ISSN 0819-2642
ISBN 0 7340 2506 8

THE UNIVERSITY OF
MELBOURNE

THE UNIVERSITY OF MELBOURNE

DEPARTMENT OF ECONOMICS

RESEARCH PAPER NUMBER 851

JULY 2002

A DISCUSSION OF THE APPROPRIATE METHOD FOR DECOMPOSING CHANGES OVER TIME IN A WEIGHTED AGGREGATE INTO ITS PROXIMATE DETERMINANTS AND AN APPLICATION TO MALE PARTICIPATION RATE CHANGES

by

Robert Dixon

Department of Economics
The University of Melbourne
Melbourne Victoria 3010
Australia.

A Discussion of the Appropriate Method for Decomposing Changes Over Time in a Weighted Aggregate into its Proximate Determinants and an Application to Male Participation Rate Changes

Robert Dixon

Department of Economics

The University of Melbourne

Melbourne Vic. 3010

The postal address for any correspondence is given above. The author's email address is r.dixon@unimelb.edu.au

ABSTRACT

This paper considers the most appropriate technique to be used to decompose moments over time of a weighted average into rate and weight (age) components and also proposes various graphical methods by which we can best present the results of decomposition procedures. The material is illustrated with reference to data on labour market participation by males in Australia over the period 1978 - 2001. The main findings are: First, that changes in the age composition are the main source of change in the (weighted) aggregate participation rate. Second, that it is the downward trend in the participation rate for males in the age group 25-54 which for some 6 or 7 years now has been virtually the only source of a reduced rate component in the aggregate. Changes in participation rates by older males, although quantitatively important prior to 1985, are no longer the main source of change in the aggregate participation rate for males.

KEYWORDS: Male Participation Rate Labor Force Australia

A Discussion of the Appropriate Method for Decomposing Changes Over Time in a Weighted Aggregate into its Proximate Determinants and an Application to Male Participation Rate Changes

1. Introduction

We often have need to consider the relative effects on aggregates over time of changes in their weights as against rates. Examples which come readily to mind are wondering how much of a change in an aggregate wage-share is due to changes in industry compositions and how much to changes in the wage shares in individual industries; How much of a change in the level of employment (or in employment growth) is due to changes in industry composition and how much to changes in employment in individual industries, and; how much of a change in an aggregate participation rate is due to changes in the age profile of the population and how much to changes in the propensity to be in the work force of individuals in those age groups. Sometimes we are interested in decomposing changes in the aggregate into these two components (that part due to changes in the weights and that part due to changes in the rates) because both are of interest. Sometimes it is because we believe the two are related in some behavioural sense and we wish to examine this relationship.[1] Sometimes we are primarily interested in the 'rate component' and are interested in ascertaining the effects of changes in the composition (or weights) on the aggregate solely in order to purge the aggregate measure of any composition effects before accepting certain stylised facts[2] or before testing behavioural models at the maco level (eg testing for encouraged/discouraged worker effects).

When exploring a weighted aggregate using a decomposition technique, there are a number of issues to be investigated/handled: How best to separate out the effects of changes in weights from changes in rates; How to establish the effects of any individual rate or weight changes of interest, and; How best to depict the results and especially the evolution of weights and rates over time. This paper is addressed in the first instance to how we ought best go about these tasks. It is thus 'descriptive' in the sense that it deals with the method by which we can and

[1] See Cunningham (1969) for an explanation of how we might proceed in this event. The case considered by Cunningham is the one mentioned above where relative employment growth in industries and changes in the (employment) composition of industry might be related.

[2] See Solow (1958) for an instructive example and one where he uses the removal of the effects of changing industrial composition to great effect.

should best describe something – namely sources of movement over time in a number which is a weighted aggregate.[3] The particular example I will use is the aggregate participation rate for Males in Australia and the aggregation will be by age group but the results can be easily applied to other aggregates (eg the wage share) and to any kind of disaggregation basis (eg by gender or educational attainment).

There are a number of reasons for exploring these matters (the choice of the most appropriate technique and the behaviour of male participation rates in the recent past): First, there does not seem to be an agreed decomposition procedure and as a result researchers use different and completely arbitrary methods. Second, the method chosen is rarely if ever justified and there is little or no recognition that alternative methods could have been used. Third, researchers are not making full use of the decomposition idea/algorithm as we can do more than simply compare in tabular form data points spaced widely apart in time, especially when the raw data is available quite frequently. The reason for using male participation rates as an application arises because the author is about to look at divergences between male participation rates across States (they have been diverging 'big time') and he has been keen to separate out rate and weight effects prior to modelling the changes. Also, it is some time since there was a systematic look at the trends and the inclusion of an 'Intergenerational Report' with the 2002-03 Budget Papers suggests that it is timely to do so.

2. Decomposition Algorithms

It is trivial to say that the ratio of the Aggregate Labour Force to the Aggregate Population (i.e. the aggregate participation rate - *PR*) is the weighted sum of the participation rates across age groups (i), so that:

[3] Measurement and, more importantly in some ways, computation are not discussed much by economists but it is important as we are usually dealing with (quite) discrete changes while our theories are often expressed using calculus which presumes that we are dealing with infinitesimally small changes in the variables. It seems to have escaped most commentators attention that Phillips deliberately chose to measure the rate of inflation in a particular way namely, "by expressing the first central difference of the index for each year as a percentage of the index for the same year" (1958, p 285) rather than the way it is usually measured and that he had good reasons for doing this (see also Lipsey, 1960, p. 2). Piero Sraffa's remarks on statistical c.f. theoretical measurement may be of interest to the reader (see Lutz and Hague, 1961, p 305f).

$$\frac{LF}{P}=\sum_i\left(\frac{LF_i}{P_i}\right)\left(\frac{P_i}{P}\right)$$

For any period, let:

$$PR_{it}=LF_{it}/P_{it}$$
$$s_{it}=P_{it}/P_t$$

then we may write

$$PR_t=\sum_i(PR_{it})(s_{it})$$

and an expression for the change in the aggregate participation rate between any two periods (t and $t-n$) may be written as:

$$PR_t-PR_{t-n}=\sum_i(PR_{it})(s_{it})-\sum_i(PR_{it-n})(s_{it-n}) \quad (1)$$

Clearly, there are two proximate sources of change in the aggregate participation rate. First, the value of the aggregate participation rate will change if over time there is a change in the participation rates (the PR_i*'s*) for the individual age groups. Second, the aggregate participation rate will change if there is a change in the age profile of the Population (that is, the s_i*'s* change). Over time both factors are likely to change, so that both elements will be contributing to any recorded change in the aggregate participation rate.

Our initial task is to find a mathematical rule which will enable us to 'decompose' changes in the aggregate participation rate into two components: (i) that part which reflects changes in the participation rate in the individual age groups (this will be some function of terms involving (PR_{it} - PR_{it-n})), and (ii) that part which reflects changes in the age structure of the population (this will be some function of terms involving (s_{it} - s_{it-n})). Clearly, there exist in principle a variety (indeed, an infinite variety) of procedures by which we might decompose the movement of a composite index into the movements of its constituent parts. Given this, and the possibility that different methods might result in different outcomes it would be nice to have a method which is suitable, agreed in advance and easy to apply.

The method I suggest we adopt for decomposing any weighted aggregate into weight and rate components uses a 'cross-weight' scheme of the type suggested by Edgeworth[4] and involves using the arithmetic mean of current and base year values as weights. The general principle to be invoked, as enunciated by Percy Harris (1966, p. 97n), is that "when calculating the contribution of one variable to a difference determined by the operation of two variables as a product, the weights adopted are the mean values of the other variable. That is, in general, $a'b' - ab = 1/2(a'+a)(b'-b) + 1/2(b'+b)(a'-a)$."

When this expression is written using the notation we have adopted above, equation (1) may be rewritten as:[5]

$$PR_t - PR_{t-n} = \sum_i 1/2(s_{it} + s_{it-n})(PR_{it} - PR_{it-n}) + \sum_i 1/2(PR_{it} + PR_{it-n})(s_{it} - s_{it-n}) \quad (2)$$

where the first term on the RHS of the above represents the effect of 'micro' changes in the participation rates of individual age groups as they respond to changing economic and financial regimes etc and the second term represents the effect of changes in the age composition of the population.

In presenting data in Tables in this paper I will refer to the first term as the 'rate component' (*ratec*) and the second term as the 'composition component' (*compc*). This means that (2) may be expressed as

$$PR_t - PR_{t-n} = ratec + compc \quad (2')$$

There is another way to arrive at these expressions ((2) and (2')) which some practitioners may find more appealing than the mere statement of principle given above.

We begin by arbitrarily adding and subtracting $\sum(PR_{it})(s_{it-n})$ to and from the RHS of (1) and then combining like terms. This gives

$$PR_t - PR_{t-n} = \sum_i PR_{it}(s_{it} - s_{it-n}) + \sum_i s_{it-n}(PR_{it} - PR_{it-n}) \quad (3)$$

[4] Obviously there is a relationship between the topic under discussion here and index number theory.
[5] It is easy to verify (by expansion and the cancellation of terms) that the expression is formally correct in the sense that the RHS equals the LHS.

Equation (3) is used by Borland (1997, p 23). However we can with equal validity arbitrarily add and subtract $\sum(PR_{it-n})(s_{it})$ to and from the RHS of (1) and then combine like terms to give

$$PR_t - PR_{t-n} = \sum_i PR_{it-n}(s_{it} - s_{it-n}) + \sum_i s_{it}(PR_{it} - PR_{it-n}) \tag{4}$$

Now (4) obviously has as much validity as (3). So in passing we should consider the circumstances under which these two expressions might be expected to yield similar (or dissimilar) results for (say) the estimate of the rate component, i.e we wish to identify the circumstances under which $\sum PR_{it}(s_{it} - s_{it-n})$ and $\sum PR_{it-n}(s_{it} - s_{it-n})$ will be approximately the equal. It is useful to approach the matter as follows: If there is to be no difference between the two then

$$\sum PR_{it}(s_{it} - s_{it-n}) - \sum PR_{it-n}(s_{it} - s_{it-n}) = 0$$

collecting like terms together gives:

$$\sum_i (PR_{it} - PR_{it-n})(s_{it} - s_{it-n}) = 0 \tag{5}$$

It follows that (3) and (4) will yield similar estimates of the rate component (and the composition component) if the LHS of (5) is zero or very close to zero. Leaving aside the trivial case where changes in the participation rates and the weights are <u>both</u> zero or extremely small we are left with the explanation that (3) and (4) will yield similar estimates of the rate component if changes in the participation rates $(PR_{it} - PR_{it-n})$ and changes in the weights $(s_{it} - s_{it-n})$ across age groups are completely uncorrelated, for in that event, and only in that event, we would expect the value of the LHS of equation (5) to be zero or very close to zero. By logical extension then, equations (3) and (4) will yield quite dis-similar estimates of the rate component (and the composition component) if changes in the participation rates and changes in the weights across age groups are highly correlated.[6]

[6] For the data we will look at later in the paper there is no reason to expect the two will be correlated and so we would expect, a priori, for both equations to give similar results and, indeed, we shall see that this is the case. Essentially this is because one feature of the current example is that one component (composition effects) given by nature (ageing) not choice in the light of economic circumstances whereas the other (rate effects) reflects choices. In fact, the correlation between changes in the participation rates and shares for the age groups reported in Table 3a is 0.101 for the whole period 1978-2001, -0.082 for the period 1978-1985, 0.194 for the period 1985-1992 and 0.058

To return to our main thread. Apriori, there is no reason to favour one of these (equations (3) and (4)) over the other. Given this, an obvious thing to do is to add these two together and take ½ of the result. If we did this we would arrive at equation (2) above. Because of this, and because of the appeal of the principle as enunciated by Harris I will use equation (2) as the decomposition algorithm and I would urge others to adopt this approach also.

In the sections which follow I apply this algorithm (equation (2) to look at weight (age) and rate effects on the participation rate of Australian Males.

3. Male Participation Rates in Australia

All of the data used in this paper has been obtained from the Australian Labour Force Statistics module of DX. Data for Labour Force and Population for Australia by age group copied over as original quarterly data (average of 3 months in the quarter) and participation rates for each age group derived as the ratio of the seasonally adjusted Labour Force to the seasonally adjusted Population.

Figure 1 shows the behaviour of the aggregate Male participation rate on a quarterly basis over the period 1978:2 – 2001:4. Over the whole of that period the participation rate declined from[7] 78.73 to 72.33, a reduction of 6.40.[8]

[FIGURE 1 NEAR HERE]

An obvious question to ask is the following: To what extent has the fall in the aggregate Male participation rate been a result of falling participation rates for specific age groups and to what extent has it been changes in the age composition of the male population? Before we explore

for the period 1992-2001. (Where rate and weight changes are correlated and both variables reflect decisions by agents the decomposition method used by Cunningham (1969) has value.)

[7] In this paper all 'annual' values are computed as average (of 4 quarters) values at start (in this case 1978:2-1979:1) and end of the period (in this case 2001:1-2001:4).

[8] The fall in the participation rate by Males is in the order of 8% over the initial level. This would translate into a fall in Output per capita (males 15 and over) by a similar amount were it not for the rise in labour productivity which took place over the period. The fall in male labour force participation would also have been associated with a fall in output per head of total population but for productivity growth and increased participation by Females.

these questions however it is sensible to state what previous research[9] suggests that the answers would be.

A fair summary of recent research findings on Male participation rates in Australia would include the following: (a) male participation rates for most if not all age groups have been falling; (b) the effects of changes in the age composition of the Male population on the aggregate participation rate for Males are negligible[10] (this is explicit in Borland (1995) and (1997)[11] and implicit in Fitzgerald (2001)), and; (c) the fall in the aggregate Male participation rate primarily reflects marked reductions in participation rates for older Males (and in particular Males aged 55-64).[12] One task of the present paper is to critically evaluate these findings and also to see if these findings still hold given that most previous studies of participation rates used data sets ending in the early or mid nineteen nineties.[13]

Table 1[14] and Figure 2[15] show participation rates by age groups while Table 2 shows the extent of the change for the whole period and for various sub-periods. Participation rates have typically fallen over the period for all age groups and for most sub-periods with the most dramatic falls being for males in the age group 60-64 in the period 1978-1985, for males in the age groups 55-59 over the period 1978-1995 and for younger males in the age group 15-19 in the period 1985-1992.

[TABLE 1 AND 2 NEAR HERE]

---

[9] I have in mind in particular the papers by Borland (1995 and 1997), Debelle and Swan (1998), Kenyon and Wooden (1996) and Fitzgerald (2001).

[10] Or, indeed, that they have acted to <u>raise</u> rather than lower the aggregate male participation rate (Borland, 1995, p 596).

[11] "[For the period 1973-93] compositional changes cannot explain changes that have occurred in labour force participation" (Borland, 1995, p 596). "The main influence on the aggregate participation rate [over the period 1966-96] have been from changes in the participation rate of the specific demographic groups." (Borland, 1997, p 24).

[12] "Declining participation by Males (over the period early 1960's to 2000) "relates almost entirely to early retirement by *older* males" (Fitzgerald, 2001, p 271 - emphasis in the original). On pages 273f it is clear that by older he means "males in the 55-64 age bracket". Borland also puts this view, he writes: "The decrease in aggregate [male] labour force participation has been primarily due to decreases in participation by older men ... (1995, p 587). "For males it is evident that the main causes of the declining participation rate have been decreases in participation for males aged 60-64 years between 1966 and 1986, and aged 45-54 years and 55-59 years between 1976 and 1986" (Borland, 1997, p 25). Although Kenyon and Wooden (1996, p 15) in their excellent survey list "declining older male participation" as one of the "major recent changes and trends in Australian labour supply that need to be explained" they go on to say that "the main changes in participation rates have occurred for <u>younger and</u> older workers" (p 21, my emphasis).

[13] Fitzgerald's 2001 paper is the major exception.

[14] None of the results reported in this paper are sensitive to the age groupings adopted as is demonstrated in Table 3. Detailed tables for all age groups (15-19, 20-24, 25-34, 35-44, 45-54, 55-59, 60-64 and 65 plus are available on request.

[15] To ensure the Figures involving data for different age groups are able to be read easily I will only present in graphical form data for the four age groups 15-24, 25-54, 55-64 and 65 plus.

[FIGURE 2 NEAR HERE]

In Figure 2 we see the slow and continuous decline in the participation rate for prime age males[16] (males aged 25-54), the marked fall in the participation rate for males aged 55-64 in the first half of the 1980's (and only in that period, see Figure 3 for details) and the movement initially up and then primarily down during the two recession episodes of the participation rate for the 15-24 age group[17] (see Figure 4 for details).

[FIGURES 3 AND 4 NEAR HERE]

Figure 5 shows the proportions of the total male civilian population over the age of 15 taken up by different age groups over the period 1978:2 – 2001:4. We see that the proportion of males in the prime age group (25-54) was rising until 1997 but has been falling since then. Also evident is that there has been a persistent fall in the proportion in the age group 15-24 over the whole of the period and that the proportions of the male population in the age groups 55-64 and 65 plus have been rising (the former since 1994, the latter throughout the whole of the period).

In then next section I look at the relative importance of rate and weight effects on the aggregate participation rate of Australian Males.

4. Decomposition across the whole period and various sub-periods

Tables 3a-3c shows rate and composition components for different age groupings arrived at using equation (2) above.[18] All of the age disaggregations convey the same impressions,[19] namely: rate components for all age groups are negative;[20] at the aggregate level, both the rate and composition components are negative and; over the whole period 1978-2001 the

[16] Although the rate at which it is falling may have slowed markedly in the most recent 2 – 3 years.
[17] Lewis and McLean (1998) point out that during the period under consideration there were marked increases in educational participation of the 15-19 age group in particular in the early 80's and again in the early 90's.
[18] For the case with the most disaggregation (Table 3a), equation (3) gives –4.296 for ratec and –1.553 for compc, while Equation (4) gives –4.856 for ratec and –1.622 for compc. Thus in this case there is little difference in the results, but that is no reason to prefer (3) or (4) over (2).
[19] And for this reason in future tables I will work only with the age groupings: 15-24, 25-34, 35-44, 45-54, 55-64 and 65 & over.
[20] Obviously this is not possible for all composition components and that any age group whose share in the total population is declining will show a negative composition component no matter what the (relative) size of that age group's participation rate.

composition effect (while not negligible, it explains around ¼ of the reduction in the aggregate participation rate over the period 1978-2001) is smaller than the rate effect.

[TABLES 3a-c NEAR HERE]

Table 4 shows rate and composition effects for three sub-periods; 1978-1985; 1985-1992 and 1992-2001. We see that the importance of changes in the participation rate for older workers is confined to the first sub period (as Figures 2 and 3 would suggest). While not all rate components are negative in all periods, the aggregate rate and composition effects are negative in all three sub-periods. Perhaps of most interest is that it would appear that the rate component is becoming less important (becoming less negative) while the composition component is becoming more important (becoming more negative) both in absolute terms and relative to the rate component. As proportions of the total change the composition effects are 10% for the period 1978-1985, 33% for the period 1985-1992 and 47% for the period 1992-2001. This suggests that it may be informative to focus on a very recent sub-period. This is done in Table 5, where we look at the rate and composition components for the period 1997-2001.

[TABLE 4 NEAR HERE]

[TABLE 5 NEAR HERE]

It is clear from Table 5 that composition changes rather than rate changes have become the dominant determinant of movements in the aggregate male participation rate in recent years. (obviously it is sensible to focus on the relative size of the two components as their absolute size will vary with the length of the interval considered).

In this section we have looked at Tables depicting rate and composition effects for various arbitrary beginning and end points. In the next section I argue that we can use an expository device which did not depend upon the arbitrary selection of a beginning and end period, or at least, which presents the results in a way where the reader could easily make comparisons across any time period they wish.

5. A Graphical Depiction of the Relative Size and Importance of Rate and composition Components

There is no reason why we should restrict ourselves to generating tables involving comparisons between values of a weighted aggregate at each end of a lengthy and arbitrarily selected time period, indeed a comparison of the results in Tables 4 and 5 compared Table 3 suggests that this may be unwise.

Instead (or in addition) it is possible to use equation (2) to generate period on period-before rate and compositional changes on a rolling basis throughout the whole of the time period for which we have data and at whatever frequency we choose (in what follows I will use quarter on previous quarter computations). The series for *ratec* and *compc* for each quarter are reported in Figures 6 and 7. This information is not very useful as there is clearly a lot of noise in the data although we can see that the two series are tending to move in opposite directions in recent years which is also consistent with the notion that composition effects have dominated in recent times.

[FIGURES 6 AND 7 NEAR HERE]

While knowledge of *ratec* and *compc* for individual quarters in this case yields little useful information, we can use the data for *ratec* and *compc* for individual quarters to do a number of things of more use to us. For example we can generate a series for the aggregate participation rate with the effects of compositional change removed (I will denote this as *PR**) thus arriving at a series which will show us the effects on the aggregate participation rate of changes in the 'rates' alone. This series can be established by creating an index with:

$$PR^*_t = PR^*_{t-1} + ratec_t$$

and $PR_0 = PR$ in the initial period (1978:2 in our study).

Figure 8 depicts the series for PR*, that is the aggregate participation rate which has been purged of the effects of compositional change given in. For comparison the original series is also given in the figure.

[FIGURE 8 NEAR HERE]

Figure 8 shows that the negative contribution of changes in rates has been persistent over the period but that some of the fall in the actual participation rate reflects the persistent negative contribution of composition effects (we know that this is the case because the solid line – the actual aggregate participation rate – lies below the dashed line – the rate purged of composition effects). Furthermore, by comparing the relative slopes of the two lines over any interval we are interested in we can see whether the rate component is working in the same direction as the composition component and also their relative strengths. For example we can see in the Figure that for the final 5 – 7 years the line depicting the participation rate with the composition effects removed has a (much) shallower slope than the solid line which shows us the behaviour of the actual participation rate over the same time period. This is showing graphically what we had already picked up from Tables 4 and 5 and by comparing Figures 6 and 7, namely that the composition component has been increasing in importance and in recent years that it has become the dominant component.

Another way to portray the relative size of rate and composition effects is to create a cumulative index of each of them.[21] Each of the indexes for the cumulative values is arrived at by the application of the following rule:

$cum * c_t = cum * c_{t-1} + *c_t$
and $cum * c_0 = 100$

Figure 9 sets out the behaviour over time of indices for the cumulative values of *ratec* and *compc*. Note that again, it is the relative slope of the two series over any time interval that we are primarily interested in, not the absolute value at any date.

[FIGURE 9 NEAR HERE]

It is clear by comparing the slopes of the two series that the negative rate contribution was most dominant (had the steepest (downwards) slope) in the periods of rising and high unemployment, that is the periods 1981-4 and 1990-3 and that since the mid-nineties composition effects have been as strong if not stronger (since 1997 at least) in their negative influence than rate effects.

We can also compute cumulative indexes for individual age groups. Figure 10 shows cumulative indices for the rate component for the age groups 15-24, 25-54, 55-64 and 65 plus.

[FIGURE 10 NEAR HERE]

[21] A graph of *ratec* and *compc* over time is available upon request. I am here borrowing an idea from Solow who, in his study of technological change (1957, p 315), moved from a display of dA/A in any period to construct an index of 'A'.

The most striking feature of this Figure is that for almost a decade now the only persistent negative rate contribution has been from the declining participation rate of prime age males.[22]

6. Conclusions

This paper has dealt with two issues. One refers to the most appropriate technique to be used to decompose moments over time of a weighted average into rate and weight components. I have argued in favour of a particular decomposition algorithm as describe in equation (2) in the paper. I have also suggested that researchers are not making full use of the decomposition idea/algorithm and have proposed various graphical methods by which we can present the results of decomposition procedures. The other matter dealt with was with determining a new and up to date set of stylised facts in relation to male labour market participation. The main findings in this paper may be summarised as follows: First, that changes in the age composition are the main source of change in the (weighted) aggregate participation rate. Second, that it is the downward trend in the participation rate for males in the age group 25-54 which for some 6 or 7 years now has been virtually the only source of a reduced rate component in the aggregate. Changes in participation rates by older males, although quantitatively important prior to 1985, are no longer the main source of change in the aggregate participation rate for males.

[22] And that decline may well be slowing.

References

Borland, J. (1995), 'Male labour market participation in Australia', *Journal of Industrial Relations*, 37, 587-609.

Borland, J. (1997), 'Changes in the Supply of Labour in Australia', in Industry Commission, *Changing Labour Markets: Prospects for Productivity Growth*, Melbourne, 19-44.

Commonwealth Government, (2002), *Intergenerational Report: 2002-03 Budget Paper No. 5*, Canberra.

Cunningham, N. (1969), 'A Note on the Proper Distribution of Industry', *Oxford Economic Papers*, 21, 122-7.

Debelle, G. and Swann, T. (1998), 'Stylised Facts of the Australian Labour Market', Reserve Bank of Australia Research Discussion Paper: 9804, Sydney.

Fitzgerald, V. (2001), 'Demography and Growth', in J. Nieuwenhuysen et al (eds), *Reshaping Australia's Economy*, Cambridge University Press, Cambridge, 268-91.

Harris, C. (1966), 'Interregional Variations in the Levels and Rates of Increase of Per Capita Personal Income', *Yorkshire Bulletin of Economic and Social Research*, 18, 95-108.

Kenyon, P. and Wooden, M. (1996), 'Changes in the Supply of Labour in Australia', in K. Norris and M. Wooden (eds), *The Changing Australian Labour Market*, Economic Planning Advisory Commission Paper No 11, AGPS, Canberra, 15-38.

Lewis, P. and Mclean, B. (1998), 'The Youth Labour market in Australia: A Survey', *Australian Journal of Labour Economics*, 2, 157-72.

Lipsey, R. (1960), 'The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957: A Further Analysis', *Economica*, 27, 1-31.

Lutz, F. and Hague, D. eds. (1961), *The Theory of Capital*, Macmillan, London.

Phillips, A. (1958), 'The Relation Between Unemployment and the Rate of Change of Money Wage Rates in the United Kingdom, 1861-1957', *Economica*, 25, 283-300.

Solow, R. (1957), 'Technical Change and the Aggregate Production Function', *Review of Economics and Statistics*, 39, 312-20.

Solow, R. (1958), 'A Skeptical Note on the Constancy of Relative Shares', *American Economic Review*, 48, 618-31.

Figure 1 Participation Rate for Males (%) - Australia 1978:2 – 2001:4

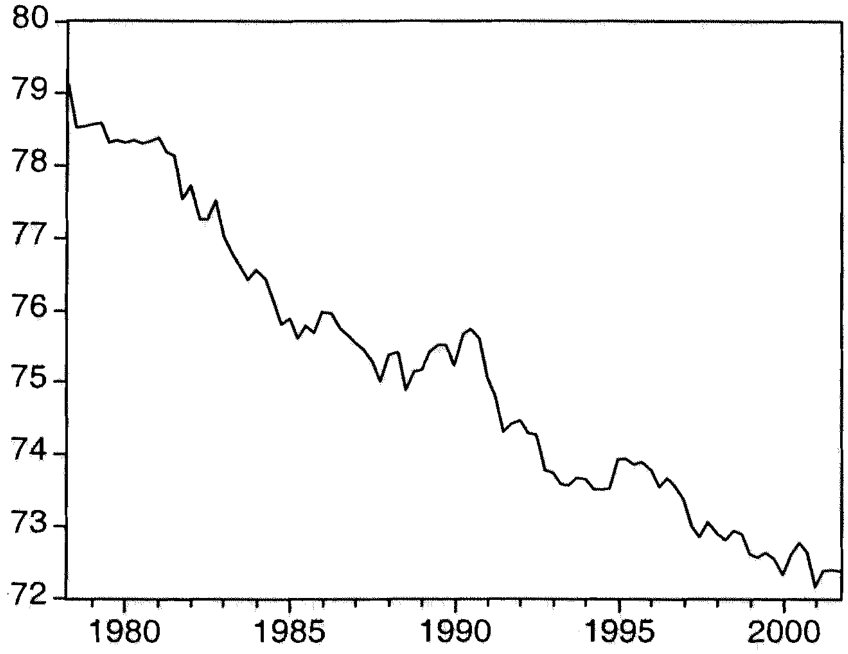

Figure 2 Male Participation Rate (%) by Age Groups 1978:2 – 2001:4

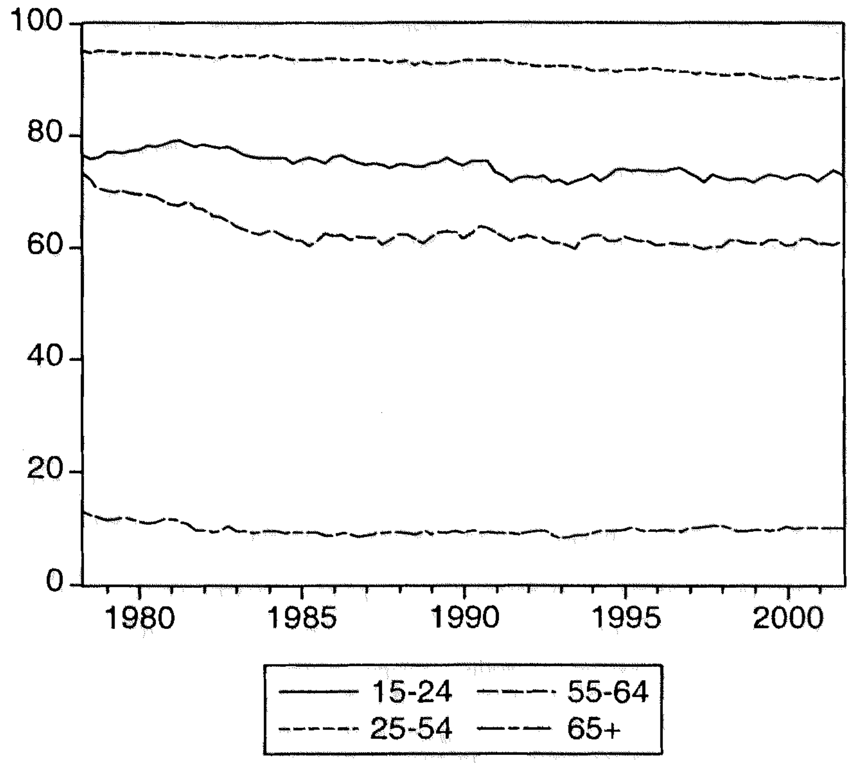

Figure 3 Participation Rate for Males Aged 55-64: 1978:2 – 2001:4

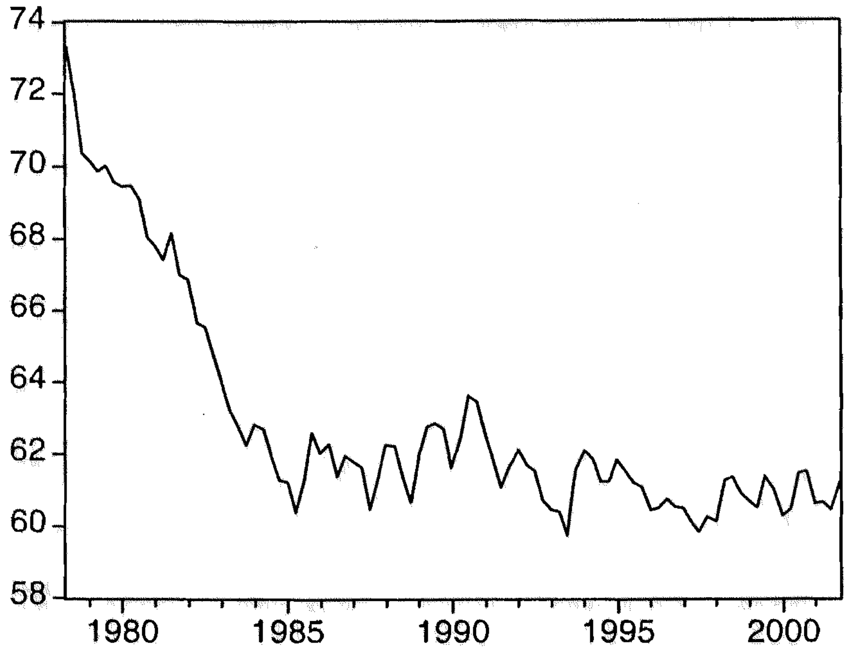

Figure 4 Participation Rate for Males Aged 19-24: 1978:2 – 2001:4

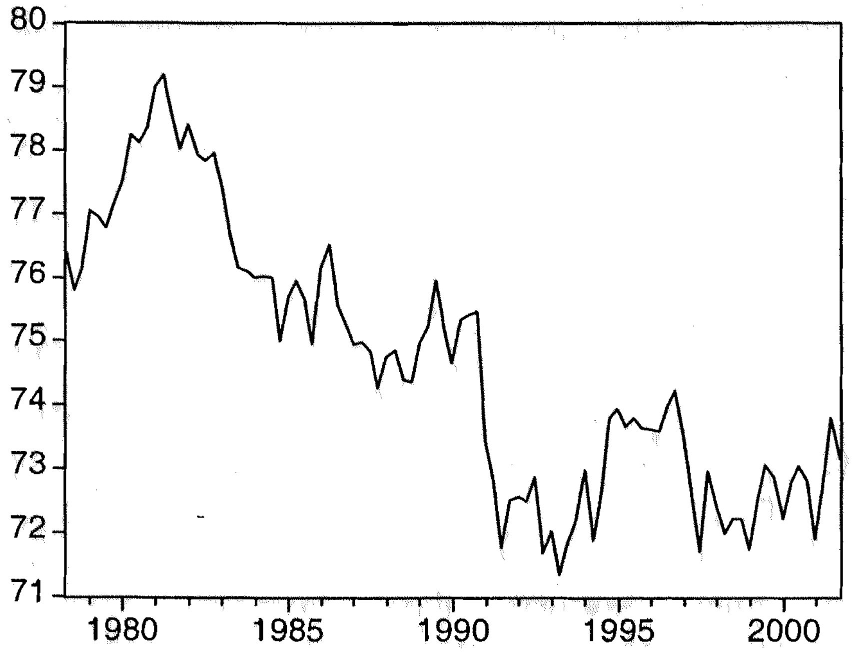

Figure 5 Male Population: Proportions of Total by Age Groups 1978:2 – 2001:4

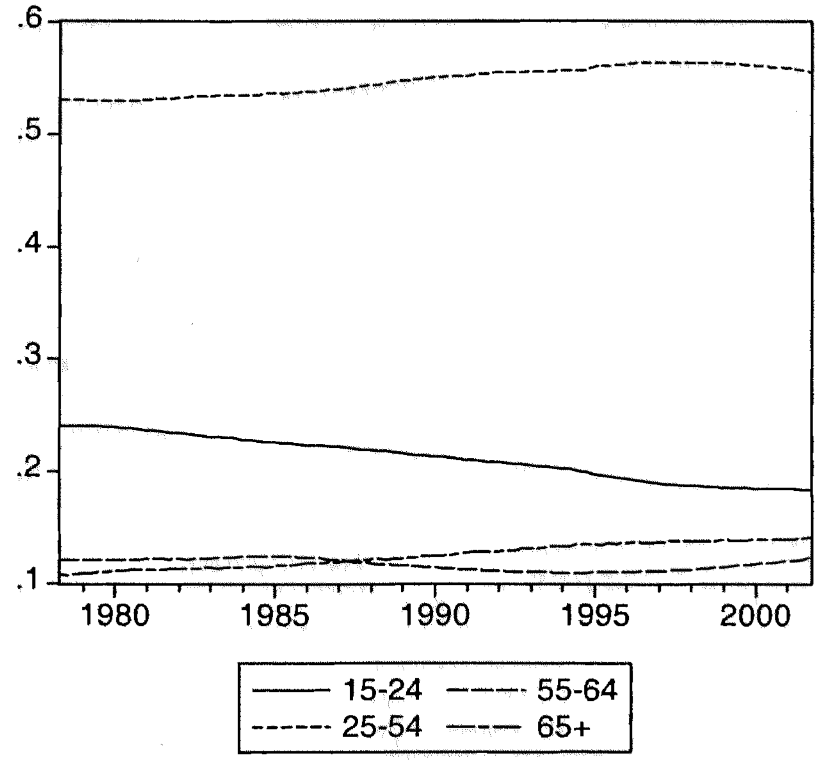

Figure 6 Rate Component for Each Quarter: 1978:2 – 2001:4

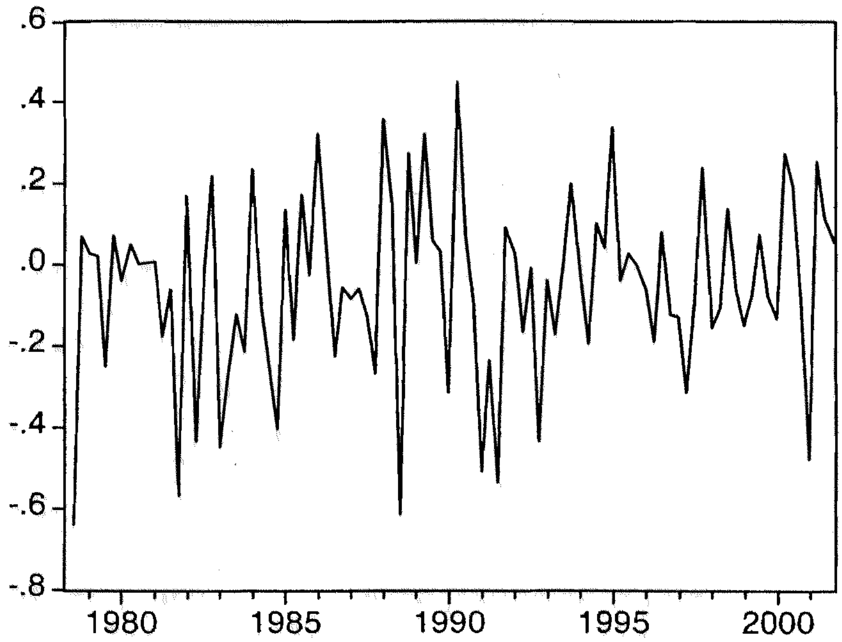

Figure 7 Composition Component for Each Quarter: 1978:2 – 2001:4

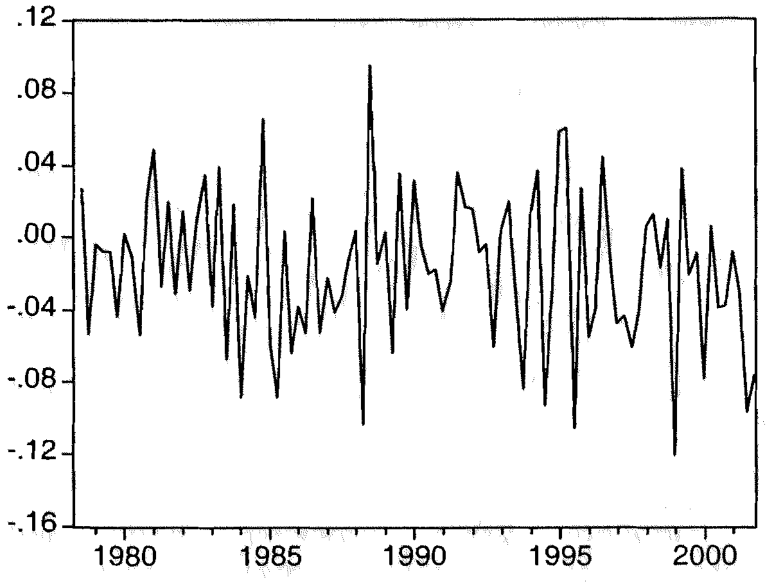

Figure 8 Actual Participation Rate (solid line) and Participation Rate with Composition Effects Removed (dashed line)

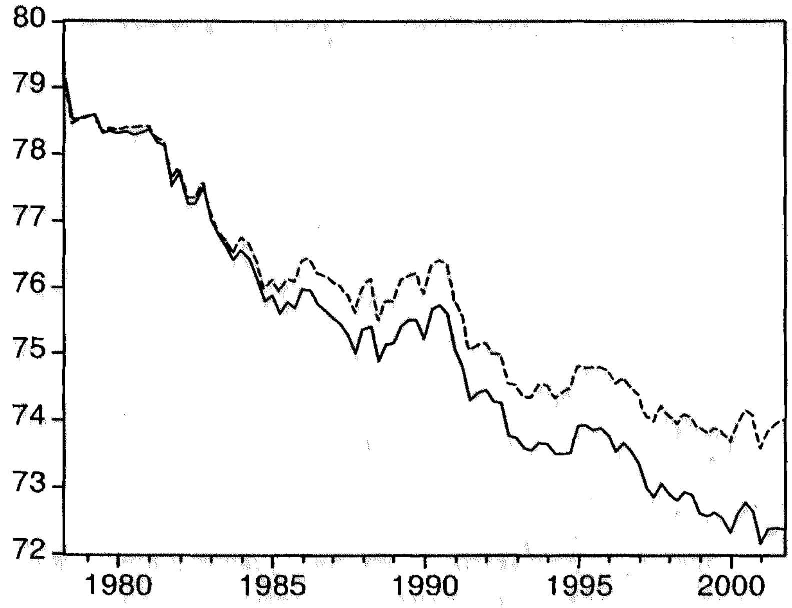

Figure 9 Cumulative Rate Component (solid line) and Cumulative Composition Component (dashed line)

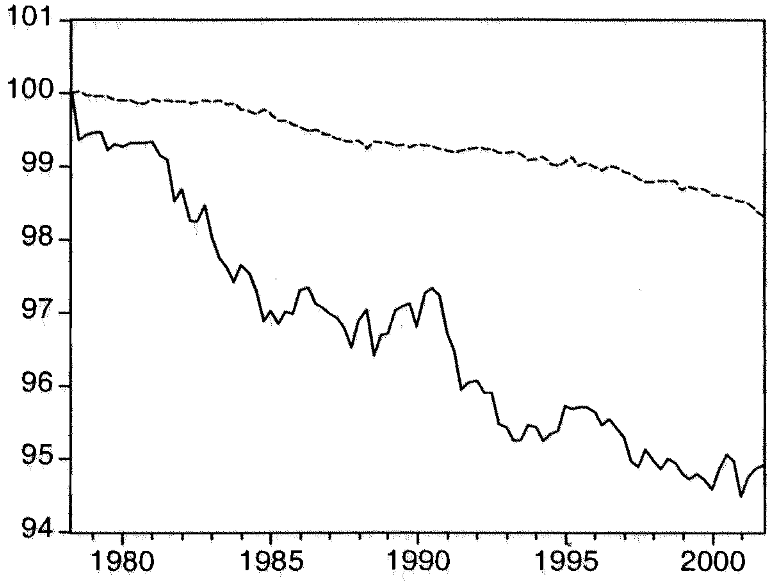

Figure 10 Cumulative Rate Component (CUMRC) for Different Age Groups

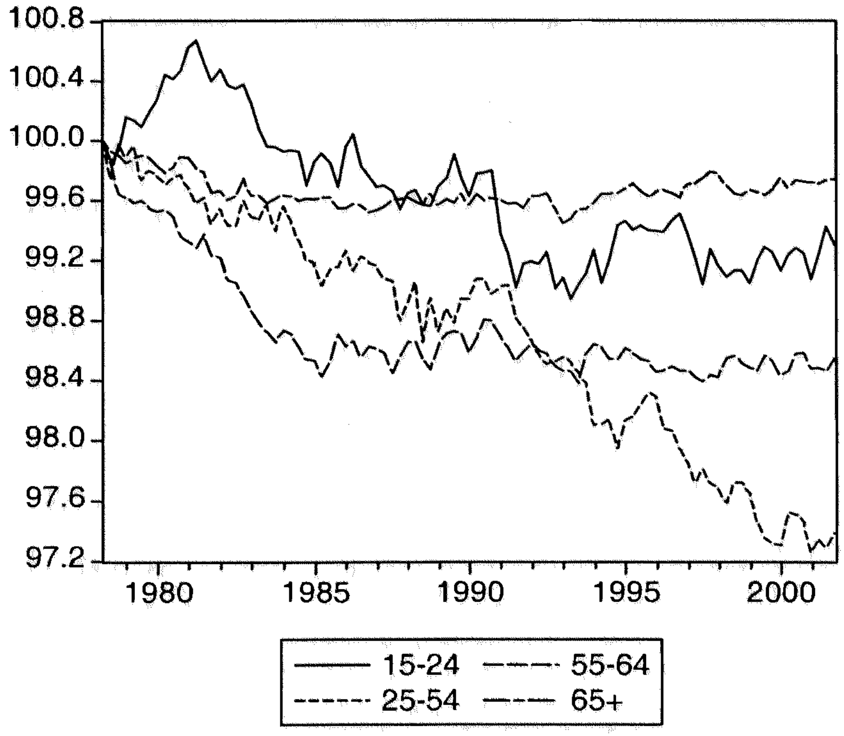

Table 1 Male Participation Rates by Age Group[1]

Age Group	1978	1985	1992	2001
15-19	63.29	60.86	55.88	60.27
20-24	90.67	90.22	88.12	85.53
25-34	96.28	94.82	93.78	91.47
35-44	95.97	94.65	93.67	91.35
45-54	91.77	90.05	88.95	87.55
55-59	82.35	76.85	73.17	71.75
60-64	57.99	43.58	49.45	46.85
65+	11.99	9.20	9.20	10.05
Total	78.73	75.95	74.20	72.33
15-24	76.35	75.74	72.41	72.92
25-54	94.91	93.57	92.43	90.20
55-64	71.48	61.16	61.53	60.74

Table 2 Changes in Male Participation Rates by Age Group

Age Group	1978-85	1985-92	1992-2001		1978-2001
15-19	-2.43	-4.98	4.39		-3.02
20-24	-0.45	-2.10	-2.59		-5.14
25-34	-1.46	-1.04	-2.31		-4.81
35-44	-1.32	-0.98	-2.32		-4.62
45-54	-1.72	-1.10	-1.40		-4.22
55-59	-5.50	-3.68	-1.42		-10.60
60-64	-14.41	5.87	-2.60		-11.14
65+	-2.79	0.00	0.85		-1.94
Total	-2.78	-1.75	-1.87		-6.40
15-24	-0.61	-3.33	0.51		-3.43
25-54	-1.34	-1.14	-2.23		-4.71
55-64	-10.32	0.37	-0.79		-10.74

[1] Figures for each year are averages of 4 quarters.

Table 3 Contribution to Change Over the Whole Period (1978:2 – 2001:4) Computed Using Equation (2) in the Text[2]

3a

Age Group	*ratec*	*compc*	Row sum
15-19	-0.329	-2.101	-2.430
20-24	-0.532	-2.026	-2.558
25-34	-0.984	-2.722	-3.706
35-44	-0.818	2.810	1.992
45-54	-0.684	2.152	1.468
55-59	-0.710	0.000	-0.710
60-64	-0.596	-0.052	-0.648
65+	-0.239	0.353	0.114
Column sum	-4.891	-1.587	-6.478

3b

Age Group	*ratec*	*compc*	Row sum
15-24	-0.727	-4.329	-5.056
25-34	-0.984	-2.722	-3.706
35-44	-0.818	2.810	1.992
45-54	-0.684	2.152	1.468
55-64	-1.294	-0.066	-1.360
65+	-0.239	0.353	0.114
Column sum	-4.745	-1.803	-6.548

3c

Age Group	*ratec*	*compc*	Row sum
15-24	-0.727	-4.329	-5.056
25-54	-2.562	2.406	-0.156
55-64	-1.294	-0.066	-1.360
65+	-0.239	0.353	0.114
Column sum	-4.822	-1.636	-6.458

[2] The aggregate of both effects (-6.478, -6.458 and –6.458) don't exactly equal each other due to rounding.

Table 4 Contribution to Changes Over Three Sub-periods

1978-85

Age Group	*ratec*	*compc*	Row sum
15-24	-0.142	-1.217	-1.359
25-34	-0.318	-0.287	-0.604
35-44	-0.230	2.287	2.058
45-54	-0.246	-1.273	-1.519
55-64	-1.259	0.133	-1.126
65+	-0.308	0.074	-0.234
Column sum	-2.503	-0.282	-2.785

1985-92

Age Group	*ratec*	*compc*	Row sum
15-24	-0.719	-1.333	-2.053
25-34	-0.220	-0.754	-0.975
35-44	-0.187	0.942	0.754
45-54	-0.157	1.253	1.096
55-64	0.043	-0.859	-0.816
65+	0.000	0.138	0.138
Column sum	-1.241	-0.614	-1.855

1992-2001

Age Group	*ratec*	*compc*	Row sum
15-24	0.099	-1.744	-1.645
25-34	-0.460	-1.667	-2.127
35-44	-0.450	-0.370	-0.820
45-54	-0.227	2.118	1.891
55-64	-0.090	0.672	0.582
65+	0.114	0.096	0.210
Column sum	-1.014	-0.895	-1.908

Table 5 Contribution to Change over the Period 1997-2001

Age Group	*ratec*	*compc*	Row sum
15-24	0.039	-0.364	-0.325
25-34	-0.301	-0.738	-1.039
35-44	-0.156	-0.551	-0.707
45-54	0.043	0.525	0.567
55-64	0.065	0.544	0.609
65+	-0.014	0.020	0.006
Column sum	-0.324	-0.564	-0.888