The Role of Training and Innovation in Workplace Performance

PRODUCTIVITY COMMISSION

Staff Research Paper

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Key Points

The economic performance of the Australian economy rests to a large extent on the performance of individual workplaces. This paper uses workplace-level data to examine the role of training and innovation in workplace performance.

Training leads to an increase in the quality of labour, by equipping employees with greater skills and knowledge (and possibly fostering greater effort). Innovation, which can take many forms (eg the introduction of new technology or of new management techniques), improves capital services and the efficiency of the production process.

The analysis yields a number of significant results:

- Training and innovation are more prevalent in workplaces experiencing strong labour productivity growth.
- Different types of innovation have different effects on labour productivity growth, with changes in how work is done having a greater immediate effect than other forms of innovation.
- Labour productivity growth appears to be enhanced by the joint introduction of training and innovation. Introducing innovation in isolation can promote labour productivity growth, although its returns are increased by the presence of training. Conversely, training is only of benefit to labour productivity growth if combined with innovation.
- The links between training, innovation and labour productivity growth differ between technically efficient and inefficient workplaces. It appears that training is an effective strategy for less efficient workplaces striving to 'catch-up' with competitors, whereas innovation appears to promote labour productivity growth among both technically efficient and inefficient workplaces.
- The timing of the effects of innovation on productivity differs depending on the types of innovation. Changing the work of non-managerial employees appears to have immediate effects on productivity growth. Workplace restructuring and changes in products and services produced seem to have a delayed effect.

1 Introduction

Improvements in workplace productivity are a major contributor to economy-wide productivity growth. How resources are managed within the workplace, the rate at which innovation is introduced and the development of skills all play an important role in productivity growth.

This study focuses on productivity growth in medium-sized to large workplaces.[1] The aim is to explore the links between training and innovation and workplace productivity. Training of workers improves their skills, enabling them to undertake more complex tasks or complete tasks better or faster. Innovation improves the efficiency of the production process, enabling more difficult tasks to be completed to a higher quality or more rapidly. In some cases innovation and training are reinforcing, with the (re)training of workers enhancing the productivity of innovative and more sophisticated technology.

In Australia, studies of the effects of training on labour productivity have generally taken the form of case studies (eg Pearson et al. 1996). It is uncertain whether the implications of those studies apply in other cases. Studies allowing for wider conclusions concerning the determinants of labour productivity do not focus specifically on the role of training and innovation (eg Loundes 1999, Hawke and Drago 1998, Rogers 1998b, Drago and Wooden 1992, Crockett et al. 1992).

This paper extends earlier studies by concentrating on the roles of training and innovation in explaining labour productivity at the workplace level in Australia. It seeks to highlight differences in the role played by training and innovation between efficient and inefficient workplaces. It also seeks to explore whether training and innovation are mutually reinforcing in their influence on workplace productivity.

The links between training and innovation and labour productivity are examined using the 1990 and 1995 Australian Workplace Industrial Relations Survey (AWIRS). The major advantage of the AWIRS is that it allows the determinants of productivity in the workplace to be examined.

Recent trends in innovation, training and productivity are described in section 2. A theoretical framework for investigating the links between training, innovation and workplace productivity is developed in section 3. The AWIRS data are described and some of their shortcomings are discussed in section 4. In section 5, the results of the analysis are presented and discussed. Section 6 draws together the key results and concludes the paper.

[1] Defined as workplaces employing 20 employees or more.

2 Recent trends in training, innovation and productivity

The incidence of and expenditure on innovation and training in Australian workplaces is rising, as is labour productivity. In this section recent trends in innovation, training and productivity are described, along with the empirical literature examining the links between them.

2.1 Innovation

Innovation can be interpreted broadly or narrowly (see box 2.1). For the purposes of this paper, innovation[2] captures a broad range of changes in the workplace including (see section 4.3 for details):

- the introduction of major new office technology;
- the introduction of major new plant, machinery or equipment;
- changes in the products or services produced;
- a restructuring of how work is done; and
- a reorganisation of the management structure.

Based on the AWIRS, there is a high incidence of innovation in medium-sized to large workplaces in Australia. As shown in figure 2.1, nearly 70 per cent of such workplaces undertook some form of innovation in 1990. By 1995 this had increased to over 80 per cent of workplaces.

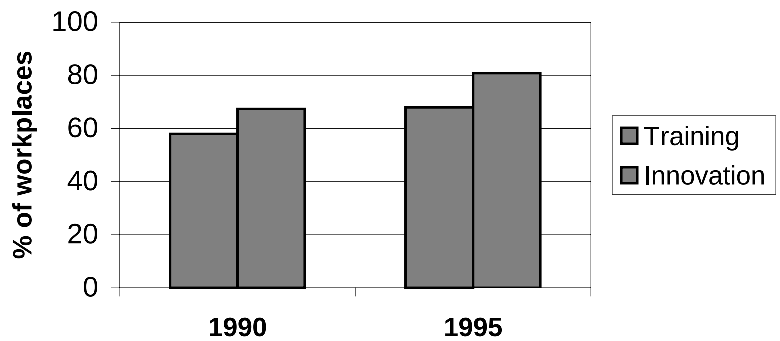
2 In the remainder of the paper, the terms ‘innovation’ and ‘organisational change’ are used interchangeably.

Box 2.1 **Innovation**

Strictly speaking, 'innovation' refers to the transformation of an invention into a commercially useable technique or product. More broadly, Stoneman (1983) defines technological change as 'the process by which economies change over time in respect of the products they produce and the processes used to produce them'.

In practice, the term 'innovation' is used to describe many forms of change within the workplace. Drago and Wooden (1994), for instance, define innovation as 'the introduction of major new plant, equipment, or office technology'. Nunes et al. (1993) extend the definition of innovation to include 'major changes in the product or service'. Rogers (1999) further extends the definition of innovation to include a 'major restructuring of how work is done' and a 're-organisation of management structure'.

Figure 2.1 **Incidence of training and innovation[a] in Australian workplaces[b]**



a See section 4 for definitions of training and innovation in the AWIRS. **b** Economy-wide estimates based on the AWIRS samples of workplaces with 20 or more employees operating in all industries except 'Agriculture, forestry and fishing' and 'Defence'.

Data source: AWIRS 1990 and 1995.

The growing incidence of innovation need not reflect an increase in expenditure. Although it is difficult to measure the amount spent on innovation in Australia, one indicator is the expenditure on research and development (R&D). As shown in figure 2.2, expenditure on R&D by businesses[3] is significant, peaking at nearly $4.5 billion (or 0.86 per cent of GDP) in 1995–96.[4]

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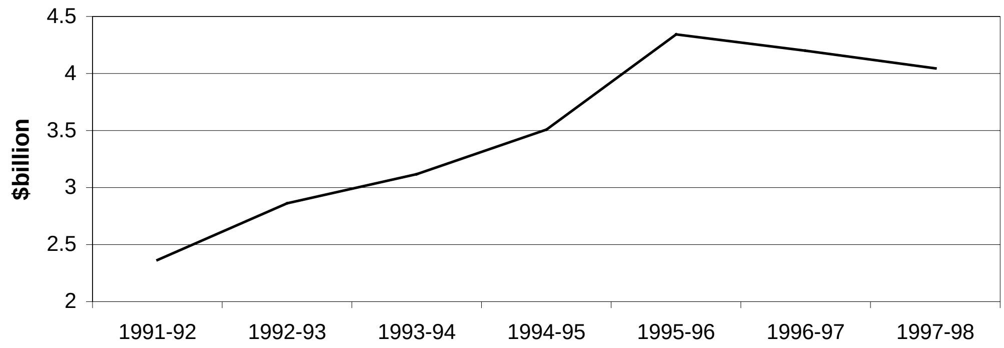
3 The coverage differs from that of the AWIRS (see figure 2.2).

4 It must be remembered, however, that R&D expenditure is, at best, a proxy for innovation. Considerably fewer firms undertake R&D than innovate in the sense used here.

Figure 2.2 **Business[a] expenditure on research and development**

At current prices



a Includes business enterprises of all sizes, but excludes those in ‘Agriculture, forestry and fishing’, higher education organisations, general government and private non-profit organisations.

Data source: ABS (*Research and Experimental Development, Businesses, 1997-98*, Cat No. 8104.0).

2.2 Training

For the purposes of this paper, training is defined as training in tasks directly related to the employment activities of the employee (see box 2.2). Figure 2.1 shows that in 1995 over 60 per cent of all workplaces provided at least some training to some of their employees. As with innovation, training became more widespread between 1990 and 1995.

Expenditure on training is significant. Employers spent approximately $185 per employee on formal training,[5] or approximately one per cent of GDP, during the September quarter in 1996 (ABS 1996). As shown in figure 2.3, there has been a small increase in total expenditure on formal training between 1993 and 1996, although employers spent less per employee.

2.3 Workplace productivity

There are many indicators of workplace performance including profit, revenue and production (see box 2.3). In this paper, the focus is on the labour productivity of workplaces. Labour productivity measures the amount of labour used for each unit of output produced by the workplace.

[5] See box 2.2 for a definition of formal training.

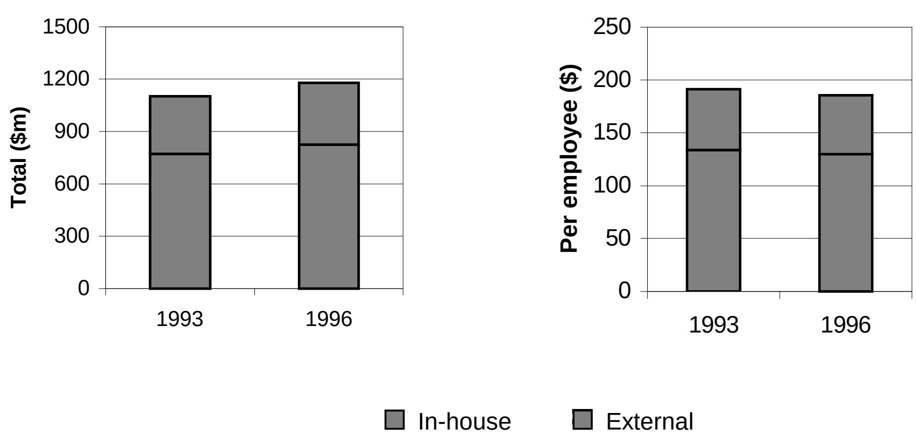
Box 2.2 **Training**

Maglen (1995) defines training as ‘instruction that is directly related to the employment activities of the trainees, and usually given in their place of employment. But even if all or part of it is conducted outside … training is usually initiated and/or sponsored by employers’. This definition differentiates between training which is contemporaneously related to employment, and education which is typically less specific to the trainee’s work tasks and most often undertaken prior to employment.

There are various forms of training:

- ‘Informal’ and ‘formal’ — Informal training consists of ‘learning-by-doing’ and guidance from colleagues during work. Formal training has a predetermined plan and format design and can be provided by external instruction or in-house.
- ‘General’ and ‘specific’ — General training provides workers with skills and knowledge that are ‘transportable’ between firms, to a lesser or greater extent. Specific training provides workers with skills that are generally of use to only one firm. In practice, there is a continuum between specific and general skills (eg some skills may be of use to a small group of firms).

Figure 2.3 **Employer training expenditure**[a]
September quarter



[a] Includes direct expenditure on training and the costs of the time employees spent on providing and receiving training.

Data source: ABS (Employer Training Expenditure Australia, July to September 1996, Cat No. 6353.0).

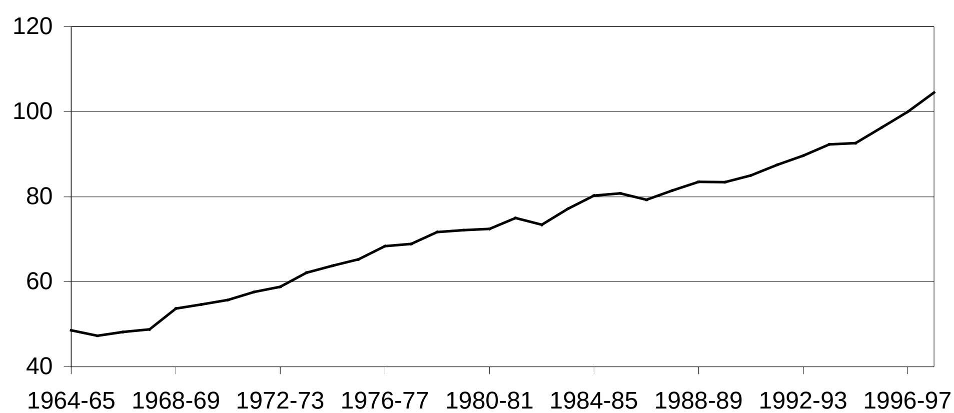
As shown in figure 2.4, there has been a general upward trend in labour productivity at the national (aggregate) level. Although cyclical factors influence the growth of labour productivity over time, during the recent cycle (93–94 to 97–98) this growth has been significantly above its long term trend (Parham 1999).

Box 2.3 **Workplace performance**

Traditionally in economics, the performance of a firm or workplace is measured by its productivity rather than its profitability. The most complete indicator of workplace productivity is multifactor productivity (MFP) which measures the ratio of all outputs of the workplace to all its inputs. The calculation of MFP requires, among other data, a capital stock index, an indicator that is not routinely collected by firms, let alone individual workplaces. In the absence of a MFP measure, productivity may be measured by labour productivity, which is the ratio of output (or value added) to the number of workers (or hours worked). This is an imperfect and partial measure of productivity. Different workplaces in the same industry, which are equally productive, may have quite different levels of labour productivity as a result of different degrees of mechanisation, computerisation or automation or differences in the skills of the labour used.

Nonetheless, many studies of workplace or establishment performance use labour productivity as the indicator of performance (Black and Lynch 1997, Crépon et al. 1998, Rogers 1998b, Lehr and Lichtenberg 1999).

Figure 2.4 **Labour productivity level**
Index, 1996–97 = 100



Data source: ABS (Australian National Accounts: National Income and Expenditure, Cat No. 5204.0).

2.4 Empirical literature on the links between training, innovation and labour productivity

As mentioned in the introduction, few studies of the determinants of labour productivity have concentrated on the role of training and innovation. Where the role of training and innovation has been specifically addressed, one or the other has been singled out for special consideration (eg Bartel 1994 for training, Lehr and

Lichtenberg 1999 for new technology). The following sections summarise some of the salient results from studies of the determinants of labour productivity.

Training and labour productivity

Studies examining the effects of training on labour productivity can be divided into two groups:

- those studies that use direct measures of labour productivity, such as output per worker; and
- those studies that use indirect measures of labour productivity, such as wages and earnings (see OTFE (1998) for a review of these studies).[6]

Both groups of studies reach a similar conclusion: that training can have a significant positive impact on productivity (OTFE 1998). For example, the OECD (1999) found that in 1995 in Australia, the mean wage of trained workers exceeded that of untrained workers by 9.6 per cent. This 'wage effect' is consistent with both international (Bartel 1994) and Australian evidence (Loundes 1999) finding that the provision of formal training to employees is a strong predictor of labour productivity growth. Drago and Wooden (1992) found a strong association between low on-the-job training (proxied by skills content) at the workplace and low labour productivity levels.

Studies have emphasised the importance of the type of training in improving productivity. Black and Lynch (1996) found that, in the non-manufacturing sector at least, it is not so much whether workers are trained, but what they are trained in (eg computer training) that affects establishment productivity.

Innovation and labour productivity

Empirical evidence suggests that innovative firms are able to achieve higher labour productivity than their less innovative counterparts. In Australia, Rogers (1998b) found that more innovative firms had an average value added per employee of $54 200 in 1994-95, compared with $46 900 for the less innovative firms. Similarly, Loundes (1999) found that organisational change (innovation) is a powerful predictor of labour productivity growth in Australia.

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[6] The use of wages as a proxy for productivity is based on the assumption that workers are paid the value of their marginal product by their employers (Becker 1964). If this is the case, then the theory predicts that wages and productivity will tend to move in unison, within the boundaries allowed by awards and conditions. There is evidence that this can indeed be the case (eg Hellerstein et al. 1999).

There is also a growing literature investigating the effects of computer technology on labour productivity (Black and Lynch 1997, Lehr and Lichtenberg 1999). Evidence from these studies suggests that the diffusion of information technology in firms has a significant positive impact on labour productivity.

As a caveat, it should be noted that the causal links between innovation and productivity have not been entirely resolved in the empirical literature. For instance, while investment in computers may be the source of higher productivity, the opposite could also be true. That is, higher productivity could lead to increased investment in computer technology. However, testing by Lehr and Lichtenberg (1999) fails to detect reverse causality for this form of innovation.

3 A framework for examining workplace productivity

In this section, a framework for analysing the interrelationships between innovation, training and workplace productivity is developed. A simplified model of a workplace's production process is presented and used to highlight the determinants of both productivity levels and productivity growth.

3.1 Workplace productivity (levels)

Consider the determinants of a workplace's production:

$$Y = Af(E_K, E_L, K, L) \tag{1}$$

where Y measures the gross product of the workplace

K measures physical units of capital

L measures physical units of labour (labour hours)

A is a parameter that shifts output for given levels of the inputs of capital and labour (such as better organisation of labour and capital)

E_K is the average quality (effectiveness) of the capital K

E_L is the average quality (effectiveness) of the labour L

These variables are elements of standard production functions (see box 3.1).

Box 3.1 **Modelling of production functions**

The production function used in this paper is based on neo-classical economic theory (Solow 1957), and provides a convenient framework for the analysis of workplace productivity. However, its use and interpretation are subject to an important caveat.

In economics, production functions traditionally describe the maximum amount of output that can be produced from a set of inputs (observed and unobserved). This implicitly describes the operation of a workplace operating on the production frontier, that is, a workplace that is technically efficient. However, not all workplaces achieve maximum output from the same set of inputs. This can be due to two reasons:

- inefficiency — such as that caused by poor managerial ability; and
- environmental variables — such as the weather.

If the first reason only is taken into account, the frontier is said to be 'deterministic' and can be represented by incorporating a one-sided error *u* into the production function:

$$Y = Af(E_K, E_L, K, L) - u \qquad \text{where} \quad u \geq 0$$

If, both the first and second reasons are taken into account, the frontier is said to be 'stochastic' and includes a two-sided error *v* as well:

$$Y = Af(E_K, E_L, K, L) + v - u \qquad \text{where} \quad v \in (-\infty, +\infty)$$

Thus, the one-sided error captures workplace-specific inefficiency whichh can only reduce output below its maximum, while the two-sided error captures unobserved workplace-specific factors that can reduce output but can also increase it above the 'normal' maximum. When *u* and *v* are both included, the frontier is represented by a distribution rather than by a point (see Battese 1991, Førsund et al. 1980 for discussions).

While the use of control variables (see box 5.1) can reduce the amount of unexplained variation in output (and productivity) between workplaces, some difference will remain due to variations in efficiency and environmental variables.

Under certain conditions,[7] it can be shown that:

$$\frac{Y}{L} = AF(E_K, E_L, \frac{K}{L}) \qquad (2)$$

That is, at a point in time, the average labour productivity of a workplace is determined by its capital-labour ratio, the quality of the capital and labour employed and the parameter A.

[7] Assuming the production function in equation (1) is homogeneous of degree one (ie constant returns to scale).

The capital-labour ratio is a measure of how much capital equipment each worker has to work with. The more capital equipment per worker, the greater the workplace's labour productivity, subject to diminishing returns.

The shift parameter A captures contributions to output that are due neither to labour nor capital (adjusted for quality). It is often defined as 'neutral' technology or multifactor productivity, and is a measure of such influences on output as capacity utilisation and organisational efficiency. Thus, it is possible to write:

$$A = f(\text{capacity utilisation, cumulative innovation}) \qquad (3)$$

By contrast, some technology is 'factor augmenting' in that it raises the quality of a specific factor of production, thus increasing the effective stock of that factor. Therefore, E_L and E_K can be interpreted as measures of labour and capital quality, respectively. These two variables are examined in turn.

Average labour quality

A given number of labour hours can contribute different amounts of labour services to the production process, depending on the intrinsic quality of that labour. Labour quality depends on the human capital of the workers and on worker effort. In contrast to labour productivity, labour quality does not depend on the environment of the worker (eg the quality or quantity of the machines he or she works with).

Human capital theory suggests that the knowledge and skills of workers directly and positively influence their productivity (Becker 1964). For example, a worker with more skills is usually able to operate the same machine at a faster or safer rate, thus producing more units of output per hour worked.

Labour quality also depends on the effort and commitment workers bring to their tasks. Both are likely to be the result of a conscious choice by the worker, based on morale, firm loyalty, work environment and remuneration schemes.

In practice, neither knowledge and skills nor effort and commitment are directly observable. As a result, indirect proxy measures of knowledge, skills and effort are used.

Human capital theory suggests that knowledge and skills are a function of education, training and experience, which are often used as proxies for labour quality.

Effort and commitment are generally recognised as being influenced by the extent of worker involvement in the decision-making process (Booth and Frank 1999, Alexander and Green 1992, Crockett et al. 1992, Blandy 1988). The operation of such schemes as joint consultative committees, team building and quality circles should therefore be included in the determinants of labour quality.

Given the above, the labour quality function can be written as:

$$E_L = f(\text{educational attainment, cumulative training, experience, worker involvement schemes}) \qquad (4)$$

It is possible that there are some synergies among these determinants of labour quality. For instance, Pearson et al. (1996, cited in OTFE 1998, pp. 22–24) suggest that training:

- enhances access to and acceptability of further training;
- increases participation in teams and meetings;
- results in promotion and job flexibility; and
- provides less tangible benefits such as improved morale and loyalty.

This implies that training can benefit labour quality directly, by equipping workers with greater skills, but also indirectly, by improving worker commitment and adaptability. This is supported by the findings of a recent survey of senior Australian executives, which concluded that:

> When asked about how companies implement a value system in their organisation, the overwhelming majority of senior executives indicated that this occurred via training programs and through employee coaching — with other approaches barely rating a guernsey. (Drake International 1999)

Average capital quality

As with physical labour inputs, physical capital can contribute varying amounts of capital services depending on the quality of the capital stock. Like human capital, physical capital embodies a certain amount of human knowledge which makes it more or less productive. The amount of knowledge embodied in, say, a new machine is the net result of all the technological innovations that have taken place up to the time when the machine was manufactured. As with labour quality, the knowledge embodied in capital equipment is largely unobservable. However, it can be proxied by the accumulated amount of innovation that has taken place prior to that capital being installed. It is therefore possible to define capital quality as a function of cumulative innovation:

$$E_K = f(\text{cumulative innovation}) \qquad (5)$$

Interaction of labour and capital quality

In addition to the direct effects that labour and capital quality can have on productivity, productivity can in some cases be further enhanced if improvements in labour and capital quality (training and innovation) are introduced together.

The literature suggests that training and innovation are frequently implemented simultaneously. The OECD (1999) found that the incidence of training in a country is correlated with measures of innovation such as R&D expenditure and the proportion of researchers in the labour force. In the US, Lynch and Black (1995) found that the proportion of workers trained is positively associated with R&D and investments in capital. In Australia, Rogers (1998c) found that the provision of formal training by the workplace is significantly associated with several forms of innovation (the introduction of new office technology; a major reorganisation of management and workplace structure; major changes to how employees do their work).

Further, the evidence points to the fact that this correlation is not coincidental but, rather, the product of a two-way causal relationship.

First, innovation may cause training if the latter is provided by the suppliers of the new technology (eg training ‘thrown in’ with new equipment), or if the new technology requires more educated workers for its operation (OTFE 1998). A number of studies provide evidence of the skills-biased nature of technological change (Haskel and Heden 1999, Lehr and Lichtenberg 1999, Berman et al. 1997, Machin et al. 1996, Eicher 1996). Rogers (1998d) found that ‘innovation-related training’ can comprise up to a third of all training in some industries.

Second, training may cause innovation. Bartel and Lichtenberg (1987) suggest that highly educated (trained) workers have a comparative advantage in adopting and implementing new technology. They may also contribute more ideas to the production process. Proponents of endogenous growth theory have argued that human capital is a driver of the production of new designs and knowledge within the firm (Romer 1990).

Thus, the available evidence strongly supports the existence of causal relationships between training and innovation. Moreover, there is evidence to suggest that the interaction of training and innovation results in greater labour productivity improvements than when each activity is implemented in isolation. Barrett and O’Connell (1998) found that the impact of general training on productivity growth varies positively with the level of capital investment (treated as a form of innovation in this paper).

In terms of the theoretical framework presented in this section, the existence of such synergies between training and innovation is equivalent to saying that the effect of cumulative training on output (via E_L) is a positive function of E_K (and hence of cumulative innovation).

3.2 Productivity growth

Given the definition of average labour productivity in equation (2), changes in that variable are a function of changes in A, E_K, E_L, and K/L.

$$d\left(\frac{Y}{L}\right) = h\left(dA, dE_K, dE_L, d\left(\frac{K}{L}\right)\right) \tag{6}$$

with *d*x representing the absolute change in variable x

That is, changes in average labour productivity are driven by changes in the state of neutral technology, the capital-labour ratio, and the quality of capital and labour. We consider each of these in turn.

First, by definition, the change in the shift parameter A will result from any change in output that is not accounted for by changes in levels and quality of capital and labour. As mentioned earlier, this could include changes in capacity utilisation or some forms of innovation leading to greater organisational efficiency of the workplace. It is therefore possible to write:

$$dA = h[d(\text{capacity utilisation}), \text{innovation}^{8}] \tag{7}$$

Second, changes in the capital-labour ratio are a function of changes in the capital stock (net investment), *d*K, and the workforce, *d*L.

The change in labour quality can be written as:

$$dE_L = f[d(\text{educational attainment}), \text{training},^{9}\ d(\text{experience}), \text{changes to or the introduction of a worker involvement scheme}] \tag{8}$$

The change in the quality of capital can be written:

$$dE_K = f(\text{innovation}) \tag{9}$$

[8] Note that *d*(cumulative innovation) = innovation.

[9] Note that *d*(cumulative training) = training.

In summary, labour productivity growth is a function of several flow variables including: training, innovation, net investment, changes in the experience or educational attainment of the workforce, the introduction of worker involvement schemes and changes in capacity utilisation.

Note that an explicit time dimension has been absent from the discussion so far. However, the effects of training and innovation on labour productivity are likely to persist beyond the period in which they take place. Moreover, their effects could differ over time. For instance, Black and Lynch (1996) found training to be associated with contemporaneous falls but subsequent increases in productivity. This is possibly the result of lost working hours, or of worker fatigue (if training is undertaken outside normal hours).

Productivity growth of less efficient workplaces

The discussion above assumes all workplaces are technically efficient in the sense they are getting the maximum output technically feasible given the level and quality of labour and capital inputs, and given their degree of capacity utilisation. In reality some workplaces are not technically efficient and could increase output without altering the level or quality of their inputs (see box 3.1 for a discussion). This could occur, for example, if demarcations between occupations were removed so that workers were able to accomplish any task that was required.

As a result, the scope for and determinants of productivity growth for technically efficient and inefficient workplaces are likely to differ. Bartel (1994) found that firms that are most likely to undertake training are those that are lagging behind their competitors in terms of labour productivity. Moreover, training appears to be preferred to other human resources strategies as a means of raising productivity. Bartel (1994) showed this strategy to be effective with firms that adopted training catching up, whereas those that did not still lagged. In this instance, the training-productivity relationship is two-way: low performance leads to the adoption of training, which in turns improves productivity. This suggests the possibility that training differs in its association with productivity growth and levels.

3.3 Summary

The analytical framework and the review of the literature discussed above give rise to the following working hypotheses:

- cumulative training and innovation have a positive effect on labour productivity levels;
- training and innovation have a positive effect on labour productivity growth;
- the effects of training and innovation on labour productivity will differ between technically efficient and inefficient workplaces; and
- the effects of training and innovation may be mutually reinforcing.

These hypotheses are examined further in section 5.

4 AWIRS data

The data used in the analyses are drawn from the Australian Workplace Industrial Relations Surveys conducted in 1989-90 (AWIRS90) and 1995 (AWIRS95).[10] The AWIRS collected a wealth of information on industrial relations and workplace characteristics, based on a number of questionnaires (workplace characteristics, general management, employee relations management, union delegate, employees, small business) sent to a sample of 2001 workplaces with 20 or more employees, drawn from the ABS Business Register.[11] Two types of data sets drawn from AWIRS90 and AWIRS95 are used in the analysis:

- cross-sectional data set (the 'main survey') based on 2001 workplaces surveyed in 1995; and
- a panel data set (the 'panel survey') of 698 workplaces surveyed in both 1995 and 1990.

Descriptive statistics and the variable codes for the data used in this study are provided in appendix B.

4.1 Measures of labour productivity levels and growth

Questions relating to workplace productivity and productivity growth are contained in the general management questionnaire of the AWIRS. General managers were asked to rank the following on a scale of 1 to 5, ranging from 'a lot lower' to 'a lot higher':

- labour productivity relative to their major competitors (AWIRS95) or to other workplaces in the industry (AWIRS90); and
- changes in labour productivity in the previous two years (AWIRS95).

These are subjective indicators of productivity levels and productivity growth. As such they are only proxies for workplace productivity. These proxies have a number of shortcomings:

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[10] These surveys, conducted on behalf of the (now) Department of Employment, Workplace Relations and Small Business of the Commonwealth Government, are described in detail in Callus et al. (1991) and Morehead et al. (1997).

[11] The sample was stratified by location, industry and size to give an accurate representation of the entire Australian workplace population. Workplaces in the 'Agriculture, forestry and fishing' and 'Defence' industries were excluded from the surveys. A telephone survey of businesses with less than 20 employees was also conducted as part of AWIRS95, but it is not used in this study.

- Although all workplaces were asked about their productivity ranking and growth, only 73 per cent of workplaces measured labour productivity in 1995.
- It is unlikely that all managers surveyed have access to productivity data from other firms, or that they all measure labour productivity in the same way (Rimmer and Watts 1994).
- It is possible that managers may have a tendency to overestimate the performance of their workplace. The possibility of such a response bias is indirectly illustrated by, based on the figures contained in table 4.1, the fact that 49 per cent of workplaces reported their productivity as above average and only 12 per cent reported below average productivity. Similarly, the majority of general managers reported that their labour productivity had increased over the two years prior to the survey. Finally, 41 per cent of workplaces surveyed answered ‘a little higher’ or ‘a lot higher’ to both questions. Such a large overlap between ‘positive’ answers to both questions is perhaps the best measure of their subjective nature.

For these reasons, productivity indicators in the AWIRS have sometimes been criticised (see box 4.1). However, other authors have argued in favour of these indicators, pointing out that the existence of a response bias did not preclude statistical analysis as long as the ranking of outcomes was preserved and the extent of the bias was not correlated with any of the explanatory variables (Crockett et al. 1992, Drago and Wooden 1992). Crockett et al. (1992) also remarked that the relative nature of the data avoided the difficulties in establishing strictly comparable measures of labour productivity between workplaces.

For these reasons, these and other studies (Hawke and Drago 1998, Loundes 1999) have used AWIRS indicators as proxies for actual labour productivity.

Box 4.1 **Productivity indicators in the AWIRS**

The labour productivity indicators found in the AWIRS have been criticised for their subjectivity and for their narrowness.

Commenting on the dangers of asking chief executives for an assessment of their workplace's productivity, Dabscheck (1989, p. 9) noted that one should 'attach as much credence to [their assessment] as asking a group of Collingwood supporters who they thought would win an Australian Football League premiership'!

Overall, it seems difficult to argue with Rimmer and Watts' contention that:

> It is probable that the main weaknesses of AWIRS (and other surveys) lies in probing the complex causal relationship behind improved workplace productivity, industrial conflict, and other such 'policy outcome' variables. (1994, p. 66)

However, their view of the alternative to surveys — case studies — is not much more positive:

> …such techniques have yet to be deployed convincingly by case study researchers on the wider question of the determinants of workplace productivity. To date, case study researchers have not thrown much light on the 'productivity' problem (1994, p. 68).

A second category of criticism is expressed by Alexander and Green (1992). They contend that the (neo-classical) production function-based approach to the measurement of workplace performance is flawed because it is overly mechanistic. Their preferred approach is to examine a range of 'performance indicators', in which productivity and efficiency are supplemented by measures of the ability to introduce change, management-employee relations, output quality and so on.

Table 4.1 **Labour productivity levels and growth**

Based on main AWIRS95 survey

		Labour productivity compared to two years ago					**Total**
		A lot lower	*A little lower*	*About the same*	*A little higher*	*A lot higher*	
Labour productivity relative to competitors	*A lot lower*	3	5	7	17	4	**36**
	A little lower	6	13	33	78	46	**176**
	About the same	6	34	139	322	195	**696**
	A little higher	4	16	105	271	228	**624**
	A lot higher	1	4	23	89	141	**258**
	Total	**20**	**72**	**307**	**777**	**614**	**1790**[a]

[a] Only 1790 out of 2001 workplaces surveyed in AWIRS95 answered both questions on labour productivity.

Source: AWIRS95.

4.2 Measures of training

The AWIRS data contain a number of measures of training activity. These include the:

- provision of formal training to employees in the previous year;
- funding of study leave for non-managerial employees;
- existence or introduction of a formal training scheme; and
- occupational distribution of training.

There are two main limitations of the training measures in the AWIRS. First, there is no direct information on the provision of informal (on-the-job) training. This is unfortunate as most employer-provided training takes the form of informal training (Frazis et al. 1998). Second, as the training variables are categorical, no information is available on the intensity of training (ie the number of hours devoted to training, the number of employees concerned or the amount of training expenditure).

These limitations notwithstanding, the available training variables allow useful distinctions to be made. Dockery (1993) interprets the funding of study leave as a form of general training, while he views the provision of formal training as more specific to the employees' work tasks. This distinction may be significant as different forms of training have been shown to affect labour productivity differently (Barrett and O'Connell 1998).

As shown in table 4.2, approximately three quarters of workplaces surveyed had provided formal training to their employees in the year preceding the 1995 survey. Twenty-eight per cent of those workplaces did so without having an explicit training scheme in place. Conversely, 17 per cent of workplaces with a training scheme did not make use of it in the year before the survey.

Table 4.2 **Training scheme[a] and training of employees**
Based on main AWIRS95 survey

	Formal training of employees in the last year		**Total**
Training scheme in place	*No*	*Yes*	
No	275	421	**696**
Yes	220	1080	**1300**
Total	**495**	**1501**	**1996[b]**

[a] As this table shows, the existence of a training scheme does not overlap perfectly with the training of employees in the previous year. It may be that a scheme refers to a recurring program which is not used in some years. [b] Five of the 2001 workplaces surveyed in AWIRS95 did not answer both questions on training.

Source: AWIRS95.

4.3 Measures of innovation

Innovation is captured in four ways[12] in AWIRS95:

- introduction of major new office technology[13] (not just routine replacement);
- introduction of major new plant, machinery or equipment (not just routine replacement);
- major reorganisation of the workplace structure (eg number of management levels, restructuring of divisions/sections); and
- major changes to how non-managerial employees do their work (eg in the range of tasks, the type of work).

These categories are broad and do not convey information on the exact nature of the innovation. The classification of innovation in the AWIRS suffers from three shortcomings.

First, while a broad definition of innovation is useful to capture 'process' innovation, it may also capture activities that are not innovative (eg the return to a previous organisational structure).

Second, the binary nature of the variables (did/did not innovate) means that, over a given period, larger firms are more likely to be classified as innovators than small firms (Rogers 1998d). This is because large firms are more likely to have carried out at least one innovative activity (even if it is small relative to their size). This is unfortunate since the impact of innovation is more likely to be related to the intensity of the innovation than to its occurrence. For instance, small firms may only innovate once every three years, but with greater consequences for their labour productivity. Ideally, an indicator such as the ratio of innovative expenditure to sales over a multiyear period would be required to address this issue.

A third methodological difficulty, as Brooks and Morris (1993) remark, is that the definition of a 'major' change may vary between firms. More objective measures of innovation, such as the ratio of innovation-related expenditure to turnover, are not available from the AWIRS.

The incidence of innovative activity in workplaces surveyed in AWIRS95 is illustrated in table 4.3. Given the broad definition of innovation used in the AWIRS, the vast majority of workplaces are innovators of one kind or another, with only 16

[12] Data on a fifth form of innovation, a major change in the product or service produced by the workplace, is only available in the panel survey, and is used in some models in this paper.

[13] Includes computers and information technology.

per cent of firms reporting no innovation in the years 1993–95.[14] Of the four forms of innovative activity, only the introduction of major new plant, machinery or equipment occurs in significantly less than half of all workplaces. This implies that several innovations are often undertaken simultaneously or in quick succession. Indeed, Rogers (1998c) calculated, based on AWIRS95, that 20 per cent of Australian workplaces implemented all four changes within two years, suggesting an innovative ‘culture’ in some Australian workplaces.

Table 4.3 **Incidence of innovation**
Based on main AWIRS95 survey

	Frequency
Innovation carried out in the two years prior to AWIRS95	*Percentage of workplaces*
Introduction of major new office technology	45.7
Introduction of major new plant, machinery or equipment	29.7
Major reorganisation of workplace structure	58.8
Major changes to how non-managerial employees do their work	47.7
No innovation	15.6[a]

[a] The percentage on non-innovating workplaces applies to the AWIRS sample only, and is different from the population-wide figure used in the construction of figure 2.1.

Source: AWIRS95.

[14] Not surprisingly, studies using a more restrictive definition of innovation (eg Rogers 1998d) report a considerably smaller percentage of innovators among businesses with 20 employees or more.

5 Empirical results

In this section, the links between training, innovation and workplace productivity are analysed using the cross-section and panel data sets of the AWIRS. First, the associations between training, innovation and productivity in the data are examined using bivariate analysis (section 5.1). This is followed by multivariate analysis to control for the influence of other variables on productivity (section 5.2). This allows for models that enable inferences of causal relationships to be tested.

5.1 Bivariate analysis

Tables 5.1 to 5.3 highlight the associations between labour productivity and training and innovation. In interpreting these results, it must be kept in mind that bivariate analysis provides only a descriptive picture of the associations in the data.

Table 5.1 summarises the associations between labour productivity levels and various measures of training and innovation from the main 1995 survey. The entries

Table 5.1 **Productivity levels cross-tabulations**
Based on main AWIRS95 survey

Variable	*Compare productivity to competitors:* *A lot lower*	*A little lower*	*About the same*	*A little higher*	*A lot higher*	*Significance level* [a]
	%	%	%	%	%	
Distribution over sample	**2.1**	**10.1**	**38.9**	**34.5**	**14.5**	
Training						
Formal training of emps in last year	2.3	10.2	37.7	36.2	13.6	5
Skills audit implemented last 2 yrs	2.0	13.0	37.0	35.5	12.5	10
Skills audit in place	2.1	12.4	36.6	35.6	13.4	10
Tradepersons got training	3.6	14.1	36.3	35.7	10.4	1
Plant/machinery operators got training	4.2	18.7	34.0	32.6	10.5	1
Labourers got training	3.2	13.2	37.0	35.8	10.9	5
Training raised by union delegate	7.4	25.9	48.2	14.8	3.7	5
Training negotiated with union delegate	4.4	20.7	29.9	33.6	11.4	5
Innovation						
Intro. new office tech. last 2 yrs	2.0	8.5	37.2	35.9	16.3	10
Intro. new plant/mach. last 2 yrs	2.4	12.2	34.5	36.4	14.6	10
Major reorg. wp. struct. last 2 yrs	2.4	11.6	37.3	35.2	13.5	5

a Pearson χ^2 test. Significant cross-tabulations only are shown.

Source: PC estimates.

in columns 2–6 of the table categorise workplaces answering in the affirmative to the question appearing in the row heading according to their relative productivity level shown in the column heading. Percentages in each cell may then be compared to those for the entire sample, shown in bold in the first row. For instance, while 14.5 per cent of all workplaces reported labour productivity levels ‘a lot higher’ than their major competitors, only 13.6 per cent of workplaces providing formal training did so. The intuitive interpretation of this result is that workplaces that provided formal training are underrepresented among those workplaces reporting ‘a lot higher’ relative labour productivity. Pearson’s Chi - square (χ^2) statistic, shown in the last column, measures whether the distribution of workplaces in that particular row differs significantly from that for the entire sample.

The results shown in table 5.1 suggest that a greater training effort occur in workplaces with relatively low labour productivity. This, in turn, may reflect an incentive for workplaces with low relative labour productivity to introduce or increase training of its workers. Results for innovation are more mixed. The introduction of new office technology appears to be overrepresented in workplaces reporting greater labour productivity than their competitors. Conversely, a major reorganisation of the workplace structures seems to be more prevalent in workplaces with relatively lower productivity.

Table 5.2 reveals that innovation and training are more prevalent in workplaces that have increased their productivity over the two years prior to the survey. This association is especially strong for innovation, with the association with productivity growth being statistically significant at the one per cent level for three of the four types of innovation. The provision of formal training to employees is equally significant.

Table 5.2 **Productivity growth cross-tabulations**
Based on main AWIRS95 survey

Variable	*Compare productivity to two years ago*					*Significance level* [a]
	A lot lower	*A little lower*	*About the same*	*A little higher*	*A lot higher*	
	%	%	%	%	%	
Distribution over sample	**1.1**	**4.1**	**16.9**	**43.2**	**34.8**	
Training						
Formal training of emps in last year	1.0	3.6	14.4	43.9	37.1	1
Consultant used for skills training	1.0	2.7	13.2	46.0	37.3	1
Training scheme implem. last 2 yrs	1.0	3.3	14.5	44.9	36.3	10
Skills audit implem. last 2 yrs	1.9	3.4	12.9	41.5	40.4	1
Skills audit in place	1.5	3.9	12.6	42.9	39.1	1
Managers got training	1.0	3.1	13.4	44.5	38.4	5
Para-profess. got training	1.0	2.3	15.1	44.4	37.6	10
Tradepersons got training	1.0	4.5	14.0	48.3	32.4	5
Clerks got training	1.0	2.7	13.8	44.3	38.4	5
Plant/machinery operators got training	1.2	6.1	13.4	49.6	29.7	1
Training raised by union delegate	9.4	9.4	6.3	59.4	15.6	1
Innovation						
Intro. new office tech. last 2 yrs	1.0	2.9	12.1	45.6	38.7	1
Major reorg. wp. struct. last 2 yrs	1.0	3.8	12.1	40.9	42.3	1
Major chg. to how work done last 2 yrs	1.0	3.3	9.7	40.1	45.9	1

a Pearson χ^2 test. Significant cross-tabulations only are shown.

Source: PC estimates.

It is worth reiterating the limitations of bivariate analysis. It is possible that other variables are the real drivers of the results presented in tables 5.1 and 5.2. For instance, if strongly innovative workplaces are also more likely to have a single union, the omission of industrial relations variables from the analysis could lead to the mistaken conclusion that innovation and productivity growth were associated in a meaningful way when, in reality, unionisation may be the key.

Nevertheless, the results in tables 5.1 and 5.2 tend to support the view that the use of training and innovation varies between workplaces, based on their labour productivity. In particular, training and innovation appear to be more strongly represented in those workplaces that:

- experience low relative labour productivity; and
- experience high labour productivity growth.

It is of interest, therefore, to examine the degree of overlap (if any) between these two groups. For instance, the frequency of workplaces belonging to both groups could provide an indication of whether training and innovation are being used by lagging workplaces to catch up with their competitors.

Table 5.3 explores this possibility by dividing the panel data from the 1990 and 1995 AWIRS into four classes:

1. Consistent overperformers — workplaces that had above-average labour productivity levels in both 1990 and 1995.
2. Improvers — workplaces that went from average-or-below productivity in 1990 to above-average in 1995.
3. Deteriorating workplaces — those that went from above-average productivity in 1990 to average-or-below in 1995.
4. Stagnating workplaces — those that had average-or-below labour productivity in both 1990 and 1995.

On the basis of this partitioning, we investigate associations with the use of training[15] and innovation by workplaces in 1988–90 and 1993–95. The results of these cross-tabulations are presented in table 5.3. As in tables 5.1 and 5.2, the first row of this table shows the distribution of the entire panel sample between the various categories (eg 33.3 per cent of panel workplaces stagnated between 1990 and 1995). The remaining rows show the distribution of a sub-sample of workplaces reporting either training or innovation (eg 19.2 per cent of workplaces reporting training of their employees in 1989–90 experienced a fall in their productivity ranking between 1990 and 1995). As before, the significance of any differences between a particular sub-sample and the whole panel sample is assessed by means of a χ^2 test.[16]

A number of significant associations are of interest:

- an improvement period was more likely to encompass one or more forms of innovation;
- a period of deterioration was more likely to have been preceded by investment in new plant, equipment or office technology;

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15 Foreshadowing the analysis in section 5.2, training is only represented by the formal training of employees in the last year.

16 However, contrary to tables 5.1 and 5.2, differences are assessed for one category at a time (eg by comparing the representation of improvers in the whole sample to their representation in the sub-sample of workplaces providing training), not for the whole row.

- a period of deterioration was less likely to have been preceded by the formal training of employees;
- a period of deterioration was less likely to comprise a change in the nature of how work is done; and
- a period of stagnation was less likely to contain a restructuring of the workplace.

Table 5.3 **Changes in productivity levels between 1990 and 1995**
Based on AWIRS90 and AWIRS95 panel surveys

	Years	*Stagnating workplaces*	*Deteriora-ting workplaces*	*Improvers*	*Consistent overperfor-mers*
		%	%	%	%
Distribution over sample		**33.3**	**21.5**	**21.7**	**23.5**
Training					
Formal training of employees in last year	1989–90	31.9	19.2*	23.3	25.6
	1994–95	31.7	21.6	22.2	24.4
Innovation (in last two years)					
Change in product/service	1988–90	25.9	23.5	21.0	29.6
	1993–95	29.5	16.7	32.1**	21.8
New plant/equipment/office tech.	1988–90	29.3	25.3*	23.2	22.2
	1993–95	33.8	17.6	26.8*	21.8
Reorganisation of wp. structure	1988–90	32.5	21.0	23.0	23.5
	1993–95	29.3*	23.6	21.4	25.8
Restructure of how work is done	1988–90	29.2	21.9	22.9	26.0
	1993–95	31.6	15.1***	26.4**	26.9

Notes: * denotes significance at the 10 per cent level of significance (Pearson χ^2 two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Source: PC estimates.

It appears, therefore, that the use of innovation and training by workplaces with low relative labour productivity increases their chances of experiencing labour productivity growth subsequently. Put another way, training and innovation help the workplace catch up with its competitors.

We now turn to the results of multivariate analysis, in an attempt to separate the effects of training and innovation on labour productivity from other variables.

5.2 Multivariate analysis

In this section, the links between labour productivity and training and innovation are investigated using multivariate analysis. Given the characteristics of the data, ordered probit models of productivity levels and productivity growth are estimated. The marginal effects of the variables of interest are then calculated and reported in the text. The full set of results is reported in appendix A.

The theoretical foundation of ordered probit models is described briefly below. Then the influence of training and innovation on the labour productivity levels of workplaces in 1995 is investigated using AWIRS95. Following this, the effects of training and innovation on labour productivity growth are examined. Finally, these effects are explored in the context of the sample of workplaces belonging to the panel data set (the ‘panel survey’). This is done in an attempt to investigate the existence of time lags between training, innovation and productivity growth and to address potential endogeneity issues with the analysis.

The ordered probit model

Consider the productivity level y* of a workplace:

$$y^* = \beta'\mathbf{x} + \varepsilon \tag{10}$$

where y^* is a continuous variable measuring the workplace’s labour productivity, $\mathbf{x}$ is a vector of observed workplace characteristics, β is a vector of parameters capturing the links between workplace characteristics and productivity and ε is an error term.[17]

In the AWIRS, y* is not observed. The AWIRS contains a discrete variable that indicates whether the workplace’s productivity is a lot lower to a lot higher than its competitors’ (values of 1 to 5). This provides a ranking of workplaces.

The basis of the ordered probit model is that there is a direct relationship between the unobserved level of workplace productivity y* and the observed productivity groups y, so that if, for instance, a workplace reports a productivity level that is a ‘lot lower’ than its competitors, then it must be that y is less than some threshold level μ_1. This yields the relationship below:

$y = 1 \quad$ if $y^* < \mu_1$

$y = 2 \quad$ if $\mu_1 \le y^* < \mu_2$

$\vdots$

$y = 5 \quad$ if $y^* \ge \mu_4$

[17] It is assumed that the error term ε has a mean of zero and a variance of one (Greene 1991).

The sign of the coefficient estimates of β can be unambiguously interpreted in terms of the probability of being located in the lowest or highest category.[18] Implications of the sign for the probability of being in the intermediate categories cannot be known a priori (Greene 1991, p. 704). Another limitation of probit model coefficients is that they do not measure how a particular workplace characteristic (eg training) influences the probability of being in the top category (the 'marginal effect'). The magnitude of this effect can, however, be derived from the estimated coefficients and the values of the various workplace characteristics. Specifically, the method chosen here consists of calculating the marginal effect of training or innovation for each workplace and then averaging across the sample.

As mentioned above, **x** is a vector of workplace characteristics thought to influence labour productivity levels. Some of these characteristics are identified by the theoretical framework presented in sections 3.1. These include measures and proxies of the quantity and quality of the labour and capital used by the workplace. A range of other variables are included to control for other factors likely to influence workplace productivity (see box 5.1 and appendix B).

Labour productivity levels

The determinants of labour productivity levels of workplaces surveyed in the 1995 AWIRS are investigated in this section. The results of two ordered probit models explaining the labour productivity rankings of workplaces (productivity level) are summarised in figure 5.1 and detailed in appendix table A.1. One model (Model 1) is a condensed version of the other (Model 2). The training variable ('formal training') in both models takes the value one if any formal training of employees has occurred during the previous year.[19] The 'organisational change' (innovation) variable in the condensed model takes the value one if one or more of the four types of innovation has been carried out in the workplace in the previous two years. The extended model separates the effects of the different types of innovation on productivity.

Both models include the same human capital and control variables.

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[18] A positive (negative) coefficient increases the probability of being in the highest (lowest) category.

[19] See appendix B for a detailed explanation of the coding of variables.

Box 5.1 **Control and human capital variables**

Control variables

The inclusion of control variables in the probit models is intended to isolate the effects of training and innovation on workplace labour productivity and productivity growth. The omission of the control variables may result in the erroneous attribution of the effects of training and innovation on productivity. For instance, if training occurs more frequently in large workplaces and large workplaces are more productive, omitting the size variable from the probit model may lead to the erroneous result that training is associated with high productivity when, in reality, training is acting as a proxy for size.

Studies of workplace productivity using the AWIRS (Crockett et al. 1992, Drago and Wooden 1992, Hawke and Drago 1998, Loundes 1999) have used a large number of control variables in ordered probit models. For ease of exposition, these variables can be grouped into the following categories:

Nature of the workplace

Workplace size can capture economies of scale in production. It is traditionally proxied by the number of employees. Studies have generally not found workplace size to be statistically associated with labour productivity.

Workplace age is commonly included as a proxy for the vintage of capital in use in the workplace. Studies have failed to detect any statistical association between workplace age and labour productivity.

Single workplace firms were found by some studies to have higher productivity levels and growth than their counterparts in larger organisations.

Industry dummies are routinely included in studies of labour productivity, to capture differences in production processes between industries.

Activity

Capital intensity (or, conversely, *labour intensity*) of the production process should be included as a determinant of productivity (see section 3). Studies that have included capital intensity have not found it to have a significant influence. This is possibly due to the fact that it cannot be measured directly and is proxied by the inverse of the share of labour in total costs.

Capacity utilisation is likely to affect labour productivity (see section 3). The rate at which capital and labour are utilised within the workplace will depend on, among other factors, the level of demand for its output. The direction of the relationship between capacity utilisation and labour productivity is uncertain. Increasing the rate at which underutilised capital and labour are utilised will increase labour productivity, but over-utilising these factors will reduce labour productivity. AWIRS studies have consistently found higher capacity utilisation to have a positive influence on productivity.

(Continued)

Workforce

For a given level of capital stock, *net employment growth* decreases the capital-labour ratio and hence reduces labour productivity growth (see section 3). On the other hand, employment growth may be the short-run consequence of an expanding demand for the workplace's output, a factor thought to be positively related to labour productivity (see below).

Worker involvement is an input into the production process, through its effect on worker effort and commitment (see section 3). In AWIRS studies, it has been proxied through such schemes as *quality circles*, *team building* and *joint consultative committees*. These variables have generally been found to have positive effects on labour productivity.

Management

Labour productivity benchmarking by the firm is sometimes included as a proxy for management ability (Rogers 1999). As such, as explained in section 3, it should result in higher productivity, a conclusion which appears to be supported by empirical results of previous studies. Other indicators of good management, such as the quality of *employee-management relations* and the implementation of *corporate plans* have also generally proved significant influences on productivity.

Environment

Standard microeconomic theory holds that firms that operate in a competitive environment are more technically efficient than those in less competitive markets. The reduced pressure to minimise costs is often put forward as the reason for the perceived inefficiency of *public sector workplaces*. In some AWIRS studies it was found that public sector workplaces have lower relative productivity.

As is well-known in labour economics, firms tend to shed labour quickly during market downturns, and to add it only slowly during market upturns. It follows from this that labour market productivity should be positively related to an *expanding demand* for the firm's product, something which AWIRS studies have tended to confirm.

Human capital variables (except training)

As mentioned in section 3, human capital is thought to be a determinant of labour quality and hence, of labour productivity. The variables that are normally used to measure human capital are not available in the AWIRS. Instead, previous studies have used proxies such as occupational shares, length of tenure and skills content, without being able to detect a strong relationship between these and productivity.

The above list of possible influences on workplace productivity is not exhaustive. Earlier AWIRS-based studies of labour productivity have included a number of control variables that have not been used in this paper, in the interest of succinctness.

Prior to examining the results of these models, a departure from the theoretical framework presented in section 3 must be noted. While labour productivity levels are thought to be influenced by cumulative training and innovation (see equations 3, 4 and 5), these variables cannot be observed in the AWIRS. Instead, training and innovation in one period are used as proxies. This is a common problem in studies measuring the impact of human capital on labour productivity (Lynch and Black 1995). While the use of these proxies is not ideal, it can be defended if training and innovation are largely recurring activities. Rogers (1998c) found this to be the case with most forms of innovation in the AWIRS panel data set. In that same sample, 58 per cent of workplaces which provided training to their employees in 1989–90 also provided it in 1994–95.

The size of the marginal effects of training and innovation is represented in figure 5.1 (panels a and b) by the length of the horizontal bars. These bars measure the increase (or decrease) in the probability of a workplace being located in the top category if it possesses a particular characteristic. Given that the maximum probability value is one, the values underlying the bars may be likened to percentage changes in the probability.

All marginal effects in figure 5.1 have the expected positive sign, except for a reorganisation of workplace structure. However, their magnitude is small, with none of these effects adding (or subtracting) more than two per cent to the probability of a workplace being located in the top productivity level category. Further, the effects of training and innovation are all insignificant, reflecting the lack of significance of these variables' coefficients in appendix table A.1. The lack of significance of training and innovation in multivariate analysis of productivity levels suggests that the significant cross-tabulations reported in table 5.1 are the product of omitted workplace characteristics. When these characteristics (eg size) are controlled for, the bivariate associations disappear.

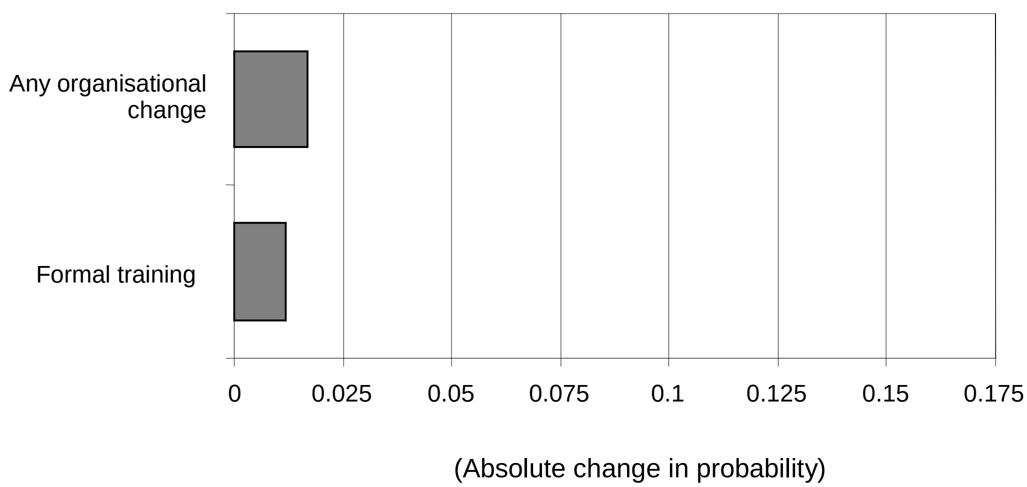
However, in the case of training, the lack of significance may also be due to simultaneity bias affecting the coefficient estimates based on the cross-section data. This bias may occur if training is endogenous, that is, both influences productivity levels and is influenced by them (see box 5.2). Bartel (1994) also found training to be an insignificant influence on labour productivity levels, and concluded that:

> …estimating the relationship between training programs and labour productivity using a cross-sectional framework does not allow us to untangle the effect of training on productivity from the effect of productivity on the use of a formal training program. (1994, p. 417)

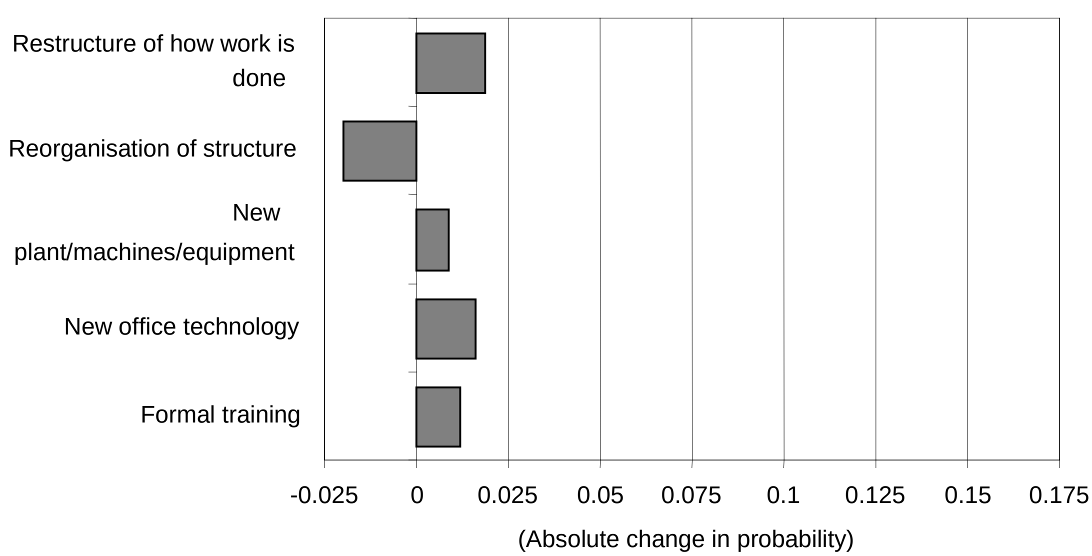
Figure 5.1 **Marginal effects[a] on productivity levels**

Based on AWIRS 1995 main survey (whole population)

(a) Condensed Model



(b) Extended Model



[a]None of these effects are significant.

Data source: Appendix table A.1.

She was able to remedy this problem by using information on the training 'history' of the firms in her cross-section. As mentioned earlier, she found that firms with lower-than-expected productivity levels in an earlier period were very likely to implement training programs as their preferred 'catch up' strategy. Further, she showed that, by the end-period, this strategy had succeeded, as 'training

Box 5.2 **Simultaneity of productivity and training***

The effect of training on labour productivity is difficult to estimate econometrically, due to the likely existence of feedback from productivity to training. Such feedback, if not formally modelled in a system of equations, can lead to simultaneity bias affecting the estimated relationship between training and labour productivity. It is possible to demonstrate the existence of the bias and predict its direction as follows.

Let Y_i be the productivity level of firm i and X_i be the training variable. The relationships of interest are:

$$Y_i = X_i\beta + Z_i\gamma + u_i \tag{1}$$

and

$$X_i = Y_i\theta + W_i\lambda + e_i \tag{2}$$

Equation (1) allows training and other factors (Z_i) to affect productivity. Equation (2) makes training a function of productivity and other factors (W_i). u_i and e_i are error terms. Estimating equation (1) on its own leads to a biased estimate of β, the coefficient of interest. This bias arises due to the fact that X_i and u_i will be correlated. To show this, substitute equation (1) into (2):

$$X_i = X_i\beta\theta + Z_i\gamma\theta + u_i\theta + W_i\lambda + e_i \tag{3}$$

Re-arranging:

$$X_i = \frac{Z_i\gamma\theta}{1-\beta\theta} + \frac{\theta}{1-\beta\theta}u_i + \frac{W_i\lambda_i}{1-\beta\theta} + e_i \tag{4}$$

Equation (4) shows that the training variable in equation (1) is correlated with the error term of that same equation, u_i. The direction and strength of the bias in the estimation of β depends on the covariance between X_i and u_i. This covariance is equal to:

$$Cov(X_i, u_i) = \frac{\theta}{1-\theta\beta}\sigma_u^2 \tag{5}$$

where σ_u^2 is the variance of u_i. As discussed, theory would predict that, in equation (5), β>0 (more training leads to higher productivity) and θ<0 (low productivity leads to more training), implying that the covariance is negative. A negative covariance implies that probit estimates of β is biased downward, although it is not possible to know the magnitude of this bias precisely.

If the variables of interest in equations (1) and (2) were continuous (ie were not limited to discrete values such as 0 and 1 in the case of training), simultaneity bias could be avoided through the use of econometric techniques such as two-stage least squares or instrumental variables estimation. However, the ordered and binary nature of the data used in this paper does not lend itself well to the use of such techniques.

*We are grateful to Professor Brett Inder, Monash University, for the following exposition.

implementers' had labour productivity levels not significantly different from those of comparable businesses.

Based on Bartel's results, therefore, an insignificant coefficient for training in Model 1 should be expected if workplaces with low relative productivity initially are more likely to undertake training. Unfortunately, information on the training and productivity 'history' of workplaces is not available from the 1995 cross-section AWIRS data. While there is information on whether firms implemented a training program in 1993–95,[20] the labour productivity ranking in 1993 is not available.

Labour productivity growth

In figures 5.2 and 5.3 (and appendix table A.2), the results of two ordered probit regressions seeking to explain labour productivity growth in the workplace are presented.[21] The aim is to determine whether training and innovation (organisational change) are associated with growth in labour productivity at the workplace level over the two year period 1993 to 1995.

We again distinguish between a condensed (figure 5.2) and an extended model (figure 5.3). While training, innovation and human capital variables are the same as in the productivity levels models, the control variables differ to some extent. As explained in section 3.2, changes in productivity levels (ie productivity growth) are likely to be primarily driven by *changes* in workplace characteristics, rather than by *existing* characteristics. For this reason, the growth models include a series of variables flagging the implementation, in the two years prior to the survey, of quality circles, just-in-time, team building, and computer-integrated management (CIM). In preliminary testing of variables affecting labour productivity growth, the *implementation* of these management and worker involvement techniques was consistently more significant than their *operation*.

Another difference between the labour productivity levels and growth models is the addition, in the latter, of a 'net employment growth' explanatory variable. This represents an attempt to control for changes in the capital-labour ratio, rather than just for its level, as 'high labour costs' does.

Figure 5.2 indicates that both training and innovation are strongly associated with high labour productivity growth. This is especially notable for innovation. These results are consistent with Loundes (1999) and with the bivariate results shown in

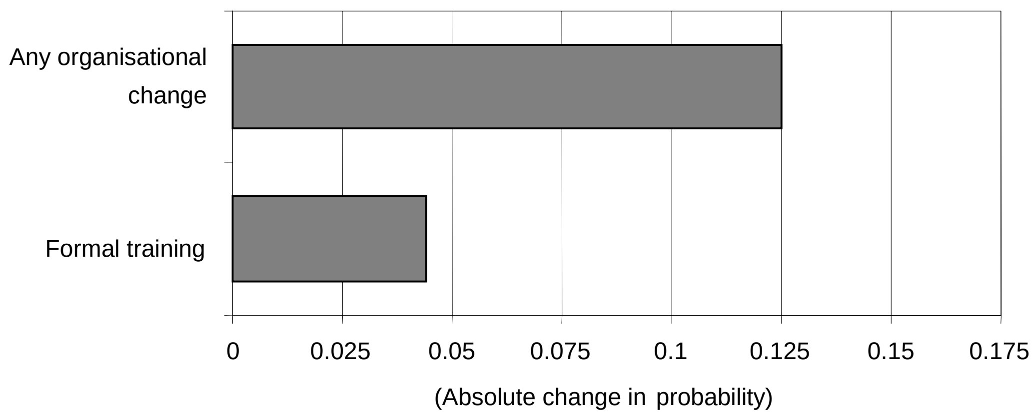
[20] This variable proved an insignificant predictor of relative labour productivity in 1995.

[21] Hereafter, only significant results are reported in the text.

table 5.2. They also satisfy the second working hypothesis in this paper (see section 3.3), by highlighting the link between labour productivity growth on the one hand, and training and innovation on the other.

As figure 5.2 reveals, the marginal effect of organisational change is almost three times greater than that of training. In other words, the implementation of some form of innovation by a workplace increases its probability of responding ‘a lot higher’ to the productivity growth question by 12.5 per cent. The corresponding figure for formal training is 4.4 per cent.

Figure 5.2 **Marginal effects[a] on productivity growth — condensed model**
Based on AWIRS 1995 main survey (whole population)



[a]Significant effects of training and innovation only.

Data source: Appendix table A.2.

The results in figure 5.2 can be usefully contrasted with those in figure 5.1, which do not lend support to the hypothesised influence of training and innovation on productivity levels. However, as explained earlier, this lack of significance could be an artefact of the simultaneity bias resulting from the use of cross-section data.

Indeed, simultaneity bias could also be affecting the validity of the estimates presented in figure 5.2. This is because the training variable signals training over *the previous year*, while labour productivity growth is tracked over *the previous two years*. Thus, as Bartel (1994) remarks, the possibility cannot be ruled out that firms will institute training programs in response to either falling or rising productivity. The possibility that the training variable in figure 5.2 is endogenous cannot be discounted, therefore.

However, as discussed in box 5.2, any simultaneous bias is likely to be downward, indicating that the marginal effects shown in figure 5.2 and the coefficients presented in table A.2 can be validly interpreted as lower bound estimates.

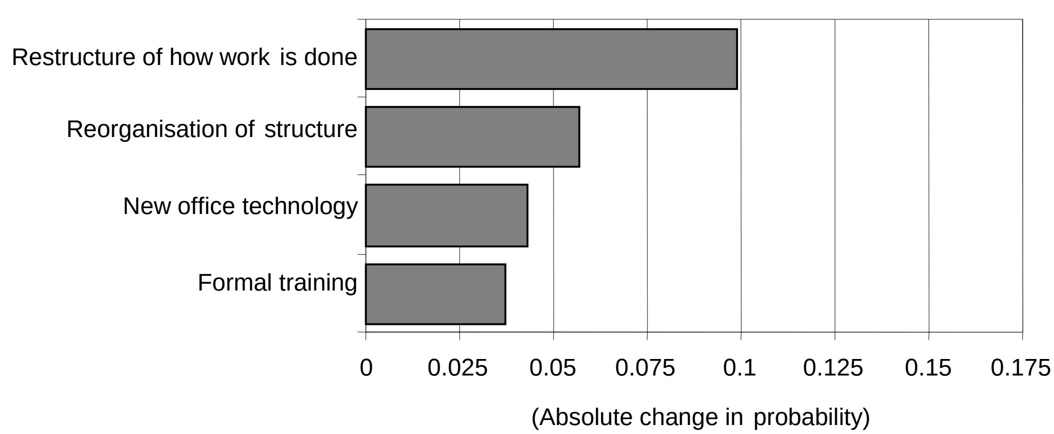
For the issue of endogeneity to be totally resolved, information on training at the beginning of the period over which labour productivity growth is recorded (1993–95) would be needed. It is, however, unavailable in the AWIRS. (Attempts to replace the formal training variable in the model with the implementation of a training program during 1993–95 proved unsuccessful.)

Fortunately, the panel data segment of the AWIRS enables the training (and productivity) history of a workplace to be traced, albeit imperfectly due to the five-year interval between successive waves of the survey. It is used in a latter section to explore issues of timing and endogeneity further.

In figure 5.3, organisational change is segregated by type. Three of the four types of innovation are strongly associated with higher productivity growth. Restructuring of how the work of non-managerial employees is done has the closest and strongest association with productivity growth. The marginal effects shown in figure 5.3 indicate that this form of innovation increases the chances of a workplace reporting high productivity growth by almost 10 per cent. The fact that the marginal effect of training is now lower than in figure 5.2 indicates that this variable is more closely correlated with some forms of innovation than with others.

Figure 5.3 **Marginal effects[a] on productivity growth — extended model**

Based on AWIRS 1995 main survey (whole population)



[a]Significant effects of training and innovation only.

Data source: Appendix table A.2.

Finally, it is of interest to note the positive association between labour productivity growth and the introduction of new office technology. This is consistent with international results showing that the spread of computers in the workplace increases productivity growth, even when allowing for differences in human capital (Lehr and Lichtenberg 1999, Black and Lynch 1997).

Leading and lagging workplaces

Another implication of the theory is that the effects of training and innovation on productivity growth are likely to differ between technically efficient and technically inefficient workplaces. Technically efficient workplaces are producing the maximum output given a set of inputs and the state of the technology/skills. It is conceivable that the distinguishing factor between the two types of workplaces is in their use of technology, innovations and skills. For instance, an inefficient workplace may not be making the most of its workforce if it does not equip it with the necessary skills. However, should it decide to provide training to its employees, this firm will be able to achieve more rapid productivity growth than technically efficient workplaces. However, as it gets closer to maximum efficiency, diminishing returns from upskilling may set in. When it has converged with the leaders, training may not have such a large impact on productivity growth.

The possibility of convergence among workplaces with differing levels of labour productivity seems reinforced by the cross-tabulations reported in table 5.3, which showed that several forms of innovation were overrepresented in 'improving' workplaces.

In an attempt to explore this possibility further, we split the workplaces in AWIRS95 into two groups of approximately equal size:

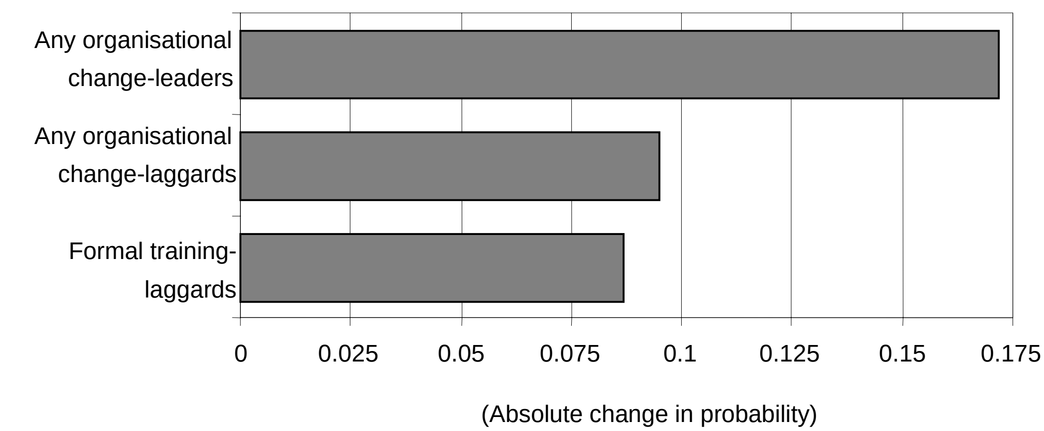
- Leaders — those workplaces that reported labour productivity levels that were 'a little higher' or 'a lot higher' than their competitors.
- Laggards — the remainder (average or below-average productivity levels).

We then re-estimate the condensed and extended growth models for these two sub-samples. The results are presented in full in tables A.3 and A.4 and selectively in figures 5.4 and 5.5.

The striking result from these models is the importance of formal training in explaining productivity growth among laggards and the lack of power of formal training in explaining productivity growth among leading workplaces. The impact of training on the labour productivity growth of laggards is reflected in figure 5.4, showing that the provision of formal training to its employees increases the likelihood of a workplace being located in the top category by 8.7 per cent. This figure is close to that for organisational change and almost exactly double that shown for the whole sample (figure 5.2). The thrust of these results does not change when innovation is disaggregated (figure 5.5).

Figure 5.4 **Productivity growth[a] by group — condensed model**

Based on AWIRS 1995 main survey (sub-samples of lagging and leading workplaces)

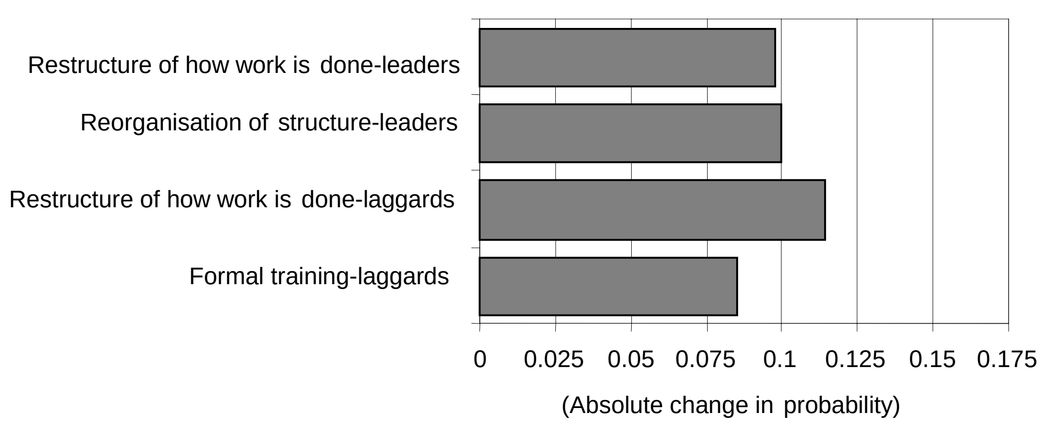


[a] Significant effects of training and innovation only.

Data source: Appendix table A.3.

Figure 5.5 **Productivity growth[a] by group — extended model**

Based on AWIRS 1995 main survey (sub-samples of lagging and leading workplaces)



[a] Significant effects of training and innovation only.

Data source: Appendix table A.4.

One possible reason behind the lack of significance of training for the leaders category is that these workplaces may use newer technology. As a result, they may need to train their employees internally rather than externally. This could explain the significance of the ‘skills content’ coefficient in Model 6 (see table A.3), as this variable is sometimes interpreted as a proxy for on-the-job training (Drago and Wooden 1992).

By contrast with training, organisational change is a powerful determinant of growth for both groups of workplaces. In the condensed model, organisational change has a larger marginal effect on the productivity growth of leaders (see figure 5.4). However, when innovation is disaggregated (figure 5.5), the restructuring of how work is done impacts on laggards more strongly. Finally, a reorganisation of the workplace appears to benefit leaders only.

An important qualification is required at the end of this section. While splitting a sample prior to model estimation is common econometric practice, the criterion used for allocating observations to one group or the other should not be correlated with the dependent variable. This rule is violated in this section’s models because a workplace’s labour productivity ranking in 1995 and labour productivity growth in 1993–95 are jointly determined. This means that, here also, the error term in each of the models is correlated with the explanatory variables, resulting in biased estimates of the coefficients (see box 5.2).

For this reason, and also on economic grounds, it would be preferable to split the sample on the basis of 1993 labour productivity levels. However, as mentioned, this information is unavailable in the 1995 AWIRS. The second-best alternative is to split the sample according to 1990 levels, which can only be done for the panel data (see below).

Fortunately, it can be shown that the removal of any simultaneity bias affecting the cross-sectional estimates would simply reinforce the results reported in figures 5.4 and 5.5 (and tables A.3 and A.4) for the laggards. This is because coefficient estimates for that sub-sample are likely to be biased downward by the joint determination of productivity levels and growth, thus compounding the downward bias already caused by the endogeneity of training (see box 5.2). In all likelihood, therefore, the true effect of training on the labour productivity growth of lagging firms is stronger than has been estimated here.

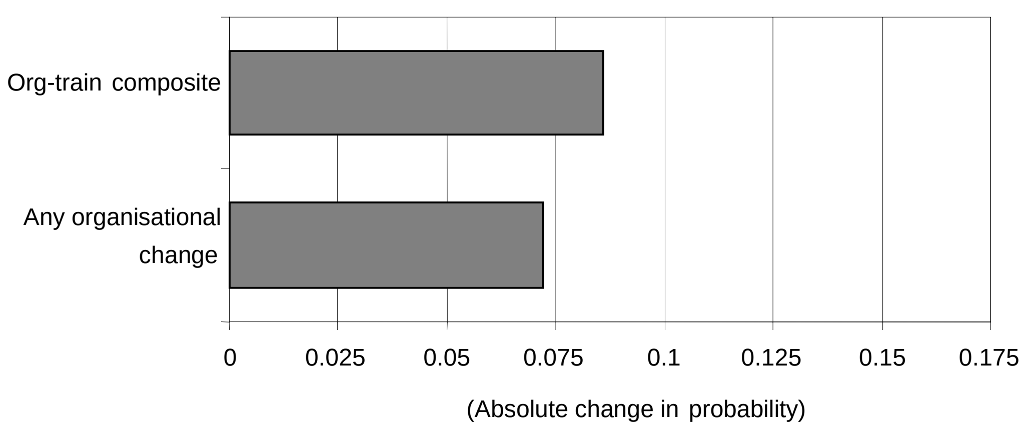
The situation is not as clearcut for leaders, however. For that sub-sample, the bias caused by the joint determination of productivity levels and growth is an upward one, whereas that caused by the endogeneity of training is downward. The net effect of these opposing biases is uncertain, therefore. This means that the marginal effects and coefficients pertaining to the leaders could be under- or overestimates, and therefore the coefficients estimated here should be interpreted with caution.

Combined effects of training and innovation

As discussed earlier (see section 3.1), training and innovation implemented together in a workplace may increase labour productivity more than if introduced by themselves. In an attempt to test this hypothesis, we follow Crockett et al. (1992) and include an interaction variable into the probit models explaining labour productivity growth.[22] This variable, a composite denoted 'org-train', assumes a value of one if there was both formal training in the previous year in the workplace and organisational change during the previous two years.[23]

The results of the condensed and extended productivity growth models incorporating the interaction variable are presented in table A.5 and summarised in figures 5.6 and 5.7. As expected, the org-train variable has a positive impact on labour productivity growth, although it is only weakly statistically significant. The joint introduction of training and organisational change raises the probability of a

Figure 5.6 **Productivity growth[a] with interaction — condensed model**
Based on AWIRS 1995 main survey (whole population, ORG-TRAIN composite variable added)



a Significant effects of training and innovation only.

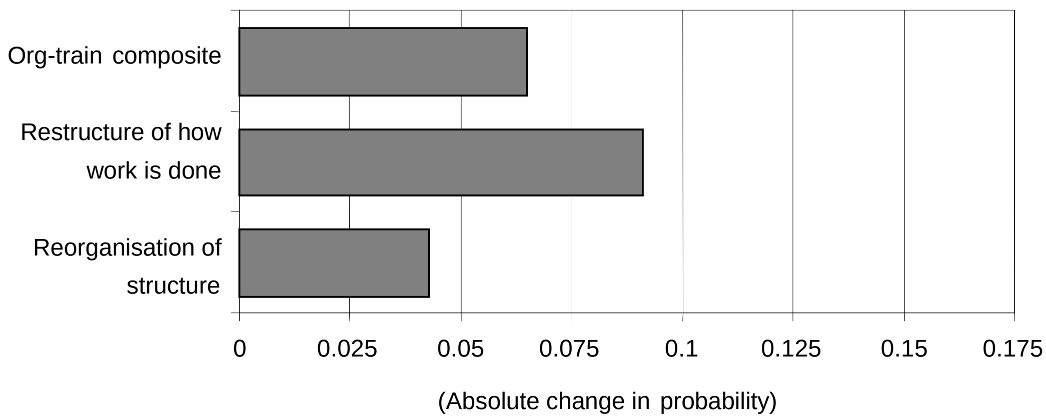
Data source: Appendix table A.5.

[22] Attempts to include this variable in the productivity levels regressions proved unsatisfactory.

[23] Of several interaction variables trialled, this is the only one that proved successful.

Figure 5.7 **Productivity growth[a] with interaction — extended model**

Based on AWIRS 1995 main survey (whole population, ORG-TRAIN composite variable added)



a Significant effects of training and innovation only.

Data source: Appendix table A.5.

workplace being in the top growth category by 8.6 per cent, which is greater than the equivalent effect for organisational change (figure 5.5). However, when different forms of innovation are distinguished, the effect of work restructuring exceeds that of the org-train variable (figure 5.7).

In order to interpret these interaction results further, it is useful to compare the coefficients contained in appendix tables A.2 and A.5. As can be seen from these tables, the introduction of the org-train variable reduces the training variable to insignificance. By contrast, the innovation variable remains significant at the 10 per cent level.[24] This suggests that training is of benefit to labour productivity growth, but only when implemented in combination with innovation. Conversely, innovation can be beneficial in isolation, although its effects are enhanced by training.

Productivity growth models using panel data

In this section, the influence of training and innovation on productivity growth is explored further, using the panel of workplaces in the 1990 and 1995 AWIRS. The panel data allows observations on training and innovation in one period and labour

[24] The significance of the formal training variable in the estimated models reported in table A.2 therefore appears to be driven by higher labour productivity growth among workplaces that have introduced both training and innovation compared to those that have introduced innovation only. Among the subset of workplaces that have not introduced innovation, training does not appear to have any influence on labour productivity growth.

productivity growth in a subsequent period to be used, thus eliminating the potential for endogeneity problems (discussed earlier).[25]

Further, the panel data allows the existence of a lag to be investigated. Longitudinal studies (eg Northwood 1999) have found that factors such as expenditure on training and R&D, and the number of major changes implemented by a firm can take several periods to enhance its performance.

However, the lag implicit when using AWIRS panel data ranges between three (1990–93) and seven years (1988–95), which could mean that the effects of training and innovation go undetected if they decay rapidly. An attempt is made to overcome this problem by adding measures of human capital in 1990 to the explanatory variables. If, as has been suggested earlier, the incidence of training and innovation is a function of the existing stock of human capital, a high value of that stock in 1990 would result in above-average training and innovation in 1990–93 (both unobserved in the AWIRS). The effects of training and innovation in that period on productivity growth in 1993–95 could thus be captured indirectly.

Accordingly, the productivity growth models (Models 3 and 4 in table A.2) are re-estimated using training and innovation in 1990.[26] The results are summarised in figure 5.8 and detailed in appendix tables A.6 and A.7.[27]

Overall, the results of these models do not support the hypothesis that labour productivity growth between 1993 and 1995 is influenced by workplace characteristics in 1990 (especially training, innovation and human capital). The overall lack of significance of lagged training and innovation variables in explaining current labour productivity growth can be interpreted in different ways.

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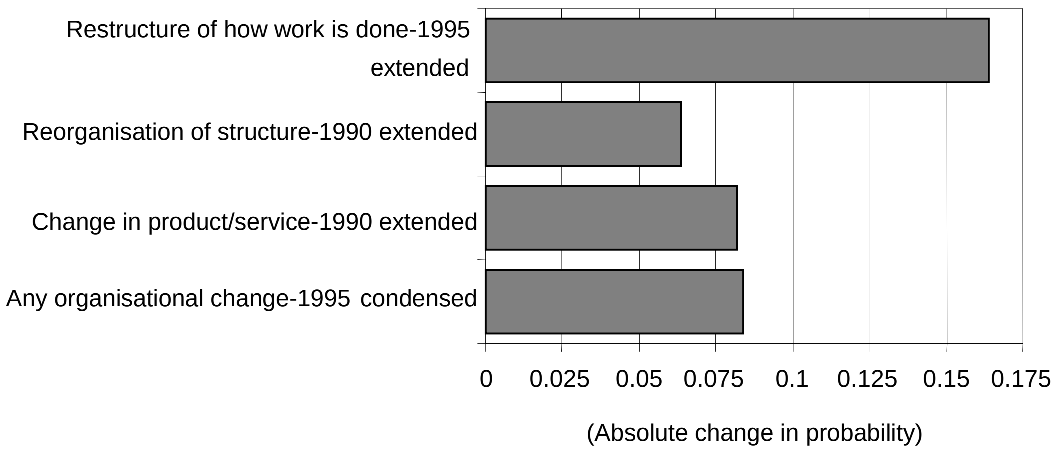
25 In principle, this problem could also be addressed by estimating a fixed workplace effects model of workplace labour productivity, based on the panel data set. However, such a model proved unsuccessful in preliminary testing and its results are not reported in this paper.

26 A perfect equivalence between the cross-sectional and panel variables is not possible. For instance, no information on the age of the workplace is available from the panel survey. On a positive note, there is now information on a form of training — study leave for non-managerial employees — that is not available in the main 1995 survey. There are also differences in variable coverage and definition between the main and panel surveys. Of particular relevance here are differences in the range of innovations, the definition of productivity levels and the categories of capacity utilisation (see appendix B for details).

27 In these appendices, Model 11 shows the estimated model of productivity growth in 1993–95 using 1990 explanatory variables (except where indicated in brackets). Model 12 shows the same model using 1995 variables exclusively. Models 13 and 14 show the extended versions of Models 11 and 12 respectively.

Figure 5.8 **Productivity growth[a] using panel data — condensed and extended models**

Based on AWIRS 1990 and 1995 panel surveys (whole population, 1990 and 1995 explanatory variables)



[a]Significant effects of training and innovation only.

Data source: Appendix table A.6 and A.7.

First, the small number of observations in the panel sample, may have limited the ability of the links to be detected.

Second, it may reflect a lack of causality between all training and innovation occurring between 1988 and 1993 and labour productivity growth in 1993–95.

Third, as discussed, it may be a product of the timing of observations. It is possible that the rate at which the effects of training and innovation decay means that they cannot be detected after the time lag implicit in this data set. While the inclusion of 1990 human capital variables is intended to remedy that problem, their lack of significance does not allow a definite conclusion to be reached.

Nonetheless, it is possible that different types of innovation have a different rate of decay. The disaggregation of the organisational change variable shows that organisational restructuring and changes in product or service in 1988–90 have a significant positive association with labour productivity growth in 1993–95. Since the timing of the observations excludes the possibility of endogeneity (productivity growth causing innovation), this result may be regarded as valid. A comparison of Models 13 and 14 (table A.7) lends qualified support to the hypothesis that different types of innovation decay at different rates, with a change of product/service and workplace restructuring having a more persistent impact than other forms of innovation (Model 13). Conversely, Model 14 suggests the effects on productivity of changes in how the work is done are more immediate. However, the latter result may be an artefact of the simultaneity bias already mentioned.

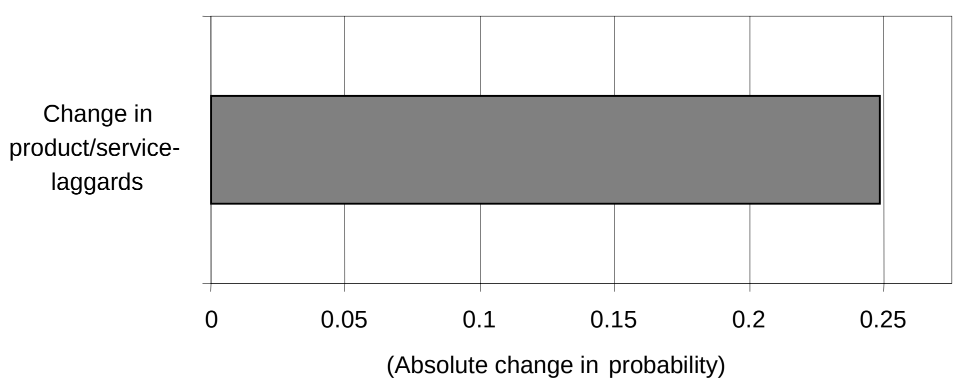
The significant marginal effects from Models 11–14 are reported in figure 5.8. While a restructure of how work is done has by far the largest contemporaneous effect on labour productivity growth in 1993–95, a 1988–90 change in the product/service produced has a marginal effect — five years later — almost as strong as that of any organisational change taking place in 1993–95. This could be a reflection of the learning curve the workplace has to go through before it can produce a new product efficiently.

In line with the cross-sectional analysis of productivity growth, the panel sample is now split into sub-samples of laggards and leaders. However, these sub-samples are defined by reference to the workplace's productivity ranking in 1990, rather than 1995. This avoids the simultaneity problem implicit in splitting the cross-sectional data according to 1995 productivity levels, discussed earlier.

The results detailed in Models 15 and 16 (table A.8) reveal a strong positive association between the introduction of a major new product or service and productivity growth of the laggards. This is not the case for the leaders. As figure 5.9 shows, the marginal effect of this form of innovation on the productivity growth of the laggards is the largest reported so far. Workplaces that were inefficient in

Figure 5.9 **Productivity growth[a] by group, using panel data — extended model**

Based on AWIRS 1990 and 1995 panel surveys (sub-samples of 1990 laggards and leaders, 1990 explanatory variables)



[a]Significant effects of training and innovation only.

Data source: Appendix table A.8.

1990 increased their chances of recording high labour productivity growth in 1993–95 by 24.8 per cent if they had changed the nature of their product or service in 1988–90.

These results offer further evidence that innovation is used differently by technically efficient and inefficient workplaces. Moreover, it tends to suggest that, for firms that are lagging, the foundations of the catch up process can be laid some time before the benefits in terms of increased labour productivity materialise. Of course, the timing issue is still somewhat imprecise in that it is not possible to observe the labour productivity growth of lagging firms over the period 1990–92.

6 Conclusion

Over the 1990–95 period, labour productivity in Australia increased at an average rate of 2.2 per cent a year. Data from the two AWIRS indicate that, over the same period, the incidence of training and innovation in medium to large-sized Australian workplaces increased. These trends suggest that training and innovation may have played a part in raising labour productivity. This study has examined the existence and nature of the links between labour productivity and training and innovation in the workplace.

The results from the analysis in this paper must be interpreted with caution, given the limitations of the AWIRS data. In particular, the measures of productivity and productivity growth are the subjective assessment of workplace managers. Ideally an objective measure is preferable. Furthermore, periods over which training, innovation and productivity growth in the AWIRS are measured makes it difficult to be definitive about the causal links between them. Nonetheless, the following conclusions are of interest.

First, training and innovation in the workplace are very likely to occur in workplaces experiencing strong labour productivity growth. By contrast, they do not appear to be significantly associated with higher levels of labour productivity, once other influences are taken into account. However, this second conclusion is not robust to possible endogeneity problems.

Second, different types of innovation have different effects on labour productivity growth, with changes in how work is done having a greater immediate effect than other forms of innovation.

Third, labour productivity growth appears to be enhanced by the joint introduction of training and innovation. This is due to the fact that training requires the support of innovation to benefit labour productivity growth. Conversely, introducing innovation in isolation is sufficient to promote labour productivity growth, although its returns are increased by the addition of training.

Fourth, the links between training, innovation and labour productivity in technically efficient and inefficient workplaces differ. It appears that training is an effective strategy for less efficient workplaces striving to ‘catch-up’ with competitors, whereas innovation appears to promote labour productivity growth among both technically efficient and inefficient workplaces.

Finally, the timing of the effects of innovation on productivity differs depending on the types of innovation. Specifically, while changing the work of non-managerial employees appears immediately beneficial, workplace restructuring and a change of product or service seem to have a delayed impact only. The latter type of innovation, in particular, proves a strong predictor of a ‘catch up’ process occurring some years later.

A Probit models

Table A.1 Productivity levels

Based on main AWIRS 1995 survey (whole population)

		Model 1 (condensed)		*Model 2 (extended)*	
Variable code[a]		*Coefficient*	*t-statistic*	*coefficient*	*t-statistic*
Dependent variable					
Productivity level					
Training variable					
Formal training		0.058	0.870	0.058	0.863
Innovation variables					
Any organisational change:		0.082	1.141		
New office technology				0.075	1.268
New plant/machines/equipment				0.041	0.613
Reorganisation of structure				-0.095	-1.574
Restructure of how work is done				0.092	1.589
Human capital variables					
Long tenure		-0.190***	-2.993	-0.192***	-3.022
Skills content		0.101	1.076	0.097	1.030
Largest occupation:	Managers	0.303	1.531	0.312	1.568
	Professionals	-0.048	-0.379	-0.038	-0.296
	Para-professionals	0.189	1.518	0.190	1.521
	Tradepersons	0.136	1.199	0.138	1.214
	Clerks	0.271**	2.423	0.263**	2.336
	Sales persons	0.329***	2.878	0.324***	2.828
	Plant operators	-0.106	-0.998	-0.108	-1.016
Control variables					
Size		0.011	0.146	-0.013	-0.175
Young workplace		-0.190	-1.194	-0.196	-1.227
Established workplace		-0.204**	-2.168	-0.207	-2.199
High labour costs		-0.005	-0.058	-0.017	-0.187
Above normal capacity		0.486**	7.150	0.488***	7.181
Public sector		-0.170*	-1.908	-0.167*	-1.870
Good relations		0.380***	6.604	0.367***	6.375
Demand expanding		0.186***	3.248	0.184***	3.190
Single workplace		0.114	1.472	0.100	1.283
<u>Statistics</u>					
Number of observations		1597		1597	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.054		0.056	

a See Appendix B for a detailed description of variables.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.2 **Productivity growth**

Based on AWIRS 1995 main survey (whole population)

		Model 3 (condensed)		Model 4 (extended)	
Variable code[a]		*Coefficient*	*t-statistic*	*coefficient*	*t-statistic*
Dependent variable					
Productivity growth					
Training variable					
Formal training		0.134**	1.970	0.115*	1.679
Innovation variables					
Any organisational change:		0.394***	5.542		
New office technology				0.130**	2.164
New plant/machines/equipment				0.019	0.293
Reorganisation of structure				0.172***	2.817
Restructure of how work is done				0.296***	4.775
Human capital variables					
Long tenure		0.083	1.352	0.081	1.316
Skills content		0.093	1.006	0.053	0.569
Largest occupation:	Managers	-0.104	-0.345	-0.024	-0.078
	Professionals	0.151	1.170	0.167	1.284
	Para-professionals	0.103	0.818	0.088	0.695
	Tradepersons	-0.128	-1.106	-0.148	-1.289
	Clerks	0.178	1.482	0.160	1.325
	Sales persons	0.292**	2.493	0.273**	2.332
	Plant operators	0.026	0.250	0.007	0.067
Control variables					
Size		0.222**	2.499	0.180**	2.012
Young workplace		-0.013	-0.077	0.028	0.164
Established workplace		-0.032	-0.327	-0.025	-0.247
High labour costs		0.033	0.376	0.008	0.093
Above normal capacity		0.240***	3.421	0.233***	3.307
Benchmarking		0.138**	2.247	0.105*	1.704
Employment growth		0.002*	1.836	0.002*	1.909
Good relations		0.170***	2.806	0.172***	2.823
Demand expanding		0.208***	3.602	0.208***	3.585
Single workplace		-0.229***	-2.779	-0.217**	-2.596
Goals		0.284***	3.388	0.251***	2.989
Quality circles implemented		0.060	0.623	0.054	0.552
Just in time implemented		0.120	1.617	0.169	1.358
Team building implemented		0.193**	3.236	0.171***	2.842
C.I.M. implemented		0.281***	3.228	0.266***	3.018
Statistics					
Number of observations		1660		1660	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.071		0.078	

[a] See appendix B for a detailed description of variables.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.3 **Productivity growth by group — condensed model**

Based on AWIRS 1995 main survey (sub-samples of lagging and leading workplaces)

		Model 5 (laggards)		*Model 6 (leaders)*	
	Variable code[a]	*Coefficient*	*t-statistic*	*coefficient*	*t-statistic*
Dependent variable					
Productivity growth					
Training variable					
Formal training		0.296***	3.085	-0.069	-0.650
Innovation variable					
Any organisational change		0.331***	3.236	0.528***	4.433
Human capital variables					
Long tenure		0.068	0.789	0.096	0.964
Skills content		-0.055	-0.411	0.295*	1.918
Largest occupation:	Managers	-0.056	-0.088	-0.143	-0.451
	Professionals	0.171	0.912	0.011	0.056
	Para-professionals	-0.030	-0.165	0.091	0.436
	Tradepersons	-0.058	-0.325	-0.304*	-1.756
	Clerks	0.005	0.026	0.164	0.903
	Sales persons	0.284	1.603	0.191	1.110
	Plant operators	0.067	0.435	-0.114	-0.713
Control variables					
Size		0.145	0.977	0.371***	3.009
Young workplace		0.148	0.504	0.001	0.005
Established workplace		0.043	0.255	-0.011	-0.084
High labour costs		0.056	0.450	0.073	0.515
Above normal capacity		0.152	1.253	0.194**	2.024
Benchmarking		0.187**	2.144	0.158	1.588
Employment growth		-0.001	-0.284	0.002	1.480
Good relations		-0.050	-0.534	0.271***	3.040
Demand expanding		0.288***	3.295	0.035	0.395
Single workplace		-0.121	-0.987	-0.346***	-2.903
Goals		0.161	1.398	0.415***	2.966
Quality circles implemented		0.151	1.027	-0.031	-0.207
Just in time implemented		0.277	1.471	0.101	0.550
Team building implemented		0.182**	2.141	0.217**	2.394
C.I.M. implemented		0.263**	2.015	0.384***	3.082
Statistics					
Number of observations		772		749	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.067		0.099	

[a] See appendix B for a detailed description of variables.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.4 **Productivity growth by group — extended model**

Based on AWIRS 1995 main survey (sub-samples of lagging and leading workplaces)

		Model 7 (laggards)		*Model 8 (leaders)*	
	Variable code[a]	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Dependent variable					
Productivity growth					
Training variable					
Formal training		0.295***	3.038	-0.096	-0.903
Innovation variables					
Any organisational change:					
New office technology		0.125	1.421	0.052	0.551
New plant/machines/equipment		-0.038	-0.378	0.073	0.749
Reorganisation of structure		0.095	1.084	0.295***	3.026
estructure of how work is done		0.375***	4.083	0.287***	3.019
Human capital variables					
Long tenure		0.096	1.107	0.056	0.556
Skills content		-0.098	-0.733	0.248	1.610
Largest occupation:	Managers	0.021	0.032	0.027	0.081
	Professionals	0.188	0.985	0.040	0.204
	Para-professionals	-0.064	-0.346	0.111	0.534
	Tradepersons	-0.063	-0.360	-0.331*	-1.949
	Clerks	-0.050	-0.266	0.179	0.989
	Sales persons	0.255	1.419	0.188	1.096
	Plant operators	0.043	0.283	-0.141	-0.856
Control variables					
Size		0.093	0.637	0.309**	2.497
Young workplace		0.120	0.407	0.123	0.543
Established workplace		-0.002	-0.010	0.052	0.392
High labour costs		0.024	0.188	0.038	0.254
Above normal capacity		0.161	1.326	0.177*	1.824
Benchmarking		0.154*	1.724	0.113	1.136
Employment growth		0.000	0.017	0.002	1.554
Good relations		-0.061	-0.644	0.293***	3.278
Demand expanding		0.301***	3.454	0.012	0.137
Single workplace		-0.098	-0.783	-0.366***	-3.097
Goals		0.116	0.987	0.399***	2.861
Quality circles implemented		0.186	1.247	-0.036	-0.232
Just in time implemented		0.241	1.301	0.059	0.321
Team building implemented		0.155*	1.814	0.184**	2.005
C.I.M. implemented		0.258**	1.996	0.365***	2.837
Statistics					
Number of observations		772		749	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.076		0.105	

[a] See appendix B for a detailed description of variables.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.5 **Productivity growth with interaction**

Based on AWIRS 1995 main survey (whole population, ORG-TRAIN composite variable added)

		Model 9 (condensed)		*Model 10(extended)*	
	Variable code[a]	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Dependent variable					
Productivity growth					
Training variable					
Formal training		-0.076	-0.609	-0.042	-0.395
Innovation variable					
Any organisational change:		0.221*	1.905		
New office technology				0.102	1.626
New plant/machines/equipment				-0.001	-0.020
Reorganisation of structure				0.130**	2.003
Restructure of how work is done				0.272***	4.302
Org-train composite		0.261*	1.839	0.198*	1.888
Human capital variables					
Long tenure		0.085	1.371	0.080	1.291
Skills content		0.097	1.051	0.063	0.674
Largest occupation:	Managers	-0.108	-0.357	-0.045	-0.146
	Professionals	0.150	1.161	0.161	1.242
	Para-professionals	0.108	0.852	0.088	0.698
	Tradepersons	-0.124	-1.070	-0.141	-1.217
	Clerks	0.179	1.485	0.161	1.337
	Sales persons	0.301***	2.568	0.280**	2.387
	Plant operators	0.030	0.288	0.014	0.135
Control variables					
Size		0.221**	2.496	0.184**	2.055
Young workplace		-0.020	-0.114	0.014	0.084
Established workplace		-0.037	-0.377	-0.032	-0.320
High labour costs		0.034	0.381	0.013	0.147
Above normal capacity		0.240***	3.419	0.235***	3.345
Benchmarking		0.137**	2.243	0.106*	1.716
Employment growth		0.002*	1.829	0.002*	1.863
Good relations		0.171***	2.826	0.175**	2.872
Demand expanding		0.210***	3.642	0.207***	3.574
Single workplace		-0.235***	-2.850	-0.220***	-2.640
Goals		0.288***	3.443	0.257***	3.065
Quality circles implemented		0.062	0.638	0.054	0.548
Just in time implemented		0.202	1.634	0.176	1.412
Team building implemented		0.192***	3.220	0.168***	2.778
C.I.M. implemented		0.280***	3.204	0.264***	2.993
Statistics					
Number of observations		1660		1660	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.072		0.079	

a See appendix B for a detailed description of variables.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.6 Productivity growth using panel data — condensed model

Based on AWIRS 1990 and 1995 panel surveys (whole population, 1990 and 1995 explanatory variables)

		Model 11 (1990 explanatory variables)[b]		Model 12 (1995 explanatory variables)	
	Variable code[a]	Coefficient	t-statistic	Coefficient	t-statistic
Dependent variable					
Productivity growth (1995)					
Training variables					
Formal training		0.030	0.281	0.035	0.289
Study leave		0.096	0.839	-0.015	-0.119
Innovation variables					
Any organisational change:		-0.007	-0.062	0.260**	2.438
Human capital variables					
Long tenure		-0.028	-0.271	0.007	0.064
Skills content		0.024	0.148	0.137	0.830
Largest occupation:	Managers	0.264	0.700	0.946**	2.455
	Professionals	0.228	1.123	0.675***	3.234
	Para-professionals	-0.259	-1.125	0.571***	2.598
	Tradepersons	-0.125	-0.684	-0.045	-0.223
	Clerks	0.126	0.625	0.380*	1.862
	Sales persons	0.081	0.443	0.490**	2.492
	Plant operators	-0.120	-0.732	-0.080	-0.475
Control variables					
Size (1995)		0.284**	2.311	0.218	1.432
High labour costs (1995)		0.053	0.340	0.005	0.033
Full capacity (1995)		0.192**	1.933	0.213**	2.121
Employment growth (1995)		0.000**	2.366	0.000*	1.701
Good relations (1995)		0.128	1.175	0.135	1.194
Demand expanding (1995)		0.327***	3.386	0.279***	2.840
Single workplace (1995)		-0.130	-0.893	-0.062	-0.427
Consultative committees		0.216*	1.693	0.096	0.882
Quality circles/productivity groups		-0.124	-0.982	0.213*	1.954
Statistics					
Number of observations		599		592	
Probability > chi^2		0.000		0.000	
Pseudo R^2		0.045		0.058	

a See appendix B for a detailed description of variables.

b 1990 explanatory variables used except where indicated.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.7 **Productivity growth using panel data — extended model**

Based on AWIRS 1990 and 1995 panel surveys (whole population)

	Model 13 (1990 explanatory variables)[b]		Model 14 (1995 explanatory variables)	
Variable code[a]	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Dependent variable				
Productivity growth (1995)				
Training variables				
Formal training	0.024	0.219	0.053	0.431
Study leave	0.103	0.899	-0.013	-0.100
Innovation variables				
Any organisational change:				
Change in product/service	0.237*	1.806	0.137	1.018
New plant/equipment/office technology	-0.097	-0.960	0.036	0.359
Reorganisation of structure	0.191**	2.002	0.072	0.695
Restructure of how work is done	0.003	0.030	0.494***	4.526
Human capital variables				
Long tenure	-0.014	-0.134	-0.011	-0.100
Skills content	-0.020	-0.123	0.042	0.243
Largest occupation: Managers	0.177	0.465	0.915**	2.405
Professionals	0.231	1.116	0.604***	2.856
Para-professionals	-0.295	-1.264	0.513**	2.416
Tradepersons	-0.148	-0.807	-0.046	-0.225
Clerks	0.104	0.514	0.360*	1.772
Sales persons	0.105	0.571	0.423**	2.162
Plant operators	-0.118	-0.723	-0.143	-0.845
Control variables				
Size (1995)	0.301**	2.381	0.145	0.920
High labour costs (1995)	0.062	0.393	0.032	0.212
Full capacity (1995)	0.181*	1.811	0.265***	2.596
Employment growth (1995)	0.000**	2.388	0.000	1.466
Good relations (1995)	0.130	1.178	0.136	1.232
Demand expanding (1995)	0.319***	3.301	0.295***	2.933
Single workplace (1995)	-0.099	-0.680	-0.064	-0.440
Consultative committees	0.182	1.423	0.059	0.541
Quality circles/productivity groups	-0.124	-0.966	0.199*	1.800
Statistics				
Number of observations	599		592	
Probability > chi^2	0.000		0.000	
Pseudo R^2	0.051		0.075	

a See appendix B for a detailed description of variables.

b 1990 explanatory variables used except where indicated.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

Table A.8 **Productivity growth by group using panel data — extended model**

Based on AWIRS 1990 and 1995 panel surveys (sub-samples of 1990 laggards and leaders, 1990 explanatory variables)[b]

	Model 15 (1990 laggards)		Model 16 (1990 leaders)	
Variable code[a]	*Coefficient*	*t-statistic*	*Coefficient*	*t-statistic*
Dependent variable				
Productivity growth (1995)				
Training variables				
Formal training	-0.304	-1.530	0.043	0.214
Study leave	0.318	1.482	-0.019	-0.087
Innovation variables				
Any organisational change:				
Change in product/service	0.763***	3.227	0.012	0.048
New plant/equipment/office technology	-0.199	-1.150	0.043	0.217
Reorganisation of structure	-0.094	-0.535	0.283	1.527
Restructure of how work is done	0.041	0.239	-0.006	-0.031
Human capital variables				
Long tenure	0.319	1.593	-0.299	-1.323
Skills content	-0.192	-0.651	-0.209	-0.675
Largest occupation: Managers	-0.278	-0.468	-0.247	-0.489
Professionals	-0.125	-0.322	0.542	1.339
Para-professionals	-0.863**	-2.047	-0.039	-0.077
Tradepersons	0.230	0.751	0.136	0.359
Clerks	-0.489	-1.037	0.679*	1.685
Sales persons	0.147	0.300	0.342	0.998
Plant operators	-0.244	-0.859	0.149	0.495
Control variables				
Size (1995)	0.497***	2.633	0.126	0.465
High labour costs (1995)	0.062	0.193	0.223	0.649
Full capacity (1995)	0.590***	3.002	-0.057	-0.270
Employment growth (1995)	0.001*	1.897	-0.007	-1.337
Good relations (1995)	0.106	0.607	-0.031	-0.125
Demand expanding (1995)	0.287*	1.688	0.485**	2.216
Single workplace (1995)	0.200	0.678	0.055	0.195
Consultative committees	0.450*	1.921	-0.044	-0.193
Quality circles/productivity groups	-0.472*	-1.927	-0.056	-0.234
Statistics				
Number of observations	225		184	
Probability > chi^2	0.000		0.019	
Pseudo R^2	0.130		0.086	

[a] See appendix B for a detailed description of variables.

[b] 1990 explanatory variables used except where indicated.

Notes: Industry dummy variables have been omitted for ease of presentation. * denotes significance at the 10 per cent level of significance (two-tailed test). ** denotes significance at the 5 per cent level of significance. *** denotes significance at the 1 per cent level of significance.

B Description of variables

Table B.1 **Description of AWIRS 1995 main survey variables**

Variable name	*Description*	*Mean*	*Std Dev.*
Dependent variables			
Productivity level	Ordered variable of labour productivity compared to competitors 1= a lot lower; 2 = a little lower, 3 = about the same; 4 = a little higher; 5 = a lot higher	3.493	0.931
Productivity growth	Ordered variable of labour productivity compared to 2 years ago 1= a lot lower; 2 = a little lower, 3 = about the same; 4 = a little higher; 5 = a lot higher	4.064	0.881
Training variable			
Formal training	Dummy variable = 1 if formal training for employees in last year	0.752	0.432
Innovation variables			
Any organisational change	Dummy variable = 1 if any organisational change in the last 2 years	0.844	0.363
New office technology	Dummy variable = 1 if introduction of new office technology in last 2 years	0.457	0.498
New plant/machines/equipment	Dummy variable = 1 if introduction of new plant/machines/equipment in last 2 years	0.297	0.457
Reorganisation of workplace structure	Dummy variable = 1 if major reorganisation of workplace structure in last 2 years	0.588	0.492
Restructure of how work is done	Dummy variable = 1 if major restructure of how work is done in last 2 years	0.477	0.500
Human capital variables			
Long tenure	Dummy variable = 1 if more than 25% of employees have tenure greater than 10 years	0.311	0.463
Skills content	Dummy variable = 1 if the average employee takes longer than one year to reach standard	0.110	0.313
Managers	Dummy variable = 1 if managers is the largest occupational group	0.012	0.109
Professionals	Dummy variable = 1 if professionals is the largest occupational group	0.150	0.357
Para-professionals	Dummy variable = 1 if para-professionals is the largest occupational group	0.104	0.305
Tradespersons	Dummy variable = 1 if tradespersons is the largest occupational group	0.108	0.310
Clerks	Dummy variable = 1 if clerks is the largest occupational group	0.134	0.340

Sales persons	Dummy variable = 1 if sales and personal service workers is the largest occupational group	0.176	0.381
Plant operators	Dummy variable = 1 if plant and machine operators and drivers is the largest occupational group	0.157	0.364
Control variables			
Size	Number of employees at the workplace (‘000)	0.187	0.344
Young workplace	Dummy variable = 1 if the workplace has been undertaking the main activity for less than 5 years	0.047	0.211
Established workplace	Dummy variable = 1 if the workplace has been undertaking the main activity for more than 10 years	0.854	0.353
High labour costs	Dummy variable = 1 if labour costs account for more than 80 per cent of total costs	0.140	0.348
Above normal capacity	Dummy variable = 1 if workplace is currently operating above normal capacity	0.244	0.430
Employment growth	Net employment growth, derived as the difference between employment levels at the time of the survey and one year earlier, expressed as a percentage of one year earlier.	4.788	67.026
Public Sector	Dummy variable = 1 if public sector workplace	0.399	0.490
Benchmarking	Dummy variable = 1 if the workplace benchmarks itself against other workplaces	0.699	0.459
Good relations	Dummy variable = 1 if the workplace has good or very good employee-management relations	0.363	0.481
Demand expanding	Dummy variable = 1 if demand for the workplace’s main product or service is currently expanding	0.537	0.499
Single workplace	Dummy variable = 1 if one workplace organisation	0.163	0.369
Goals	Dummy variable = 1 if management have a plan for corporate goals	0.867	0.340
Quality circles implemented	Dummy variable = 1 if quality circles implemented in the last 2 years	0.119	0.324
Just in time implemented	Dummy variable = 1 if Just in time implemented in the last 2 years	0.062	0.240
Team building implemented	Dummy variable = 1 if team building implemented in the last 2 years	0.403	0.491
CIM implemented	Dummy variable = 1 if computer integrated management implemented in the last 2 years	0.130	0.336

Source: AWIRS 1995 main survey.

Table B.2 **Description of AWIRS 1990 and 1995 panel variables**

Variable name	*Description*	*Year*	*Mean*	*Std Dev.*
Dependent variables				
Productivity level	Ordered variable of labour productivity compared to competitors 1= a lot lower; 2 = a little lower, 3 = about the same; 4 = a little higher; 5 = a lot higher	1995 1990	3.486 3.436	0.876 0.910
Productivity growth	Ordered variable of labour productivity compared to 2 years ago 1= a lot lower; 2 = a little lower, 3 = about the same; 4 = a little higher; 5 = a lot higher	1995	4.041	0.882
Training variables				
Formal training	Dummy variable = 1 if formal training for employees in last year	1995 1990	0.792 0.681	0.406 0.467
Study Leave	Dummy variable = 1 if paid study leave provided in last year	1995 1990	0.736 0.671	0.441 0.470
Innovation variables				
Any organisational change	Dummy variable = 1 if any organisational change in the last 2 years	1995 1990	0.791 0.797	0.407 0.403
Change in product/service	Dummy variable = 1 if major change in product/service in last 2 years	1995 1990	0.170 0.183	0.376 0.387
New plant/equipment/office technology	Dummy variable = 1 if introduction of new plant/equipment/office technology in last 2 years	1995 1990	0.484 0.401	0.500 0.490
Reorganisation of structure	Dummy variable = 1if reorganisation of management structure in last 2 years	1995 1990	0.519 0.467	0.500 0.499
Restructure of how work is done	Dummy variable = 1 if major restructure of how work is done in last 2 years	1995 1990	0.331 0.415	0.471 0.493
Human capital variables				
Long tenure	Dummy variable = 1 if more than 25% of employees have tenure greater than 10 years	1995 1990	0.398 0.327	0.490 0.469
Skills content	Dummy variable = 1 if the average employee takes longer than one year to reach standard	1995 1990	0.107 0.096	0.309 0.294
Managers	Dummy variable = 1 if managers is the largest occupational group	1995 1990	0.016 0.014	0.125 0.119
Professionals	Dummy variable = 1 if professionals is the largest occupational group	1995 1990	0.139 0.122	0.346 0.327
Para-professionals	Dummy variable = 1 if para-professionals is the largest occupational group	1995 1990	0.126 0.122	0.332 0.327

Tradespersons	Dummy variable = 1 if tradespersons is the largest occupational group	1995 1990	0.097 0.106	0.297 0.308
Clerks	Dummy variable = 1 if clerks is the largest occupational group	1995 1990	0.122 0.141	0.327 0.348
Sales persons	Dummy variable = 1 if sales and personal service workers is the largest occupational group	1995 1990	0.170 0.138	0.376 0.345
Plant operators	Dummy variable = 1 if plant and machine operators and drivers is the largest occupational group	1995 1990	0.155 0.158	0.362 0.365
Control variables				
Size	Number of employees at the workplace ('000)	1995 1990	0.241 0.276	0.487 0.564
High labour costs	Dummy variable = 1 if labour costs account for more than 80 per cent of total costs	1995 1990	0.135 0.125	0.342 0.331
Full capacity	Dummy variable = 1 if workplace is currently operating at full capacity	1995 1990	0.409 0.440	0.492 0.497
Employment growth	Net employment growth, derived as the difference between employment levels at the time of the survey and one year earlier, expressed as a percentage of one year earlier.	1995 1990	15.003 5.078	222.850 50.094
Public Sector	Dummy variable = 1 if public sector workplace	1995 1990	0.448 0.484	0.498 0.500
Good relations	Dummy variable = 1 if the workplace has good or very good employee-management relations	1995 1990	0.228 0.284	0.420 0.451
Demand expanding	Dummy variable = 1 if demand for the workplace's main product or service is currently expanding	1995 1990	0.495 0.577	0.500 0.494
Single workplace	Dummy variable = 1 if one workplace organisation	1995 1990	0.119 0.112	0.324 0.315
Consultative committees	Dummy variable = 1 if formal joint consultative committees are used	1995 1990	0.438 0.232	0.497 0.422
Quality circles/productivity groups	Dummy variable = 1 if quality circles or productivity improvement groups are used	1995 1990	0.269 0.165	0.444 0.371

Source: AWIRS 1990 and 1995 panel surveys.

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