Alternative Measures of Labour Underutilisation: Gender, education and unemployment

by

Kevin J. Fox* and Carmit M. Schwartz

The University of New South Wales

December 2006

Abstract

Labour underutilisation is typically measured by dividing the number of employed workers by the total labour force. This yields the "unemployment rate," which is commonly used for modelling, policy and public debate purposes. Clearly this measure ignores the fact that workers are heterogeneous, and hence is likely to overstate the degree to which a society's productive labour resources are underutilised; highly skilled workers are less likely to be unemployed, and these workers are generally more productive. This paper uses census data for the period 1981 to 2001 for Australia to calculate alternative measures of labour underutilisation. Results are reported for males, females and all persons. Deviations from the conventional measure can be substantial.

Key words: Labour underutilisation, exact index numbers, unemployment rate, education, gender

JEL classification: C43, E24, J31

---

* The authors gratefully acknowledge financial assistance from the Australian Research Council, and helpful comments from participants at the Economic Measurement Group Workshop '06, UNSW.

Contact Author:

Kevin J. Fox
School of Economics & CAER
The University of New South Wales
Sydney 2052
Australia

E-mail: K.Fox@unsw.edu.au
Tel: +61-2-9385-3320
Fax: +61-2-9313-6337

1 Introduction

The extent to which the available labour supply is underutilised is an important economic issue. It reflects the performance of an economy and as such is of interest to policy makers, academics and the community in general. Because of its importance it is necessary to measure it accurately. The conventional unemployment rate (the number of unemployed workers divided by the labour force) is widely used as a key indicator to the degree of labour underutilisation. Although this measure serves as a good indicator to the social and political cost of unemployment, many criticisms have been raised with respect to its ability to accurately measure the level of labour underutilisation. These problems have not gone unnoticed by leading statistical agencies. For example, acknowledging some of the limitations of the conventional measure, the Australian Bureau of Statistics (ABS) has produced a series of additional measures to better reflect the extent of labour underutilisation; see e.g. '2006 Year Book Australia'. Generally speaking, these measures use broader definitions of unemployment and include in their calculations people such as discouraged job seekers.[1]

A problematic aspect of the conventional measure, and the measures based on broader definitions, is that they are all based on the assumption that workers are homogeneous and they do not take into account the fact that the productive capacity of the labour force depends both on the number of available workers and their characteristics (skills). Greenwood and Kohli (2003, p. 218) note the following concerning this type of aggregation:

> There are few examples in economics in which aggregation is routinely carried out in so crude a fashion. To draw a blunt analogy, it is as if one measured the nation's capital stock by adding up the numbers of trucks, office buildings, and screwdrivers."

Recognising that workers are heterogeneous is not new in the economics literature; see for example Becker (1962), Lucas (1988), Jorgenson and Fraumeni (1992) and Griliches (1996). Nor is it new in statistical agency measurement of labour inputs; see for example Bureau of

[1]These measures include both headcount measures (based on the number of people whose labour is underutilised) and volume measures (based on the number of hours of available labour that are underutilised).

Labor Statistics (1993) and Reilly *et al.* (2005). In a recent paper, Greenwood and Kohli (2003) proposed a number of alternative measures for the degree of labour underutilisation, which take into account the different skills of members of the labour force. They emphasised that accounting for differences in skills in the measurement of the degree of labour underutilisation is important as workers with low skills are generally less productive, hence, in situations where unemployment is relatively higher among less skilled workers than among the more skilled workers, the conventional measure of the unemployment rate will tend to overestimate the degree of labour underutilisation. This is the flip side to the argument that labour inputs should be quality-adjusted to appropriately account for changes in the resources utilised in production.

The purpose of this paper is to compute estimates of the degree of labour underutilisation in Australia for the census years 1981, 1986, 1991, 1996 and 2001, using the alternative measures suggested by Greenwood and Kohli (2003). While these authors looked at aggregate measures for the U.S., our census-based dataset for Australia allows us to examine unemployment for groups with different educational backgrounds *and* look at differences in unemployment between females and males. It also seeks to explore the nature of any difference between the alternative measures and the conventional measure.

The paper is organised as follows. The next section presents the theoretical background based on which Greenwood and Kohli (2003) derived their new unemployment measures. Then the basic dataset that was used in computing the alternative measures is described in section 3. Section 4 presents and analyses the estimates, and section 5 draws some conclusions and offers suggestions for future research.

2 Theoretical Background

Greenwood and Kohli (2003) model the aggregate production by a multiple-input multiple-output transformation function. They distinguish between non-labour inputs and labour inputs, where the latter are divided into H categories.[2] In addition, Greenwood and Kohli (2003) assume weak separability between labour inputs and the other inputs and outputs in the transformation function, that is, the categorized labour inputs can be consistently aggregated by a labour aggregator function. Formally, letting n_h, $h = 1, \ldots, H$, be the number of workers (employed) in the h^{th} category, we have:

$$n = h(n_1, \ldots, n_H), \tag{1}$$

where n is an index of aggregate labour and $h(\cdot)$ is the labour aggregator function, which is assumed to be increasing, quasi-concave, and linearly homogenous.

The number of workers (employed) in each category of labour n_h is determined by optimizing behaviour. More specifically, Greenwood and Kohli (2003) assume profit maximization and divide the optimization problem into two stages:[3] the first stage determines the optimal labour mix that minimizes labour cost, given the level of aggregate labour n, the labour aggregator function $h(\cdot)$ and the wage rates of the different labour categories.[4] The second stage determines the optimal level of aggregate labour, of non-labour inputs and of outputs that maximises profit, given all input and output prices and the transformation function. To derive the different measures of the rate of unemployment it is sufficient to consider the first stage only. Note that the first order conditions of the optimization problem in the first stage require that the marginal products of each category of labour be equal to their marginal cost.[5] Although these conditions might not hold in reality (due to, for example, monopoly conditions in the labour supply), Greenwood and Kohli (2003) argue that it is still a good starting point. We will address this point later in sections 4 and 5.

We now turn to Greenwood and Kohli's (2003) definition of the rate of unemployment.

[2]The classification into categories can be done by educational attainment, age (experience), sex etc. Greenwood and Kohli (2003) also assume that the workers within each category are perfectly homogeneous.

[3]Price-taking is assumed for all markets (inputs and outputs) in the optimization problem.

[4]This stage of minimizing labour cost for a given level of aggregate labour n is necessary for profit maximization behaviour.

[5]The assumption of quasi concavity of $h(\cdot)$ makes the first order conditions of this optimization problem sufficient for optimal solution.

Let l_h, $h = 1, \ldots, H$, denote the total number of workers (employed and unemployed) of the h^{th} category, then the index of aggregate labour when all workers are employed (l) is given by:

$$l = h(l_1, \ldots, l_H). \tag{2}$$

Using equations (1) and (2), the rate of unemployment u (i.e., the rate of labour capacity underutilisation) is then defined as:

$$u \equiv 1 - \frac{h(n_1, n_2, ..., n_H)}{h(l_1, l_2, ..., l_H)}. \tag{3}$$

From (3), it is clear that the rate of unemployment u depends on the labour aggregator function $h(\cdot)$, the specification of which is unknown. Greenwood and Kohli (2003) overcome this obstacle by using two different approaches: the first is an index-number approach and the second is an econometric approach. In the second approach, econometric techniques are used to estimate the labour aggregator function $h(\cdot)$. Since our basic dataset is not appropriate for estimation we will not apply this approach. However, it is possible to apply the index-number approach with census-based dataset and so this is the focus of what follows.

In the index-number approach measures for the rate of unemployment are derived by specifying different functional forms for $h(\cdot)$ while using the optimizing behaviour assumption. More specifically, the derivation of the different measures consists of the following steps: first Greenwood and Kohli (2003) solve the first order conditions of the first stage of the optimization problem using a specific functional form. Then, they use these conditions together with the specific functional form for $h(\cdot)$ to substitute into (3) and derive a measure for the unemployment rate u as a function of the number of workers (employed) in each category of labour, the total number of workers (employed and unemployed) in each category of labour (labour force) and the wage rate of workers in each category of labour (all observed variables). Each measure that is derived in this way is "exact" (in the sense of Diewert (1976)) for the underlying functional form.

Letting w_h, $h = 1, \ldots, H$, denote the wage rate of the employed workers in the h^{th}

category, Greenwood and Kohli (2003) derive the different measures of the rate of unemployment using the linear, Leontief, Cobb-Douglas and Constant Elasticity of Substitution (CES) functional form specifications. These are described in the following sections.

2.1 Linear Functional Form

Linear functional form assumes perfect substitution between workers from different labour categories. Therefore, the unemployment rate that is derived from this functional form sets the upper bound for the class of alternative unemployment rate measures.[6]

Formally, Greenwood and Kohli (2003) assume the following linear form:

$$h(\cdot) = \sum_{h=1}^{H} b_h n_h, \tag{4}$$

where b_h is a parameter satisfying the restriction that $b_h \geq 0$.

The functional form in (4) implies the following linear version of the rate of unemployment:

$$u^{LN} = 1 - \frac{\sum_{h=1}^{H} w_h n_h}{\sum_{h=1}^{H} w_h l_h}. \tag{5}$$

The conventional measure of the unemployment rate, $\tilde{u}$, can be derived from a special case of (4), with the parameters b_h for all h equal to a constant, b:

$$h(\cdot) = b \sum_{h=1}^{H} n_h. \tag{6}$$

Then substituting (6) into (3) we get

$$\tilde{u} = 1 - \frac{\sum_{h=1}^{H} n_h}{\sum_{h=1}^{H} l_h}. \tag{7}$$

However, it should be mentioned that optimization with the functional form in (6) implies

[6] Intuitively, under perfect substitution the aggregate labour that is available for employment is in its highest level (since workers are perfect substitutes), which in turn will drive the degree of labour underutilisation upwards.

that wages do not differ across the labour categories. Since this is very unlikely to be the case, the assumption of optimizing behaviour might not be met for this special case and therefore it cannot be used as a motivation for the use of (7) as a measure of the unemployment rate.

2.2 Leontief Functional Form

As a second specification for $h(\cdot)$, Greenwood and Kohli (2003) assume the following Leontief functional form:

$$h(\cdot) = \min\left\{\frac{n_1}{a_1}, \frac{n_2}{a_2}, ..., \frac{n_H}{a_H}\right\}, \tag{8}$$

where a_h is a parameter satisfying the restriction that $a_h > 0$. This functional form implies the following measure for the rate of unemployment:

$$u^{LF} = \min\{u_1, u_2, ..., u_H\}, \tag{9}$$

where $u_h \equiv 1 - n_h/l_h$ is the unemployment rate for the h^{th} category of labour.

Note that the Leontief functional form in (8) assumes that there is no substitution between workers from different labour categories. Therefore, the measure for the unemployment rate in (9) sets the lower bound for the class of alternative unemployment rate measures.[7]

2.3 Cobb-Douglas Functional Form

The next specification takes the following Cobb-Douglas functional form:

$$h(\cdot) = \prod_{h=1}^{H} n_h^{\alpha_h}, \tag{10}$$

where α_h is a parameter, $\alpha_h \geq 0$, and linear homogeneity is imposed by the restriction that $\sum_{i=1}^{H} \alpha_i = 1$.

[7] Intuitively, when there is no substitution between the different labour categories the aggregate labour that is available for employment is at its lowest level (since workers from different labour categories cannot substitute for one another), which in turn will drive the degree of labour underutilisation downwards.

For the functional form in (10), the corresponding rate of unemployment is as follows:

$$u^{CD} = 1 - \frac{\prod_{h=1}^{H} n_h^{s_h}}{\prod_{h=1}^{H} l_h^{s_h}}, \qquad s_h \equiv \frac{w_h n_h}{\sum_{k=1}^{H} w_k n_k}, \tag{11}$$

That is, under optimisation and the assumption of linear homogeneity, $\alpha_h = s_h$, the share of category h in the total wage bill.

While the above functional form specifications (Linear and Leontief) were extreme in their degree of substitution between the different labour categories, the Cobb-Douglas functional form allows for some degree of substitution between the different labour categories. Therefore, the implied measure in (11) should lie between the upper and lower bounds of the unemployment rate which are set by the measures in (5) and (9) respectively.

2.4 CES Functional From

The last specification for $h(\cdot)$ is the Constant Elasticity of Substitution (CES) functional form which takes the following form:

$$h(\cdot) = (\delta_1 n_1^{\rho} + \delta_2 n_2^{\rho} + ... + \delta_H n_H^{\rho})^{\frac{1}{\rho}}, \qquad \delta_h > 0, \qquad \rho \leq 1, \tag{12}$$

where δ_h and ρ are parameters, and the Allen-Uzawa elasticities of substitution between the different labour categories can be written as $\sigma = 1/(1-\rho)$, where σ can range between zero (when $\rho \to -\infty$) and infinity (when $\rho \to 1$).

The CES functional form can be viewed as containing all the above specifications as special cases. The linear specification in (4) can be viewed as a special case of the CES functional form with $\rho = 1$ (and hence $\sigma \to \infty$). Similarly, with $\rho \to -\infty$ (and hence $\sigma \to 0$) we get the the Leontief specification in (8), and with $\rho \to 0$ (and hence $\sigma \to 1$) we get the Cobb-Douglas specification in (10).

The functional form in (12) implies the following CES version for the rate of unemployment:

$$u^{CES} = 1 - \frac{(\sum_{h=1}^{H} n_h w_h)^{\frac{1}{\rho}}}{(\sum_{h=1}^{H} n_h^{1-\rho} l_h^{\rho} w_h)^{\frac{1}{\rho}}} \tag{13}$$

3 The Basic Dataset

The basic dataset for Australia is taken from Wei (2004). Wei (2004) constructed a database which was drawn from the Australian Census of Population and Housing conducted in 1981, 1986, 1991, 1996 and 2001. This database includes information on personal incomes, employment rates and the labour force, all cross-classified by gender and educational attainment. This information is for the Australian adult working age population, defined as everyone aged between 25 years and 65 years.[8]

Educational attainment is determined by the highest post-school educational qualification that an individual holds. Since the definitions of the educational qualifications in the Australian censuses were revised over the years, the educational qualifications had to be re-classified into broader categories of educational attainment to allow comparability across the different census years. Specifically, Wei (2004) re-categorized the educational qualifications in each census year into the following four broad categories of educational attainment: unqualified, skilled labour, bachelor degree and higher degree.[9]

3.1 Market Labour Incomes

Since only information on gross personal income from all sources is available from the census questionnaire,[10] we used Wei's (2004) estimates of gross annual incomes per capita as a proxy for annual labour incomes. Table A1 in the appendix reports estimates of gross annual incomes per capita in constant prices (2001 dollars) of those employed, classified

[8]Although this dataset does not include the end points of the labour force age distribution (that is, persons aged below 25 and over 65), it seemed reasonable to use it since we are going to categorise labour by educational attainment (and gender).

[9]For a detailed description on how the categories of educational qualifications in each census year have been re-classified into the above four categories see appendix 3 in Wei (2004).

[10]The census questionnaire does not distinguish between labour incomes and non-labour incomes.

by educational attainment and gender.[11] We chose to present the gross annual incomes in terms of constant prices (2001 dollars) and not in terms of current prices in order to allow the comparison of gross annual incomes between the different census years.[12] Note, however, that whether one uses annual incomes in terms of current prices or annual incomes in terms of constant prices ("real" annual income) does not affect the different measures of the unemployment rate presented in section 2 above.[13]

It is clear from table A1 that, for both female and male, annual income increases with the level of education. These findings can be explained by a number of competing models, such as the human capital and screening models; see Griliches (1996) for a review. It is also worth noting that for each level of educational attainment, men's incomes are higher than women's incomes. There are a number of possible explanations for these substantial differences: first, women are more likely to have less work experience than men because of the time spent out of the labour force due to raising children. These differences in the level of experiences, in turn, can lead to differences in incomes. Second, men tend to work more hours than women; also women are more likely than men to be employed as part-time employees.[14] These potential differences in the number of hours worked might partially explain the differences in the annual figures. Lastly, wage discrimination can also explain the disparities between men's and women's incomes.[15] These differences in incomes across female and male will play a significant role in the computation of the unemployment measures for all persons. We will address this point in more details in the next section.

One can observe the similar trend that annual incomes of all women and men education

---

[11]Wei (2004) derived these estimates using the weighted averages of the reported personal income ranges for each category of educational attainment and gender.

[12]Wei (2004) used the ABS Consumer Price Index (CPI) to convert estimates of gross annual incomes in current prices to estimates of gross annual incomes in constant prices (2001 dollars). Readers who are interested in the estimates of gross annual incomes in current prices are referred to table 3.1 in Wei (2004).

[13]It is straight forward to verify that the Linear, Cobb-Douglas and CES measures are not affected when wage rates are multiplied by a constant (the conversion to constant prices). Also, the conventional measure and the Leontief measure do not depend on wages at all.

[14]See for example '2006 Year Book Australia' (ABS Catalogue No. 1301.0).

[15]We should bear in mind that these estimates are gross annual incomes so the above explanations hold as long as the differences in incomes result from the labour income components and not from the non-labour ones.

categories have experienced: real annual incomes increased between 1981 and 1986, fell between 1986 and 1991 and since 1991 have increased again. These movements in annual incomes can be explained by the economic downturn that Australia has experienced in the early 1990s followed by periods of economic recovery (late 1990s and onwards); for more on Australian business cycles, see e.g. Bodman (1998) and Bodman and Crosby (2002).

3.2 Labour Force

Table A2 in the appendix presents Wei's (2004) estimates of the labour force (in thousands) for persons aged between 25 years and 65 years in the different census years, classified by educational attainment and gender. As one can see, the number of labour force members, both women and men, has increased over the 20 year period for almost all educational attainment categories, with the exception of unqualified men, which has decreased since 1991. It is also interesting to note that in 2001 the number of women with bachelor degrees in the labour force exceeded the number of men with bachelor degrees in the labour force. Except for this observation, the number of male members of the labour force exceeded the number of female members of the labour force across the different years for all levels of educational attainment.

3.3 Employment Rates

Table A3 in the appendix presents Wei's (2004) estimates of the employment rates (percentages) for the different census years, classified by educational attainment and gender.[16] We used these estimates together with the above estimates of the labour force to derive the unemployment rates and the number of employed workers for each category of educational attainment and gender.[17] Tables A4 to A8 in the appendix present, for each census year,

[16] Wei (2004) derived the estimates for each cohort by taking the ratio of the number of employed people and the number of labour force members in that cohort.

[17] Estimates of the number of employed workers were derived by multiplying the employment rates with the corresponding number of members of the labour force. The unemployment rate was calculated as one minus the employment rate.

the number of labour force members, the number of employed workers, annual incomes and unemployment rates, all cross-classified by educational attainment and gender.

The negative relationship between unemployment rates and levels of education is evident when observing the male figures in these tables. As one can see, higher educational levels are associated with lower unemployment rates. A different pattern occurs for the female figures; women with more education generally experience lower unemployment rates.[18] However, the higher degree category for women breaks this negative relationship. In particular, for all the census years, women from the higher degree category experienced higher unemployment rates than women from the bachelor degree category. The different pattern between the female figures and the male figures in the higher degree category possibly can be explained by the different difficulties that unemployed men and women encounter when looking for jobs. In particular, it might be the case that women are more likely to experience insufficient work experience as their main difficulty in finding a job than their male counterparts.[19] Additional difficulties that women are more likely to encounter than men could be unsuitable hours and difficulties related to family responsibilities (e.g., child care).[20] This, together with the assumption that relative to bachelor degree positions, higher degree positions require more experience and entail inflexible working hours, can explain the above findings. Differences between males and females in terms of subjects studies may also provide an explanation. An alternative explanation might be that discrimination in the acceptance for jobs is more prevalent among the higher degree category (relative to the bachelor degree category).

[18]This is true except for the census year 1981 when the unemployment rate of skilled women (2.78%) was lower than the unemployment rate of women with bachelor degree (3.12%).

[19]As was mentioned above, women are more likely to have less work experience than men because of the time spent outside the labour force on raising children; see e.g. Drago, Wooden and Black (2006), Blank and Shierholz (2006).

[20]See for example '2006 Year Book Australia' (ABS Catalogue No. 1301.0), 'Job Search Experience, Australia, July 2004' (ABS Catalogue No. 6222.0) and 'Job Search Experience, Australia, July 2005' (ABS Catalogue No. 6222.0) for data that supports this view.

4 Estimates of the Unemployment Rate

This section presents estimates of the rate of unemployment for the Australian adult working age population (25-65 years). Since our basic dataset is categorized by educational attainment and gender we first begin by constructing unemployment rate estimates for females and males, where female and male labour are categorized by their level of educational attainment. We then move to calculate the estimates of the unemployment rate for all persons aged 25 to 65. Here we construct two sets of estimates: one which is derived by categorizing labour by educational attainment and gender (method I) and another which is derived by categorizing labour by educational attainment only (method II).

The different estimates of the rate of unemployment for females, males and all persons are calculated according to (5), (7), (9), (11) and (13) above, using the basic dataset (Tables A4 to A8). Following Greenwood and Kohli (2003), u^{CES} is calculated for $\rho = -4$ ($\sigma = 0.2$).[21] Tables 1 and 2 report unemployment rates for males and females respectively. Tables 3 and 4 report unemployment estimates for all persons, using method I and II respectively. We also provide in the appendix (Table A9) descriptive statistics of the different measures of the rate of unemployment for females, males and all persons over the five census years.[22]

4.1 Unemployment Rates for Females and Males

Looking at Tables 1 and 2 we see that the first measure, the conventional rate of unemployment, $\tilde{u}$ from (7), varies between 4.03 percent (in 1981) and 10.49 percent (in 1991) for male, and between 4.23 percent (in 1981) and 8.33 percent (in 1991) for females. This result is not surprising when considering the economic decline that Australia has experienced in the early 1990s. For the linear measure, u^{LN} from (5), the estimates for both males and females are consistently lower than for the conventional measure, $\tilde{u}$. The difference between the two measures varies between 0.17 percentage points (in 1981) and 0.54 percentage points (in

[21] For other values of ρ, see Table A11 in the appendix.

[22] The descriptive statistics are calculated over the five census years and hence should be interpreted cautiously and with respect to the census years only (that is, these statistics do not reflect the behaviour of the measures for the entire 20 year period).

1991) for males, and between 0.11 percentage points (in 1981) and 0.43 percentage points (in 1991) for females.

The estimates of the Cobb-Dougals measure, u^{CD} from (11), are systematically lower than the estimates of u^{LN} and of $\tilde{u}$, both for females and males, although the difference between u^{CD} and u^{LN} for females seems to be marginal. The overestimation of $\tilde{u}$ relative to u^{CD} varies between 0.18 percentage points (in 1981) and 0.61 percentage points (in 1991) for males, and between 0.12 percentage points (in 1981) and 0.46 percentage points (in 1991) for females. As for the fourth measure u^{CES}, observe that its values, both for women and men, are lower than u^{CD}, u^{LN} and $\tilde{u}$ for all census years. In particular, the difference between u^{CES} and $\tilde{u}$ varies between 0.22 percentage points (in 1981) and 0.89 percentage point (in 1991) for males, and between 0.13 percentage points (in 1981) and 0.57 percentage points (in 1991) for females. Finally, and not surprisingly, u^{LF} is the lowest measure of all, both for females and males. The maximum difference between u^{LF} and $\tilde{u}$ is 6.64 percentage points (in 1991) for males and 3.78 percentage points (in 1991) for females.

A few observations can be made in regards to the above results. First, the alternative measures, both for men and women, exhibit the following relation: $u^{LN} \geq u^{CD} \geq u^{CES} \geq u^{LF}$. These results are not surprising as we expected (from section 2 above) that assuming a lower degree of substitution between workers would result in lower estimates of the rate of unemployment.[23] Second, the conventional measure of the unemployment rate does not fall within the lower (u^{LF}) and the upper (u^{LN}) bounds for any single census year. That is, relative to all other alternative measures, the conventional measure overstates the degree to which labour's productive capacity is underutilised. This is true for both the female estimates and the male estimates. That the conventional measure exceeds the alternative measures can be explained by the general trend we saw above (section 3) of more educated workers experiencing lower unemployment rates.[24] Finally note that, both for females and

[23]Recall that the Linear, Cobb-Douglas, CES (with $\rho = -4$) and Leontief functions imply the following elasticities of substitution between the different labour categories: $\sigma \to \infty$, $\sigma = 1$, $\sigma = 0.2$, $\sigma \to 0$ (respectively).

[24]This trend was less obvious for the female data which might explain the smaller difference between the conventional and alternative measures for females.

males, the overstatment increases over the census years 1981-1991 and decreases over the census years 1991-2001; this is true with respect to all the alternative measures. A possible explanation for this result is that the least skilled workers suffered a disproportionate increase in unemployment relative to the most skilled ones over the census years 1981-1991. For instance, in 1991 the unemployment rate of unqualified male workers increased by 3.98 percentage points (compared to 1986), whereas for male workers who hold higher degrees it only increased by 2.03 percentage points (compared to 1986). On the other hand, the least skilled workers enjoyed a disproportionate return to the job market relative to the most skilled workers over the census years 1991-2001. For example, in 2001 the unemployment rate for male workers with a higher degree decreased by 0.25 percentage points (compared to 1996), while the unemployment rate of unqualified male workers decreased by 2.16 percentage points (compared to 1996). A similar trend, but smaller in magnitude, can also be found for women (excluding the higher degree category).

4.2 Unemployment Rates for All Persons

Since our basic dataset is categorized by educational attainment and gender we chose two methods of labour categorization in computing the estimates of the rate of unemployment for the Australian adult working age population (25-65 years).

The first method classifies labour by educational attainment and gender (method I). This means that women and men with the same educational background are treated as two different categories. At first glance this might seem an odd distinction. Note, however, that for each level of educational category men's incomes are higher than women's incomes (section 3 above). If these differences represent differences in productivity levels (e.g., differences in work experience) then the distinction between females and males with the same educational background can be justified. Obviously this argument does not support this method of classification if differences in incomes result from factors other than differences in productivity levels (such as wage discrimination). This method is straightforward to apply but, as we will see in the results below, it also commands careful attention when applied. We label measures that are derived using this method of classification as measures for persons I.

The second method classifies labour by educational attainment only (method II). This means that women and men with the same educational background are treated as one category. Considering the differences in incomes of male and female from the same educational background, this method of labour classification can be justified when the income disparities do not reflect differences in productivity level. Note that this argument is opposite to the one used to justify method I, and in that sense the two methods complete each other. To remove differences in men's incomes and women's incomes belonging to the same category, we used the weighted average of their incomes to represent the income level of that category.[25] Also, for each education category, the number of members of the labour force is derived by summing up the number of female members of the labour force in that category with the number of male members of the labour force in that category. The same is done with respect to the number of employed workers. We label measures that are derived using this method of classification as measures for persons II.

The choice between these two alternative methods of labour categorization matters when deriving estimates for the alternative unemployment measures. Generally, the Linear, Cobb-Douglas, CES and Leontief measures depend on which classification we use and would yield different estimates for each method.[26] The degree of divergence between the estimates for the two methods depends on the specific dataset under consideration. Note, however, that the conventional measure is not affected by the classification method.[27]

Tables 3 and 4 report estimates of the different unemployment measures for all persons with labour categorised according to methods I and method II, respectively. As expected the estimates of the conventional measure are the same for both methods while the estimates

[25]For each educational level, the weights were determined by the number of employed male workers and number of employed female workers. Note that taking the weighted average income can remove any possible effects of wage discrimination.

[26]It is straightforward to construct examples to demonstrate this point. One exception should be mentioned in regards to the Linear measure. If the female and male incomes were equal for each education category (which is unlikely to be the case in practical terms) then the Linear measure would yield the same estimates for both methods.

[27]This issue will come up whenever a decision has to be made in regards to how labour should be classified, and is therefore not a feature peculiar to this study.

of the alternative measures differ between the two methods. The estimates of the Linear, Cobb-Douglas and CES measures for persons I are consistently higher than those for persons II. Note that the estimates of the CES measure for persons I are quite close to the estimates of the CES measure for persons II. As for the Leontief measure, its estimates for persons I are lower than its estimates for persons II and the difference between the estimates is quite large.

Looking at Tables 3 and 4 one can see that the conventional rate of unemployment ($\tilde{u}$) varies between 4.1 percent (in 1981) and 9.61 percent (in 1991) for persons I and II. Once again, this result is consistent with the economic slowdown that Australia experienced in the early 1990s. Moving on to the next measure, we see that for all census years the estimates of u^{LN}, both for persons I and persons II, never exceed the conventional estimates. The gap between the two measures varies between 0.17 percentage points (in 1981) and 0.38 percentage points (in 1986) for persons I, and between 0.18 percentage points (in 1981) and 0.54 percentage points (in 1991) for persons II. Next observe that the estimates of u^{CD}, both for persons I and persons II, are consistently lower than the estimates of u^{LN} and of $\tilde{u}$, with estimates of u^{CD} being quite close to estimates of u^{LN}. The difference between $\tilde{u}$ and u^{CD} varies between 0.18 percentage points (in 1981) and 0.41 percentage points (in 1986) for persons I, and between 0.19 percentage points (in 1981) and 0.59 percentage points (in 1991) for persons II. As for the estimates of u^{CES}, they lie below the estimates of u^{CD}.[28] This observation holds for all census years and both for persons I and II. The difference between u^{CES} and $\tilde{u}$ varies between 0.22 percentage points (in 1981) and 0.6 percentage points (in 1991) for persons I, and between 0.22 percentage points (in 1981) and 0.77 percentage points (in 1991) for persons II. Lastly, the estimates of u^{LF}, both for persons I and II, lie far below the estimates of the rest of the measures. The maximum gap between u^{LF} and $\tilde{u}$ is 5.76 percentage points (in 1991) for persons I and 5.29 percentage points (in 1991) for persons II.

As in the case of the male and female measures, the estimates of the alternative measures,

[28]Table A11 reports additional estimates of u^{CES} for males, females, persons I and persons II using $\rho =$ -8, -2 and 0.5. These specifications imply elasticities of substitution of 0.111, 0.333, and 2 respectively. As expected, the estimates decrease with the degree of substitution.

both for persons I and II, decrease with the level of substitution, that is, $u^{LN} \geq u^{CD} \geq u^{CES} \geq u^{LF}$. Also, we see again that, both for persons I and II, the conventional measure is greater than all other alternative measures. However, the magnitude of the difference varies between persons I and persons II. In particular, the difference relative to the Linear, Cobb-Douglas and CES measures in persons II case is consistently higher than the one in persons I; while the difference relative to the Leontief measure in persons II case is consistently lower than the one in persons I. This result is not surprising as we already saw above that the estimates of the Linear, Cobb-Douglas and CES measures for persons I are higher than those for persons II, while the estimates of the Leontief measure for persons I are lower than its estimates for persons II.

Generally, different methods of classification will yield different estimates for the alternative measures. It is interesting to note that not only the differences but also the trend of the differences between the conventional and alternative measures vary between the two methods. Specifically, the difference for persons II follows the same pattern as the difference for females and males with increases over the census years 1981-1991 and decreases over the census years 1991-2001. This is true with respect to all the alternative measures. Although the difference of the conventional measure relative to the CES and Leontief measures in the case of persons I also follows this pattern, a different pattern occurs relative to the Linear and Cobb-Douglas measures.

Similar to the explanation given above for females and males, the explanation for the pattern of the difference in the persons II case is a combination of two factors: first, when labour is categorised by education only (method II) income increases with the level of education so, generally, less educated workers get less weight in the alternative measures. Second, the least educated workers in this method suffered a disproportionate increase in unemployment (relative to the most educated ones) over the census years 1981-1991 and enjoyed a disproportionate return to the job market (relative to the most educated ones) over the census years 1991-2001. The same cannot be said about persons I case. In particular, when labour is categorised by education and gender we can no longer say that income increases with the level of education of workers. A closer look at the income disparities between the different labour categories in method I reveals that for all census years the order of the different labour categories from highest income to lowest is as follows:[29]

Male with higher degree

Male with bachelor degree

Female with higher degree

Male skilled labour

Female with bachelor degree

Male unqualified

Female skilled labour

Female unqualified

This means that, for example, the “male skilled labour” category generally gets a higher weight than “women with bachelor degree” category and that the “male unqualified” category gets higher weight than the “female skilled labour” category.[30] the pattern also occurs because of the number of This feature of the weights causes the observed pattern; generally, more weight is given to categories that suffer from high unemployment rates and disproportionate withdrawals and returns from and to the pool of unemployed. The reason why the pattern occurs in the difference of the conventional measure relative to the Linear and Cobb-Douglas measures and not in the difference relative to the CES and Leontief measures, is that as the degree of substitution decreases the alternative measures take less into account the categories that suffer from high unemployment rates, irrespective of their incomes.

Also, if differences in education reflect productivity differences, it is clear that the assumption that the marginal product of each type of labour equal to its marginal cost is not met in persons I case. Since this assumption is the main assumption on which the alternative measures are based, it seems inappropriate to apply the alternative measures while using classification method I.

[29] See table A1 for the the actual incomes.

[30] In the Cobb-Douglas case of equation (11), this is also because the number of employed “male skilled labour” is greater than the number of employed “women with bachelor degree”. Similarly for “male unqualified” and “female skilled labour”.

4.3 Comparison with Official Unemployment Rates

Table A10 reports the official unemployment rates measured by the ABS Labour Force Survey (LFS). Although these estimates were collected at the same month and year that our five censuses were collected,[31] they are not strictly comparable to our estimates due to differences between the two surveys (LFS and census). In particular, the two surveys differ in their scope, coverage, timing,[32] collection methodology, measurement of underlying labour force concepts, treatment of non-response, non-response bias, non-sampling error and sampling variability. In addition, the LFS estimates are calculated for all persons aged 15 years and over, while our estimates were calculated using data on persons aged between 25 years and 65 years. While we focus on the more complete census data in this study, a practical implementation of the alternative unemployment measures would require the use of LFS data.

Despite the incomparability between the official estimates and our estimates (in terms of their values), we can still compare their general trend. As is clear from Tables 3, 4 and A10 the official estimates and our estimates follow the same pattern: increases over the census years 1981-1991 and decreases over the census years 1991-2001.

4.4 Discussion and Possible Extensions

Although the alternative measures were straightforward to apply, some practical decisions still had to be made. In particular, when calculating the alternative measures one has to decide how labour should be categorized, e.g. education, age (as a proxy for experience), gender, or even some combination of these. In generally, different methods of classification would yield different estimates. However, no matter what method is used, one should ensure that the main assumption on which the alternative measure are based, namely that income

[31] The censuses in 1981 and 1986 were conducted in June and the censuses in 1991, 1996 and 2001 were conducted in August.

[32] Although the two surveys were collected at the same month, the information they collect refer to different weeks.

differentials between workers reflect productivity differentials, can reasonably be met.[33] In our case, for example, when labour was classified by educational attainment and gender we saw that for all census years unqualified men had higher incomes than women from the skilled labour category. To the extent that differences in education reflect productivity differences, it is clear that the above assumption cannot be met.

Once the method of labour categorization is chosen one also has to decide how detailed the classification should be. It seems that too detailed classification should be avoided as this will cause the number of observations in each category to decline, which in turn will increase the likelihood that the alternative measures could be affected by a few outliers. Lastly, when incomes differ between individuals belonging to the same labour category, one has to decide on how to determine the income level of that category. In our case we used the weighted average income. The averaged income method is simple and its computation is straightforward. However, other more sophisticated alternatives are available. For example, one can use econometric techniques to fit an earnings function or wage model to derive the income level of that labour category. The advantage of such an approach is that one can control for factors that are responsible for the differences in incomes other than the labour category itself.[34] The disadvantage of such an approach is that it involves further practical decisions (such as model specification) and possible estimation difficulties.

With the availability of an appropriate dataset, further refinements to the presented methods are possible. First, depending on data availability, classification could be by age (as a proxy for experience) or a combination of educational attainment and age. Second, in our basic dataset educational attainment was divided into four broad levels: unqualified, skilled labour, bachelor degree and higher degree. With the availability of an appropriate dataset a more detailed grouping could be used in the future. Third, in calculating our

[33] We use the term "reasonably met" in the sense that when labour is categorized into different categories, each of which reflects a different level of productivity, incomes should at least increase with the productivity level. Obviously this is not enough to ensure the validity of the assumption that the marginal product of each type of labour is equal to its marginal cost, and other factors that might affect it should be taken into account (e.g., the existence of strong trade unions or wage discrimination).

[34] This can also help to ensure that wages better reflects the productivity level of that labour category.

estimates we used estimates of gross annual incomes as a proxy for annual labour incomes. Future refinement could involve the use of more accurate information on labour income.[35] We also think that the use of hourly rate, instead of annual rate, will also help in eliminating some of the differences in incomes, which are not related to differences in productivity levels (such as part time/full time status). Fourth, one might also consider measuring the degree of labour underutilisation in terms of the number of potential hours of labour that are not used (percentage wise) instead of the number of potential workers that can be employed (percentage wise). This might better reflect the potential capacity of the labour force. Finally, the availability of more observations (beyond the five census years) would allow the application of the econometric approach suggested by Greenwood and Kohli (2003).

5 Conclusion

In this paper we presented estimates of the degree of labour underutilisation for the Australian adult working age population (25-65 years), using data from the censuses conducted in the years 1981, 1986, 1991, 1996 and 2001. We constructed unemployment rates for females and males, where members of the female and male labour groups were categorized by their level of educational attainment. Then we calculated estimates of the unemployment rate for all persons aged 25 to 65, using two methods of labour classification: one which classifies labour by educational attainment and gender ("persons I") and another which classifies labour by educational attainment only ("persons II").

The results for Australia show that the conventional measure of the unemployment rate does not fall within the lower bound (Leontief measure) and the upper bound (Linear measure) for the exact indexes, for any single census year. This was true in all cases considered: male, female, persons I and persons II. Similar to the results obtained by Greenwood and Kohli (2003) for the US, the conventional measure of unemployment rate for Australia overestimated the rate of labour underutilisation, although the scale of the overestimation in the

[35] Preferably, this should include the basic wage and all non-wage entitlements.

Australian case was less in magnitude. In the U.S. case, Greenwood and Kohli (2003) found that the conventional unemployment rate for persons aged 25 and over yielded an overestimate of about 13.9%, on average, relative to the Cobb-Douglas unemployment index. In the Australian, case we found that relative to the Cobb-Douglas index the conventional unemployment rate yielded, on average, an overestimation of 6.5% for males, 5.6% for females, 4.9% for persons I and 6.7% for persons II, all.

We hope that the results in this paper will prompt the statistical agencies to consider adding the alternative measures to published measures of unemployment. These measures are simple to calculate and do not involve many methodological obstacles. Moreover, these measures require observable information that is already routinely gathered in labour surveys, and related supplementary surveys. We are confident that the inclusion of these estimates will provide a deeper understanding of developments in the economy, aid in the estimation of potential output in macroeconomic modelling, and inform the formulation of appropriate education, sex discrimination and labour market policies.

References

Becker (1962), "Investment in Human Capital: A Theoretical Analysis," *Journal of Political Economy* 70, 9–49.

Blank, R.M. (2006), "Exploring Gender Differences in Employment and Wage Trends Among Less-Skilled Workers," NBER Working Paper No. W12494.

Bodman, P. (1998), "Asymmetry and Duration Dependence in Australian GDP and Unemployment," *Economic Record* 74, 399–411.

Bodman, P. and M. Crosby (2002), "The Australian Business Cycle: Joe Palooka or Dead Cat Bounce?" *Australian Economic Papers*, June, 191–206.

Bureau of Labor Statistics (1993), *Labor Composition and U.S. Productivity Growth, 1948–90*, U.S. Department of Labor, Bulletin 2426, U.S. Government Printing Office, Washington D.C.

Diewert, W.E. (1976), "Exact and Superlative Index Numbers," *Journal of Econometrics*, 4, 115–145.

Drago, R.W., M. Wooden and D. Black (2006), "Who Wants Flexibility? Changing Work Hours Preferences and Life Events," IZA Discussion Paper No. 2404.

Greenwood, M. J., and U. Kohli (2003): "Exact Unemployment Rate Indices," *Contemporary Economic Policy*, 21(2), 218–226.

Griliches, Z. (1996), "Education, Human Capital, and Growth: A Personal Perspective," NBER Working Paper 5426.

Job Search Experience, Australia, July 2004 (ABS Catalogue No. 6222.0).

Job Search Experience, Australia, July 2005 (ABS Catalogue No. 6222.0).

Jorgenson, D.W. and B. Fraumeni (1992), "Investment in Education and U.S. Economic Growth," *Scandinavian Journal of Economics* 94, S51–70.

Labour Force, Australia, Spreadsheets (ABS Catalogue No. 6202.0.55.001).

Lucas, R.E. (1988), "On the Mechanics of Development," *Journal of Monetary Economics* 22, 3–42.

Reilly, R., W. Milne, and S. Zhao (2005): "Quality-adjusted Labour Inputs," Australian Bureau of Statistics Research Paper (ABS Catalogue No. 1351.0.55.010).

Wei, H. (2004): "Measuring the Stock of Human Capital for Australia," Australian Bureau of Statistics Research Paper (ABS Catalogue No. 1351.0.55.001).

2006 Year Book Australia (ABS Catalogue No. 1301.0).

Table 1: Alternative Unemployment Rate Indices (%) for Males

Year	$\tilde{u}$	u^{LN}	u^{CD}	u^{CES}	u^{LF}
1981	4.03	3.86	3.85	3.81	1.25
1986	7.18	6.80	6.76	6.59	1.82
1991	10.49	9.95	9.88	9.60	3.85
1996	8.53	8.01	7.95	7.73	3.54
2001	6.70	6.28	6.24	6.11	3.29

Notes: $\tilde{u}$ is the conventional unemployment rate from equation (7), u^{LN} is the linear version of the unemployment rate from (5), u^{CD} is the Cobb-Douglas version from (11), u^{CES} is the constant-elasticity-of-substitution version from (13) for $\rho = -4$, and u^{LF} is the Leontief version from (9).

Table 2: Alternative Unemployment Rate Indices (%) for Females

Year	$\tilde{u}$	u^{LN}	u^{CD}	u^{CES}	u^{LF}
1981	4.23	4.11	4.11	4.09	2.87
1986	7.26	6.93	6.91	6.82	3.66
1991	8.33	7.90	7.88	7.77	4.55
1996	6.81	6.44	6.42	6.33	3.57
2001	5.38	5.03	5.01	4.96	2.74

Note: See the notes to Table 1.

Table 3: Alternative Unemployment Rate Indices (%) for All Persons, Method I

Year	$\tilde{u}$	u^{LN}	u^{CD}	u^{CES}	u^{LF}
1981	4.10	3.92	3.92	3.88	1.25
1986	7.21	6.83	6.80	6.65	1.82
1991	9.61	9.32	9.26	9.01	3.85
1996	7.80	7.48	7.43	7.25	3.54
2001	6.11	5.83	5.80	5.69	2.74

Note: See the notes to Table 1.

Table 4: Alternative Unemployment Rate Indices (%) for All Persons, Method II

Year	$\tilde{u}$	u^{LN}	u^{CD}	u^{CES}	u^{LF}
1981	4.10	3.92	3.91	3.88	1.63
1986	7.21	6.80	6.76	6.63	2.33
1991	9.61	9.07	9.03	8.84	4.32
1996	7.80	7.30	7.27	7.12	3.76
2001	6.11	5.71	5.69	5.60	3.08

Note: See the notes to Table 1.

Appendix

Table A1:
Gross Annual Incomes Per Capita by Educational Attainment and Sex (2001 AUS Dollars)

		1981	1986	1991	1996	2001
Male	Higher Degree	63245	68173	65793	70281	74019
	Bachelor Degree	55285	58084	55310	57536	62856
	Skilled Labour	40938	42969	40566	41535	46245
	Unqualified	34941	36586	34847	35941	39335
Female	Higher Degree	46025	49479	48515	51312	56664
	Bachelor Degree	39944	41521	38121	39285	44188
	Skilled Labour	29244	29581	28401	29072	31674
	Unqualified	22917	23377	22085	24267	26933

Data Source: Wei, H. (2004): "Measuring the Stock of Human Capital for Australia," Australian Bureau of Statistics Research Paper (ABS Catalogue No. 1351.0.55.001).

Table A2:
Labour Force (25-65 Years) by Educational Attainment and Sex (thousands)

		1981	1986	1991	1996	2001
Male	Higher Degree	37.4	45	80.2	107.8	138.8
	Bachelor Degree	193.9	259.8	367.2	482.1	592.4
	Skilled Labour	1016.6	1135.9	1241.4	1316.1	1453.6
	Unqualified	1898.6	1921.4	1994.1	1912.2	1828.3
Female	Higher Degree	8.5	12.7	28.4	51.2	84.6
	Bachelor Degree	84.7	143.9	289.7	450	637.4
	Skilled Labour	354.7	481.9	521.9	593.3	687.2
	Unqualified	1212.1	1377.3	1697.1	1761.5	1780.9

Data Source: Wei, H. (2004): "Measuring the Stock of Human Capital for Australia," Australian Bureau of Statistics Research Paper (ABS Catalogue No. 1351.0.55.001).

Table A3:
Employments Rates by Educational Attainment and Sex (%)

		1981	1986	1991	1996	2001
Male	Higher Degree	98.75	98.18	96.15	96.46	96.71
	Bachelor Degree	98.35	97.7	95.63	96.06	96.55
	Skilled Labour	97.37	95.22	91.87	93.73	95.01
	Unqualified	94.92	90.62	86.64	88.47	90.63
Female	Higher Degree	96.68	95.86	94.36	95.77	96.62
	Bachelor Degree	96.88	96.34	95.45	96.43	97.26
	Skilled Labour	97.13	95.2	94.15	94.72	95.15
	Unqualified	95.29	91.47	90.21	91.77	93.38

Data Source: Wei, H. (2004): "Measuring the Stock of Human Capital for Australia," Australian Bureau of Statistics Research Paper (ABS Catalogue No. 1351.0.55.001).

Table A4:
Labour Force, Workers, Gross Annual Incomes and Unemployment Rate by Educational Attainment and Sex: 1981

		No. of Labour Force Members (l_h) (thousands)	No. of Workers (n_h) (thousands)	Gross Annual Incomes (w_h) (2001 dollars)	Unemployment Rate (u_h) (%)
Male	Higher Degree	37.4	36.932	63245	1.25
	Bachelor Degree	193.9	190.701	55285	1.65
	Skilled Labour	1016.6	989.863	40938	2.63
	Unqualified	1898.6	1802.151	34941	5.08
Female	Higher Degree	8.5	8.218	46025	3.32
	Bachelor Degree	84.7	82.057	39944	3.12
	Skilled Labour	354.7	344.52	29244	2.87
	Unqualified	1212.1	1155.01	22917	4.71

Table A5:
Labour Force, Workers, Gross Annual Incomes and Unemployment Rate by Educational Attainment and Sex: 1986

		No. of Labour Force Members (l_h) (thousands)	No. of Workers (n_h) (thousands)	Gross Annual Incomes (w_h) (2001 dollars)	Unemployment Rate (u_h) (%)
Male	Higher Degree	45	44.181	68173	1.82
	Bachelor Degree	259.8	253.825	58084	2.3
	Skilled Labour	1135.9	1081.604	42969	4.78
	Unqualified	1921.4	1741.173	36586	9.38
Female	Higher Degree	12.7	12.174	49479	4.14
	Bachelor Degree	143.9	138.633	41521	3.66
	Skilled Labour	481.9	458.769	29581	4.8
	Unqualified	1377.3	1259.816	23377	8.53

Table A6:
Labour Force, Workers, Gross Annual Incomes and Unemployment Rate by Educational Attainment and Sex: 1991

		No. of Labour Force Members (l_h) (thousands)	No. of Workers (n_h) (thousands)	Gross Annual Incomes (w_h) (2001 dollars)	Unemployment Rate (u_h) (%)
Male	Higher Degree	80.2	77.112	65793	3.85
	Bachelor Degree	367.2	351.153	55310	4.37
	Skilled Labour	1241.4	1140.474	40566	8.13
	Unqualified	1994.1	1727.688	34847	13.36
Female	Higher Degree	28.4	26.798	48515	5.64
	Bachelor Degree	289.7	276.517	38121	4.55
	Skilled Labour	521.9	491.369	28401	5.85
	Unqualified	1697.1	1530.954	22085	9.79

Table A7:
Labour Force, Workers, Gross Annual Incomes and Unemployment Rate by Educational Attainment and Sex: 1996

		No. of Labour Force Members (l_h) (thousands)	No. of Workers (n_h) (thousands)	Gross Annual Incomes (w_h) (2001 dollars)	Unemployment Rate (u_h) (%)
Male	Higher Degree	107.8	103.984	70281	3.54
	Bachelor Degree	482.1	463.105	57536	3.94
	Skilled Labour	1316.1	1233.58	41535	6.27
	Unqualified	1912.2	1691.723	35941	11.53
Female	Higher Degree	51.2	49.034	51312	4.23
	Bachelor Degree	450	433.935	39285	3.57
	Skilled Labour	593.3	561.974	29072	5.28
	Unqualified	1761.5	1616.529	24267	8.23

Table A8:
Labour Force, Workers, Gross Annual Incomes and Unemployment Rate by Educational Attainment and Sex: 2001

		No. of Labour Force Members (l_h) (thousands)	No. of Workers (n_h) (thousands)	Gross Annual Incomes (w_h) (2001 dollars)	Unemployment Rate (u_h) (%)
Male	Higher Degree	138.8	134.233	74019	3.29
	Bachelor Degree	592.4	571.962	62856	3.45
	Skilled Labour	1453.6	1381.065	46245	4.99
	Unqualified	1828.3	1656.988	39335	9.37
Female	Higher Degree	84.6	81.74	56664	3.38
	Bachelor Degree	637.4	619.935	44188	2.74
	Skilled Labour	687.2	653.871	31674	4.85
	Unqualified	1780.9	1663.004	26933	6.62

Table A9:
Descriptive Statistics of the Different Measures of the Unemployment Rate over the Five Census Years

		$\tilde{u}$	u^{LN}	u^{CD}	u^{CES}	u^{LF}
Male	Mean	7.39	6.98	6.94	6.77	2.75
	Std Dev.	2.384	2.244	2.222	2.132	1.145
	Coef. of variation	0.323	0.322	0.32	0.315	0.416
	Min.	4.03	3.86	3.85	3.81	1.25
	Max.	10.49	9.95	9.88	9.6	3.85
Female	Mean	6.4	6.08	6.06	5.99	3.48
	Std Dev.	1.614	1.512	1.504	1.468	0.725
	Coef. of variation	0.252	0.249	0.248	0.245	0.209
	Min.	4.23	4.11	4.11	4.09	2.74
	Max.	8.33	7.9	7.88	7.77	4.55
Persons	Mean	6.97	6.68	6.64	6.5	2.64
(Method I)	Std Dev.	2.043	1.996	1.977	1.899	1.105
	Coef. of variation	0.293	0.299	0.298	0.292	0.419
	Min.	4.1	3.92	3.92	3.88	1.25
	Max.	9.61	9.32	9.26	9.01	3.85
Persons	Mean	6.97	6.56	6.53	6.41	3.02
(Method II)	Std Dev.	2.043	1.912	1.898	1.839	1.077
	Coef. of variation	0.293	0.291	0.291	0.287	0.356
	Min.	4.1	3.92	3.91	3.88	1.63
	Max.	9.61	9.07	9.03	8.84	4.32

Table A10:
Official Unemployment Rates (%)
Persons (15 years and over)

	Unemployment rate
June 1981	5.2
June 1986	7.2
August 1991	9.2
August 1996	8.1
August 2001	6.7

Data source: Labour Force, Australia, Spreadsheets
Table 03. Labour force status by sex (original series)
(ABS Catalogue No. 6202.0.55.001)

Table A11:
u^{CES} (%) **Calculated for Different Values of ρ**

		1981	1986	1991	1996	2001
Male	ρ = -8	3.77	6.42	9.32	7.52	5.98
	ρ = -2	3.83	6.67	9.74	7.84	6.17
	ρ = 0.5	3.85	6.78	9.91	7.98	6.26
Female	ρ = -8	4.08	6.73	7.65	6.25	4.9
	ρ = -2	4.1	6.86	7.82	6.38	4.99
	ρ = 0.5	4.11	6.92	7.89	6.43	5.02
Persons	ρ = -8	3.85	6.51	8.77	7.07	5.58
(Method I)	ρ = -2	3.9	6.73	9.14	7.34	5.75
	ρ = 0.5	3.92	6.82	9.29	7.46	5.82
Persons	ρ = -8	3.85	6.49	8.65	6.98	5.51
(Method II)	ρ = -2	3.89	6.7	8.93	7.2	5.64
	ρ = 0.5	3.91	6.78	9.05	7.29	5.7