PRODUCTIVITY COMMISSION

Resource Movements and Labour Productivity, an Australian Illustration: 1994-95 to 1997-98

Staff Research Paper

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1 Introduction

1.1 Background and objectives

Australia's labour productivity has improved substantially since the recession of the early 1990s. Australian Bureau of Statistics (ABS) estimates show that labour productivity growth in the market sector averaged 3.1 per cent a year between 1993-94 and 1999-2000, in contrast with long-term annual average growth prior to 1993-94 of 2.2 per cent (ABS 2000).

In seeking to better understand the factors that led to this improvement, the Productivity Commission developed a framework of productivity growth determinants (PC 1999). Reallocation or movement of resources from less to more productive firms is one element of the framework. To date, a lack of suitable data has limited empirical analysis of this phenomenon for Australia. This paper uses a recently released dataset to address this gap in the literature. An important feature of the analysis is that it examines labour productivity at the level of the firm, in contrast to most analyses to date that have used more aggregated data.

In this study, resource movements result from the exit of firms that cease operation, the entry of start-up firms, and changes in employment shares at incumbent firms.[1] Productivity is measured as the ratio of value added to full-time equivalent workers, that is, as labour productivity. While capital flows and changes in capital productivity are interesting research topics, data limitations preclude them from the current analysis.

In addition, it must be emphasised that labour productivity improvement is not necessarily an indication of good firm performance. A firm could substitute capital for labour but use relatively more inputs to produce a given level of output. While this would result in an increase in labour productivity, total factor productivity would have fallen.

[1] The term resource 'reallocation' is used in the relevant literature. Because the analysis presented in this paper is based on a sample of firms and it is unlikely that resources flow, or are reallocated, only between firms in the sample, the term resource movements is adopted.

Despite this drawback, many studies investigate trends in labour productivity because, in contrast with total factor productivity, data are often more readily available, and analysis of labour productivity does provide some insights into firm performance.

Data limitations also place special caveats on the results. In this study the dataset used is not representative of the population of Australian firms, but it is the only one of its kind available (characteristics of the data are discussed in section 1.3). The paper therefore represents an exploration of this dataset for insights into firm-level dynamics of productivity change. The results reflect the activity of firms included in the sample and not the activity of all Australian firms.

Investigation of the role of resource movements in labour productivity change begins with a decomposition analysis. However, decomposition methodologies of the type adopted are limited in the insights they permit into the contribution of resource movements to labour productivity change. In this paper, therefore, the traditional decomposition approach is supplemented by an analysis of a taxonomy of firms in operation for the duration of the survey.

1.2 Major findings from the literature

The increasing availability of suitable data has generated a growing body of research that investigates productivity at the firm level (for example for the United States, Baily, Hulten and Campbell 1992; Baily, Bartelsman and Haltiwanger 1994; Baldwin 1995; Haltiwanger 1997; Bartelsman and Dhrymes 1998; Foster, Haltiwanger and Krizan 1998; and Bartelsman and Doms 2000).

Many of these studies comment on the distribution of productivity at the firm level. All, whether looking at total factor or labour productivity, conclude that firm performance is heterogeneous. Even firms with similar observable characteristics can report considerably different productivity levels and rates of growth.

Productivity differences have been found to be reasonably persistent across time. Bartelsman and Dhrymes (1998) in a study of total factor productivity find that one-third of US manufacturing firms remained in the same quintile of the productivity distribution over a five-year period. And studies of the distribution of productivity have in common the finding that firms with high levels of productivity are less likely to exit business than are firms with low levels.

Analyses of productivity change (both total factor and labour productivity) have concluded that the net changes observed in aggregate data comprise large increases at some firms and decreases at others.

Studies have also shown that resource movements (or reallocation) has played an important positive role in total factor productivity growth. In a study of total factor productivity change in US manufacturing from 1977 to 1987, Haltiwanger finds that 'about half of the increase in productivity for the average industry is accounted for by composition effects involving the reallocation of output across production sites' (1997, p. 65).

Research into labour productivity growth, however, has found a smaller role for resource reallocation (for example Foster et al. 1998). This is to be expected because resource reallocation is captured only in changing employment shares in these analyses and significant labour productivity improvement occurs as firms employ more capital per worker.

Haltiwanger (1997) found that the entry and exit of firms accounted for about 18 per cent of average industry total factor productivity change in US manufacturing for the period 1977–87. The contribution to productivity change (both total factor and labour) of resource reallocation associated with this entry and exit is larger the longer the time horizon considered.

In a study of US manufacturing, Baily, Bartelsman and Haltiwanger (1994) extended the analysis of resource reallocation. They found that 'plants that raised employment as well as productivity contributed almost as much to overall productivity growth in the 1980s as the plants that raised productivity at the expense of employment' (p. 25).

1.3 The Business Longitudinal Survey

This study uses data on Australian firms (management units) from the ABS's *Business Longitudinal Survey* (BLS).[2] The BLS is a rich panel dataset collected from Australian firms for the years 1994-95 to 1997-98. The data cover firms in the non-agriculture market sector. Firms in the government sector are excluded — including those in Utilities, Telecommunications, Education, Health and Community services. In addition, firms in selected personal service subdivisions are excluded.

[2] The management unit is the highest level accounting unit within a business for which detailed accounts are maintained (ABS 1998). Generally this coincides with the legal entity owning the business, and therefore the management unit is more aligned toward a 'firm' rather than 'establishment' or 'plant'. However, large businesses may have several management units, corresponding with a division or line of business. In these cases, the management unit will not necessarily coincide with the legal entity. For ease of exposition, 'firm' is used for 'management unit'.

While the BLS is a valuable resource, it has a number of features that present challenges to researchers seeking to use it. These challenges and approaches to dealing with them are documented in Will and Wilson (2001).

In terms of this paper, the features of the data have meant that the analysis is performed on a selected sample of firms from the BLS. The sample, referred to as the 'RR sample', is restricted to firms with less than 200 workers and excludes a considerable number of firms deemed to be outliers or for which data were missing. The exclusion of these observations means that population representative results cannot be obtained. The analysis is therefore 'within sample' — inferences about the population of firms from which the BLS was drawn are not made.

In addition, small sample sizes in some industries restrict the analysis to six industries — Manufacturing, Construction, Wholesale trade, Retail trade, Accommodation, cafes and restaurants and Property and business services. The difference in coverage between the sample and broader population of Australian firms as at 1997-98 are highlighted in table 1.1. Further detail on the RR sample and its construction is presented in chapter 3, appendix B and Will and Wilson (2001).

Table 1.1 **The RR sample versus the economy, 1997-98**

		RR sample	*Economy*
GDP	$bn	6.2	564.7
Employment			
Total	'000	115	7650
By firm size (workers)[a]			
1 to 4	%	1.9	19.9
5 to 19	%	11.9	34.9
20 to 99	%	57.8	32.6
100 to 199	%	28.4	12.6
By industry[b]			
Manufacturing	%	47.9	22.7
Construction	%	4.0	12.8
Wholesale trade	%	19.9	10.9
Retail trade	%	12.0	25.7
Accommodation, cafés and restaurants	%	4.0	8.8
Property and business services	%	12.9	19.0

a The data on employment by firm size for the economy cover only private sector workers. Firms with more than 200 workers are excluded from the comparison because they are not in the BLS file used for this research. **b** The presentation of employment data for only six industries reflects the industry coverage of the RR sample.

Sources: For the economy: ABS (*Australian System of National Accounts 1999-00*, Cat. no. 5204.0); ABS (*Labour Force, Australia*, Cat. no. 6203.0); ABS (*Small Business in Australia 1999*, Cat. no. 1321.0). For the RR sample: ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

The firms included in the RR sample account for only 1.1 per cent of Australia's value added and 1.5 per cent of Australia's workers. In addition, firms with 20 to 199 workers are over-represented, and firms with more than 200 workers are excluded. Firms in the Manufacturing and Wholesale trade industries are considerably over-represented in the RR sample while those in Construction and Retail trade are under-represented.

1.4 Structure of the paper

The paper is structured as follows. The methodological approach, including the decomposition technique and a taxonomy of firms that flows from components of the decomposition, is described (chapter 2). Characteristics of the data used in the empirical analysis and the labour productivity measure are summarised (chapter 3). Results from application of the decomposition technique and firm taxonomy are then presented (chapter 4). A summary of results and discussion of possible directions for future research concludes the paper (chapter 5).

2 A decomposition framework

Substantial movements of labour and capital accompany the entry and exit of firms, and the expansion and contraction of firms that operate continuously over the period of the survey (continuing firms). A number of overseas studies (Baily et al. 1994; Foster et al. 1998) have used decomposition techniques to analyse the contribution made by these resource movements to productivity growth.

The Foster et al. decomposition methodology is adopted in this paper. Interpretation of components of the decomposition proved not to be straightforward. This prompted the development of an alternative analytical tool — a taxonomy of firms. The decomposition methodology, reservations about its usefulness and the taxonomy are described in this chapter.

2.1 Decomposition methodology

The decomposition progresses from a measure of labour productivity.[1]

For any group of firms, average labour productivity (P) is the sum of value added produced by each firm (VA_f) divided by the sum of each firm's employment (L_f), or total employment for the group of firms (L).

$$P = \frac{\sum VA_f}{\sum L_f} = \frac{\sum VA_f}{L} \tag{1}$$

Average labour productivity can also be expressed as the weighted sum of individual firms' labour productivity (P_f) where the weights are each firm's share of employment ($L_f/L = S_f$).[2]

$$P = \sum \frac{L_f}{L} \frac{VA_f}{L_f} = \sum S_f P_f \tag{2}$$

The change across time in average labour productivity is

[1] Some authors work with total factor productivity. The data used in this study do not permit this approach and so the focus is on labour productivity only.

[2] The use of employment shares as weights is dictated by the analysis of labour productivity.

$$\Delta P_t = P_{t3} - P_{t0} = \sum S_{ft3} P_{ft3} - \sum S_{ft0} P_{ft0} \quad (3)$$

where

- $t0$ denotes the base period, $t3$ the end period (where the use of $t3$ reflects the duration of the longitudinal database used in the empirical work);
- $S_{ftj} = L_{ftj} / L_{tj}$ denotes a firm's share of employment at time j = 0 or 3; and
- P_{ftj} denotes a firm's labour productivity at time j = 0 or 3.

The change in average labour productivity can be decomposed into a contribution from firms in operation for the duration of the study period, termed continuing firms (C), and contributions from firms that begin (N) and cease operation (X).

$$\Delta P_t = \sum_{f \in C} S_{ft3} P_{ft3} - \sum_{f \in C} S_{ft0} P_{ft0} + \sum_{f \in N} S_{ft3} P_{ft3} - \sum_{f \in X} S_{ft0} P_{ft0} \quad (4)$$

where

- $f \in C$ denotes firms that operated continuously between $t0$ and $t3$;
- $f \in N$ denotes firms that entered the group between $t0$ and $t3$;
- $f \in X$ denotes firms that exited the group between $t0$ and $t3$; and
- $\sum_{f \in C} S_{ft3} + \sum_{f \in N} S_{ft3} = \sum_{f \in C} S_{ft0} + \sum_{f \in X} S_{ft0} = 1$, that is, the weights are determined on the basis of the entire sample at the beginning and the end of the study period.

Inspection of the contribution from continuing firms raises a question common to situations in which change in a variable is driven by a combination of two factors — to what extent is each factor responsible for the change? In this case, to what extent is the contribution from continuing firms determined by shifts in employment shares (a direct effect of resource movements) versus changes in labour productivity at individual firms. It is feasible, for example, (although extremely unlikely), that labour productivity at individual firms may not change over time, but that average labour productivity increases because the employment share accounted for by firms with higher labour productivity rises (while that of less productive firms falls).

A standard approach for examining questions of this type is captured in a further decomposition of equation 4 (see appendix A for details) — the goal of which is to measure the contribution to changes in average labour productivity of:

- productivity changes at individual firms, holding employment shares constant; and
- employment share changes, holding productivity at each firm constant.

In this instance, the decomposition also takes into account the contribution of entering and exiting firms (equation 5).

$$\Delta P_t = \sum_{f \in C} S_{ft0} \Delta P_{ft} + \sum_{f \in C} (P_{ft0} - \overline{P}_{t0}) \Delta S_{ft} + \sum_{f \in C} \Delta S_{ft} \Delta P_{ft} + \sum_{f \in N} S_{ft3} (P_{ft3} - \overline{P}_{t0}) - \sum_{f \in X} S_{ft0} (P_{ft0} - \overline{P}_{t0}) \quad (5)$$

where

- ΔP_{ft} denotes the change in labour productivity for a firm between $t0$ and $t3$;
- $\overline{P}_{t0}$ denotes average productivity at $t0$; and
- ΔS_{ft} denotes the change in employment share for a firm between $t0$ and $t3$.

The first three terms capture the contribution from continuing firms and are labeled the within-firm, between-firm and mix effects respectively. Contributions from entering and exiting firms are captured in the fourth and fifth terms.[3,4]

The standard interpretation of each term in equation 5 is presented below. A discussion of how well these terms measure the impact of resource movements on the change in average labour productivity is presented in section 2.2.

In theory, the within-firm effect captures the contribution from labour productivity changes within firms, holding employment shares constant (at their base period level).

The between-firm effect measures the contribution from changes in employment shares (or resource use), holding labour productivity at each firm constant (at its level relative to the group average in the base period).

This term is therefore positive for firms that have above (below) average labour productivity in the base period and gain (lose) employment share across the study period. This term is negative for firms with above (below) average productivity in

3 Note that this decomposition is not unique. Final period employment shares could weight productivity change in the within-firm term, and employment share changes in the between-firm term could be weighted by the final period difference between a firm's productivity and the industry average (analogous to a Laspayres index approach). Final period average productivity would then also be used in the entry and exit terms. In this analysis however, it is logical to weight a firm's employment share change by its initial period productivity standing.

4 This specification means that the contribution from each group of firms is measured slightly differently in equation 4 than in equation 5. For example, the difference between the contributions from continuing firms is $-\overline{P}_0 \sum_{f \in C} \Delta S_{ft3}$.

the base period and a declining (increasing) share of employment across the study period. On net, this term may be positive or negative depending on a firm's initial productivity and the movement of labour into or out of it.

The mix effect arises as a residual from specification of the within-firm and between-firm effects. It accounts for the interaction of changes in employment shares and labour productivity.

This term is positive for firms that increase (lose) employment share across the study period and record an increase (decline) in labour productivity. Firms that record a decline (increase) in productivity across time and a rise (fall) in employment share contribute negatively. On net, the term may be positive or negative.

This specification has the advantage that the contributions from entering and exiting firms (the fourth and fifth terms) are specified relative to the average labour productivity of firms in operation in the base period. This means that the contribution from entering (exiting) firms is positive if they are of higher (lower) average labour productivity than firms in operation at the start of the study period.

2.2 How is the contribution of resource movements to the change in average productivity measured?

Within the decomposition, the effects of resource movements on labour productivity change are captured in one way for entering and exiting firms and in another way for continuing firms.

Entering and exiting firms

The entry of start-up firms and the exit of firms that cease business involves a movement of resources including capital and labour. The impact of this activity is captured in the fourth and fifth terms of equation 5. If firms that commence operation are more productive on average than those already in existence, the movement of resources into start-up firms contributes positively to labour productivity growth. If the firms that cease business have lower labour productivity on average than those that continue to trade then the movement of resources away from exiting firms improves average labour productivity.

Continuing firms

The expansion and contraction of continuing firms involves resource flows that potentially affect average labour productivity. Intuitively, the expansion of firms with high labour productivity and contraction of firms with low productivity should boost average labour productivity, provided the more productive firms maintain their productivity level as they grow and the less productive do not fall further behind as they contract.

In the decomposition analysis, resource movements associated with expansion and contraction at continuing firms are captured indirectly through changes in labour productivity (an element of the first and third terms of equation 5) and directly by changes in employment shares (elements of the second and third terms).

Indirect effect of resource movements for continuing firms

Resource movements are likely to be responsible for some of the labour productivity change captured in both the within-firm and mix effects. Recall that labour productivity is defined as the ratio of value added to employment. Increased use of capital, for example, is likely to raise a firm's value added. Provided employment does not change in the same proportion labour productivity will rise. Furthermore, ignoring capital flows, if employment changes, labour productivity will only be constant if value added changes at the same rate. In other words, using this technique it is not possible to hold resources constant and examine the extent to which firms use an unchanged quantity of resources more or less productively.

In addition, while the productivity change components of the decomposition reflect resource movements it is not possible to interpret a positive change as the result of resource flows out of less productive firms and into more productive firms. In other words, while resource flows are embodied in productivity changes at individual firms it is not possible to get insight into the question of interest to this study from analysis of this term.

Direct effect of resource movements for continuing firms

Changing employment shares affect both the between-firm and mix effects (second and third terms of equation 5). A positive between-firm effect could be interpreted to mean that employment movements out of less productive firms and into more

productive firms contributed to an increase in average labour productivity.[5] But this ignores the productivity changes that actually accompanied these flows — the effect of which is captured in the mix effect. In looking at the effect of resource movements on productivity change it is important to take these into account.

For example, a firm with an increasing employment share across the study period and above-average labour productivity in the base period will make a positive contribution to aggregate productivity change through the between-firm effect. However, this will be offset by a negative contribution through the mix effect if the firm's labour productivity falls as it expands. In other words, expansion at more productive firms will only contribute to increased average labour productivity if those firms maintain their productivity level as they expand. In a similar vein, a declining employment share at less productive firms potentially contributes to an increase in labour productivity growth if those firms improve their productivity as they contract.

The net contribution of employment changes captured in the decomposition therefore depends on the magnitudes of the firms' initial levels of productivity (relative to the group's) and the extent to which that productivity changes across time. This is illustrated by combining the second and third terms of equation 5 generating the second term in the following expression.

$$\Delta P_t = \sum_{f \in C} S_{ft0} \Delta P_{ft} + \sum_{f \in C} [(P_{ft0} - \overline{P}_{t0}) + \Delta P_{ft}] \Delta S_{ft} + \sum_{f \in N} S_{ft3} (P_{ft3} - \overline{P}_{t0}) - \sum_{f \in X} S_{ft0} (P_{ft0} - \overline{P}_{t0}) \quad (6)$$

The components of the second term of equation 6 could take very different values for different firms. Firms could record an increase or decline in labour productivity, along with a growing or shrinking employment share and above or below-average productivity in the base period. It is not possible to determine whether resource flows from less and into more productive firms are making a positive contribution to the change in average labour productivity.

In summary, the decomposition permits an assessment of the impact on average labour productivity growth of the resource movements that accompany firm entry and exit. But the treatment of employment changes means that it is not possible using this technique to sign the contribution to average labour productivity change

[5] Strictly speaking, the between-firm effect represents the impact of firms increasing or decreasing their share of total group employment. In the vast majority of cases changes in employment shares reflect changes in employment in the same direction.

of resource movements out of less productive continuing firms and into more productive continuing firms.

2.3 A taxonomy of firms

A taxonomy of firms was developed to study the contribution to average labour productivity change of resource movements (captured in employment changes) from less productive firms and growth at more productive firms. The taxonomy proposed here is an extension of the classification of firms employed by Baily, Bartelsman and Haltiwanger (1994) in their study of the impact of downsizing on productivity growth.[6]

Continuing firms are classified into one of eight groups defined by whether the firms had:

- above or below-average productivity in the base period;
- increased or lost employment share over the study period (upsizers and downsizers); and
- reported an increase or decrease in labour productivity over the study period (successful or unsuccessful).

The taxonomy is summarised in table 2.1.

The first column in table 2.1 contains the sign the within-firm effect takes for each group. Columns two and three contain the signs that can be taken by the two components of the between-firm effect, and columns four and five denote the signs that can be taken by the components of the mix effect.

The terms successful and unsuccessful are used to describe firms that recorded an increase or decrease, respectively, in labour productivity across the study period.[7] A firm's position in the distribution of labour productivity in the base period is described by the expressions above and below average. And firms that gain employment share across the survey period are described as upsizers, in contrast with those that lose employment share — the downsizers.

6 These authors categorised firms into one of four groups depending on whether the changes in their employment share and productivity were positive or negative.

7 Note that the characterisation of firms as successful or unsuccessful is based only on changes in labour productivity. On multi-factor productivity measures successful firms might be deemed unsuccessful and *vice versa*.

Table 2.1 **A taxonomy of continuing firms**

		Within-firm effect	*Between firm effect*		*Mix effect*	
		$S_0\Delta P$	$(P_0 - \overline{P}_0)$	ΔS	ΔP	ΔS
1	Successful above average upsizers	+	+	+	+	+
2	Unsuccessful above average upsizers	–	+	+	–	+
3	Successful above average downsizers	+	+	–	+	–
4	Unsuccessful above average downsizers	–	+	–	–	–
5	Successful below average upsizers	+	–	+	+	+
6	Unsuccessful below average upsizers	–	–	+	–	+
7	Successful below average downsizers	+	–	–	+	–
8	Unsuccessful below average downsizers	–	–	–	–	–

a The components of this table reflect the first three terms of equation 5. Summation signs, and the firm and time subscripts are omitted from the column headings to improve presentation.

The impact on average labour productivity change of a movement of resources (employment) into more productive firms can be assessed through the contributions from the first and second categories of the decomposition — the above average upsizers. Similarly, the contributions from categories seven and eight, the below average downsizers, indicates the impact on average labour productivity change of resource (employment) movements out of less productive firms.

The contribution to labour productivity change made by each group is presented in chapter 4.

3 The BLS and the RR sample

In this chapter the primary dataset (the *Business Longitudinal Survey* or BLS), and the sample drawn from it on which the empirical work in this paper is based (the RR sample), are described, and the calculation of labour productivity is explained.

3.1 The Business Longitudinal Survey

The *Business Longitudinal Survey* (ABS Cat. no 8141.0.30.001) was collected annually for the years 1994-95 to 1997-98 and includes data on market-sector firms from all industries except Agriculture, forestry and fishing; Electricity, gas and water supply; Communication services; Government administration and defence; Education; and Health and community services.

The BLS was designed to facilitate research into growing, exporting and innovating firms so these firms are over-represented in the sample. The survey also focuses on small and medium-sized firms although data were collected for a sample of large firms (more than 200 workers). In each year after 1994-95, the sample of continuing firms was supplemented by a random sample of firms new to the Business Register (births). The sample also changed across time as units exited the survey (deaths). Weights that permit the calculation of population representative statistics are available. The sample selection rules mean, however, that the unweighted sample is not a representative selection of the population of Australian firms.[1,2]

The dataset used for this project was derived from the BLS confidentialised unit record file (CURF). All large businesses (more than 200 workers) are excluded from the CURF.[3]

1 The extent to which the sample differs from the population is unknown.

2 For more information on the BLS see Hawke (2000), Tozer (2000) and Will and Wilson (2001).

3 About 160 additional records were dropped from the file because they were 'large businesses' in terms of variables other than employment — for example, sales. In addition, the values of some financial variables are perturbed. The degree of perturbation is small and does not affect the results.

3.2 The RR sample

The BLS has some characteristics that presented challenges to the current research (see Will and Wilson 2001 for a detailed discussion). Derivation of the sample on which the empirical work is based therefore entailed a number of steps beyond the usual task of identifying and taking action on outliers. These steps are documented in appendix B.

Two steps of particular note for the analysis presented in chapter 4 — those associated with the identification of start-up firms from among births, and firms that had actually ceased to operate from among deaths — are discussed below.

Nearly 50 per cent of firms that entered the dataset in the second, third and fourth years of the survey reported an age of greater than 2 years.[4] This indicated that these firms were not new start-ups. Discussions with the ABS revealed that BLS births were selected from additions to the Business Register (BR). Firms were added the BR when they registered a new Group Employer number with the Australian Tax Office — an event triggered by many actions in addition to the establishment of a new business, for example, incorporation.

Discussions with the ABS also revealed that some firms that incorporated or underwent a change in ownership had been treated as deaths.[5] It could be argued that these firms should have been regarded as continuing firms.

For the purposes of the decomposition, both births and deaths were therefore divided into two groups: true births and deaths and illegitimate births and deaths. (The rules used to make these classifications are detailed in appendix B.)

For the purposes of the decomposition analysis illegitimate births and deaths should ideally be grouped with continuing firms, but a lack of information prior to survey entry for births, and following exit for deaths, precludes this approach. They are therefore included in the decomposition separately but in the same way as true births and deaths.

A summary of the number of firms in the unweighted sample is presented in table 3.1. Small cell sizes for Accommodation, cafes and restaurants in particular suggest the need for caution in interpreting the results for this industry.

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4 Age is defined as the length of time the current owner has had the firm or, for a public company, the time it has been listed on the stock exchange.

5 This approach was adopted in 1995-96. During the processing of 1996-97 data this approach was altered and the firms were instead treated as continuing.

Table 3.1 **Number of firms in the RR sample, by industry**

	Continuing	*True births*	*True deaths*	*Illegit. births*	*Illegit. deaths*
Manufacturing	1321	89	128	182	161
Construction	193	30	25	55	27
Wholesale trade	515	51	38	71	58
Retail trade	343	56	54	79	66
Accommodation etc	119	17	24	38	25
Property etc	411	38	51	78	52
Total	2902	281	320	503	389

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

3.3 Calculating labour productivity

Ideally labour productivity would be measured as value added per hour worked. The BLS, however, does not collect data on hours worked. Instead a measure of equivalent full-time workers in the last pay period of the financial year is used.[6] It is assumed that a part-time worker is equivalent to 0.426 of a full-time worker. The number 0.426 is the ABS estimate of average hours worked by part-time non-managerial employees per week in 1995 compared to full-time employees (ABS Cat. no. 6306.0).

Value added is calculated as sales plus the change in inventories less purchases of intermediate inputs and other operating expenses.[7] [8]

[6] The labour stock includes working proprietors, partners, directors, managerial and other employees (including casuals).

[7] For example, in terms of the BLS variables, value added in 1994-95 is calculated as (sales5 + clstock5 – opstock5– purchas5 – mvexp5 – othexp5).

[8] Because value added is calculated from flow variables, the employment measure was calculated as the average of employment in period t and t-1, where t represents the years 1994-95 to 1997-98. (Employment in 1997-98 is used for firms born in 1997-98.)

4 Resource movements and productivity change in Australia

Results from an analysis of labour productivity change between 1994-95 and 1997-98 in the RR sample are presented in this chapter. A comparison of labour productivity growth in the RR sample and the economy precedes presentation of the research findings.

4.1 Labour productivity growth — the RR sample and the economy

In interpreting the results in this chapter it must be stressed that because they are based on the RR sample it is not possible to generalise from them to all firms in the economy. The extent of difference between productivity change calculated for the RR sample and the economy is illustrated in table 4.1. Over the study period average labour productivity growth for the RR sample was 0.6 per cent per annum in contrast with the 3.1 per cent recorded for all market sector firms. Several factors explain this difference.

First, as described in table 1.1, the RR sample is considerably different to the population of market sector firms. Second, the results for the RR sample are unweighted. Use of weighted data yields lower levels of labour productivity for all industry subsamples, and higher average growth of 4.8 per cent (appendix C). While the weighted estimates are no better a reflection of what was happening in the population than the unweighted estimates, they highlight the fact that results from this analysis do not represent what was happening in the economy.

Third, while firms with high employment and/or sales growth between 1993-94 and 1994-95 are over-represented in the RR sample, these characteristics do not necessarily translate into productivity growth. In fact, firms that met the high growth criteria were more likely than those that did not to record a decline in labour productivity.[1] This is consistent with regression to mean labour productivity, and

[1] This conclusion was derived from inspection of transition matrices containing the probabilities of moving productivity deciles for high growth firms and the complement to this set. These matrices are available from the authors on request.

lower productivity growth estimates than would be derived from a random sample of firms.

Table 4.1 **Average labour productivity by industry subsample, 1994-95 to 1997-98**

Average value added per worker in 1994-95 prices

	RR sample productivity		*Change 1994-95 to 1997-98*		
	'94-'95	*'97-'98*	*RR sample*	*RR sample*	*Economy*
	$000	$000	$000	% p.a.[a]	% p.a.[b]
Manufacturing	57.2	54.2	-3.0	-1.7	1.9
Construction	57.2	57.0	-0.2	-0.1	2.8
Wholesale trade	60.5	71.2	10.7	5.9	8.2
Retail trade	42.2	41.9	-0.3	-0.2	1.9
Accommodation	39.4	36.8	-2.6	2.2	-0.5
Property etc	64.4	69.4	5.0	2.6	**na**
Total	56.8	57.8	1.0	0.6	3.1

a Average annual labour productivity change between 1994-95 and 1997-98 for firms in the RR sample. **b** Annual average labour productivity change between 1993-94 and 1997-98 for market sector firms from Parham (1999). **na** not available

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001); Economy wide estimates from Parham (1999).

4.2 Average labour productivity in the RR sample — levels and growth

Considerable variation in labour productivity levels across industry subsamples is evident in the RR sample (table 4.1). While average value added per worker, or labour productivity, for the sample was $56 800 in 1994-95, firms in the Property and business services subsample, for example, had an average of $64 400, compared with $39 400 for Accommodation, cafes and restaurants firms.[2]

There were also large differences between the industry subsamples in productivity growth between 1994-95 and 1997-98. While average labour productivity grew only slightly for the RR sample, firms in the Wholesale trade and Property and business services subsamples experienced marked real growth. This contrasts with the decline in average labour productivity for firms in the Manufacturing subsample.

Further evidence of the heterogeneity of labour productivity levels and growth is presented in a matrix capturing the probabilities that firms move from one decile in the productivity distribution in 1994-95 to another decile in 1997-98 (appendix D).

[2] Industry specific deflators were used to generate real figures.

In 1994-95 average value added per worker at the upper boundary of the lowest decile was $17 800 compared with $84 000 at the lower boundary of the highest decile. Almost 60 per cent of firms in the lowest decile in 1994-95 were in a higher decile in 1997-98. Likewise, around 50 per cent of firms moved from the highest decile into lower deciles over the survey period.

It is also interesting to note that movement by more than one decile was more likely to occur for firms in the middle deciles. In other words, firms at either end of the productivity distribution — those with really high and very low labour productivity — were less likely to change relative position.

4.3 Decomposing productivity change

Changes in average labour productivity are dominated by the contribution from continuing firms in each industry subsample (table 4.2).[3] The entry of start-ups and exit by firms that cease operation (true entry and exit), together contribute little to the change in average labour productivity. The contribution from illegitimate births and deaths is also small relative to that from continuing firms.[4]

Table 4.2 **Decomposition of changes in average labour productivity by industry subsample, 1994-95 to 1997-98**

	Net continuing firm effect	*Net true entry & exit*	*Net illegitimate entry & exit*	*Overall change*[a]
	$000	$000	$000	$000
Manufacturing	-3.1	0.3	-0.2	-3.0
Construction	0.9	-0.7	-0.3	-0.2
Wholesale trade	8.3	0.3	2.2	10.7
Retail trade	2.4	-0.5	-2.2	-0.3
Accommodation	-1.6	-0.2	-0.9	-2.6
Property etc	6.1	0.2	-1.5	5.0
Total	1.1	0.1	-0.2	1.0

a Slight differences between the sum of figures in columns 1 through 3 and the final column reflect rounding.

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

3 In this respect the results are similar to those obtained by other researchers (for example, Baily, Bartelsman and Haltiwanger 1992; Foster et al. 1998)

4 It is assumed that illegitimate births and deaths have similar experiences to the average continuing firm, and they are therefore given no further attention in the analysis.

The contribution from continuing firms

The within-firm effect dominates the contribution from continuing firms in each industry subsample — productivity changes at firms contributed more to average labour productivity change than changes in firms' employment shares (table 4.3).[5]

Table 4.3 **Decomposition terms for continuing firms by industry subsample, 1994-95 to 1997-98**

	Within-firm effect	*Between-firm effect*	*Mix effect*	*Net continuing firm effect*
	$000	$000	$000	$000
Manufacturing	-2.8	1.5	-1.8	-3.1
Construction	1.3	-0.3	-0.1	0.9
Wholesale trade	6.8	2.5	-1.0	8.3
Retail trade	2.9	0.1	-0.6	2.4
Accommodation	-0.9	-0.6	-0.1	-1.6
Property etc	8.2	1.0	-2.9	6.1
Total	1.1	1.3	-1.3	1.1

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

The positive between-firm effect for the sample means that, on average, employment fell at firms with below-average labour productivity in the base period, and rose at firms with above-average labour productivity. This may indicate that resource movements out of less productive firms and into more productive firms contributed positively to average labour productivity change. But this ignores the impact of employment changes captured in the mix effect.

The negative mix effect for the sample (and each industry subsample) means that, on average, labour productivity rose at firms that shed employment and fell at firms that gained employment. In tandem with the positive between-firm effect this term could be interpreted as indicating that resource movements out of less productive firms and into more productive firms contributed negatively to average labour productivity change.

Because of the combination of the between and mix effects, it is not possible using the decomposition to determine whether resource flows out of less and into more productive continuing firms made a positive or negative contribution to the change in average labour productivity.

[5] Foster et al. (1998) report a similar finding for US manufacturing over the period 1977 to 1987.

The contribution from entering and exiting firms

The contributions to average labour productivity change from entering and exiting firms is presented in more detail in table 4.4.

True birth firms in all industry subsamples had lower labour productivity in 1997-98 than the average firm in operation in 1994-95. This is not surprising given the short time period covered by the BLS.[6] It is likely that these firms were still approaching effective operation. In fact, inspection of the position of birth firms within the distribution of labour productivity in 1997-98 reveals that they were disproportionately located in the lowest deciles (appendix D).

True death firms had lower productivity in 1994-95 than the average firm in operation at that time. In fact, almost a quarter of true deaths was located in the lowest decile of the productivity distribution in 1994-95 (in contrast with 16 per cent of illegitimate deaths).

Table 4.4 **Decomposition of changes in labour productivity by industry subsample, 1994-95 to 1997-98**

Decomposition of change among entering and exiting firms

	True births	*True deaths*	*Net true entry & exit*	*Illeg. births*	*Illeg. deaths*	*Net illeg. entry & exit*
	$000	$000	$000	$000	$000	$000
Manufact.	-0.4	-0.7	0.3	-1.0	-0.8	-0.2
Construct.	-1.1	-0.4	-0.7	-1.6	-1.3	-0.3
Wholesale.	-0.2	-0.5	0.3	1.7	-0.5	2.2
Retail trade	-0.6	-0.1	-0.5	-2.9	-0.7	-2.2
Accomm.	-1.0	-0.8	-0.2	-0.7	0.2	-0.9
Property	-0.5	-0.7	0.2	-2.5	-1.0	-1.5
Total	-0.5	-0.6	0.1	-1.0	-0.8	-0.2

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

4.4 A taxonomy of continuing firms

The taxonomy of continuing firms (described on pages 11 and 12) represents an alternative approach to decomposing the change in average labour productivity. The contributions made by different groups of firms to the overall increase in average labour productivity between 1994-95 and 1997-98 shed insight into productivity change in the RR sample.

6 International research has found that the contribution of net entry rises as the duration of the survey period increases (Baldwin 1995b).

For example, almost 30 per cent of firms accounting for 40 per cent of employment in the RR sample had above-average labour productivity in 1994-95 (table 4.5). These firms made a negative contribution to the change in average labour productivity between 1994-95 and 1997-98 (table 4.6). Almost 60 per cent of firms (59 per cent of employment) shed employment, or downsized. As a group these firms made a positive contribution to the change in average labour productivity. And labour productivity rose at just over 50 per cent of firms (52 per cent of employment) between 1994-95 and 1997-98.

Successful below-average downsizers represent the largest group. Almost 30 per cent of firms in the RR sample, accounting for a quarter of employment, had below-average labour productivity in 1994-95, shed employment and improved their labour productivity. This group of firms also made the largest positive contribution to productivity change among continuing firms (table 4.6). It is possible that members of this group substituted capital for labour, or experienced a productivity gain through the outsourcing of employment or work intensification among remaining workers.[7]

Resource movements and labour productivity change

The impact on the overall change in labour productivity of employment increases at more productive firms and falls at less productive firms on the increase in average labour productivity can be assessed through inspection of the above-average upsizer (categories 1 and 2) and below-average downsizer (7 and 8) categories.

For the RR sample, almost 16 per cent of firms (accounting for 19 per cent of employment) had above-average labour productivity in 1994-95 and expanded between that point and 1997-98. But labour productivity increased at only a quarter of these firms. In other words, resources flowed into these better performers but a large majority did not maintain their labour productivity level in the process.[8] As a group these firms made a negative contribution to average labour productivity change. (Note that this conclusion does not apply for all industry subsamples.)

[7] Further investigation is required to analyse whether substitution of capital for labour did occur. Unfortunately the BLS data on owned capital reflect the book value of that capital. A firm could purchase new capital, leading to a rise in book value, but the flow of capital services used in production might remain unchanged. The BLS contains some information on outsourcing that could be used to look in more detail at the impact of outsourcing. Unfortunately, there is no data in the BLS which could be used in an investigation of the incidence of work intensification.

[8] The focus on labour productivity in this study is of importance for this conclusion. Changes in employment shares and labour productivity are not independent. A rise in employment, with unchanged value added, means a decrease in labour productivity.

Table 4.5 **Distribution of continuing firms and employment across the taxonomy by industry, 1994-95 employment shares in brackets**

	Mfg	*Const.*	*W'sale*	*Retail*	*Accom.*	*Property*	*Total*
	%	%	%	%	%	%	%
1 Successful above-average upsizers	2.4 (2.9)	3.6 (5.3)	9.5 (11.6)	1.2 (0.5)	0.8 (4.8)	7.5 (13.6)	4.2 (5.7)
2 Unsuccessful above-average upsizers	12.3 (14.3)	9.3 (14.0)	14.0 (13.5)	7.3 (7.0)	10.1 (8.8)	11.4 (11.3)	11.6 (12.9)
3 Successful above-average downsizers	4.9 (7.6)	2.6 (4.1)	9.5 (13.0)	2.0 (3.6)	3.4 (3.8)	8.8 (11.8)	5.7 (8.5)
4 Unsuccessful above-average downsizers	9.3 (14.9)	6.7 (16.9)	8.4 (9.4)	4.7 (6.3)	5.9 (10.9)	9.0 (14.1)	8.2 (12.7)
5 Successful below-average upsizers	11.4 (8.3)	14.5 (15.9)	15.9 (12.6)	22.7 (26.6)	14.3 (11.6)	17.3 (14.0)	14.7 (12.1)
6 Unsuccessful below-average upsizers	13.7 (10.7)	11.9 (8.4)	8.0 (6.1)	20.4 (16.7)	18.5 (20.7)	7.3 (5.1)	12.7 (10.0)
7 Successful below-average downsizers	27.4 (23.1)	36.3 (26.4)	27.6 (28.4)	28.9 (29.8)	29.4 (28.7)	28.2 (28.4)	28.4 (25.2)
8 Unsuccessful below-average downsizers	18.7 (18.3)	15.0 (9.1)	7.2 (5.4)	12.8 (9.4)	17.7 (10.7)	10.5 (6.9)	14.5 (13.0)
Number of firms	1321	193	515	343	119	411	2902
Number of workers	44 252	3086	17 008	8972	2421	9660	85 399

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

Table 4.6 **Contribution of continuing firms to labour productivity growth by taxonomy category**

	Mfg	*Const.*	*W'sale*	*Retail*	*Accom.*	*Property*	*Total*
	$000	$000	$000	$000	$000	$000	$000
1 Successful above-average upsizers	1.0	0.9	2.8	1.8	0.0	4.0	1.9
2 Unsuccessful above-average upsizers	-3.5	-2.6	-2.0	-1.4	-0.4	-3.0	-2.6
3 Successful above-average downsizers	0.9	0.6	1.4	0.8	0.0	1.5	1.1
4 Unsuccessful above-average downsizers	-2.7	-4.5	-1.2	-2.0	-4.1	-4.2	-2.8
5 Successful below-average upsizers	1.2	3.1	3.1	1.5	0.1	2.1	1.7
6 Unsuccessful below-average upsizers	-2.3	-0.7	-1.0	-0.7	-0.2	-0.7	-1.5
7 Successful below-average downsizers	2.7	4.1	5.4	2.5	2.6	6.4	3.5
8 Unsuccessful below-average downsizers	-0.3	0.0	-0.1	-0.2	0.4	-0.1	-0.2
Total	-3.1	0.9	8.3	2.4	-1.6	6.1	1.1

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

In contrast, almost 43 per cent of firms (38 per cent of employment) had less than average labour productivity in 1994-95 and shed employment. Labour productivity increased at two-thirds of these firms and as a group these firms made a large positive contribution to productivity change. (A similar conclusion applies for all industry subsamples.)

Overall, for the firms in the RR sample, the movement of resources (employment) into firms with above-average labour productivity in 1994-95 and out of firms with below-average labour productivity was associated with a positive contribution to average labour productivity change. But this contribution was driven by increases in labour productivity at firms that shed employment.

The above discussion encompasses only 60 per cent of firms in the sample. Almost half the firms that had above-average labour productivity in 1994-95 shed employment, and of these around 40 per cent had an increase in labour productivity. Similarly, a substantial proportion (almost 40 per cent) of firms with below-average labour productivity upsize, and about half of these recorded increasing labour productivity.

These results illustrate the heterogeneity of labour productivity change at Australian firms.

5 Conclusions

5.1 Summary

This paper presents results of an investigation of the hypothesis that labour productivity change is driven by resource movements from less to more productive firms. Although the results are derived from a select sample of Australian firms, they illustrate how estimates of aggregate labour productivity growth mask variations in growth between both industries and firms — and suggest that the hypothesis tested reflects too simple a view of the world.

For the RR sample, average value added per worker, or labour productivity, increased by 0.6 per cent per annum between 1994-95 and 1997-98. But underlying this average was, for example, an increase of 5.9 per cent per annum on average for firms in the Wholesale trade subsample and a fall of 1.7 per cent per annum on average for firms in the Manufacturing subsample.

Considerable variation was also found in labour productivity levels and growth between firms within industry subsamples.

The research results revealed no clear relationship between resource movements (changes in employment shares) and labour productivity change for continuing firms. The overall increase in labour productivity at continuing firms was the net outcome of increases at some (53 per cent) and declines at others.

Increases in labour productivity occurred both at firms that were below-average or less productive in the base period, and at those that were above-average, or more productive. Resources moved out of some of these firms and into others. Similarly, decreases in labour productivity occurred both at firms that were more and less productive, and that shed and gained employment share. The largest group of continuing firms (comprising 28 per cent of these firms), began the survey period with relatively low labour productivity, reduced their workforce and maintained or improved their output, thus improving their labour productivity.

Overall, among continuing firms, the movement of resources into firms with above-average labour productivity and out of firms with below-average productivity was associated with a positive contribution to average labour productivity change.

But this contribution was driven by increases in labour productivity at firms that shed employment.

The movement of resources associated with firm entry and exit accounted for only a small share of labour productivity change. Firms that ceased operation tended to have low labour productivity prior to exiting the sample. Their departure contributed to positive labour productivity growth, but this effect was offset by the fact that firms that began operation also tended to display relatively low labour productivity. The result for entering firms suggests that they require time to become established and show strong labour productivity improvement.

In sum, for the sample of firms studied, it is not possible to draw a firm conclusion about the relationship between the movement of resources out of less and into more productive firms and labour productivity change.

5.2 Directions for future research

The taxonomy developed in chapter 2 reveals the extent of variation in productivity between firms in the sample. Possible reasons for these differences could be explored further using information in the BLS. For example, data on size, export activity, and changes in production or service technology, could be used to explore the characteristics of firms in each taxonomy class.

Part of this exploration may focus on the possible effect on labour productivity of capital for labour substitution and outsourcing in firms in this sample.

An improved understanding of the various sources of change in aggregate productivity would be achieved by replicating the analysis in this report using a representative sample of Australian firms.

Finally, future research could benefit from further investment in firm-level data. Much could be learned about the dynamics of firm performance. Longitudinal data spanning at least 5 years is needed to understand short-run dynamics. Interesting questions surrounding long-run dynamics require data spanning at least 10 years.

A Decomposition

The decomposition proceeds from a measure of average productivity. Average labour productivity (P) is the sum of value added produced by each firm (VA_f) in divided by the sum of each firm's employment (L_f), or total employment (L).

$$P = \frac{\sum VA_f}{\sum L_f} = \frac{\sum VA_f}{L}$$

If average labour productivity is derived using firm-level data, each firm's value added per worker or labour productivity (P_f) must be weighted by its share of employment ($L_f/L = S_f$).

$$P = \sum \frac{L_f}{L} \frac{VA_f}{L_f} = \sum S_f P_f$$

The change across time in average labour productivity can be expressed as

$$\Delta P_t = P_{t3} - P_{t0} = \sum S_{ft3} P_{ft3} - \sum S_{ft0} P_{ft0}$$

Productivity change can be decomposed into shares from continuing firms (C), entering (N) and exiting (X) firms.

$$\Delta P_t = \left(\sum_{f \in C} S_{ft3} P_{ft3} - \sum_{f \in C} S_{ft0} P_{ft0} \right) + \sum_{f \in N} S_{ft3} P_{ft3} - \sum_{f \in X} S_{ft0} P_{ft0}$$

The contribution from continuing firms can be further decomposed into three terms.

The within-firm effect is derived as follows and is represented by the first term in the final line of the following expression.

$$\begin{aligned} \Delta P_{t(f \in C)} &= \sum S_{ft3} P_{ft3} - \sum S_{ft0} P_{ft0} \\ &= \sum S_{ft3} P_{ft3} - \sum S_{ft0} P_{ft0} + \sum S_{ft0} P_{ft3} - \sum S_{ft0} P_{ft3} \\ &= \sum S_{ft0} (P_{ft3} - P_{ft0}) + \sum S_{ft3} P_{ft3} - \sum S_{ft0} P_{ft3} \end{aligned}$$

The size change term is derived in two steps. First, a size change effect with initial productivity held constant is derived.

$$\Delta P_{t(f\in C)} = \sum S_{ft0}\Delta P_{ft} + \sum S_{ft3}P_{ft3} - \sum S_{ft0}P_{ft3} +$$
$$(\sum S_{ft3}P_{ft0} - \sum S_{ft0}P_{ft0} - \sum S_{ft3}P_{ft0} + \sum S_{ft0}P_{ft0})$$
$$= \sum S_{ft0}\Delta P_{ft} + \sum P_{ft0}\Delta S_{ft} + \sum \Delta S_{ft}\Delta P_{ft}$$

(The third term in the above expression represents the mix effect.)

Second, a relative productivity term $(P_{ft0} - \overline{P}_{t0})$ is incorporated into this expression.

Denote average productivity in the initial period by $\overline{P}_{t0}$ and note that when all firms are included in the analysis

$$-\overline{P}_{t0}\sum \Delta S_{ft} = -\overline{P}_{t0}\sum S_{ft3} + \overline{P}_{t0}\sum S_{ft0} = -\overline{P}_{t0} + \overline{P}_{t0} = 0$$

and that

$$-\overline{P}_{t0}\sum \Delta S_{ft} = -\overline{P}_{t0}\sum_{f\in C}\Delta S_{ft} - \overline{P}_{t0}\sum_{f\in N} S_{ft3} + \overline{P}_{t0}\sum_{f\in X} S_{ft0}$$

then average labour productivity change can be expressed as

$$\Delta P_t = \sum_{f\in C} S_{ft0}\Delta P_{ft} + \sum_{f\in C}(P_{ft0} - \overline{P}_{t0})\Delta S_{ft} + \sum_{f\in C}\Delta S_{ft}\Delta P_{ft} +$$
$$\sum_{f\in N} S_{ft3}(P_{ft3} - \overline{P}_{t0}) - \sum_{f\in X} S_{ft0}(P_{ft0} - \overline{P}_{t0})$$

The fourth and fifth terms respectively represent the contribution of entering and exiting firms to the change in average labour productivity.

B Adjustments to the CURF

This appendix details the adjustments made to the BLS in arriving at the RR sample from which the productivity decomposition results presented in Chapter 4 were derived. A summary of the number of observations omitted from the sample at each adjustment is presented in Appendix table B1.

Step 1: Finance and insurance industry

The concept of sales can be ill-defined for firms that lend money as part of their operations. Rogers (1998), in an analysis of labour productivity using the BLS, found that half the firms in the Finance and insurance industry had labour productivity of less than zero because the survey excluded interest income from the basic 'sales' question. The data from firms in this industry was consequently judged to inadequate for this project and the industry was dropped from the analysis.

Step 2: Property and business services industry

The concept of sales was also ill-defined for many firms in the Property and business services industry. Of 902 firms, 97 reported no sales figure for either 1995 or 1998. Firms that reported no sales in either year were dropped from the dataset.

Step 3: 'Irrelevant' firms

The decomposition uses data from firms that were in operation in either 1995 or 1998 or in both years. Firms that were born post-1995 yet died before or in 1998 are omitted from the sample.

Step 4: Imputed data

If firms had either a half or full survey imputed for two or more years preceding 1997-98 they were dropped from the dataset.

Step 5: Reclassification of birth firms

Birth firms were reclassified according to whether they were legitimate (or start-up firms) or not. A firm was judged to be legitimate if its age in the year of survey entry was less than 2 years and it had less than 30 employees. See Will and Wilson (2001) for more information.

Step 6: Firms with labour productivity equal to zero or missing

Firms for which labour productivity was calculated to be zero or missing were dropped from the dataset.

Step 7: Reclassification of death firms

In 1996-97 and 1997-98 true deaths were deemed to be firms that exited the survey, and recorded a decline in employment, and a rise in capital stock of no more than five per cent, in the year prior to death.

The data for many exiting firms indicated no change in employment or capital stock in the year prior to exit. This strongly suggested that the data had been imputed (see Will and Wilson 2001 for more discussion of this issue). For a sizeable number of firms capital stock grew marginally. This suggested the data had been perturbed following imputation, hence the criterion on capital stock allows for some growth.

If a firm was missing information on employment or capital stock, information on sales growth was used to classify firms. Due to the absence of capital stock information for 1993-94, true deaths in 1995-96 were identified on the basis of changes in their sales and employment information.

Step 8: Outliers in terms of productivity growth

Outliers among the continuing firms were deemed to be those whose productivity had risen by a factor of five or fallen to a less than a fifth of its initial level over the survey period.

The sets of entering and exiting firms were also investigated for outliers. The distribution in the levels of labour productivity in 1997-98 for entering firms and labour productivity in 1994-95 for exiting firms was inspected. Firms with labour productivity of greater than $1 million per worker were dropped from the analysis.

Step 9: Outliers in terms of productivity levels

Some of the previous steps in the data cleaning/adjustment process identified outliers on the basis of changes in their labour productivity. This approach did not identify firms that were outliers in both years in their levels of labour productivity.

Data for each industry were plotted and firms that were distinctly different were dropped.

Step 10: The Mining, Transport and storage, Cultural and recreation services and Personal services industries

Following the data cleaning exercise some of the samples of birth and death firms for these industries were too small to warrant including the industries in the analysis.

One potential step not taken: Recoding of incorrectly classified death firms

The ABS practice of coding deaths in the second half of a financial year as deaths in the following year, and therefore as continuing in the actual year of death means that the 1998 sample of continuing firms contains some firms which actually had ceased operation. For the purposes of this project it would be preferable that they be classed as deaths. It was not possible however, to identify them, so the potential adjustment was not undertaken.

One further adjustment

Part-time employment fell 20 per cent among continuing firms between 1995-96 and 1996-97. It is suspected that this reflects a change in the employment questions between these years and the approach taken by the ABS to accommodate this change.

To account for this decline an estimate of part-time employment in 1997-98 was obtained by multiplying total employment in 1997-98 by the ratio of part-time to full-time employment in 1995-96. Full-time employment in 1997-98 was therefore calculated to be the difference between total and estimated part-time employment.

This adjustment means that the structure of employment is maintained across the BLS for continuing firms. It also means that part-time employment in 1997-98 will be understated for firms that experienced growth between 1995-96 and this year. The full-time equivalent employment measure will be too high for these firms in 1997-98 and hence their labour productivity will be too low. The converse could also apply.

Table B.1 **Number of firms involved in each step of the adjustments, by continuing, birth or death status**

	Birth in 1998	*Birth in 1997*	*Birth in 1996*	*Live in all survey years*	*Death in 1998*	*Death in 1997*	*Death in 1996*	*Birth in 1996, death in 1997*	*Birth in 1997, death in 1998*	*Birth in 1996, death in 1998*	*Illegitimate Births*	*Illegitimate deaths*	
Panel codes	XXXL	XXLL	XLLL	LLLL	LLLD	LLDX	LDXX	XLDX	XXLD	XLLD			Total
Raw data	448	387	273	4068	183	298	482	26	22	28			6215
Step 1	-29	-17	-21	-152	-16	-16	-18	-1		-2			-272
	419	370	252	3916	167	282	464	25	22	26			5943
Step 2	-2	-1	-2	-76	-3	-3	-10						-97
	417	369	250	3840	164	279	454	25	22	26			5846
Step 3								-25	-22	-26			-73
	417	369	250	3840	164	279	454						5773
Step 4		-1	-12	-219									-232
	417	368	238	3621	164	279	454						5541
Step 5	-259	-235	-164								658		0
	158	133	74	3621	164	279	454				658		5541
Step 6		-1		-73	-3	-2	-26				-12		-117
	158	132	74	3548	161	277	428				646		5424
Step 7					-65	-69	-347					481	0
	158	132	74	3548	96	208	81				646	481	5424
Step 8				-250		-1					-2		-253
	158	132	74	3298	96	207	81				644	481	5171
Step 9	-17	-22	-6	-143	-11	-16	-8				-67	-42	-332
	141	110	68	3155	85	191	73				577	439	4839
Step 10	-18	-9	-11	-253	-5	-14	-10				-74	-50	-444
	123	101	57	2902	80	177	63				503	389	4395

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001)

Table B.2 **Number of firms involved in each step of the adjustments, by industry**

Panel codes	*Mining*	*Manufact.*	*Construct.*	*Wholesale*	*Retail*	*Accomm.*	*Transp.*	*Finance*	*Property*	*Cultural*	*Personal*	*Total*
Raw data	84	2162	387	888	704	266	236	272	899	164	153	6215
Step 1												
	84	2162	387	888	704	266	236	0	899	164	153	5943
Step 2									-97			-97
	84	2162	387	888	704	266	236		802	164	153	5846
Step 3	-3	-16	-2	-11	-10	-7	-4		-7	-8	-5	-73
	81	2146	385	877	694	259	232		795	156	148	5773
Step 4	-1	-89	-11	-32	-38	-12	-8		-22	-10	-9	-232
	80	2057	374	845	656	247	224		773	146	139	5541
Step 5												
	80	2057	374	845	656	247	224		773	146	139	5541
Step 6	-7	-37	-6	-14	-12	-3	-8		-15	-11	-4	-117
	73	2020	368	831	644	244	216		758	135	135	5424
Step 7												
	73	2020	368	831	644	244	216		758	135	135	5424
Step 8	-5	-63	-15	-55	-21	-10	-5		-55	-17	-7	-253
	68	1957	353	776	623	234	211		703	118	128	5171
Step 9	-21	-76	-23	-43	-25	-11	-27		-73	-26	-7	-332
	47	1881	330	733	598	223	184		630	92	121	4839
Step 10	-47	0	0	0	0	0	-184		0	-92	-121	-444
	0	1881	330	733	598	223	0		630	0	0	4395

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001)

C Weighted results

Weighted results are presented to illustrate the impact of weighting on the research findings. The weights were derived for the full sample and do not reflect the construction of the RR sample. The weighted results are therefore not representative of the population of firms with less than 200 employees in the industries studied.

The weighted results differ markedly from those presented in chapter 4. For example, average labour productivity increases only 4.1 per cent in Wholesale trade in comparison with 5.9 per cent in the unweighted results, and the within-firm, between firm and mix effects are larger in absolute terms for the weighted RR sample.

Table C.1 **Average labour productivity by industry subsample, 1994-95 to 1997-98**

Weighted results, average value added per worker, in 1994-95 prices

	Weighted productivity		*Change in productivity*	
	1994-95	*1997-98*	*1994-95 to 1997-98*	
	$000	$000	$000	% p.a.
Manufacturing	50.7	47.2	-3.5	-2.3
Construction	40.2	42.6	2.4	2.0
Wholesale trade	57.5	64.6	7.1	4.1
Retail trade	34.5	39.5	5.0	4.8
Accommodation	34.2	30.4	-3.8	-3.7
Property etc	49.1	57.8	8.7	5.9
Total	45.2	48.1	2.9	2.1

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

Table C.2 **Decomposition of changes in labour productivity by industry subsample, 1994-95 to 1997-98**

Weighted results

	Within-firm effect	*Between-firm effect*	*Mix effect*	*Net entry & exit effect*	*Overall change*
Manufacturing	-2.1	1.9	-2.4	-0.9	-3.5
Construction	5.4	2.5	-3.8	-1.7	2.4
Wholesale trd.	4.0	3.8	-2.0	1.3	7.1
Retail trade	3.8	0.9	-1.6	1.9	5.0
Accommod.	0.4	0.1	-1.1	-3.2	-3.8
Property etc	9.0	2.3	-4.1	1.4	8.7
Total	3.3	2.0	-2.3	-0.1	2.9

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

Table C.3 **Decomposition of changes in labour productivity by industry subsample, 1994-95 to 1997-98**

Weighted results, decomposition of change among entering and exiting firms

	True births	*True deaths*	*Net true entry & exit*	*Illeg. births*	*Illeg. deaths*	*Net illeg. entry & exit*
Manufact.	-1.1	-0.6	-0.5	-1.0	-0.7	-0.3
Construct.	-0.1	0.1	-0.2	-1.7	-0.2	-1.5
Wholesale	-0.9	-1.3	0.4	-0.4	-1.3	0.9
Retail trade	-1.2	-1.1	-0.1	1.5	-0.5	2.0
Accomm.	-2.8	-1.6	-1.2	-1.7	0.3	-2.0
Property	0.8	-0.7	1.5	-0.9	-0.9	0.0
Total	-0.9	-1.1	0.2	-1.0	-0.7	-0.3

Source: PC estimates based on ABS (*Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001).

D Transition matrix

Figures in parentheses are percentages

Productivity deciles in 1998	Productivity deciles in 1995: 1	2	3	4	5	6	7	8	9	10	Total cont'ing	Illeg. births	True births	Total 1998
1	89	36	20	15	10	2	5	3	1	0	181	107	80	368
	(40.3)	(13.3)	(7.0)	(5.1)	(3.3)	(0.7)	(1.7)	(1.0)	(0.3)	(0.0)	(6.2)	(21.3)	(28.5)	
2	45	77	42	31	24	17	14	9	10	0	269	64	36	369
	(20.4)	(28.5)	(14.6)	(10.6)	(7.9)	(5.7)	(4.7)	(2.9)	(3.3)	(0.0)	(9.3)	(12.7)	(12.8)	
3	28	47	58	40	31	26	23	11	12	5	281	54	33	368
	(12.7)	(17.4)	(20.2)	(13.7)	(10.3)	(8.7)	(7.6)	(3.6)	(4.0)	(1.5)	(9.7)	(10.7)	(11.7)	
4	18	35	49	60	44	36	21	14	8	6	291	44	35	370
	(8.1)	(13.0)	(17.1)	(20.5)	(14.6)	(12.0)	(7.0)	(4.6)	(2.7)	(1.9)	(10.0)	(8.7)	(12.5)	
5	19	15	40	44	46	42	38	21	20	9	294	51	23	368
	(8.6)	(5.6)	(13.9)	(15.1)	(15.2)	(14.0)	(12.6)	(6.9)	(6.6)	(2.8)	(10.1)	(10.1)	(8.2)	
6	9	14	30	35	53	47	55	30	21	19	313	44	12	369
	(4.1)	(5.2)	(10.5)	(12.0)	(17.5)	(15.7)	(18.3)	(9.8)	(7.0)	(5.9)	(10.8)	(8.7)	(4.3)	
7	6	13	21	27	40	50	47	52	45	21	322	35	11	368
	(2.7)	(4.8)	(7.3)	(9.2)	(13.2)	(16.7)	(15.6)	(17.0)	(15.0)	(6.5)	(11.1)	(7.0)	(3.9)	
8	5	16	12	16	28	36	45	67	53	35	313	38	17	368
	(2.3)	(5.9)	(4.2)	(5.5)	(9.3)	(12.0)	(15.0)	(21.9)	(17.6)	(10.8)	(10.8)	(7.6)	(6.0)	
9	2	14	10	17	22	27	32	61	70	69	324	28	18	370
	(0.9)	(5.2)	(3.5)	(5.8)	(7.3)	(9.0)	(10.6)	(19.9)	(23.3)	(21.4)	(11.2)	(5.6)	(6.4)	
10	0	3	5	7	4	16	21	38	61	159	314	38	16	368
	(0.0)	(1.1)	(1.7)	(2.4)	(1.3)	(5.4)	(7.0)	(12.4)	(20.3)	(49.2)	(10.8)	(7.6)	(5.7)	
Total continuing	221	270	287	292	302	299	301	306	301	323	2902	503	281	3686
Illegitimate deaths	63	47	36	39	38	38	36	32	34	26	389			
	(16.2)	(12.1)	(9.3)	(10.0)	(9.8)	(9.8)	(9.3)	(8.2)	(8.7)	(6.7)	(100.0)			
True deaths	76	46	37	31	20	25	23	24	25	13	320			
	(23.8)	(14.4)	(11.6)	(9.7)	(6.3)	(7.8)	(7.2)	(7.5)	(7.8)	(4.1)	(100.0)			
Total 1995	360	363	360	362	360	362	360	362	360	362	3611			

References

ABS (Australian Bureau of Statistics) 2000a, *Australian National Accounts 1999-00*, Cat. no. 5204.0, Canberra.

—— 2000b, *Small Business in Australia 1999*, Cat. no. 1321.0, Canberra.

—— 2000c, *Business Longitudinal Survey Confidentialised Unit Record File*, Cat. no. 8141.0.30.001.

—— 1998, *Labour Force, Australia*, Cat. no. 6203.0, Canberra.

Baily, N., Hulten, C. and Campbell, D. 1992, 'Productivity dynamics in manufacturing plants', *Brookings Papers in Microeconomics*, 187–249.

Baily, N., Bartelsman, E. J. and Haltiwanger, J. 1994, *Downsizing and Productivity Growth: Myth or Reality*, National Bureau of Economic Research, Working Paper No. 4741.

Baldwin, J. 1995a. 'Productivity growth, plant turnover and restructuring in the Canadian manufacturing sector', in Mayes, D. (ed.), *Sources of Productivity Growth*, Cambridge University Press, Cambridge.

—— 1995b. *The Dynamics of Industrial Competition*, Cambridge University Press, Cambridge.

Bartelsman, E. J. and Doms, M. 2000, 'Understanding productivity: lessons from longitudinal microdata', *Journal of Economic Literature*; 38(3), pp 569–94.

Foster, L., Haltiwanger, J. and Krizan, C. J. 1998, *Aggregate Productivity Growth: Lessons from Microeconomic Evidence*, National Bureau of Economic Research, Working Paper 6803.

Grigg, C. 1999, *Small Business in Australia*, New England Perspectives, (3), pp 45-60.

Haltiwanger, J. 1997, *Measuring and Analysing Aggregate Fluctuations: The Importance of Building from Microeconomic Evidence*, Federal Reserve Bank of St Louis, Economic Review, January/February.

Hawke, A., 2000, 'Data Surveys: The Business Longitudinal Survey', *Australian Economic Review*, 33(1), pp 94–99.

Parham, D. 1999, *The New Economy? A New Look at Australia's Productivity Performance*, Productivity Commission Staff Research Paper, AusInfo, Canberra.

PC (Productivity Commission) 1999, *Microeconomic Reforms and Australian Productivity: Exploring the Links*, Commission Research Paper, AusInfo, Canberra.

Rogers, M. 1998, *Productivity in Australian Enterprises: Evidence from the ABS Growth and Performance Survey*, Melbourne Institute of Applied Economic and Social Research, Melbourne Institute Working Paper No. 20/98.

Tozer, C. 2000, The Australian Bureau of Statistics (ABS) Business Longitudinal Survey, Paper presented at the Industry Economics Conference, Australian Graduate School of Management, Sydney, 11–12 July.

Will, L. and Wilson, H., (forthcoming), *Tricks and Traps of the BLS*, Productivity Commission Staff Working Paper, AusInfo, Canberra.