Sector GDP from 1975 to 2015](image)

Source: ABS, cat no. 5204.0

The tertiary sector is comprised of services output. This includes all public, private, and construction services – not including the ownership of dwellings. Figure 4.6 depicts a smooth increasing trend in services GDP. Furthermore, the trend shown in figure 4.6 largely mimics that of total GDP in figure 4.1. This relationship suggests services output is the main driver of economic growth in Australia. Stevens (2008) declares the two most striking changes from the 1970’s to the 2000’s to be the rise in financial business services and declining share of output from manufacturing. Recessions in 1982 and 1992 have also shown to have had little impact on the
growth trend of the sector. During these times, only small reductions of 1.98% and 0.21% took place between 1982-83 and 1990-91 respectively. McLachlan et al (2012) show that between 1975 and 2000, the fastest growing service industry was communications at an average annual growth rate of 8.4%. In the same period, construction was the slowest growing at 2.2% per annum. According to Giesecke (2008), the services sector from 1996 to 2002 achieved average growth rates double to that of the primary and secondary sectors. By 2000, business and property services produced the largest service industry output totalling 14% of GDP (McLachlan et al 2002).

Rising commodity prices from increasing global resource demand in the 2000’s translated to continued services sector expansion. Business services – such as engineering and technical services, vehicle and equipment leasing, and employment services – have been the fastest growing industry in the economy as a result of growing mining investment and export activity (Manalo and Orsmond 2013; Department of Industry, Innovation and Science 2015; Lowe 2012). Furthermore, according to Connolly and Lewis (2010), change in the economy’s composition of GDP has been driven by an increasing demand for services coupled with economic reform and industrialisation of East Asia. Ville and Withers (2014) determine that growth will continue to be driven by services in future as a result of the sectors increasing sophistication.

Table 4.3: Sector Share of GDP, 1975-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary</th>
<th>Secondary</th>
<th>Tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>9.3</td>
<td>15.2</td>
<td>63.7</td>
</tr>
<tr>
<td>1985</td>
<td>9.3</td>
<td>12.9</td>
<td>65.2</td>
</tr>
<tr>
<td>1995</td>
<td>9.7</td>
<td>11.0</td>
<td>69.6</td>
</tr>
<tr>
<td>2005</td>
<td>9.6</td>
<td>9.2</td>
<td>71.6</td>
</tr>
<tr>
<td>2015</td>
<td>11.7</td>
<td>6.7</td>
<td>72.4</td>
</tr>
</tbody>
</table>
Note: Ownership of dwellings is not included in the data set

Table 4.3 breaks down each sector share of industry gross value added in the economy. What is shown is a continual structural shift toward services output since 1975. The growth in GDP has been primarily driven by the growth of services in the economy. As such, since 1975 the tertiary sector’s share of GDP has continuously increased. By 2015, services contributed 72.4% of industry gross value added.

A contrasting story is shown in that of agriculture and manufacturing industries. Since the 1960’s, the overall trend in each industry’s share of gross value added has been declining (Connolly and Lewis 2010). However, the primary sector as a whole has witnessed a gradual increase over the study period. This has been predominantly caused by the rise in output value from mining. Diverting sub-sector industry values have seen the primary sector’s contribution to GDP improve marginally by a total of 2.4%.

What isn’t portrayed in table 4.3 is how manufacturing’s output value has increased in size since the 1960’s. Causation for this occurrence is in the fact that although manufacturing has experienced positive growth rates, they are extremely moderate compared to that for services. Therefore, the sheer size of the tertiary sector diminishes manufacturing’s contribution to gross value added.

4.2.2 Gross Fixed Capital Formation

This section will discuss Australia’s fixed capital accumulation covering the study period 1965 to 2015. Gross fixed capital formation is defined as net expenditure on second-hand fixed assets – including additions and replacements – plus expenditure on new fixed assets (Australian Bureau of Statistics 2016). The accumulation of fixed capital is subdivided into two main types.
Firstly, private capital formation accounts for fixed capital expenditure from the private, non-government enterprise sector. And secondly, public fixed capital formation is derived from the expenditure of general government and government corporations. As Solow (1956) and Swan (1956) stipulate, national savings and depreciation of capital play a key role in the growth equation. As such, trends in both will be examined.

Figure 4.7: Australia’s Gross Fixed Capital Formation, 1965-2015

Source: ABS, cat no. 5204.0

Figure 4.7 shows the level of capital density in Australia being relatively low from 1965 to 1980. A moderate increase over the next decade would see Australia’s capital stock surpass a $100 billion value. However, the stand out period in the trend is post-2000 where the rate of capital deepening accelerated until a plateau in 2013. As the mining boom took off after 2000, so did capital accumulation in the economy. According to Fisher et al (1996), in terms of the Australian business cycle, the capital stock is pro-cyclical with output with a lag of approximately one year.
Figure 4.8: Private Fixed Capital Formation (current prices), 1965-2015

Source: ABS, cat no. 5204.0

Over the study period, it is apparent that the private capital accumulation trend mimics that of gross capital formation (see figure 4.8). The main similarities between the two are characterised by the rapid rate of capital deepening since 2000. Such capital utilisation in mining can be traced back to earlier periods of mining prominence, such as the 1960’s. According to Battellino (2010), the 1960’s to early 1970’s mining boom differed from previous ones in Australia’s history as it employed a higher capital intensity. Thanks to supply and technological factor improvements in capital markets, mining investment was boosted from 0.5% to almost 3% of GDP during this period (Battellino 2010).

For the thirty-five-year period of 1964 to 1999, the rate of capital deepening has been relatively stable averaging 1.2% every five years (Parham 2003). This was a far cry from many OECD countries from 1973 to the mid-90’s who were experiencing declining capital stock growth.
(Rowthorn 1995). As shown in figure 4.7, Australia mostly avoided this global trend. Rowthorn (1995) continues to show that productive capacity-creating capital investment is effective in raising the employment of labour in the economy. This has taken place in the private sector as services firms have employed high amounts of new capital (see figure 4.10). In 2000, $27.8 billion was invested in new capital equipment by private services firms (McLachlan et al 2002).

Figure 4.9: Public Fixed Capital Formation (current prices), 1965-2015

Although private capital deepening has brought large value in production, government capital expenditure has played an important role in private sector productivity. Figure 4.9 shows that until 1990, general government and government corporation’s investment was relatively in line. Yet, since 1990 general government expenditure has seen an exponential increase until a peak in 2010. Whereas public corporation’s investment levels have remained relatively stable over the period until post-2000.
Otto and Voss (1994) advocate the role public capital plays in private output showing a public capital output elasticity of approximately 0.4. However, little policy guidance has been provided by these results since public decisions are made on aggregate levels (Otto and Voss 1995). Other Australian studies have found an even stronger relationship. Song (2002) determined a 1% fall in public capital expenditure results in a 0.5% decrease in private sector output. Similar results have been found in the United States during the 70’s and 80’s productivity decline. Lynde and Richmond (1993) show approximately 40% of the productivity fall during this period is attributable to a decrease of the public capital-to-labour ratio. In Australia, main growth effects from public investment have come from transport facilities and education (Anderson and Gruen 1995). Furthermore, through improving private sector productivity, per capita incomes will rise. Evidence of such is provided by Kostakis (2014), who found a positive correlation between public capital and the growth rate of per capita income.

4.2.2.1 Sectoral Gross Fixed Capital Formation

Figure 4.10: Capital Formation by Sector, 1965-2015

Source: ABS, cat no. 5204.0
Figure 4.10 shows a changing landscape in the capital stock through the three primary, secondary, and tertiary sectors. The primary sector comprises of agriculture and mining capital, the secondary sector of manufacturing capital, and the tertiary sector comprises of all services (public and private) and construction capital – not including ownership of dwellings. In terms of value order, the trends in sectoral capital accumulation reflect the same to that of their respective GDP. Comparisons in tertiary sector capital accumulation to that of gross fixed capital formation (figure 4.7) show that services determine the majority of the aggregate trend. As services GDP value has increased, so has the rate of capital accumulation. But the capital growth from services has increased at a faster rate than that of its GDP output; the same can be seen for the primary sector. From 2000 to 2015, the primary sectors capital stock quadrupled, whereas its GDP value only increased by 80%. This accelerating trend occurred until a peak of both sectors in 2013. Slightly before the peak, however, mining investment accounted for approximately 20% of total investment in Australia (Lowe 2011).

From 1965 to 1990 the secondary sector’s capital accumulation was moderate – increasing from $5.1 billion to $13.3 billion respectively. According to the Productivity Commission (2003), from 1966 to 2002, manufacturing only accounted for 7% of Australia’s net capital stock, whereas 80% was attributable to services. Yet, during the same period of time, the capital-to-labour ratio in manufacturing increased by 150%, whilst services only rose by 51% (Productivity Commission 2003). These findings concur with the previous discussion pertaining to the capital-augmenting trends of Australian manufacturing (see Bloch 2010).

The year of 2006 saw a peak in the secondary sectors capital stock growth path. Since such time it has seen a decline from $27.8 billion to $16.3 billion in 2015. An intriguing comparison is the secondary sectors GDP growth over the same period reflects much the same trend (see figure
4.5). Overall, both the tertiary and primary sector have experienced an exponential trend in the second half of the study period. Conversely, manufacturing has remained relatively stagnant and only managed a 55% increase in its capital stock since 1965.

Table 4.4: Sector Share of Gross Fixed Capital Formation, 1965-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary</th>
<th>Secondary</th>
<th>Tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>19.0</td>
<td>10.1</td>
<td>35.9</td>
</tr>
<tr>
<td>1975</td>
<td>19.0</td>
<td>8.3</td>
<td>37.1</td>
</tr>
<tr>
<td>1985</td>
<td>17.1</td>
<td>7.0</td>
<td>37.1</td>
</tr>
<tr>
<td>1995</td>
<td>14.5</td>
<td>9.3</td>
<td>36.2</td>
</tr>
<tr>
<td>2005</td>
<td>11.9</td>
<td>8.8</td>
<td>44.1</td>
</tr>
<tr>
<td>2015</td>
<td>25.0</td>
<td>3.9</td>
<td>45.3</td>
</tr>
</tbody>
</table>

Note: Ownership of dwellings and ownership transfer costs are not included in the data set

Table 4.4 breaks down the three sectors into their individual contributions to aggregate capital formation. The contribution trends in each of the primary, secondary, and tertiary sectors reflect the same story to that of their capital formation growth. Firstly, is the secondary sectors declining contribution to gross capital formation. Due to services and mining’s accelerating capital growth, manufacturing’s proportion of gross capital formation has diminished. From 1985 to 1995 the secondary sector saw a recovery from 7.0% to 9.3% respectively. However, this is mainly due to the slumps in growth in the primary and tertiary sectors at the time (see figure 4.10). Since 1995, the secondary sectors contribution has plummeted to 3.9% in 2015.

Secondly, the primary sectors contribution has seen an overall increase of 6.0% from 1965 to 2015. But, for the thirty-year period of 1975 to 2005 the sectors contribution percentage decreased by 7.1%. This was a result of the tertiary sectors growth outpacing that of the primary
sector during this period. Recently, however, a resurgence in the sectors contribution to the gross capital stock – to 25% in 2015 – has resulted from a decade of prominent capital growth.

Lastly, the tertiary sectors dominance in capital formation has increased its percentage contribution by 9.4%. Over the fifty-year period, services capital formation only experienced one period of negative growth. This took place during the recession of the early 1990’s. Although during the decade to 1995, all three sectors saw a decline in their respective percentage shares. Much like that of the primary sector, services growth mainly occurred in the second half of the study period. As such, its proportion of gross capital formation grew by 9.1% from 1995 to 2015.

4.2.2.2 National Savings

Figure 4.11: National Net Savings, 1965-2015

Source: ABS, cat no. 5204.0

According to the Solow (1956) – Swan (1956) growth model, savings play an integral role in funding capital investment. Australian trends in investment have shown gross fixed capital
formation accelerating since 1965. Historically, investment in Australia has outpaced that of national savings which has largely contributed to the widening of the CAD (Bishop and Cassidy 2012). According to Fisher et al (1996), real savings cycles are similar to that of private investment with a cyclical correlation of 0.5.

National savings is defined as the sum of net savings of each of the resident sectors (Australian Bureau of Statistics 2016). Figure 4.11 shows a relatively consistent trend to that of figure 4.7. Historically, vigilant fiscal policy coupled with the introduction of compulsory superannuation has resulted in relatively high national savings rates compared to other countries (Gruen and Soding 2011). Following the war until the mid-1970’s, FitzGerald (1993) determine Australia’s savings as consistently 25% of GDP. Over this same period, public savings from the general government sector had remained fairly stable at 3% of GDP (Edey and Gower 2000). Moving past 1975, however, saw a drop in savings rates that was predominantly caused by the public sectors negative saving levels until 1985 (Edey and Gower 2000). By the late 80’s an improvement in savings had taken place, but was inevitably short-term.

A time of growing concern for savings rates was during the recession of the early 90’s. As net national savings has declined as a gross measure due to depreciation increasing as a proportion of GDP (see figure 4.13), national savings declined to 16% of GDP in 1992 (FitzGerald 1993; Edey and Gower 2000). Yet, moving through the decade into the 2000’s saw a consistent upward trend as the mining boom gathered momentum. As determined by Anderson and Gruen (1995), domestic savings for capital formation is important as Foreign Direct Investment (FDI) flows can be limited. The extent to which a country can rely on foreign funds to fund domestic investment depends on the level of capital inflow the market deems as sustainable (Anderson and Gruen 1995). Australia fares well in these respects.
From 1965 to 2005 household and corporation savings experienced a moderate degree of volatility. Anderson and Gruen (1995) argue that the decline in household saving rates from 1960 to 1994 is due to a sensitivity of the different cyclical conditions of each decade. An initiative to encourage savings for retirement was set up by the Hawke government in 1987 through the *Occupational Superannuation Standards Act*. The Labor government under Paul Keating then implemented the *Superannuation Guarantee (Administration) Act* in 1992, extending retirement funds to 72% of workers (Nielson 2010). Under this legislation, super contributions by employers were to be progressively increased from 3% to 9% over the next decade (Nielson 2010). According to Connolly and Kohler (2004), policies encouraging superannuation have increased household savings rates by up to 2% a year. However, the growth in national savings through the 90’s and
early 2000’s may be more than offset by increasing levels of borrowing in the newly deregulated environment (Freestone et al 2011).

The most notable event in figure 4.12 is the sharp rise in savings around the 2008 GFC. During this phase between 2005 and 2010, household savings surpassed that of the corporations. A significant fall in consumption at the time underpinned the acute rise in household savings (Freestone et al 2011). Findings by FitzGerald (1993) show that in Australia, life cycle spending patterns, after-tax real rates of returns, and growth or decline in incomes affect household savings rates.

According to Anderson and Gruen (1995), economies tend to grow slower when investment is lower due to shallow national savings. In recent years since the GFC, the investment-savings gap in Australia has diminished as a result of increased saving rates. This has mainly been from corporations and households in attempts to cover debt investments accumulated from mining (Bishop and Cassidy 2012). A shift to safer assets away from shares was the driver of the rise in household savings after the GFC (Freestone et al 2011). Since 2012 where household and corporation savings peaked, reductions have taken place. However, compared to that of households, corporation savings rates have dramatically reduced from $77.5 billion in 2012 to $27.7 billion in 2015. According to Bishop and Cassidy (2012), across the study period corporations have tended to be net borrowers rather than savers. In terms of the public sector, government savings have also shown sharp declines during the recessions which have adversely impacted budget deficits (Bishop and Cassidy 2012). Overall, recent trends show improvements in national savings are attributable to households and corporations offsetting the decline in public sector savings. This has aided in keeping the CAD at historic lows (Freestone et al 2011; Bishop and Cassidy 2012).
4.2.2.3 Depreciation of Capital

Figure 4.13: Depreciation of Fixed Capital, 1965-2015

Source: ABS, cat no. 5204.0

The trend in the depreciation of fixed capital largely follows that of gross fixed capital accumulation in figure 4.7. That is, as the level of fixed capital increases in the economy, the higher the value of depreciation. From 1965 to 1990 depreciation increased in a moderately exponential fashion. The early 90’s recession caused a reduction in capital investment (see figure 4.7), thus the rate at which depreciation of the capital stock occurred slowed. From the late 90’s, depreciation began accelerating again. This was a result of an increasing rate of capital stock investment which continued until 2014. As discussed in chapter 2, output is considered net output after accounting for the depreciation of capital. An appropriate rate of depreciation for TFP estimations will be determined in chapter 5.
4.2.3 The Labour Force

The aim of this section is to examine the evolution of the Australian labour market from 1965 to 2015. Being the third key variable in the Solow (1956) – Swan (1956) growth framework, the labour force will be the main focus of this section. Upon analysis, it is shown that the labour force has grown in a relatively linear trend much like that of GDP. The discussion of employment will be divided into the three primary, secondary, and tertiary sectors. Following this will be an examination of the significant structural change that has taken place in the labour market in the last fifty years. The protagonists of this transition include the decline in unionism, growth in part-time employment, and the increasing participation rates of women in the labour force. In contemporary times, the greater level of flexibility and resilience of labour has been derived from such structural change.

Figure 4.14 Australian Labour Force and Total Employment, 1965-2015

Source: ABS, cat no. 6202.0
For the decade 1965 to 1975 the labour force and employment grew concurrently (see figure 4.14). Post-1975, however, the rate of growth of employment fell which initiated a widening of the labour force-employment gap. The employment decline at the time was due to large rises in real wages (Russel and Tease 1988). Wage hikes were primarily driven by union disputes which deepened the issue of stagflation during the decade. Malcolm Fraser’s Liberal-National Party Government was unsuccessful in its efforts to reduce unemployment and inflation pressures – a legacy left by his predecessor Gough Whitlam and the Australian Labor Party.

Entering the 1980’s saw employment growth decline further as a result of the global recession in 1982. However, an immediate recovery post-recession saw employment grow relatively parallel with the labour force until 1990. The prompt recovery of employment is attributable to the Income and Prices Accord introduced by the Hawke government in 1983. This was an agreement between the Australian Council of Trade Unions (ACTU) and the government that entailed restrictions on wage demands and a commitment to reducing inflation. The principal objective of the Accord was to solve the stagflation remaining from the 1970’s (Wright 2014; Chapman 1998). This was to be achieved through continual amendments to the Accord from 1983 to 1996 in the form of Mark I – VII. These amendments catered for the changing economic landscape to encourage deregulation and microeconomic reform. In its initial three years of operation, the Accord facilitated five hundred thousand jobs and decreased unemployment during the 80’s (Chapman 1998; Lewis and Spiers 1990; Morris and Wilson 1994).

Over the 70’s and 80’s average employment growth was 1.8% a year (Russel and Tease 1988). According to Blanchard and Giavazzi (2003), reforms in the product market will raise employment from reduced barriers to entry. The late-1980’s was an era of various structural reforms and deregulation. Australia made progress in this area through implementing labour
industrial relations reforms via the Accord Mark I - V. However, the full run on effects for employment did not materialise until the mid-90’s. The late 80’s was also a time of mass government enterprise privatisation. As a result of such, public sector employment plummeted heading into the 1990’s. A total of 304,000 jobs were lost and were not fully offset by private sector employment growth (Burgess and Mitchell 2001). Coupled with the early 90’s recession, the labour force-employment gap widened.

The recession of 1992 saw employment recovery slower than that of the 1980’s recession. From 1983 to 1987 employment grew by 12.5%, compared to 9.2% over the same period in the 90’s (Borland 1997). The 90’s was also a time of changing industrial composition of employment. This is reflected in the decline of manufacturing employment since 1970 (see figure 4.16). What was also gaining momentum was a shift in the pattern of relative labour demand. Findings from Borland and Wilkins (1997) show that between 1975 to 1994 there was an increasing demand for higher skilled workers in the economy. Supporting this claim is Wilkins and Wooden (2014) who found that an increase in the significance of knowledge-based service industries coincided with a decline in the importance of goods-producing industries. In this regard, capital advancements such as computerisation have contributed to this movement. Autor et al (2003) found that computerisation of manual and routine cognitive tasks has shifted the dynamics of employment toward educated labour by 60%. Consequently, tertiary sector employment accelerated (see figure 4.17).

Overall, during the mid-phase of the study period – 1970 to 2000 – the Australian labour force achieved an annual compound growth rate of 1.87% (Burgess and Mitchell 2001). Furthermore, Battersby et al (2015) found that over the 70’s, 80’s and 90’s, the GDP cycle elicited similar turning points and amplitudes in the employment cycle. Here, the results also showed that
the GDP cycle tends to lag that of employments by six to twelve months (Battersby et al 2015). Adding to this context is Fisher et al (1996) who found that from 1959 to 1995, employment and total hours worked are pro-cyclical and contemporaneous with the aggregate cycle.

Moving through the 2000’s, employment grew at a faster rate than the labour force to 2008 having a narrowing effect on the labour force-employment gap. During this decade, labour force and employment growth is shown to be strongest between 2004 to 2008 (Borland 2011). Post-GFC, however, employment growth began to slow. According to Borland (2015), the slow-down in the rate of economic growth has caused the decrease in employment. China was no longer experiencing double-digit growth which relatively lowered the demand for resources. This is evident in the decreasing primary sector employment post-2012 (see figure 4.15). Historical evidence of recessions in Australia suggests that the impact on employment in future recessions will depend on the effect GDP growth incurs (Borland 2009). According to Dawkins and Freebairn (1997), in order to increase employment faster, positive economic growth coupled with wage restraints is necessary. Across the study period, growth in the labour force and employment in Australia has experienced a continual upward trend.
4.2.3.1 Primary Sector Labour

Figure 4.15: Primary Sector Employment, 1965-2015

Source: ABS, cat no. 6202.0; Withers et al (1985), pg. 100

The primary sector is comprised of agriculture and mining employment. Figure 4.15 shows a relatively stagnant primary sector employment growth from 1965 to 2015. From 1965 to 1990, employment in the sector grew by only 6%. Conversely, from 1990 employment decreased by 14% to 455,000 people in 2003. The rest of the 2000’s decade shows the highest growth in primary sector employment for the study period. This was a result of mining employment growth accelerating as part of the resources boom. According to Tyers and Walker (2016), between 2000 to 2012, the mining industry achieved an average annual employment growth rate of 10%. But, the mining boom during the decade was subject to a sector-specific employment cycle. The Australian resource sector is relatively insensitive to domestic economic cycles as 60% of industry value added is attributable to foreign demand (Battersby et al 2015). As China’s resource demand increased, mining employment jumped 146,000 people from 2005 to 2012. Yet, as a result of the
mining boom income inequality has been exacerbated. Due to its capital intensive nature, labour's share in income has progressively declined to have created a more limited domestic labour market (Dunn 2009).

4.2.3.2 Secondary Sector Labour

Figure 4.16: Secondary Sector Employment, 1965-2015

Source: ABS, cat no. 6202.0; Withers et al (1985), pg. 100

The secondary sector is comprised of manufacturing employment. From 1965 to 1973 manufacturing employment grew by 6.2%. This was one of only two short improvements in employment growth. The second took place from 1985 to 1989 where employment grew by 7.6%. Yet, as shown in figure 4.16, manufacturing’s proportion of total employment has declined since the 1970’s. The wage hikes and inflationary pressures of the 70’s lead to the demise of the Whitlam Labor government in 1975. By the recession in 1982, manufacturing had witnessed a loss of 100,000 jobs as a result of these factors (Wright 2014). According to Borland and Foo (1996),
from the 1950’s to the late 80’s, manufacturing’s composition of employment shifted from production workers to non-production higher educated workers. Furthermore, non-production worker demand was found to be not as cyclical as blue-collar production workers (Borland and Foo 1996). Overall, the underlying trend in manufacturing employment has been decreasing since the 1970’s. Borland (1996) attributes this to a higher rate of manufacturing job destruction than job creation. He discovered that between 1978 to 1992, average annual job destruction was 4.3% whereas job creation was 2.3% (Borland 1996). This is supported by Bloch (2010) who found that from 1968 to 2000 technological change in the secondary sector has been bias toward labour saving over capital.

The mining boom of the 2000’s did not provide much of a recovery in secondary sector employment. Although the resources boom did not greatly aid manufacturing employment growth, it was seen to not have exacerbated the declining long-term trend (Tyers and Walker 2016). The mining boom did, however, create a shift in the composition of manufacturing’s employment. This was a move away from import-competing manufacturing to mining-related manufacturing (Connolly and Lewis 2010). Due to the secondary sectors continuously declining employment, it has been labelled the “lagging sector” of the Australian economy (Tyers and Walker 2016, pg. 23). However, despite the continuously declining employment levels, manufacturing still remains the second largest sectoral employer in Australia.
4.2.3.3 Tertiary Sector Labour

Figure 4.17: Tertiary Sector Employment, 1965-2015

The tertiary sector is comprised of services employment. This includes all public, private, and construction services. Services employment for the study period exhibits a consistently increasing trend (see figure 4.17). According to Henderson (1979), demand shifts towards services as an economy’s wealth rises. Therefore, the proportion of people employed in services will increase as manufacturing employment growth slows (Henderson 1979). This reflects the events that have occurred in the Australian labour force from 1965 to 2015. A comparison between figure 4.16 and figure 4.17 depicts this trend.

From 1965 to 1982, tertiary employment grew continuously. During the 70’s, community services were found to be the largest contributor to tertiary sector employment growing at an average annual rate of 2.6% (Henderson 1979). But, positive employment growth was temporarily
interrupted in 1983 as a result of the global recession. However, the decrease experienced was extremely moderate at 1.6% since 1982. This was one of only two periods of time where services employment growth declined in the economy. The second occurrence was from 1990 to 1992 during the domestic recession. Yet, compared to the recession of the 80’s, an even smaller decline of 1.3% took place. According to Lowe (2011), in the decades since the 1960’s, a shift from manufacturing to services employment took place as tariff barriers were reduced and average incomes rose.

Post-1992, services employment continued on its positive growth path. Construction, property and business services, and health and community services were the drivers of tertiary sector employment growth for the fifteen years to 2007 (Dunn 2009). According to Connolly and Lewis (2010), service industries were much more labour intensive than the primary and secondary sector during the 2000’s. Driven by the mining boom, the demand for mining-related construction services increased which raised employment in the sector (Connolly and Lewis 2010). This is supported by Lowe (2011) who attributes the rise in demand for ancillary professional services to the positive outlook for resource sector investment at the time. By the end of the decade, approximately 86% of total employment was accounted for by the tertiary sector (Tyers and Walker 2016).

Over the study period, it is clear that the tertiary sector has been the primary force behind Australia’s employment growth. Much of this is predominantly due to most services being produced domestically, labour productivity growth in services being slower than manufacturing, and the demand for services rising faster than that of produced goods (Lowe 2012). The dominance of services toward total employment can be seen in table 4.5 below.
Table 4.5: Sector Share of Total Employment, 1965-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Primary</th>
<th>Secondary</th>
<th>Tertiary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>10.9</td>
<td>28.1</td>
<td>61.7</td>
</tr>
<tr>
<td>1975</td>
<td>8.2</td>
<td>21.6</td>
<td>70.2</td>
</tr>
<tr>
<td>1985</td>
<td>7.7</td>
<td>16.2</td>
<td>76.6</td>
</tr>
<tr>
<td>1995</td>
<td>5.8</td>
<td>13.0</td>
<td>80.6</td>
</tr>
<tr>
<td>2005</td>
<td>4.8</td>
<td>10.5</td>
<td>86.0</td>
</tr>
<tr>
<td>2015</td>
<td>4.6</td>
<td>7.7</td>
<td>89.1</td>
</tr>
</tbody>
</table>

Table 4.5 breaks down each sector share of total employment. Since 1965, tertiary employment growth has been the underlying story of employment the economy. This has coincided with the increasing importance of services to GDP (Betts et al 2007). Across the study period, the tertiary sector was the only sector that has increased its employment share. By 2015, tertiary sector employment contributed 89.1% of total employment in the economy.

The secondary sector’s employment contribution has seen the biggest decline of the three sectors. As a result of consistently declining employment since 1965 (see figure 4.16), manufacturing’s share of total employment has diminished. The largest decreases of such occurred in the first two decades of the study – from 1965 to 1985 manufacturing’s employment share fell 11.9%. Once making almost one-third of total employment, the secondary sector only contributed 7.7% in 2015.

Primary sector share in total employment has also consistently decreased since 1965. However, not to the same extent to that of the secondary sector. The worst of the fall occurred from 1965 to 1975 by a total of 2.7%. A continual decline since has seen the sector's employment share hit a mere 4.6% in 2015.
4.2.3.4 Unions and the Labour Market

Figure 4.18: Number of Days Lost in Industrial Disputes, 1965-2015

A major structural change in the Australian labour market has been the rise and demise of unionism. As shown in figure 4.18, union involvement in industry has massively declined since the 1970’s. The trend in the number of employees involved in industrial disputes largely mimics that of the number of working days lost. From 1965, union activity skyrocketed as over 6,000 days a year lost to industrial disputes occurred by the mid-1970’s. Between 1970 and 1974, public sector union membership more than doubled. According to Bowden (2011), this was attributable to 119 pro-union policies that were legislated during this period. By 1982, as a result of the global recession, private sector union density decreased to 39% (Bowden 2011). At the time, a large disparity between public and private sector unionism existed as in the same year public sector membership was 72.9% (Patmore 1992).
Australian trade unions had considerable power in Federal politics during the 1980’s. As previously discussed, one of the most notable achievements of the Hawke government was the Income and Prices Accord of 1983. According to Patmore (1992), in 1986 wage indexation was abandoned by the Australian Conciliation and Arbitration Commission, with further decentralising reforms introduced in 1988 and 1989. Studies have shown that Australian industrial relations greatly benefitted from the introduction of the Accord as a result of wage inflation and working days lost to disputation declines (see Beggs and Chapman 1987; Chapman 1998). Furthermore, even though strengthening macroeconomic conditions also contributed to these improvements, they only explain less than half of the movement (Beggs and Chapman 1987).

The structural change the economy was experiencing contributed to the sharp declines in union density (Bell and Quiggin 2008; Peetz 1990). According to Peetz (1990), the significant decline of the public sector size during the decade was why industrial change was negatively impacting unions. The emergence of think tanks – such as the H.R. Nicholls Society and New Right employer associations – further threatened union power by calling for an end to arbitration (Bowden 2011). As seen in table 4.6, employment growth during the 80’s prospered in lower union-dense industries.

Table 4.6: Australian Union Density and Employment Growth, 1982 to 1990

<table>
<thead>
<tr>
<th>Industry group</th>
<th>Percentage growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>High density</td>
<td>4.3</td>
</tr>
<tr>
<td>Moderately high</td>
<td>4.6</td>
</tr>
<tr>
<td>Moderately low</td>
<td>19.5</td>
</tr>
<tr>
<td>Low density</td>
<td>18.7</td>
</tr>
</tbody>
</table>

Source: Patmore (1992), pg. 235
The 1990’s began with 730 lost work days due to industrial disputes before declining to a mere 344 by 1995 (see figure 4.18). In 1990, both public and private sector union membership had fallen to 66.8% and 30.8% respectively (Patmore 1992). A fundamental shift in industrial relations was implemented by the Labor government with the introduction of enterprise bargaining in 1991 via the Accord Mark VII (Bell and Quiggin 2008). According to Valadkhani (2003), a significant source of productivity gains was the move towards a decentralised enterprise bargaining system after 1992. Since the legislation of the Industrial Relations Reform Act 1993 and the Workplace Relations Act 1996, trade union relevance has fallen as employers and employees now independently arrange their agreements (Wooden 2001; Borland 2011). Unionism continued its demise into the late 90’s with overtly anti-union legislation produced by the Howard government (Bowden 2011).

Decentralisation of the wage system continued into the 2000’s. From 2000 to 2005 union activity decreased by 60%. Union power was revoked further with the introduction of the Workplace Relations Amendment Act 2005 or WorkChoices legislation (Bowden 2011). According to Bhattacharyya and Hatton (2011), since 1987 the decline in unionism has decreased the unemployment rate, on average, by 2.3% per year. As such, by 2007 union density was only 18.9% of the workforce (Howard and King 2008). For the remaining eight years of the study period, industrial disputes declined further to just 71 lost days in 2015. The contrasting nature of contemporary times show union disputes are a relative non-event compared to the 70’s and 80’s.
4.2.3.5 Labour Market Structure and Composition

Figure 4.19: Full-time and Part-time Employment Growth, 1965-2015

Source: ABS, cat no. 6202.0

The composition of the Australian labour market in terms of employment type has also undergone a transformation. Figure 4.19 illustrates the growing proportion of part-time employment in the labour force. Part-time employment is defined by the ABS (2016) as an employed person who, in all jobs of employment, works less than 35 hours in the reference week. According to de Ruyter and Burgess (2000), some part-time employment is a refuge from unemployment as, in the Australian labour force, there is a high degree of involuntary part-time employment. Yet, casual employment also makes up a high proportion of part-time employment (de Ruyter and Burgess 2000).

Since 1965 the growth in part-time employment has been relatively steady. Part-time work gained traction in the 1970’s as more jobs were created with lesser hours (Pissarides 1991). This
had an indirect positive effect of raising female employment in the labour force. According to Stricker and Sheehan (1981), a cohort effect from world war two veterans eligible for the pension and rising unemployment contributed to the mid-70’s decline in male participation. Concurring with Stricker and Sheehan (1981) was Merrilees (1982; 1983) and Moir (1982), who added increased access to other pensions and the lack of evidence for changes in the structure of labour demand was working against male employment. By 1981, women accounted for 36.5% of the labour force providing an income for a household (Bowden 2011).

During the 70’s and 80’s, annual average growth in part-time employment was higher than full-time employment at 5.2% and 1.2% respectively (Russel and Tease 1988). According to Patmore (1989), by 1989 one fifth of the labour force worked part-time. This acceleration coincided with the rise of the services and fall in manufacturing employment (see figures 4.17 and 4.16). Evidence of such is shown by retail, personal services, and community services industries contributing to 68% of part-time employment in 1989 (Patmore 1992).

This trend continued into the 1990’s as the distribution of employment type continued to shift (Wilkins and Wooden 2014). After the recession in 1992, part-time jobs made up 42% of all new jobs created with 51.2% being filled by women (Burgess and Mitchell 2001). However, at the time in 1993, women only made up 42% of total employment (Burgess and Mitchell 2001). According to Borland (2009), the growth in both part-time and full-time employment of females has been the cause of the decreases in unemployment during recessions. For the 90’s decade, casual employment contributed 71.4% of total employment growth (Campbell and Burgess 2001). It is apparent that female participation in the labour force has continually increased whilst male participation is declining (see table 4.7).
Using consensus data, a study by Black et al (2010) sought to examine the reasons as to why employment of working aged males has decreased in recent decades. Their findings imply that from 1971 to 2000, changes in the structure of labour demand away from male-dominated industries and the decline in households with dependent children has been attributable to decreasing male employment. Furthermore, increases in income tax between 1971 and 1981 coupled with the increase in unemployment benefits between 1971 and 1991 have also contributed to this trend (Black et al 2010).

During the 2000’s the proportion of people working fifty hours a week or more declined whilst part-time employment continued to grow (Wilkins and Wooden 2014). Table 4.7 shows that since 2000 male participation has fallen 1.1% to 71% in 2015, whereas female participation has grown 4.4% over the same period. According to Borland (2011), the increasing participation rate
of females can be explained by part-time/flexible employment availability, household financial considerations, and improving child care availability. Hence, as a result of an increasingly flexible labour market, the GFC had minimal adverse effects on employment in comparison to other economies.
4.3 Conclusion

This chapter aimed to provide a brief overview of the macroeconomic data for TFP estimates covering the period 1965 to 2015. At the centre of the discussion was the various policy, political, and structural change that has occurred. Complimenting such, was the breaking down of output, capital, and labour into their respective primary, secondary, and tertiary economic sectors.

In terms of output, GDP shows a linear growth trend resulting from a volatile growth rate. Prosperity in the 1960’s transitioned to a turbulent twenty-year period for the economy. To combat the issue, deregulation and reforms took place in the 1980’s which enabled greater growth in the decades following. The story of output is one found to be primarily driven by the tertiary sector.

Perhaps the greatest growth in value was that of the capital stock’s, predominantly led by the private sector. However, an issue concerning such a rate of investment is the level of national savings available to fund the expenditure. Historically being a net lender, Australia’s savings of late have risen exponentially since around the GFC of 2008. From a sectoral perspective, services have generated the highest levels of capital accumulation.

Behaviour in labour growth patterns exhibit much the same story of GDP. Major developments in the labour market included wage hikes in the 1970’s and stagflation. However, these pressures were seen to ease by the late-80’s as a result of reforms. Significant structural change also occurred in the form of declining unionism, the rise in part-time employment, and diverting male and female labour force participation trends. The tertiary sector was found to contribute the vast majority of labours employment.
The historical data analysis has brought additional clarity to the underlying trends and influences of Australia’s economic growth. With this now in place, the next chapter will seek to conduct TFP estimations and decompose economic growth over this timeframe.
Chapter 5: Estimating Australia’s TFP

5.1 Introduction

The aim of this chapter is to estimate TFP growth for Australia covering the period 1965 to 2015. Prior to conducting empirical estimations, it is important to derive an appropriate capital depreciation rate, the sources of macroeconomic data, and capital’s share of output, \( \alpha \). Failure to do so could bias TFP growth either upwards or downwards. TFP estimations and growth decomposition will occur at both the national and sectoral level. The rationale for doing so is to examine what sector(s) has provided the most significant contribution to the aggregate economy. Furthermore, trends within each sector may also supply evidence of any underlying structural shifts in output Australia has experienced. Included amongst this discussion will be a comparison of TFP against that of GDP growth using the RBC theory.
5.2 The Model

The estimation of TFP takes the following production function,

\[ Y(t) = f(A(t) K(t)^\alpha L(t)^\beta) \]

Where \( Y(t) \) is real aggregate output, \( K(t) \) is the capital stock, \( L(t) \) is labour, and \( A(t) \) denotes the TFP being estimated. The parameter \( \alpha \) depicts capital's contribution to economic growth and is a value between 0 and 1. \( \beta \) denotes labour's contribution to economic growth and is equal to \( 1 - \alpha \).

As previously discussed, the Solow (1956) – Swan (1956) model assumes constant returns to scale. Hence, the capital and labour parameters must always sum to one \( (\alpha + \beta = 1) \). The capital stock in this framework is to be known as the sum of the capital stock less depreciation at a rate of \( \delta \). In Australia, the Australian Taxation Office (ATO) determines the depreciation rates of capital.

Table 5.1: ATO General Plant Depreciation Rates

<table>
<thead>
<tr>
<th>Effective life (years)</th>
<th>Diminishing value rate, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3</td>
<td>-</td>
</tr>
<tr>
<td>3 to less than 5</td>
<td>60</td>
</tr>
<tr>
<td>5 to less than 6(\frac{2}{3})</td>
<td>40</td>
</tr>
<tr>
<td>6(\frac{2}{3}) to less than 10</td>
<td>30</td>
</tr>
<tr>
<td>10 to less than 13</td>
<td>25</td>
</tr>
<tr>
<td>13 to less than 30</td>
<td>20</td>
</tr>
<tr>
<td>30 or more</td>
<td>10</td>
</tr>
</tbody>
</table>

**Average** 30

Source: Australian Taxation Office (2016), pg. 40

As shown in table 5.1, depreciation for capital changes according to its age. Furthermore, rates of depreciation differ according to the type of asset being depreciated. For the purpose of this
thesis, a uniform depreciation rate of capital across the study period will be used. The $\delta$ value used will be an average of the depreciation rates in table 5.1, thus, $\delta = 0.3$. Rearranging equation 5.1 for $A(t)$ we receive,

\[ \hat{A}(t) = Y(t) - K^\alpha(t) - L^\beta(t) \]

(5.2)

The hat above $A(t)$ depicts the estimation for TFP. Output, capital, and labour are now converted to an annual percentage change and equation 5.2 can be rewritten as follows,

\[ \hat{A}(t) = \dot{Y}(t) - \alpha \dot{K}(t) - (1 - \alpha)\dot{L}(t) \]

(5.3)

The dots above $Y(t)$, $K(t)$, and $L(t)$ signify the annual percentage rate of change in output, capital, and labour respectively. Once an estimate for $\alpha$ is given, $\alpha^\hat{}$, then TFP, $\hat{A}$, is estimated as follows,

\[ \hat{A}(t) = \dot{Y}(t) - \alpha^\hat{} \dot{K}(t) - (1 - \alpha^\hat{})\dot{L}(t) \]

(5.4)
5.3 Data Sources

Australian data is collected and published by the Australian Bureau of Statistics. The data catalogue's available provide accurate and comprehensive long-run data series that will be used for the purpose of this thesis.

Table 5.2: Data Sources for Australian Study

<table>
<thead>
<tr>
<th>Model Factor</th>
<th>ABS catalogue no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Domestic Product ((Y(t)))</td>
<td>5204.0</td>
</tr>
<tr>
<td>Gross Fixed Capital Formation ((K(t)))</td>
<td>5204.0</td>
</tr>
<tr>
<td>Labour Force ((L(t)))</td>
<td>6202.0</td>
</tr>
</tbody>
</table>

The availability of data for this study from the same source yields consistency and credibility in the TFP estimations performed in section 5.5.
5.4 Estimating Capital’s Share of Output

One of the major issues when estimating TFP is the determination of capital’s share of output, or the value of $\alpha$. Once $\alpha$ is established, labour’s share in output can be calculated as $\beta = 1 - \alpha$. As $\alpha$ is a parameter to the capital stock, variations in its value effect the estimated TFP. Therefore, as a result of $\alpha$ itself being an estimation, TFP calculations are conducted with capital’s share of output being determined \textit{a priori}.

The level of capital’s share of output has been the centre of most the literature debate. This has provided for little evidence in factor share changes in an economy over time (Collins and Bosworth 1996). Capital’s share of output also differs between developed and developing economies. In developed or industrialised economies $\alpha$ value estimates have been found to be 0.3 (Maddison 1987; Collins and Bosworth 1996). Whereas in developing or industrialising economies, such as the East Asian newly industrialising economies, $\alpha$ value estimates are higher at 0.4 (Kim and Lau 1995; Collins and Bosworth 1996). Elias (1990), found that for developing Latin American countries $\alpha$ tended to be between 0.45 to 0.69. The rationale behind the higher $\alpha$ value in developing economies is that since the capital stock is smaller, diminishing returns to scale has not been reached and therefore the output elasticity of capital should be higher (Taylor 2007). However, Chen (1997) argues that capital’s contribution to growth is overstated as the output elasticity of capital is lower than the capital share allocated. This is the result of the factor market not being in equilibrium in developing economies (Chen 1997).

TFP calculations have a high sensitivity toward the allocated capital’s share of output. According to Sarel (1996), interpretational problems of TFP arise from the estimation of $\alpha$ and the timeframe of TFP estimation chosen. As a result of such, he argues that TFP results should not be
viewed as definitive, rather “interesting, but only suggestive” (Sarel 1996, pg. 7). Findings from a study conducted by Dowling and Summers (1998) support the argument put forth by Sarel (1996). In their TFP calculations for Asian economies, they presented a sensitivity test to show how TFP estimations differ according to the value of $\alpha$. Their findings are presented in table 5.3 below.

Table 5.3: TFP Sensitivity to $\alpha$ Values, 1961-1995

<table>
<thead>
<tr>
<th>$\alpha$</th>
<th>Indonesia</th>
<th>India</th>
<th>Malaysia</th>
<th>Singapore</th>
<th>Taiwan</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.40</td>
<td>-0.1</td>
<td>0.9</td>
<td>1.9</td>
<td>2.8</td>
<td>2.5</td>
</tr>
<tr>
<td>0.35</td>
<td>0.4</td>
<td>1.1</td>
<td>2.2</td>
<td>3.1</td>
<td>2.9</td>
</tr>
<tr>
<td>0.30</td>
<td>0.9</td>
<td>1.3</td>
<td>2.5</td>
<td>3.5</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Source: Dowling and Summers (1998), pg. 181

The results in table 5.3 show the same trend in all country TFP estimates when capital’s share of output is changed. As the value of $\alpha$ decreases, Dowling and Summers (1998) found that TFP estimates increase and vice versa. Singapore is shown to be most sensitive to changes in $\alpha$ as its TFP increased from 2.8% to 3.5% with $\alpha$ values of 0.4 and 0.3 respectively. Additional findings from Maddison (1987), show that TFP sensitivity is still subject to stages of economic growth and other external factors once changes to $\alpha$ is accounted for. Such factors include distortions in the measurement of capital and labour and the level of economic growth (Maddison 1987). As part of the TFP estimations presented in section 5.5 of this thesis, a sensitivity analysis will be carried out for the study of Australia. For the purpose of this thesis an examination of developed economy $\alpha$ values is required. The literature for estimations of $\alpha$ used for different developed countries are shown below in table 5.4.
Table 5.4: Different $\alpha$ Values for Selected Countries

Maddison (1987), pg. 659

<table>
<thead>
<tr>
<th>OECD Countries, 1973-1982</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>0.31</td>
</tr>
<tr>
<td>Germany</td>
<td>0.30</td>
</tr>
<tr>
<td>Japan</td>
<td>0.29</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.30</td>
</tr>
<tr>
<td>UK</td>
<td>0.26</td>
</tr>
<tr>
<td>US</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.29</strong></td>
</tr>
</tbody>
</table>

Englander and Gurney (1994), pg. 116

<table>
<thead>
<tr>
<th>Pre-1973 to 1990</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>0.35</td>
</tr>
<tr>
<td>Germany</td>
<td>0.33</td>
</tr>
<tr>
<td>Japan</td>
<td>0.31</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.34</td>
</tr>
<tr>
<td>UK</td>
<td>0.31</td>
</tr>
<tr>
<td>US</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.34</strong></td>
</tr>
</tbody>
</table>

Christensen et al (1980), pg. 620

<table>
<thead>
<tr>
<th>1947-1973</th>
<th>$\alpha$</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>0.40</td>
</tr>
<tr>
<td>Germany</td>
<td>0.39</td>
</tr>
<tr>
<td>Japan</td>
<td>0.39</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.45</td>
</tr>
<tr>
<td>UK</td>
<td>0.38</td>
</tr>
<tr>
<td>US</td>
<td>0.40</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td><strong>0.41</strong></td>
</tr>
</tbody>
</table>

A total of six OECD economies were chosen for comparison of their respective $\alpha$ value estimations. The $\alpha$ values display variation between author estimations across all six countries.
These findings reiterate the methodological difficulties associated with calculating TFP as previously discussed. Of the three authors presented in table 5.4, Englander and Gurney (1994) provided an estimation of Australia’s $\alpha$ value at 0.36. For the purpose of this thesis, the $\alpha$ value used in the TFP estimations will be an average of the averages presented in table 5.4. This is to determine a uniform $\alpha$ value, comparable to developed economies estimated over different time periods, and to minimise concern of methodological differences. Therefore, $\alpha = 0.35$. 
5.5 Australian TFP Estimation

The estimation of TFP requires the coefficients of $\alpha$ and $1 - \alpha$. By substituting these together with the annual percentage change in output $Y(t)$, capital $K(t)$, and labour $L(t)$, TFP growth for Australia can be estimated. In each year the capital stock is depreciated at a rate of 0.3 before being converted to an annual percentage change. Table 5.5 below shows the relevant coefficients being used in the calculations. Following table 5.5 is table 5.6 which shows the annual rate of change in each factor and TFP estimates.

Table 5.5: Model Coefficients of $\alpha$, $1 - \alpha$ and $\delta$

<table>
<thead>
<tr>
<th></th>
<th>$\alpha$</th>
<th>$1 - \alpha$</th>
<th>$\delta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>0.35</td>
<td>0.65</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Table 5.6: TFP Growth for Australia, 1965-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>$Y(t)$</th>
<th>$(K(t) \times 0.35)$</th>
<th>$(L(t) \times 0.65)$</th>
<th>$A(t)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965-66</td>
<td>2.37%</td>
<td>2.85%</td>
<td>3.05%</td>
<td>-3.53%</td>
</tr>
<tr>
<td>1966-67</td>
<td>6.30%</td>
<td>1.78%</td>
<td>1.56%</td>
<td>2.96%</td>
</tr>
<tr>
<td>1967-68</td>
<td>5.09%</td>
<td>2.57%</td>
<td>1.52%</td>
<td>1.01%</td>
</tr>
<tr>
<td>1968-69</td>
<td>7.05%</td>
<td>2.24%</td>
<td>1.58%</td>
<td>3.23%</td>
</tr>
<tr>
<td>1969-70</td>
<td>7.17%</td>
<td>1.15%</td>
<td>2.62%</td>
<td>3.40%</td>
</tr>
<tr>
<td>1970-71</td>
<td>4.01%</td>
<td>1.14%</td>
<td>1.60%</td>
<td>1.28%</td>
</tr>
<tr>
<td>1971-72</td>
<td>3.91%</td>
<td>0.98%</td>
<td>1.69%</td>
<td>1.25%</td>
</tr>
<tr>
<td>1972-73</td>
<td>2.60%</td>
<td>1.06%</td>
<td>1.52%</td>
<td>0.01%</td>
</tr>
<tr>
<td>1973-74</td>
<td>4.10%</td>
<td>1.51%</td>
<td>1.19%</td>
<td>1.40%</td>
</tr>
<tr>
<td>1974-75</td>
<td>1.34%</td>
<td>-2.24%</td>
<td>1.34%</td>
<td>2.24%</td>
</tr>
<tr>
<td>1975-76</td>
<td>2.59%</td>
<td>1.19%</td>
<td>0.75%</td>
<td>0.64%</td>
</tr>
<tr>
<td>1976-77</td>
<td>3.61%</td>
<td>1.36%</td>
<td>1.72%</td>
<td>0.53%</td>
</tr>
<tr>
<td>1977-78</td>
<td>0.90%</td>
<td>1.34%</td>
<td>0.50%</td>
<td>-0.94%</td>
</tr>
<tr>
<td>Year</td>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
<td>Value 4</td>
</tr>
<tr>
<td>--------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>1978-79</td>
<td>4.05%</td>
<td>3.42%</td>
<td>0.53%</td>
<td>0.10%</td>
</tr>
<tr>
<td>1979-80</td>
<td>3.05%</td>
<td>1.01%</td>
<td>2.21%</td>
<td>-0.17%</td>
</tr>
<tr>
<td>1980-81</td>
<td>3.36%</td>
<td>4.47%</td>
<td>0.96%</td>
<td>-2.07%</td>
</tr>
<tr>
<td>1981-82</td>
<td>3.32%</td>
<td>2.54%</td>
<td>0.64%</td>
<td>0.14%</td>
</tr>
<tr>
<td>1982-83</td>
<td>-2.23%</td>
<td>-3.32%</td>
<td>0.83%</td>
<td>0.26%</td>
</tr>
<tr>
<td>1983-84</td>
<td>4.63%</td>
<td>1.78%</td>
<td>1.33%</td>
<td>1.51%</td>
</tr>
<tr>
<td>1984-85</td>
<td>5.25%</td>
<td>3.37%</td>
<td>1.64%</td>
<td>0.25%</td>
</tr>
<tr>
<td>1985-86</td>
<td>4.10%</td>
<td>2.07%</td>
<td>2.40%</td>
<td>-0.38%</td>
</tr>
<tr>
<td>1986-87</td>
<td>2.57%</td>
<td>0.14%</td>
<td>1.54%</td>
<td>0.90%</td>
</tr>
<tr>
<td>1987-88</td>
<td>5.77%</td>
<td>2.62%</td>
<td>1.67%</td>
<td>1.48%</td>
</tr>
<tr>
<td>1988-89</td>
<td>3.88%</td>
<td>3.75%</td>
<td>2.40%</td>
<td>-2.27%</td>
</tr>
<tr>
<td>1989-90</td>
<td>3.53%</td>
<td>0.31%</td>
<td>1.66%</td>
<td>1.56%</td>
</tr>
<tr>
<td>1990-91</td>
<td>-0.38%</td>
<td>-3.30%</td>
<td>0.27%</td>
<td>2.65%</td>
</tr>
<tr>
<td>1991-92</td>
<td>0.40%</td>
<td>-1.41%</td>
<td>0.68%</td>
<td>1.13%</td>
</tr>
<tr>
<td>1992-93</td>
<td>4.06%</td>
<td>2.34%</td>
<td>0.16%</td>
<td>1.56%</td>
</tr>
<tr>
<td>1993-94</td>
<td>4.04%</td>
<td>1.99%</td>
<td>1.12%</td>
<td>0.93%</td>
</tr>
<tr>
<td>1994-95</td>
<td>3.88%</td>
<td>3.83%</td>
<td>1.91%</td>
<td>-1.86%</td>
</tr>
<tr>
<td>1995-96</td>
<td>3.95%</td>
<td>0.96%</td>
<td>1.10%</td>
<td>1.89%</td>
</tr>
<tr>
<td>1996-97</td>
<td>3.95%</td>
<td>2.32%</td>
<td>-0.08%</td>
<td>1.70%</td>
</tr>
<tr>
<td>1997-98</td>
<td>4.44%</td>
<td>3.39%</td>
<td>0.59%</td>
<td>0.46%</td>
</tr>
<tr>
<td>1998-99</td>
<td>5.01%</td>
<td>1.60%</td>
<td>0.70%</td>
<td>2.71%</td>
</tr>
<tr>
<td>1999-00</td>
<td>3.87%</td>
<td>2.80%</td>
<td>1.00%</td>
<td>0.07%</td>
</tr>
<tr>
<td>2000-01</td>
<td>1.93%</td>
<td>-2.78%</td>
<td>1.20%</td>
<td>3.52%</td>
</tr>
<tr>
<td>2001-02</td>
<td>3.86%</td>
<td>3.14%</td>
<td>1.12%</td>
<td>-0.40%</td>
</tr>
<tr>
<td>2002-03</td>
<td>3.07%</td>
<td>4.39%</td>
<td>1.17%</td>
<td>-2.49%</td>
</tr>
<tr>
<td>2003-04</td>
<td>4.15%</td>
<td>2.99%</td>
<td>0.68%</td>
<td>0.48%</td>
</tr>
<tr>
<td>2004-05</td>
<td>3.21%</td>
<td>2.21%</td>
<td>1.49%</td>
<td>-0.50%</td>
</tr>
<tr>
<td>2005-06</td>
<td>2.98%</td>
<td>3.26%</td>
<td>1.62%</td>
<td>-1.90%</td>
</tr>
<tr>
<td>2006-07</td>
<td>3.76%</td>
<td>1.77%</td>
<td>1.61%</td>
<td>0.38%</td>
</tr>
<tr>
<td>2007-08</td>
<td>3.71%</td>
<td>3.34%</td>
<td>1.80%</td>
<td>-1.43%</td>
</tr>
<tr>
<td>2008-09</td>
<td>1.82%</td>
<td>0.73%</td>
<td>1.60%</td>
<td>-0.51%</td>
</tr>
</tbody>
</table>
Over the study period, the results show that output, capital, and labour have seen positive annual percentage changes the majority of the time. Output experienced only two periods of negative change which occurred in 1982-83 and 1990-91. During these times the economy experienced recessions as discussed in chapter 4. Comparatively, capital experienced a total of seven negative change periods, where labour had only one in 1996-97. The story of the annual percentage change in TFP is seen to be volatile. TFP’s percentage change fluctuated between a low point of -3.53% in 1965-66 and a peak of 3.52% in 2000-01. Overall, from 1965 to 2015, Australia’s TFP averaged an annual rate of 0.55%.

Table 5.7: Decade Average TFP Estimations, 1965-2015

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( A(t) )</td>
<td>1.32%</td>
<td>0.02%</td>
<td>0.57%</td>
<td>0.74%</td>
<td>0.10%</td>
<td>0.55%</td>
</tr>
</tbody>
</table>

Table 5.7 displays decade average TFP estimations. It is seen that in the first decade of the study period TFP was most prominent in contributing to economic growth at 1.32%. The decade following 1975, TFP decreased considerably to 0.02%. What is made apparent in table 5.7 is since
the mid-1980’s, decade average TFP has struggled to rise above 1% – with fluctuations between 0% and 1%. TFP’s dismal trend in the 2000’s is shown in figure 5.1.

Figure 5.1: Australia’s TFP Growth Trend, 1965-2015

Australia’s TFP from 1965 to 2015 depicts an overall decreasing trend (see figure 5.1). However, further analysis of the trend in figure 5.1 shows three distinct periods. Firstly, from 1965 to 1980 TFP was decreasing considerably from 2.96% in 1966-67 to -2.07% in 1980-81. Second, between 1980-81 and 2000-01 TFP shows a moderately increasing trend – whilst subject to significant volatility – from -2.07% to 3.52% respectively. Lastly, since 2000 TFP was predominantly negative, barring a sharp recovery in more recent times. From 2001-02 to 2011-12, TFP was negative in nine out of the twelve years averaging -0.67% over the period. Yet, across the total study period, TFP growth contributed to output an average of 2.80% per year. Comparatively, capital and labour were responsible for an average of 57.69% and 39.52% of Australia’s economic growth per year respectively. These findings suggest that from 1965 to 2015, the Australian economy was mostly driven by the output of capital and labour rather than TFP.
The following section 5.5.1 will conduct a sensitivity test of capital’s parameter, $\alpha$, to assess the impact different values have on Australia’s TFP.

5.5.1 TFP Sensitivity Test

This section will undertake TFP sensitivity tests on the results found in section 5.5. As previously discussed, the model for estimating TFP is dependent upon a predetermined capital share of output, or $\alpha$ value. The literature presented in section 5.4 (see Sarel 1996; Dowling and Summers 1998; Maddison 1987) shows that TFP holds an inverse relationship with $\alpha$. The following discussion will seek to test these findings and the degree of TFP sensitivity toward $\alpha$ Australia holds from 1965-2015.

Figure 5.2: Australia’s TFP Growth Trends at Different $\alpha$ Values, 1965-2015
Figure 5.2 shows the different trends in Australia’s TFP from 1965-2015 as the value of \( \alpha \) changes. The solid black line depicts TFP with the value of \( \alpha \) chosen for this study, 0.35. All other dotted lines depict a different capital share of output. What is shown is the same underlying trend in TFP. However, differences are apparent in the size and degree of the peaks and troughs throughout the period. For the majority of the study period, the lower \( \alpha \) values of 0.3 and 0.25 display higher TFP values than that of the chosen \( \alpha \) value of 0.35. Comparatively, when \( \alpha \) is higher at 0.4, TFP is lower – predominantly in the troughs. It must be noted that there are instances where TFP experiences higher peaks when \( \alpha = 0.4 \) and also lower peaks when \( \alpha = 0.3 \) and 0.25. Yet, across the time series to an extent, the expected trend of higher TFP at lower \( \alpha \) values have occurred.

Table 5.8: Australia’s TFP at Different \( \alpha \) Values, 1965-2015

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0.25</td>
<td>1.43%</td>
<td>0.34%</td>
<td>0.71%</td>
<td>1.21%</td>
<td>0.32%</td>
<td>0.80%</td>
</tr>
<tr>
<td>0.30</td>
<td>1.37%</td>
<td>0.18%</td>
<td>0.64%</td>
<td>0.98%</td>
<td>0.21%</td>
<td>0.68%</td>
</tr>
<tr>
<td><strong>0.35</strong></td>
<td><strong>1.32%</strong></td>
<td><strong>0.02%</strong></td>
<td><strong>0.57%</strong></td>
<td><strong>0.74%</strong></td>
<td><strong>0.10%</strong></td>
<td><strong>0.55%</strong></td>
</tr>
<tr>
<td>0.40</td>
<td>1.27%</td>
<td>-0.13%</td>
<td>0.50%</td>
<td>0.51%</td>
<td>-0.01%</td>
<td>0.43%</td>
</tr>
</tbody>
</table>

Table 5.8 shows a different look at Australia’s TFP sensitivity to \( \alpha \) through decade average TFP. Here, it is shown that in all decades from 1965 to 2015, as capital’s share of output decreased TFP increased. These findings support the works of Maddison (1987), Sarel (1996), and Dowling and Summers (1998).
5.5.2 Sectoral TFP Estimation

Using the same methodology as the previous section (equation 5.4), primary, secondary, and tertiary economic sector TFP will be estimated. In doing so, an insight into where the main regions of productivity have occurred in the Australian economy will be provided. The following discussion of such will be related back to national TFP shown in figure 5.1 to compare any similar trends in values and volatility. Due to data restrictions of sectoral GDP, TFP calculations will be for the period 1975 to 2015.

Figure 5.3: Primary Sector TFP Growth Trend, 1975-2015

Of the three economic sectors, the primary sector is seen to have experienced the greatest degree of volatility in the scale of change in TFP. As such, the sector also recorded both the highest peak and trough of TFP at 25.1% and -18.2% respectively. These are seen to have occurred in
1983-84 and 2011-12 (see figure 5.3). The declining trend across the period can be seen by the dotted trend line in figure 5.3. Within the trend shown appears to be three distinct phases. The first is the decreasing trend from 1975-76 to 1980-81 from 6.7% to -13.7% respectively. Secondly, is the extremely acute rise in TFP from 1980-81 to 1983-84 from -13.7% to 25.1% respectively. And lastly, since 1983-84 TFP has overall been declining with the exception of a sharp recovery post-2011. These results suggest that the primary sector in the Australian economy is the most susceptible to large gains and losses in production from advancements in technology. In comparison to figure 5.1, the primary sector displays the least amount of similarities. Most of the difference observed is in the scale of change which is depicted on the vertical axis.

Figure 5.4: Secondary Sector TFP Growth Trend, 1975-2015

Figure 5.4 shows the growth trend in TFP for the secondary sector. Whilst the primary sector is shown to have the greatest scale of change in its TFP values, manufacturing is seen the
be the most volatile in the frequency of annual change. This is shown by the constantly fluctuating TFP between positive and negative values. Overall, there is an increasing trend in manufacturing productivity across the forty-year period as depicted by the dotted line. This coincides with what the literature suggested in chapter 4 (see Bloch 2010). This was that technological change in manufacturing has been biased towards labour-saving capital which has improved productivity and reduced per unit labour costs.

A period of interest appears to be in the second half of the trend post-1995. Here, between 1995-96 to 2002-03, was the most volatile period in manufacturing’s TFP which included a trough of -8.17% in 1999-00. Moving into the 2000’s, TFP is shown to have been predominantly negative for the first half of the decade before a spike around the GFC. Post-GFC, TFP has remained positive in all but two years displaying the least amount of volatility across the period. Whilst the scale of change is smaller than the primary sector, comparisons to figure 5.1 still show scale discrepancies. In terms of the trends in TFP, there are similar periods of fluctuation from 1988-89 onwards. These fluctuations, however, are of course to a lesser extent in the aggregate trend of figure 5.1.
The first observation that can be made from tertiary sector TFP growth (see figure 5.5) is the scale of change on the vertical axis. Of the three sectors, services are shown to have the most comparable scale changes in productivity to that in figure 5.1. Furthermore, in relation to figure 5.1, the same can be said for the growth trend in TFP of the tertiary sector. Comparisons show a considerably similar trend between national and tertiary TFP since 1975. As the discussion in chapter 4 highlighted, this suggests that the tertiary sector has been the dominant driving force of economic growth in Australia over the study period. What is striking, however, is how the overall trend in tertiary productivity has remained relatively stagnant across the period. This is shown by the horizontal dotted line in figure 5.5.
Table 5.9: Decade Average Sector TFP Estimations, 1975-2015

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary</td>
<td>1.13%</td>
<td>0.28%</td>
<td>2.17%</td>
<td>-0.76%</td>
<td>1.56%</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.85%</td>
<td>-0.50%</td>
<td>0.08%</td>
<td>1.75%</td>
<td>0.54%</td>
</tr>
<tr>
<td>Tertiary</td>
<td>-0.15%</td>
<td>1.21%</td>
<td>0.13%</td>
<td>0.33%</td>
<td>0.38%</td>
</tr>
</tbody>
</table>

Table 5.9 shows the decade average TFP estimations of each sector from 1975 to 2015. Across the forty-year period, it is shown that the primary sector has had, on average, the highest TFP growth rates of the three sectors. This is not surprising given the scale of the positive TFP growth values shown in figure 5.3 offsetting the negative ones. The secondary sector exhibits the second highest average TFP and the tertiary sector in third at 0.54% and 0.38% respectively. The lower average TFP from services was expected as the discussion in chapter 4 highlighted the sector as having slower productivity growth than manufacturing. Overall, the sectoral analysis of TFP growth has portrayed services as having the closest relation to national trends in productivity.
5.6 TFP and The Real Business Cycle

One of the developments in economic growth theory TFP has generated is the Real Business Cycle (RBC) theory. RBC theory seeks to provide technological shocks as the explanation of fluctuations in GDP growth. This differs from classical business cycle theory where, in the Walrasian sense, prices simultaneously adjust in every market to equate demand and supply via the invisible hand (Mankiw 1989). Therefore, aggregate output fluctuations are a result of various influences such as aggregate demand, supply-side shocks, and credit cycles. The RBC originates from the works of Kydland and Prescott (1982) who aimed at explaining output cycles with other aggregate economic indicators. Their results indicated that quantitative co-movements and serial correlation to output were best described by the preference-technology environment. Therefore, according to Prescott (1986), determining the average rate at which technology advances should be the devotion of focus in understanding fluctuations in output. Findings from Kydland and Prescott (1982) and Prescott (1986), were expanded on by Mankiw (1989), as shown in figure 5.6 below.
Mankiw’s (1989) time series of TFP growth and output growth for the US economy from 1948 to 1985 shows a strong trend between the two variables (see figure 5.6). As TFP growth experienced sharp rises and falls year to year, GDP growth largely reflects the same behaviour. The following section will look to examine the relationship between TFP and GDP growth for Australia from 1965 to 2015, to assess whether the trends experienced are consistent with RBC theory.
5.6.1 Australia and the Real Business Cycle

Figure 5.7: TFP and GDP Growth for Australia, 1965-2015

Figure 5.7 shows Australia’s TFP growth – where $\alpha = 0.35$ – and GDP growth for the period 1965 to 2015. It is evident that, to an extent, some of the trend in TFP is reflected in that of GDP. Unlike Mankiw’s (1989) findings, figure 5.7 does not depict such close behaviour between TFP and GDP. However, what is noticeable is the overall underlying trends are much the same. The caveat here is in certain periods the volatility of each variable differs. Such behaviour is apparent from 1972 to 1985 and 1992 to 2001. Whereas, periods which display the most prominent relationship include 1967 to 1975, 1988 to 1996 and 2000 to 2009.

What is noticeable in Australia’s case is the frequency that TFP negatively contributes to GDP growth. This occurred in every decade of the study with the 2000’s displaying the worst
period of negative occurrences. Such findings suggest that the composition of GDP growth in some decades would have been more driven by capital and labour than TFP. Periods where this is evident include the 1970’s, 1980’s, and 2000’s. Conversely, the late 1960’s and 90’s exhibit strong positive TFP which would have driven growth to a higher extent. The findings from The Treasury (2001), Parham (1999), and Parham (2003) discussed in chapter 4 support this finding.

Given the examination from the visual time series in figure 5.7, Australia from 1965 to 2015 is seen to hold a relationship between TFP and GDP growth that is consistent with RBC theory. The degree of the relationship is, however, not as strong as the trend shown by Mankiw (1989) in figure 5.6. The next section aims to take the analysis deeper by decomposing Australia’s GDP growth to determine its main driving factors in each decade.
5.7 Decomposition of Australia’s Economic Growth

In order to paint a clearer picture of TFP’s influence on economic growth in Australia, GDP needs to be decomposed into the three contributing factors of capital, labour, and TFP. Through doing so, this section aims to provide evidence on whether TFP has been an important growth driver for the Australian economy over the study period. As discussed in chapter 4, the economic history of Australia from 1965 to 2015 has experienced vast structural change, recessions, and more recently, prolonged periods of positive growth. By breaking down the composition of growth, it can be determined what factor, or combination of factors, has proved to be most prominent in different time periods.

Table 5.10: Factor Contribution to Economic Growth in Australia, 1965-2015

<table>
<thead>
<tr>
<th>Year</th>
<th>$\hat{Y}(t)$</th>
<th>$K(t)$</th>
<th>$L(t)$</th>
<th>$A(t)$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965-66</td>
<td>2.37%</td>
<td>120.31%</td>
<td>128.81%</td>
<td>-149.12%</td>
<td>100%</td>
</tr>
<tr>
<td>1966-67</td>
<td>6.30%</td>
<td>28.33%</td>
<td>24.70%</td>
<td>46.98%</td>
<td>100%</td>
</tr>
<tr>
<td>1967-68</td>
<td>5.09%</td>
<td>50.51%</td>
<td>29.75%</td>
<td>19.74%</td>
<td>100%</td>
</tr>
<tr>
<td>1968-69</td>
<td>7.05%</td>
<td>31.76%</td>
<td>22.45%</td>
<td>45.79%</td>
<td>100%</td>
</tr>
<tr>
<td>1969-70</td>
<td>7.17%</td>
<td>16.02%</td>
<td>36.52%</td>
<td>47.45%</td>
<td>100%</td>
</tr>
<tr>
<td>1970-71</td>
<td>4.01%</td>
<td>28.32%</td>
<td>39.87%</td>
<td>31.81%</td>
<td>100%</td>
</tr>
<tr>
<td>1971-72</td>
<td>3.91%</td>
<td>24.93%</td>
<td>43.12%</td>
<td>31.95%</td>
<td>100%</td>
</tr>
<tr>
<td>1972-73</td>
<td>2.60%</td>
<td>40.91%</td>
<td>58.60%</td>
<td>0.49%</td>
<td>100%</td>
</tr>
<tr>
<td>1973-74</td>
<td>4.10%</td>
<td>36.90%</td>
<td>28.94%</td>
<td>34.16%</td>
<td>100%</td>
</tr>
<tr>
<td>1974-75</td>
<td>1.34%</td>
<td>-167.46%</td>
<td>100.12%</td>
<td>167.33%</td>
<td>100%</td>
</tr>
<tr>
<td>1975-76</td>
<td>2.59%</td>
<td>46.10%</td>
<td>29.04%</td>
<td>24.86%</td>
<td>100%</td>
</tr>
<tr>
<td>1976-77</td>
<td>3.61%</td>
<td>37.62%</td>
<td>47.79%</td>
<td>14.59%</td>
<td>100%</td>
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<tr>
<td>1977-78</td>
<td>0.90%</td>
<td>148.88%</td>
<td>55.88%</td>
<td>-104.76%</td>
<td>100%</td>
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<td>1978-79</td>
<td>4.05%</td>
<td>84.40%</td>
<td>13.10%</td>
<td>2.51%</td>
<td>100%</td>
</tr>
<tr>
<td>1979-80</td>
<td>3.05%</td>
<td>32.97%</td>
<td>72.56%</td>
<td>-5.53%</td>
<td>100%</td>
</tr>
<tr>
<td>Year</td>
<td>First Value</td>
<td>Second Value</td>
<td>Third Value</td>
<td>Fourth Value</td>
<td>Total</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
<td>--------------</td>
<td>-------------</td>
<td>--------------</td>
<td>-------</td>
</tr>
<tr>
<td>1980-81</td>
<td>3.36%</td>
<td>133.16%</td>
<td>28.53%</td>
<td>-61.69%</td>
<td>100%</td>
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<tr>
<td>1981-82</td>
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<td>76.61%</td>
<td>19.18%</td>
<td>4.20%</td>
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<tr>
<td>1982-83</td>
<td>-2.23%</td>
<td>148.78%</td>
<td>-37.15%</td>
<td>-11.64%</td>
<td>100%</td>
</tr>
<tr>
<td>1983-84</td>
<td>4.63%</td>
<td>38.52%</td>
<td>28.83%</td>
<td>32.64%</td>
<td>100%</td>
</tr>
<tr>
<td>1984-85</td>
<td>5.25%</td>
<td>64.11%</td>
<td>31.21%</td>
<td>4.68%</td>
<td>100%</td>
</tr>
<tr>
<td>1985-86</td>
<td>4.10%</td>
<td>50.58%</td>
<td>58.57%</td>
<td>-9.16%</td>
<td>100%</td>
</tr>
<tr>
<td>1986-7</td>
<td>2.57%</td>
<td>5.32%</td>
<td>59.86%</td>
<td>34.82%</td>
<td>100%</td>
</tr>
<tr>
<td>1987-88</td>
<td>5.77%</td>
<td>45.44%</td>
<td>28.95%</td>
<td>25.61%</td>
<td>100%</td>
</tr>
<tr>
<td>1988-89</td>
<td>3.88%</td>
<td>96.64%</td>
<td>61.92%</td>
<td>-58.56%</td>
<td>100%</td>
</tr>
<tr>
<td>1989-90</td>
<td>3.53%</td>
<td>8.86%</td>
<td>47.01%</td>
<td>44.13%</td>
<td>100%</td>
</tr>
<tr>
<td>1990-91</td>
<td>-0.38%</td>
<td>869.67%</td>
<td>-72.38%</td>
<td>-697.29%</td>
<td>100%</td>
</tr>
<tr>
<td>1991-92</td>
<td>0.40%</td>
<td>-353.87%</td>
<td>169.71%</td>
<td>284.17%</td>
<td>100%</td>
</tr>
<tr>
<td>1992-93</td>
<td>4.06%</td>
<td>57.66%</td>
<td>3.97%</td>
<td>38.37%</td>
<td>100%</td>
</tr>
<tr>
<td>1993-94</td>
<td>4.04%</td>
<td>49.36%</td>
<td>27.72%</td>
<td>22.92%</td>
<td>100%</td>
</tr>
<tr>
<td>1994-95</td>
<td>3.88%</td>
<td>98.68%</td>
<td>49.32%</td>
<td>-48.00%</td>
<td>100%</td>
</tr>
<tr>
<td>1995-96</td>
<td>3.95%</td>
<td>24.40%</td>
<td>27.84%</td>
<td>47.76%</td>
<td>100%</td>
</tr>
<tr>
<td>1996-97</td>
<td>3.95%</td>
<td>58.86%</td>
<td>-1.94%</td>
<td>43.08%</td>
<td>100%</td>
</tr>
<tr>
<td>1997-98</td>
<td>4.44%</td>
<td>76.33%</td>
<td>13.21%</td>
<td>10.46%</td>
<td>100%</td>
</tr>
<tr>
<td>1998-99</td>
<td>5.01%</td>
<td>31.87%</td>
<td>14.00%</td>
<td>54.13%</td>
<td>100%</td>
</tr>
<tr>
<td>1999-00</td>
<td>3.87%</td>
<td>72.34%</td>
<td>25.89%</td>
<td>1.77%</td>
<td>100%</td>
</tr>
<tr>
<td>2000-01</td>
<td>1.93%</td>
<td>-144.18%</td>
<td>61.94%</td>
<td>182.24%</td>
<td>100%</td>
</tr>
<tr>
<td>2001-02</td>
<td>3.86%</td>
<td>81.38%</td>
<td>28.93%</td>
<td>-10.31%</td>
<td>100%</td>
</tr>
<tr>
<td>2002-03</td>
<td>3.07%</td>
<td>143.11%</td>
<td>38.03%</td>
<td>-81.14%</td>
<td>100%</td>
</tr>
<tr>
<td>2003-04</td>
<td>4.15%</td>
<td>71.96%</td>
<td>16.40%</td>
<td>11.65%</td>
<td>100%</td>
</tr>
<tr>
<td>2004-05</td>
<td>3.21%</td>
<td>68.86%</td>
<td>46.59%</td>
<td>-15.45%</td>
<td>100%</td>
</tr>
<tr>
<td>2005-06</td>
<td>2.98%</td>
<td>109.32%</td>
<td>54.40%</td>
<td>-63.72%</td>
<td>100%</td>
</tr>
<tr>
<td>2006-07</td>
<td>3.76%</td>
<td>47.07%</td>
<td>42.79%</td>
<td>10.13%</td>
<td>100%</td>
</tr>
<tr>
<td>2007-08</td>
<td>3.71%</td>
<td>89.99%</td>
<td>48.62%</td>
<td>-38.61%</td>
<td>100%</td>
</tr>
<tr>
<td>2008-09</td>
<td>1.82%</td>
<td>40.32%</td>
<td>87.94%</td>
<td>-28.26%</td>
<td>100%</td>
</tr>
<tr>
<td>2009-10</td>
<td>2.02%</td>
<td>36.49%</td>
<td>49.92%</td>
<td>13.60%</td>
<td>100%</td>
</tr>
<tr>
<td>2010-11</td>
<td>2.38%</td>
<td>55.62%</td>
<td>52.94%</td>
<td>-8.55%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Table 5.10 deconstructs the proportion of the rate of change in output $\dot{Y}(t)$ that is attributable to each growth factor of capital $K(t)$, labour $L(t)$, and TFP $A(t)$. The contribution values of capital, labour, and TFP shown in table 5.10 have been equated by dividing each of the annual percentage change of each factor (see table 5.6) by the corresponding annual percentage change in GDP. As previously mentioned, on average across the study period, capital has been the largest contributor to growth in Australia at 57.69% – followed by labour and TFP at 39.52% and 2.80% respectively. However, a deeper look into each decade tells a different story. Figure 5.8 below graphically represents table 5.10.
In the first year of the study, TFP had a substantial negative impact on GDP at -149.12%. As such, capital and labour offset this effect by both contributing output amounts larger than the annual percentage change in GDP – yielding a positive output growth of 2.37%. Proceeding this event, in the late 1960’s growth in three out of the five years to 1970 was predominantly driven by TFP. Whereas, capital and labour were prominent in one year each. These results shifted into the 1970’s and 1980’s.

For the twenty-year period from 1970 to 1990, capital was the main output driver in the economy. During this period capital was dominant in eleven out of the twenty years, contributing an average of 49.08% of output per year. Labour also contributed strongly as in eight of the twenty years it was most prominent to output contribution at an average of 40.80%. Such dominance of
capital and labour leaves a dismal story for TFP. In six of the twenty years in this period, TFP held negative contribution values. An outlier to this fact is in 1974-75 where 167.33% of growth was attributable to TFP whilst capital offset this by an almost equal negative amount (see table 5.10).

Moving into the 1990’s saw the trend in TFP improve. During the recession of 1990 to 1992, capital and TFP switched roles as the dominant growth driver. Over the decade until 2000, TFP managed positive contributions to growth in all but two years. This growth pattern differs to previous decades as it appears to be more distributed between each growth factor. The generally ‘balanced’ growth is what generated the prosperity in the late 1990’s. A noteworthy development leaving the decade is that even though strong positive growth continued in the 2000’s, the driver of the growth once again switched hands.

Australia’s growth composition in the 2000’s mirrors that of the 1980’s. After a strong turnaround of TFP in the 1990’s the positive trend came to an end in the new millennia. Now, capital was once again the dominant output driver in the economy. From 2000 to 2010 capital was the main driver of growth in seven of the ten years at an average of 54.43%. Conversely, TFP negatively impacted growth in six of the ten years. Labour is seen to have been a consistently positive contributor to growth averaging 47.56% over this period. These findings suggest that the Australian economy during this time was primarily driven by factor accumulation rather than productivity gains. This may be a result of the mining boom that took place which required a significant amount of capital investment due to the industry’s high capital intensity. Evidence of mass capital accumulation is clear in chapter 4, section 4.2.2. In more recent periods since 2010, TFP has experienced a large recovery. Since 2011-12, TFP has increased from -29.85% to 108.05% in 2014-15.
Overall from 1965 to 2015, it is shown that economic growth in each decade has been predominantly driven by different factors. Yet, proven to be most influential across the study period was capital’s contribution to output. However, what’s discovered to be equally important is labour’s consistently positive values. Whilst TFP has experienced the most volatility, capital’s contribution has also seen a degree of fluctuation. This is shown with extremely low values such as 1974-75 and extremely high values such as 1990-91. Output growth was only primarily driven by TFP in ten out of the fifty years. As such, the results depict capital and labour as the primary proponents of growth in the Australian economy. This is suggested by the two factors holding twenty-seven and thirteen years of dominant output contribution respectively.

**Figure 5.9: Decade Average Growth Decomposition, 1965-2015**

Figure 5.9 above shows figure 5.8 in a decade average format. It shows that capital and TFP have fluctuated the most of the three growth factors, whereas labour is seen to be the least
volatile. In the first decade of the study it is shown that, on average, all three growth factors contributed positively to output growth. This is also the only decade where TFP averaged a higher output contribution than that of capital. The decades following 1975, however, show an overall declining trend in TFP as discovered in figure 5.1. The same story occurs for labour as its overall contribution to growth since the 1960’s has declined. Conversely, capital is shown to have remained relatively steady in its output proportion of GDP. From 1965 to 2005 capital’s contribution to output increased before returning to levels similar to that of 1965 to 1975 in the last decade of the study. Overall, figure 5.9 reiterates that from 1965 to 2015 the Australian economy was, on average, predominantly driven by capital and labour output. With national growth decomposed, the same analysis for each of the three primary, secondary, and tertiary economic sectors will now be performed.

5.7.1 Decomposition of Sectoral Economic Growth

The following discussion seeks to decompose sectoral economic growth in the same fashion as in section 5.7. In doing so, an insight into what growth factors drive output within each sector will be provided. Here, inter-sectoral comparisons can be made in relation to what factors of production are seen to have the most influence on output growth. Much like section 5.5.2, the decomposition of sectoral growth is restricted to the period 1975 to 2015 as a result of data constraints.
A decomposition of primary sector growth in figure 5.10 depicts two main themes. The first is that labour is seen to play a minimal role in output as it is driven mostly by capital and TFP. Secondly, across the period, both capital and TFP values have been predominantly positive. This has resulted in a positive growth trend in output for the majority of the period since 1975 (exhibited by the dotted line). These findings suggest that primary sector output growth is relatively dependent on the amount of capital and technological progress employed in the production process. As such, comparisons to the national growth decomposition in figure 5.8 are minimal when focusing on the extensive role TFP plays in primary sector output.
The secondary sector is shown to display much of the same growth decomposition characteristics as the primary sector (see figure 5.11). In this case, whilst labour is slightly more productive than the primary sector, capital and TFP are still shown the be the dominant drivers of manufacturing output. Comparisons between the primary and secondary sector show TFP as having the same ratio of negative-to-positive values. However, a caveat in the similarities lies in the labour component where it has been negative in four more periods in manufacturing. In terms of the national growth trend, little similarity can be seen. The three commonalities between the two are negative capital output during the 1982 and 1992 recessions and also at the turn of the millennia.
Figure 5.12 displays tertiary sector growth decomposition. Initial observations show that compared to that of the primary and secondary sector’s, labour has positively contributed to a larger proportion of services output. Labour is also shown to be the most consistently positive with only three periods of negative values. What this has meant for the tertiary sector is the most balanced growth path of the three. This is apparent in the relatively equal contribution to output each growth factor makes across the period. Comparisons to national growth decomposition in figure 5.8 depicts a close match in both the composition of growth in a given period and the underlying trend in output. These results give further evidence to the claim of the tertiary sector’s dominance in driving economic growth over the study period.
5.8 Conclusion

The objective of this chapter was to conduct TFP estimates for Australia from 1965 to 2015. Using ATO figures an appropriate depreciation of capital was determined to be 0.3. After such, the literature in determining capital’s share of output, \( \alpha \), discovered that developed economies such as Australia generally hold lower \( \alpha \) values. After taking an average of developed economies \( \alpha \) values, it was determined that 0.35 would be used.

TFP estimations were then conducted for the national economy. High volatility from year to year was discovered which resulted in an overall declining trend. A sensitivity test using different \( \alpha \) values then showed small alterations of TFP values in Australia’s case. Next, considerable differences between sectoral TFP in terms of the scale and frequency of annual change was found. Here, the tertiary sector held the closest comparison to the national trend. Following this, a comparison of GDP and TFP using the RBC theory revealed Australia as having a similar underlying trend between these factors. However, they were not as strongly correlated as Mankiw’s (1989) work depicted. Lastly, national and sectoral economic growth was decomposed. On average, it was found that national growth has been primarily driven by capital output, with labour a close second. Here, TFP was shown to be strongest in the late 1960’s and 1990’s. On a sectoral level, services were found to be the most prominent growth driver of the national economy.
Chapter 6: Thesis Review and Conclusion

6.1 Introduction and Review

The primary objective of this section is to review the discussion and findings of each chapter presented earlier in the dissertation. In doing so, it will provide the foundations of an appropriate conclusion of the study in section 6.2 of this chapter.

The aim of chapter 2 was to review the Solow (1956) – Swan (1956) growth model to provide the theoretical framework for dissecting Australia’s economic growth. The central proposition of such is that positive and long-run growth of per capita output rested on technological progress. Solow (1956) and Swan (1956) demonstrate that progressing along the productivity curve is achieved through increasing the capital-to-labour ratio of workers. However, it was discovered that when the steady-state is reached, growth rates of capital and labour remain constant. Accordingly, without technological progress aggregate output growth would cease as a result of diminishing returns to factor inputs.

Chapter 3’s objective was to provide a brief literature review of other TFP studies. The rationale for doing so was to add depth to the significance, meaning, and interpretation of the Solow (1956; 1957) residual. It was discovered that prolonged growth is not necessarily driven by technological change. Whilst looking into the relationship between TFP and macroeconomic variables of output, employment, and R&D revealed positive correlations on all fronts. However, clarity issues of the measure have been pointed out. It was found that by including a human capital
element in TFP estimations, changes in the efficiency of labour rather than technology itself can be accounted for. Lastly, questions of accuracy are found to be primarily influenced by the methodology used and the quality of the input data.

Chapter 4 aimed to provide a brief historical overview of the macroeconomic data for conducting TFP estimates covering the period 1965 to 2015. A focus of such was the various policy, political, and structural change each decade was presented with. By doing so at a national and sectoral level, the objective was to mould an understanding of the events that have shaped the growth path of the Australian economy. In terms of output, it was discovered that GDP has endured a volatile growth rate to depict a linear growth trend. Whilst the 1960’s were prosperous, a turbulent 70’s and 80’s was what followed. This built the momentum for deregulation and reform which paved the way for growth in proceeding decades. Capital’s story was one of exponential proportions, primarily driven by the private sector. Here, national savings have significantly recovered in recent times which was ignited around the GFC of 2008. With regards to labour, consistently positive growth has taken place. Within the labour market, vast structural change has occurred in the form of declining unionism, the rise in part-time employment, and diverting male and female labour force participation trends. From a sectoral perspective the primary and secondary sectors remain vital in output, capital, and labour growth. However, the tertiary sector was found to dominate all facets of each variable throughout the study period. Accordingly, Australia is seen to have made a shift away from the production of goods toward a services-based economy.

The aim of chapter 5 was to conduct TFP estimates for the period 1965 to 2015. With an appropriate depreciation rate determined 0.3, capital’s share in output, \( \alpha \), was then taken as an average of the averages found for developed economies, 0.35. TFP estimations were then
conducted for the national economy. As a result of high annual volatility, an overall declining trend was discovered with an average of 0.55% a year. Small sensitivities in TFP from changes to $\alpha$ were then shown. Next, considerable differences between sectoral TFP in terms of the scale and frequency of annual change was found. Here, the tertiary sector held the closest comparison to the national trend. Yet, proving an anomaly amongst the three was manufacturing. The secondary sector displayed the only overall increase in productivity over the last half-century. A comparison of GDP and TFP using the RBC theory then revealed a similar underlying trend. However, the correlation was weaker than what Mankiw’s (1989) work depicted. Lastly, national and sectoral economic growth was decomposed. Across the period, it was found that capital (57.69%) and labour (39.52%) have primarily driven national growth, whilst TFP was shown to be strongest in the late 1960’s and 1990’s. On a sectoral level, services were found to be the most prominent growth driver of the national economy.
6.2 Conclusion

The objective of this dissertation was to provide empirical work pertaining to what has driven Australia’s prosperity over the last half-century. The rationale for doing so was to determine the growth path of the economy from 1965 to 2015 and assess whether it has been driven by factor accumulation or productivity gains. As put forth in chapter 1, the primary questions this thesis seeks to answer were the following i) What have been the main drivers of growth in the Australian economy i.e. TFP or factor accumulation? ii) What patterns, if any, exist in terms of the economy’s growth composition? iii) What are the contributions of each economic sector toward the growth path of the economy? iv) Given the findings of the status quo, what is the importance of productivity in sustaining growth moving forward?

The decomposition of growth portrayed technological progress as, on average, a relatively small component of the growth course. Yet, taking only the average does not tell the whole story. Over the fifty-year span, it has been the combination of capital accumulation and labour output that has driven Australia’s growth path. However, the role TFP has played can be viewed as key in that it has proven to sustain growth moving into future periods. What is apparent, are two main phases of growth – a transition from TFP sustained growth, to factor led output. The pattern observed is as follows,

i) High TFP during the 1960’s to mid-70’s sustained the positive growth of this period. Yet, from the mid-70’s to early 90’s, TFP fell fluctuating between negative and marginally positive values. As such, economic growth during this time was more volatile and reliant upon the output of capital and labour.

ii) The market reforms and deregulation of the 1980’s propelled the productivity surge of the late-90’s. As such, GDP growth coincided with this trend. Productivity then
sustained growth into the 2000’s, where TFP values have been predominantly negative since. Hence, the economy has transitioned to relying on capital and labour output once again.

From a sectoral perspective, disaggregating the economy displayed different individual trends and patterns of growth. But, in conclusion of determining the backbone sector of the Australian economy, the answer is clear cut – services. The role policy and structural change have played in these events also appear to be of significance. This is the case as Australia, during the period of study, undertook vast changes in structural reforms and policies aimed at decentralisation. The discussion of such in chapter 4, coupled with the results discovered in chapter 5, suggest that these changes have formed the bedrock of what has promoted the prosperity of the economy for the last quarter of a century. However, the benefits provided from the reforms may have been exhausted. If the two phases of economic growth witnessed depict a longer term trend than the one in this study, Australia may be in need of generating a period of higher productivity in the coming years. Failing to do so will see economic growth begin to halt due to diminishing returns of production as stipulated by Solow (1956; 1957) and Swan (1956). If this is the case as the evidence suggests, Australia may benefit from lessons of the past and change policy momentum directed at further market liberalisation.
References


