Productivity in Australian Enterprises:

Evidence from the ABS Growth and Performance Survey *

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Abstract

This paper constructs a measure of labour productivity from the ABS Growth and Performance Survey. An overview of labour productivity is provided by considering differences between industry, firm size and firm age categorisations. In addition, the distribution within these categories are analysed. Labour productivity if found to vary substantially across industries and firm size. Since labour productivity does not control for the level of capital used in production this is to be expected. Less expected is the fact that levels of firm productivity within industries (and firm size categories) also vary substantially. This suggests that the factors determining firm productivity must be investigated at the firm level and cannot be assumed to be similar within an industry.

Key words: labour productivity, firm performance, distributions

Working papers from the 'Performance of Australian Enterprises' project

Title	Number	Author(s)
The Theory and Measurement of Profitability	7/98	Gow/Kells
The Definition and Measurement of Productivity	9/98	Rogers
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Contents

1 Introduction

The level and growth of labour productivity is of key interest to managers, unionists, economists and the government. It is probably the main productivity measure used to assess a range of performance and competitiveness issues. This paper uses data from the Growth and Performance Survey (GAPS) to provide an overview of firm-level productivity in Australia. It should be stressed that the paper is concerned with firm-level data and the various statistics and graphs presented are concerned with exploring firm-level differences. Many previous Australian studies use industry level data and there has been a paucity of firm-level studies (see the review by Dawkins and Rogers, 1998). With this fact in mind, the paper sets out to provide a preliminary investigation into firm-level productivity by using various summary statistics and graphs. The central aim is to understand some of the basic properties of the data before more adavanced econometric analysis is undertaken.

Labour productivity is a widely used partial measure of productivity. It is important to note that partial measures of productivity can have drawbacks since, by definition, they are only describe part of productivity differences. Some studies try and avoid partial productivity measures by calculating total factor productivity (which assesses the rise in real output when changes in both capital and labour have been accounted for). However, there are a range of problems in calculating capital and total factor productivity (see Hall, 1986, Morrison, 1993) which can make these measures difficult to interpret. In this paper we focus solely on labour productivity and leave capital and total factor productivity measures for future research.

The paper is structured in the following way. In the next section we discuss the method by which labour productivity is calculated from the data available in GAPS. Section 3 provides a brief theoretical discussion on the determinants of labour productivity. At the most general level, labour productivity is a function of the capital to labour ratio, the level of technology and the existence of returns to scale. However, these factors are in turn determined by the rate of innovation, managerial ability, market conditions, the tax system, labour markets and other variables. Although this paper does not intend to investigate all these issues, section 3 provides a framework for thinking about labour productivity. Section 4 contains an overview of the data. Various statistics are presented along with breakdowns by industry, firm size and firm age. In addition, the section takes a first look at productivity differences between exporters and non-exporters, innovators and non-innovators, those firms which compare their performance to other firms (to those that don't), and those firms that participate in a government program (to those that don't). This type of bivariate analysis is only preliminary since it does not control for other variables that may affect productivity levels.

2 Measuring labour productivity

Labour productivity is calculated using data in the Australian Bureau of Statistics' Growth and Performance Survey (GAPS) (also known as the Business Longitudinal Survey). The first survey collected data on the financial year ending 30 June 1995, or the firm's closest financial period. This is the data used here. The GAPS covers a wide range of Australian firms, however, a number of firm types and industry sectors are deliberately excluded from the sample. The excluded groups include non-employing firms, all government enterprises and the following industry sectors: agriculture, forestry and fishing; electricity, gas and water; communication services; government administration and defence; education; and a number of other smaller industry codes (see Industry Commission/DIST, 1997, p. 5). The 1995 survey covers almost 9,000 firms and is designed to allow estimates of the entire population of Australian firms (for those firms not explicitly excluded from the survey). The ABS have developed a set of weights based on the sampling technique and the population frame (taken from the Business Register), and these weights are used in this paper.[1]

Labour productivity is the ratio of real output produced to the quantity of labour employed. Real output is a measure of the production of the firm which, when comparisons across firms or time are made, should be expressed in constant prices

[1] Further details of the survey method can be found in Industry Commission/DIST (1997) and a paper by the ABS presented at the SEAANZ 1997 conference. The ABS provides three different weights: a general purpose weight, a weight for flow variables and a weight for 'point in time' variables. The appropriate weight is used for the specific variable under consideration. When a ratio of a flow to a 'point in time' variable is calculated (i.e. labour productivity) the ABS's advice was to use the general purpose weight.

and constant quality units. The quantity of labour input is normally expressed in either numbers of people or the number of hours. The latter is preferable since it allows for part time workers, overtime, variations in standard hours worked per week, sick leave and alike. In many cases, however, data on hours are not available and the numbers of employed people is used instead. This is the case with the GAPS. The GAPS questions (in 1994/95) asked for details on the number of working proprietors (*wp*), managers (*man*), full time employees (*ft*) and part time employees (*pt*). Since the hours worked by each of these categories is likely to vary substantially, these data can only be used to form an approximate measure of labour input. For the purposes of this paper we use a measure of effective full time employees (*eft*) defined as

$$eft \quad wp + man + ft + 0.426(pt)$$

The number 0.426, which is used to scale the number of part time employees to full time equivalents, comes from ABS data on the average hours worked by part timers and full time employees.[2] An alternative method would have been to use data on part time hours at an industry level.[3] Equally, it may have been possible to try and adjust working proprietors and managers into full time equivalents (since both are likely to work more hours that full time employees). These potential improvements on the labour input measure were not investigated for this paper.

The measure of real output (or value added) used is given by

value added = sales + (closing stocks – opening stocks) -
material purchases – motor vehicle expenses

[2] Specifically, ABS (6306.0, Employee Earnings and Hours, May 1995) states that the average full time, non-managerial employee hours per week was 39.9, while the part time equivalent was 17.0 hours (0.426 = 17/39.9).

[3] An analysis of the ratio of part time workers to full time workers shows that the majority of firms have no part time employees at all (the median of the ratio is zero). In Appendix 1 we provide an industry breakdown of the part time to full time ratio at the two digit ANZSIC level. Most industries have a minority of firms that employ part time workers (the exceptions are 21, 22, 24, 51, 52, 57, 64, 74, 91, 92, 93 and 95). Even so, all industries have a few firms that use part time workers relatively intensively. This suggests that the labour input measure used above may be biased for certain firms. The extent and direction of the bias for a firm depends on how different its average hours worked by part time employees is from the '17 hour' economy wide average.

This corresponds, as closely as is possible given the survey data, to the ABS measure of gross product. Table 1 below shows summary statistics for the entire sample of firms. The statistics are produced using the weights provided by the ABS. Use of these weights allows the statistics to reflect the entire population of firms (at least the population which the survey is intended for).

Table 1 Summary statistics for key variables

Variable	Mean	Std. Dev.	Median
	in thousands of dollars		
Sales (net of change in stocks)	1594	18347	205
Value added	708	9781	118
Effective full time employees	8.3	68.7	3
labour productivity	64.2	264.2	40.5

Table 1 shows that the mean labour productivity is $64,200, the standard deviation is $264,200, and the median is $40,500. These statistics indicate the distribution is highly skewed to the right. In fact, the highest labour productivity value is $19.2 million per effective full time worker. Inspection of the data reveals a number of firms with extremely high labour productivity. These high values may be due to the firm having very high capital intensity, or the employee(s) having very large human capital (for example, corporate financiers), or extreme market power. Alternatively, such high values may be due to survey error.[4] Whatever the causes of such outliers, their presence has a number of implications when the firm is taken as the unit of analysis.[5] Using the mean as a measure of central tendency can be misleading, implying use of

[4] Due to the ABS requirements for confidentiality it is not possible to investigate the characteristics of these firms.

[5] An alternative method of analysis is to consider 'average' productivity for a group of firms, such as a 2 digit ANZSIC industry. The 'average' can be calculated by summing all value added to form the numerator and then summing all labour to form the denominator, then calculating the ratio. This is the method normally used by the ABS and also in IC/DIST (1997). In much of our research we prefer to focus of the firm as the unit of analysis since we are interested in understanding firm performance.

the median and a trimmed mean. Equally, results from regression analysis may be sensitive to the inclusion of such high values.

3 What determines labour productivity ?

Economists generally use the concept of the production function to describe the production process of firms. A production function, in its most general form, links output (*Y*) to the range of inputs (*X*), where both can be vectors. To empirically use such a concept the actual functional form of the production function needs to be specified. A common choice is the Cobb-Douglas production function

$$V = AK \quad L^{\beta} \ , \qquad [1]$$

where *V* is value added[6], *K* is capital, *A* is level of 'technology', and *L* is labour. This functional form assumes a constant elasticity of substitution between capital and labour (which is equal to 1, see Griliches and Ringstad, 1971, for a discussion). Rearranging [1] we can write labour productivity (*V*/*L*) as

$$\frac{V}{L} = AK \quad L^{\beta - 1} = A \ \frac{K}{L} \qquad [2]$$

where the far right has assumed that there are constant returns to scale (i.e. $\alpha +\ =1$).

Equation [2] gives us a simple way of thinking about labour productivity differences. According to this equation, and the method of deriving it, there are the following sources of variation in labour productivity across firms

- elasticities (i.e. α and
- capital to labour ratio

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[6] Equation [1] is specified in terms of value added rather than output which implies materials do not enter the production function in the same way as labour or capital.

- technology (which, interpreted broadly, reflects not only technology, but also managerial, organisation, marketing and distribution efficiency).

The above categories can be thought of as the proximate causes of labour productivity differences. The ultimate determinants are likely to be linked to a range of other factors. For example, the capital to labour ratio for a firm may be related to tax policies, competitive conditions or managerial abilities. In general, we might expect less variation in labour productivity between firms when they are grouped into similar categories. For example, firms in an industry might be expected to have similar capital to labour ratios as well as technology levels.

Even within similar groups of firms there are still likely to be variations in productivity levels. For example, consider the capital to labour ratio. If capital was perfectly flexible all firms might choose an optimal level. In reality, adjustment of the capital stock takes time since it is not optimal to scrap old capital even though it is not as efficient as the latest capital available (see Salter, 1966). Firms within an industry are also unlikely to have the same technology. This is partly due to the fact that firms invest in R&D and innovation to improve their technology and productivity levels. Those firms that are most efficient at R&D (and those who experience good luck, since R&D is inherently risky) will have higher productivity (Griliches, 1995). Acting against this process is the fact that new technologies diffuse to other firms. However, once again, the diffusion of new technology is not an instantaneous process (see Karshenas and Stoneman, 1995, Iwai, 1994a, 1994b). These are some of the reasons why we would expect variations in productivity levels within groups. They also point to the possibility of using such variations to assess such issues as the extent of innovation and the rate of technology diffusion.

Another potential source of labour productivity differences is the existence of measurement errors in the data. As noted in section 2, the definitions of labour, capital and output – although clear in theory – are difficult to measure in practice. Our measure of labour productivity will contain measurement errors of this kind. In addition, any survey based data source is likely to have 'errors in reporting' (i.e. respondents misunderstand questions or report false values). Thus, in an empirical specification, an error term would be added to equation [2]. Again, this is a reason why productivity levels with groups of similar firms will vary.

4 An analysis of labour productivity

The above sections have set the scene for the analysis that follows. In this section we group firms together by industry, firm size and firm age and then describe the data with various summary statistics and histograms. The central questions we ask are (1) how does the typical level of labour productivity vary across groups and (2) how does the distribution of productivity vary within and between groups. The answers to these questions are not an end in themselves, instead they provide a foundation for future research. Understanding the basic properties of the data is an important, if somewhat mundane, task before attempting more advanced research. Furthermore, in analysing the basic data we are prompted to consider the fundamental reasons for the differences in labour productivity across (potentially) homogenous groups.

4.1 Industry breakdown

Tables 2 and 3 show the mean, standard deviation and median for the full sample of firms by 2 digit ANZSIC industry code. The tables also show the mean and the standard deviation for the 'trimmed' sample, which is the sample trimmed at the 5th and 95th percentile.[7] Various sector level differences are immediately apparent. The mining industries have higher means and medians than other industries. This is likely to reflect the fact that mining is capital intensive hence output per employee is high. The high labour productivity in 'Air and Space Transport' (64) and 'Other Transport' (65) may also be due to capital intensity (note both of these have small sample sizes). The manufacturing industries tend to have median and trimmed mean labour productivity of between 40 and 60 thousand dollars per employee. The selection of other industries (Table 3) have a wider variation in the mean and median levels of labour productivity, with the lowest trimmed mean being 34 thousand (food retailing (51) and personal services (95)) and the highest 70 thousand (insurance (74)).

[7] Percentiles are defined from data on all firms in the sample (i.e. we do not calculate the percentiles for each industry separately). This means all histograms can easily be plotted on the same horizontal scale for comparison purposes. For reference, the 5th percentile labour productivity value for the sample is \$3,085 and the 95th percentile 15,667.

Table 2 Summary statistics, by industry (mining and manufacturing)

Industry	Mean		Stn.deviation		Median
	Full sample	Trimmed	Full sample	Trimmed	Full sample
			thousands of dollars		
Coal Mining (11)	1047.6	na	1230.6	na	280.8
Metal Ore Mining (13)	113.7	na	174.3	na	81.5
Other Mining (14)	124.7	na	244.1	na	86.8
Services to Mining (15)	166.1	84.3	207.4	16.1	85.0
Food, Beverage and Tobacco Manufacturing (21)	65.2	52.0	77.9	32.4	45.1
Textile, Clothing, Footwear, and Leather Manufacturing (22)	50.3	40.3	69.6	28.7	37.6
Wood and Paper Product Manufacturing (23)	45.3	44.5	35.7	26.4	36.3
Printing, Publishing and Recorded Media (24)	81.6	58.0	86.8	31.5	56.9
Petroleum, Coal, Chemical and Associated Product Manufacturi (25)	78.2	61.1	105.5	30.6	59.0
Non-Metallic Mineral Product Manufacturing (26)	62.7	52.1	61.8	34.2	46.9
Metal Product Manufacturing (27)	54.0	50.8	42.9	28.7	45.8
Machinery and Equipment Manufacturing (28)	61.0	52.1	70.8	26.9	47.8
Other Manufacturing (29)	46.5	43.5	46.6	23.4	38.6

Notes: na indicates less than 10 observations in the industry sample

To investigate the skewness of the distributions, a simple method is to consider the ratio of the mean to the median for the full sample. For example, distributions that are skewed to the right (a small number of large values) will have a mean greater than the median. Of the industries in Tables 2 and 3 only two have a mean/median ratio less than 1 ('other transport' (65) and 'finance' (74)); all the other industries have distributions skewed to the right. One industry – finance (73) – has a median value of zero, indicating that half the firms surveyed in this industry have a labour productivity of less than zero. This is likely to be due to the design of the survey which excluded interest income from the basic 'sales' question and included interest income in a subsidiary question on 'other income' (which also included 9 other categories of income). [8] This issue reflects the fact that it is difficult to design a survey which is both manageable in size and has sufficient information for all potential uses.

A further area of interest is the shape of the distribution of labour productivities within each industry. As discussed in the section above, a simple model of labour productivity would suggest that variation in productivity should be less at the industry level. For each of the 2 digit ANZSIC industries we plot a histogram of the trimmed population of firms. These are shown in Appendix 2 (industries with less than 10 (unweighted) observations are excluded). Visual inspection of the histograms suggests a number of points. Most industries have a right hand tail of high productivity firms, although the size of this tail does vary between industries (for example industries 29, 42, 52, and 73 appear to have a smaller right hand tail). Note that the skewed distributions still exist even though the entire sample has been trimmed at the 5th and 95th percentile. Most industries tend to have an approximate 'bell shaped' distribution in the middle range of the distribution, suggesting the majority of firm productivity's are in a narrow band. However, a few industries (for example 41, 47, 52 and 74) do not appear to this 'bell shaped' central area.

[8] Since these were aggregated together, and most of the categories would not normally be included in a definition of value of production, we cannot calculate a 'sales' figure more relevant to the finance sector.

Table 3 Summary statistics by industry (other industries)

Industry	Mean		Stn.deviation		Median
	Full sample	Trimmed	Full sample	Trimmed	Full sample
	thousands of dollars				
General Construction (41)	102.4	57.0	141.2	40.5	63.2
Construction Trade Services (42)	68.7	45.6	184.9	29.0	38.2
Basic Material Wholesaling (45)	68.4	59.9	83.2	34.8	51.5
Machinery and Motor Vehicle Wholesaling (46)	70.1	62.7	78.3	31.8	60.2
Personal and Household Good Wholesaling (47)	133.9	57.1	1012.0	37.2	58.5
Food Retailing (51)	34.6	33.9	23.8	19.6	29.5
Personal and Household Good Retailing (52)	52.1	48.8	42.2	27.5	45.6
Motor Vehicle Retailing and Services (53)	46.9	40.5	45.5	22.3	37.4
Accommodation, Cafes and Restaurants (57)	49.2	45.7	40.5	29.3	39.7
Road Transport (61)	59.1	48.0	75.6	30.8	42
Air and Space Transport (64)	85.0	na	122.5	na	68.5
Other Transport (65)	76.8	na	91.2	na	95.5
Services to Transport (66)	70.0	42.0	205.4	25.8	37
Finance (73)	108.8	45.1	514.0	35.3	0
Insurance (74)	43.0	69.7	155.0	44.8	45.3
Services to Finance and Insurance (75)	55.4	56.1	62.6	34.4	45
Property Services (77)	48.1	54.0	94.3	33.5	31.7
Business Services (78)	62.5	47.0	108.1	29.3	42
Motion Picture, Radio and Television Services (91)	453.4	50.9	2356.5	32.0	52.9
Libraries, Museums and Arts (92)	30.1	na	62.2	na	24.9
Sport and Recreation (93)	94.5	41.3	265.1	29.9	36
Personal Services (95)	30.1	33.7	27.5	22.4	27.4

The distribution of firm productivities can be linked to a number of economic issues. Iwai (1994a, 1994b) provides two theoretical paper that look at the relationship between shape of the distribution and innovation, imitation and competition. Although we cannot discuss these papers in detail in this paper – or undertake more advanced analysis, it is worthwhile mentioning some of theoretical results. Iwai shows that increasing the rate of underlying technological change will skew the distribution to the right. Increasing the rate of imitation will have the opposite effect, shifting the distribution towards a single sharp peak. These results are intuitive; when underlying technological advance is rapid, those firms which make an advance pull away from the average. In contrast, if imitation is rapid the remaining firms catch-up quickly. In the extreme case where there is no technical advance, and imitation is rapid, the distribution should collapse to single value: all firms are equally productive. These ideas suggest that the distribution of firm's productivities may contain information about the rates of technological change and imitation in an industry. The situation is further complicated when competition between firms is considered. The level of competition may affect the rate of innovation and imitation through changing the incentives to invest and, possibly, by affecting the level of resources available for such investment.[9]

4.2 Firm size

The size of a firm may impact on labour productivity through a number of avenues. Larger firms may have higher capital intensity and hence higher labour productivity. Conversely, larger firms may have lower so-called X-efficiency, possibly sustainable due to large firms having greater market power.[10] Figure 1 below plots the productivity distribution of firms for four size categories (again, the histograms are based on the trimmed sample). The figure shows that the smallest category has a higher relative proportion of firms with low productivity – although this category still has a right tail of high productivity firms. As firms size increases the distribution shifts to the right, with the largest (100 plus employees) category having the highest proportion in the $70,000 to $80,000. A similar pattern is shown in Table 4 with the trimmed mean and median rising with firm size. The relatively high full sample mean in the 1 to 4 employee group is driven by the presence of the firm with $19 million

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[9] The former issue is essentially concerned with whether greater market power raises innovation (see Arrow, 1962, Hay and Morris, 1991, for theoretical arguments and Symeondis, 1996, for an empirical review). The latter issue concerns whether firms are able to finance innovation externally or have to fund from retained profits.

[10] The use of the term X-efficiency is somewhat general. X-efficiency, which is a concept associated with Harvey Leibenstein, covers a varied of reasons why firms may not use its resources efficiency. These include imperfect labour contracts, incomplete knowledge of production techniques, motivation issues and competitive pressures (see Frantz, 1997, for a discussion).

labour productivity. The summary statistics and histograms can only show a simple bivariate relationship between firm size and productivity. This relationship may or may not be robust to controlling for other factors.

Figure 1 Histograms of labour productivity by firm size

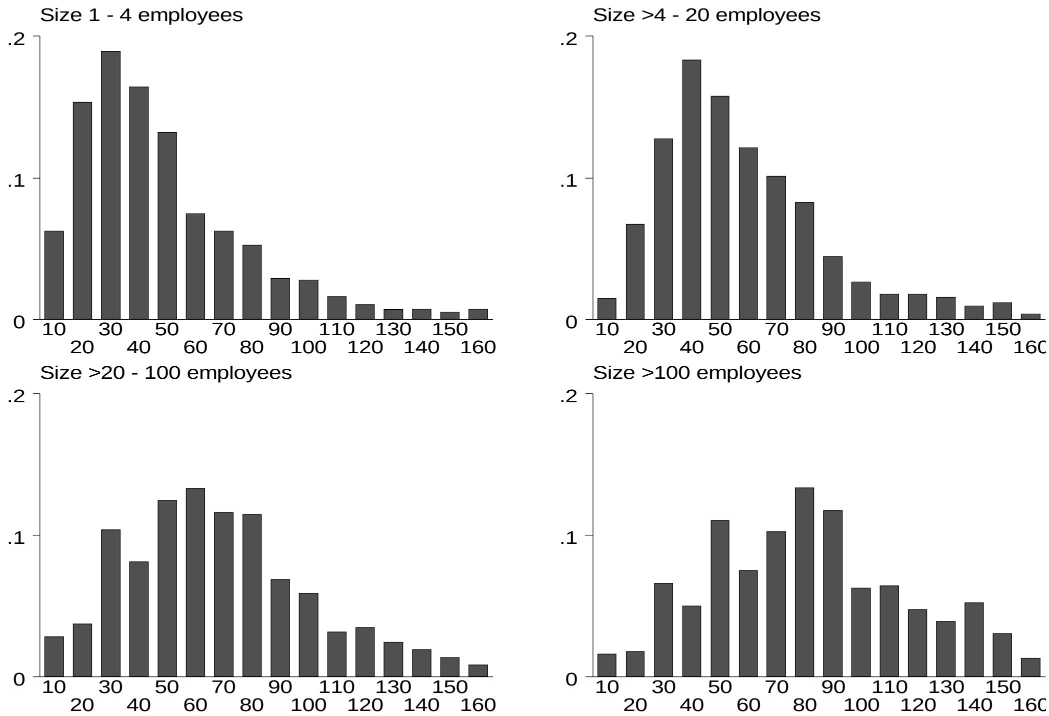

Table 4 Summary statistics by firm size

Firm size	Mean		Stn.deviation		Median
	Full sample	trimmed	Full sample	Trimmed	Full sample
			thousands of dollars		
1 to 4 employees	64.4	43.3	320.3	29.5	35.9
>4 to 20 employees	60.4	53.1	73.1	28.7	47.9
>20 to 100 employees	80.7	65.5	118.6	32.5	62.8
>100 plus employees	105.6	76.5	135.3	35.0	79.7

4.3 Firm age

The histograms for the 6 categories of firm age are shown in Appendix 3. The six categories of firm age shown range from 'less than 1 year' to '20 plus years'. Looking at the figures in the Appendix, only the less than 1 year category has a substantially different distribution (note that the y-axis in this histogram is scaled differently). The remaining age categories do not appear to have major differences in distribution. Table 5 shows that the median, trimmed mean and the full sample mean are lowest for the category of youngest firms. For the older age groups, only the full sample mean – which is sensitive to outliers – shows any age effect. In general therefore, inspection of Table 5 and the histograms in Appendix 3 suggest there is no strong age-productivity relationship at this broad level of analysis.

Table 5 Summary statistics by firm age

Firm age	Mean		Stn.deviation		Median
	Full sample	trimmed	Full sample	Trimmed	Full sample
			thousands of dollars		
< 1 year	30.2	30.7	58.5	25.1	19.7
1 to 2 years	49.0	44.6	51.3	28.7	39.5
2 to 5 years	58.3	43.1	360.7	27.5	39.1
5 to 10 years	72.5	49.3	194.0	31.0	42.0
10 to 20 years	60.6	50.1	86.5	30.1	43.2
20 years plus	70.4	50.0	144.2	31.3	42.1

4.4 Exporters, innovators and other categorisations

This section presents some basic statistics on the differences between dichotomous groups of firms. The groupings we consider are: exporters vs. non-exporters, innovators vs. non-innovators, those firms which compare their performance to other firms vs. those that don't, and those firms that participate in a government program vs. those that don't. Looking for differences between such aggregated groups of firms is a crude method of analysis. A more normal approach would be to use multivariate analysis to assess the links between variables. However, multivariate analysis does have its drawbacks since it can only estimate relationships based on the non-overlaping covariance of the explanatory variables (see Kennedy, 1992, for a discussion).

Figure 2 shows two histograms for exporters and non-exporters (as before the histograms are based on the trimmed sample). The differences between the two histograms appear quite striking; exporters have a much flatter distribution centred over a high value. The trimmed mean for the exporters' labour productivity is $70,800, while the non-exporters the trimmed mean is $46,400 (see Table 6). No doubt many of the reasons for the differences lie in various industry and capital intensity factors, however, the basic data confirms an important role for the export sector.

Figure 2 Histograms of labour productivity by export status[11]

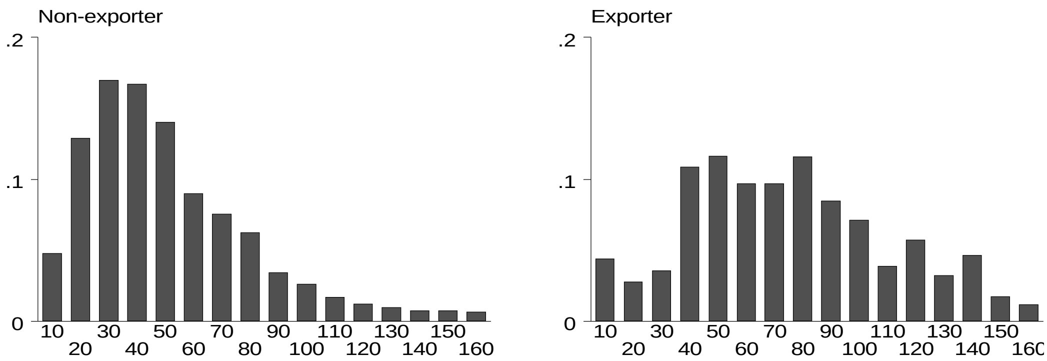

Figure 3 plots similar histograms for the innovators verses non-innovators. Use of a single measure of innovative status (here, whether a new product, process or service was introduced) can be misleading (see Rogers, 1998). The histograms suggest that innovators have slightly higher labour productivity, although the result is not as strong as for export status. The summary statistics confirm this view with the trimmed mean of labour productivity for innovators equaling $54,200 and only $46,900 for non-innovators (Table 6).

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[11] An exporter is defined as a firm with some income from exports of goods or services in any of the three years 1992/93 to 1994/95.

Figure 3 Histograms of labour productivity by innovative status[12]

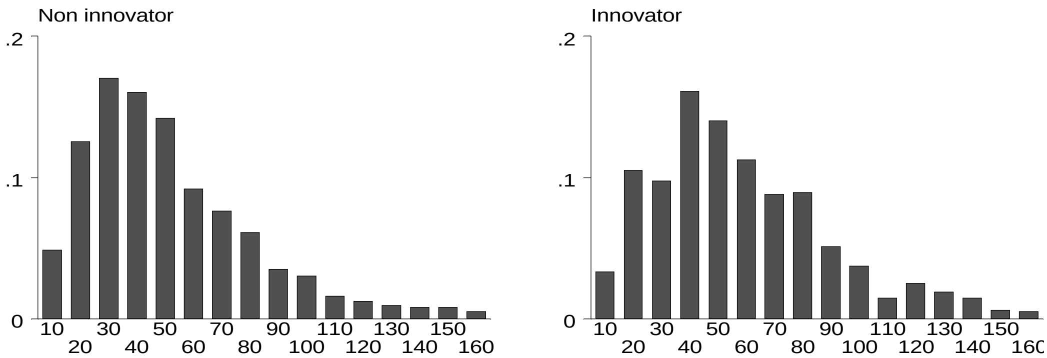


Table 6 Summary statistics by various dichotomous categories

Firm age	Mean		Stn.deviation		Median
	Full sample	Trimmed	Full sample	Trimmed	Full sample
	thousands of dollars				
Exporters	121.2	70.8	230.8	35.3	78.3
Non-exporters	62.1	46.4	266.6	29.5	40.0
Innovators	77.8	54.2	579.6	31.2	47.2
Non-innovators	64.2	46.9	218.9	29.7	40.5
Government program participant	74.3	54.6	174.4	31.8	49.7
Non –gov. program participant	63.7	46.8	270.4	30.0	40.0
Business comparisons	90.2	53.2	563.6	32.1	48.6
No business comparisons	58.3	46.0	118.3	29.6	39.5

Figures 4 and 5 use two additional questions from the 1995 GAPS. These are 'did this business participate in any government programs during the financial years 1993-94 or 1994-95?', and 'did this business compare its performance with any other businesses during 1994-95?' Looking at differences in productivity between categories based on such questions does not infer any causal link (e.g. it could be that using government programs may lead to high productivity, or that high productivity

[12] Innovative status is defined by whether a firm introduced a new product, service or process in 1994/95.

firms may use government programs, or, of course, that the relationship is spurious and caused by other factors). This, of course, applies equally to the export and innovator categories above. However, it is interesting to see that the 'government participants' appear to have a flatter distribution. The trimmed mean for this group is $54,600, as opposed to $46,800 for non-participants (see Table 6). A similar situation is shown in Figure 5; firms that compare performance with others have a different distribution and a higher trimmed mean ($53,200 versus $46,000).

Figure 4 Histograms of labour productivity by participation in government program

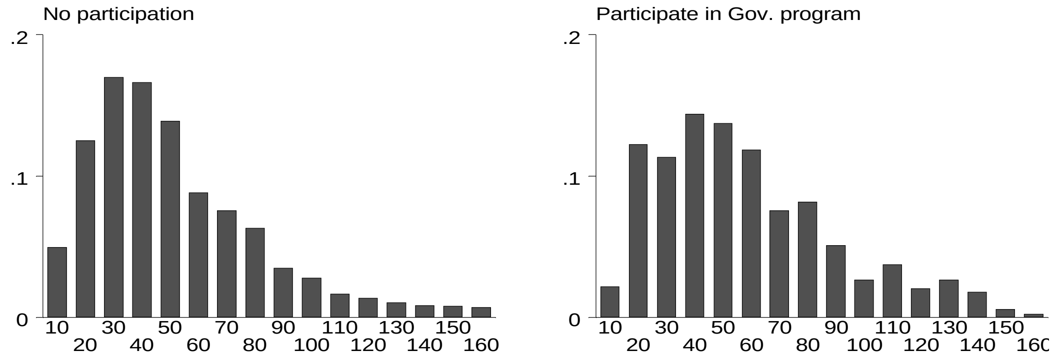
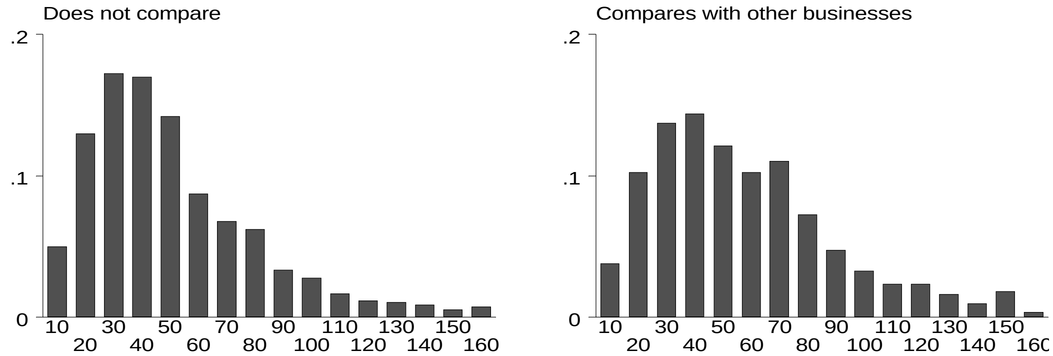


Figure 5 Histograms of labour productivity by whether firm compares performance with other firms



5 Conclusions

This paper has shown how a measure of labour productivity can be calculated from data in the ABS Growth and Performance Survey (GAPS). In any such calculation it has to be recognised that measurement problems exist and that subsequent analysis is subject to some level of error. The method of calculating labour productivity, and the potential measurement issues, are discussed in section 2. Section 3 of this paper consider some simple theory of the determinants of the level of labour productivity. The proximate determinants are the capital to labour ratio, returns to scale and the level of technology. Section 4 of the paper provides an overview of the data. Since we expect the basic determinants of labour productivity to vary between firms we group firms into similar categories which, in theory, should have similar labour productivities. The categorisations used are industry (2 digit ANZSIC level), firm size and firm age.

As might be expected the typical level of labour productivity varies considerable across industries. High labour productivities – as indicated by the mean, trimmed mean and median – are found in mining, road and air transport and general construction (with value added per worker of between $60,000 and $280,000 as indicated by the median level). The use of various central tendency statistics is necessitated by the extreme skewness of the data, with some firms have extremely high levels of labour productivity. Manufacturing industries have typical levels of labour productivity of between $37,000 and $61,000 (as measured by the trimmed mean and the median). Other non-manufacturing industries (apart from mining, transport and construction) have a wide range of typical labour productivities, from a low in food retailing (trimmed mean of $34,000 per employee) to insurance (with $63,000 per employee).

A central finding of this paper was that firm-level labour productivity varies substantially *within* industries (this is shown by the histograms in Appendix 2). This has a number of important and inter-related implications. First, that simple models that specify an industry level production function which is identical for all firms are unrealistic.[13] Second, it indicates that the factors determining labour productivity are likely to vary within industries. The paper briefly discussed why the capital to labour

[13] In fact, many economic analyses use production functions at the economy level (see Mankiw, Romer and Weil, 1992, for an economic growth example, or Holland and Scott, 1998, for a business cycle application).

ratio and the level of technology may vary within an industry. More research into these issues appears important. An alternative possibility is that the industrial classification used does not really group together firms with similar production methods and facing similar market conditions. This has ramifications for a variety of issues such as protection and competition policy.

As alternative methods of providing an overview of the data this paper also considered firm size and firm age classifications. Labour productivity rises with firm size. This may be due to increasing capital to labour ratios, economies of scale or other factors. In contrast, apart from the very youngest firms, there appears to be no link between labour productivity and age of firm. This paper also considers the difference between labour productivity between exporters and non-exporters, innovators and non-innovators, and some other binary classifications. Of these, the difference between exporters and non-exporters was the most striking: exporters have higher levels of productivity and a different distribution of productivity.

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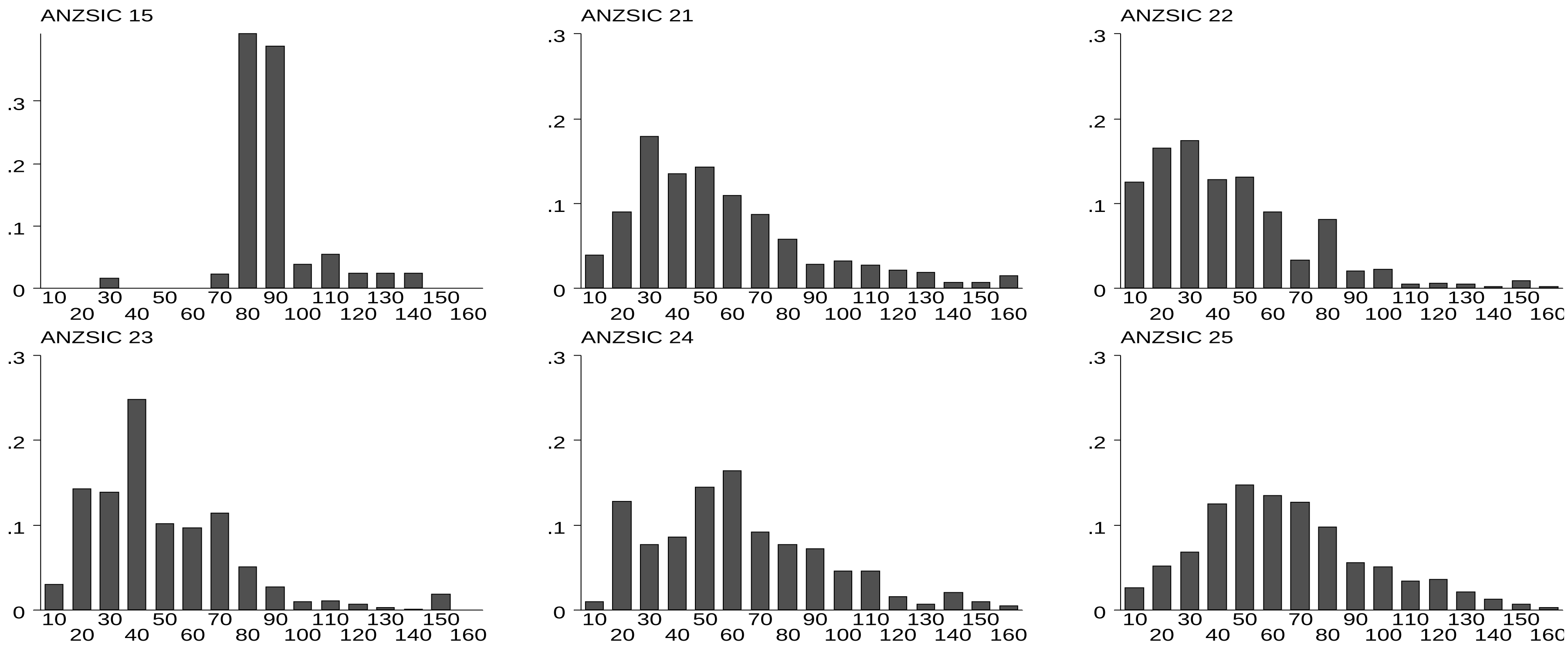
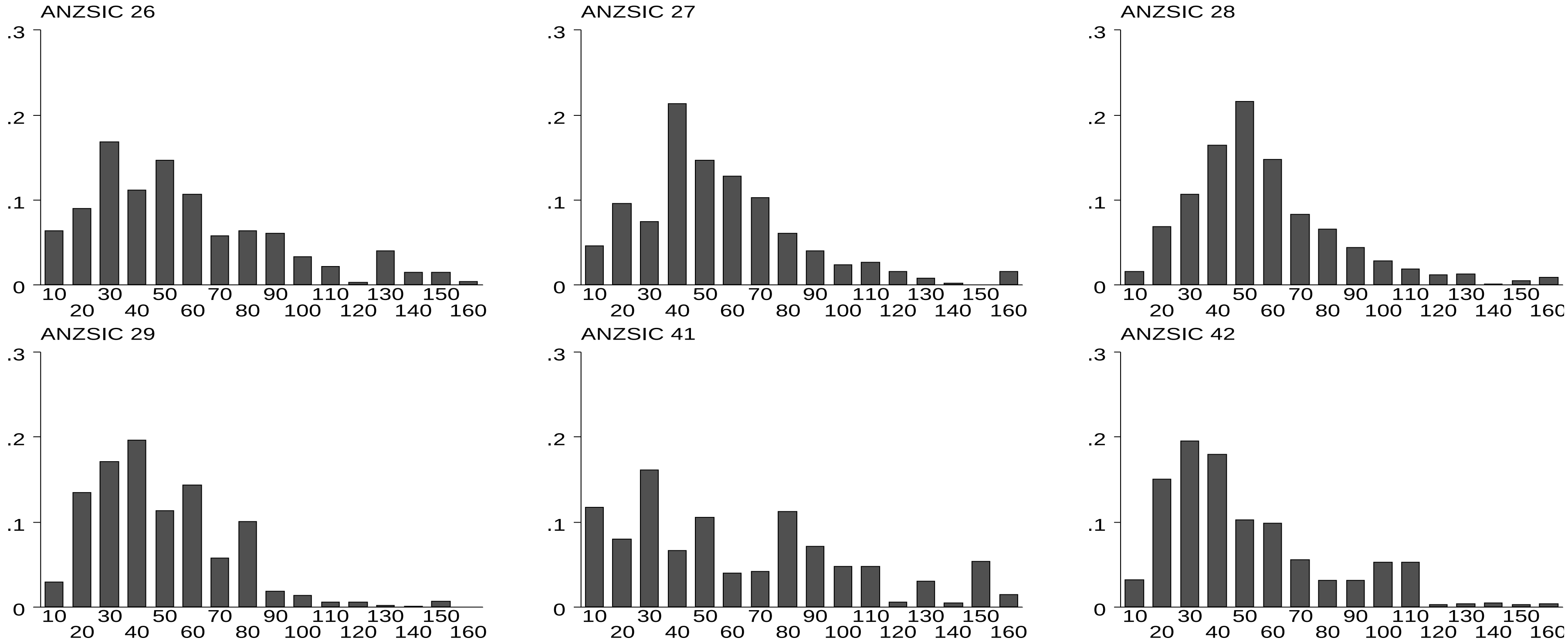
Appendix 1 Part time to full time employees by industry

Industry (2 digit ANZSIC)	Mean	Std. Dev.	Median
11	0.01	0.07	0
12	0.08	0.13	0
13	0.02	0.08	0
14	0.06	0.10	0
15	0.16	0.27	0
21	0.42	0.52	0.25
22	0.32	0.52	0.01
23	0.15	0.36	0
24	0.21	0.37	0.03
25	0.14	0.28	0
26	0.19	0.35	0
27	0.15	0.26	0
28	0.15	0.31	0
29	0.15	0.24	0
41	0.13	0.30	0
42	0.21	0.44	0
45	0.18	0.28	0
46	0.14	0.29	0
47	0.21	0.33	0
51	0.55	0.54	0.52
52	0.40	0.42	0.29
53	0.22	0.40	0
57	0.80	0.61	0.70
61	0.24	0.49	0
63	0.20	0.22	0
64	0.75	0.90	0.23
65	0	0	0
66	0.31	0.53	0
67	0.05	0.14	0
73	0.22	0.57	0
74	0.51	0.79	0.09
75	0.17	0.35	0
77	0.18	0.37	0
78	0.27	0.47	0
91	0.40	0.54	0.13
92	0.48	0.36	0.73
93	0.98	0.80	1.08
95	0.41	0.53	0.29
All firms	0.31	0.49	0

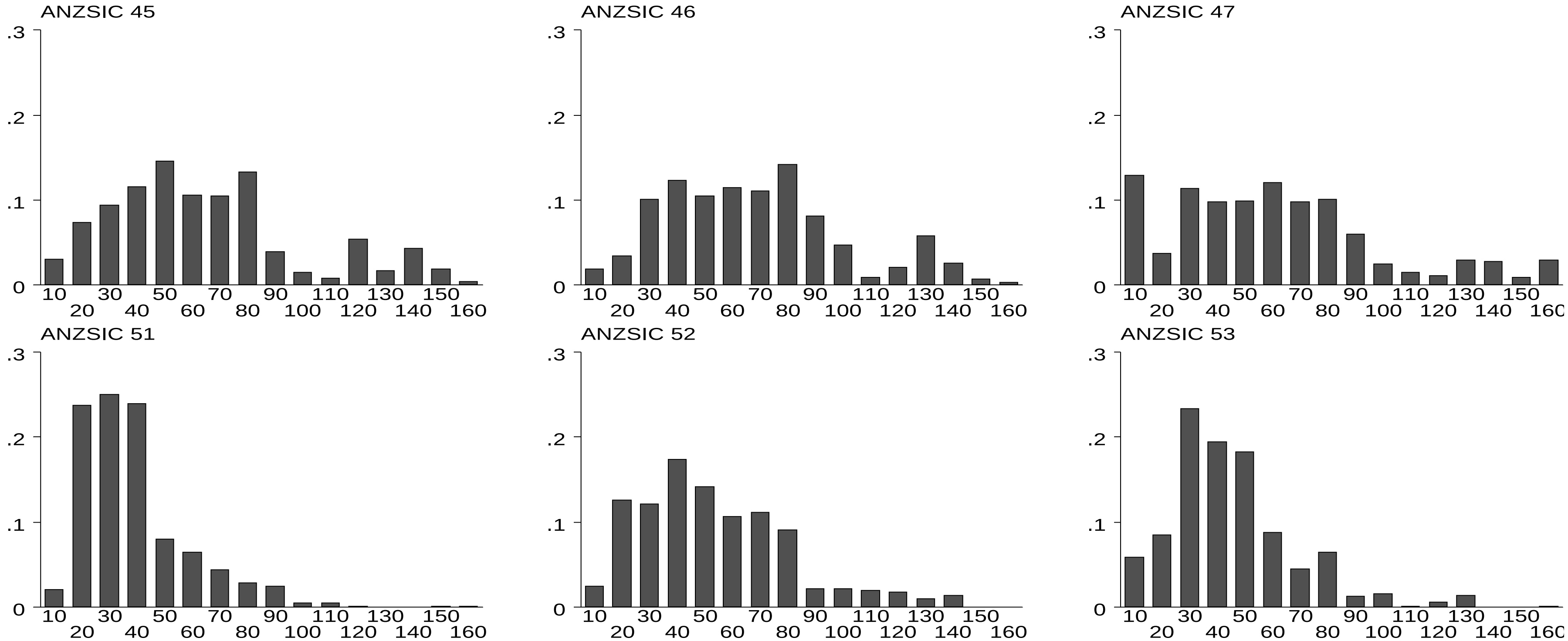
Appendix 2 Histograms of labour productivity by industry



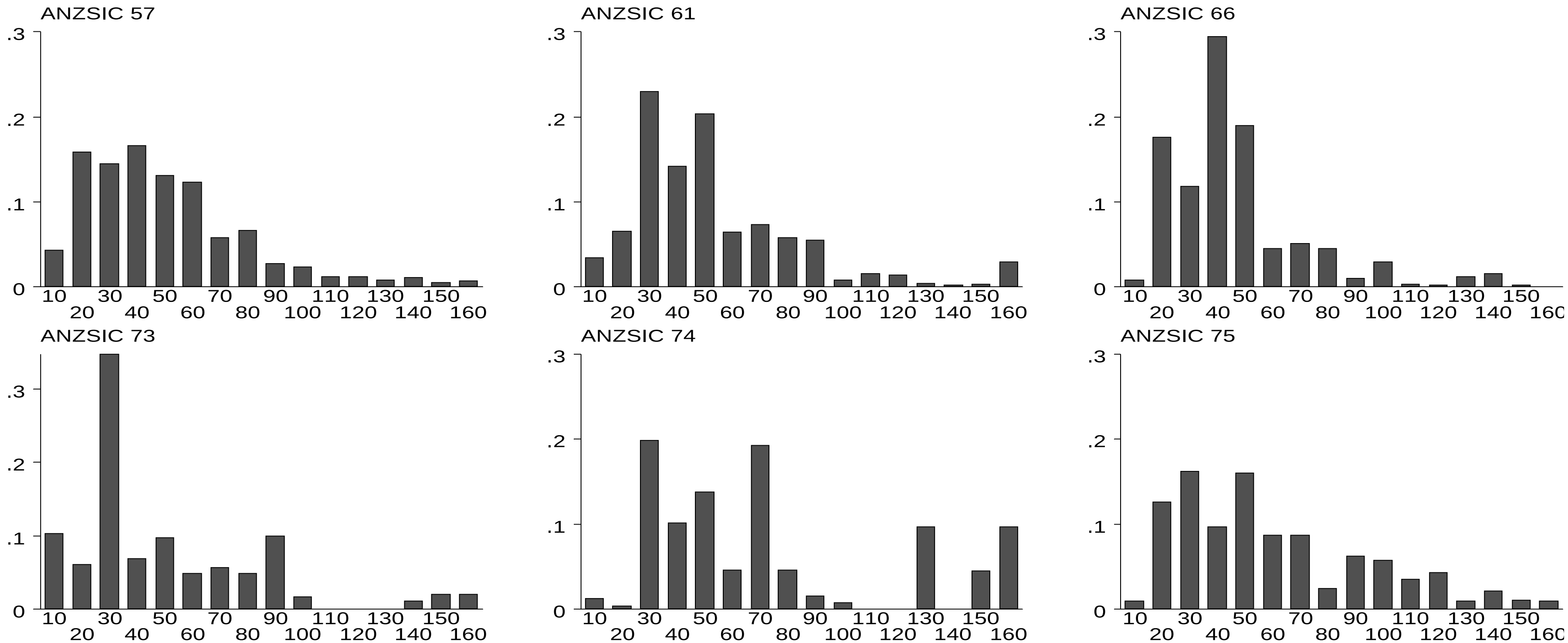
Histograms of labour productivity by industry (cont)



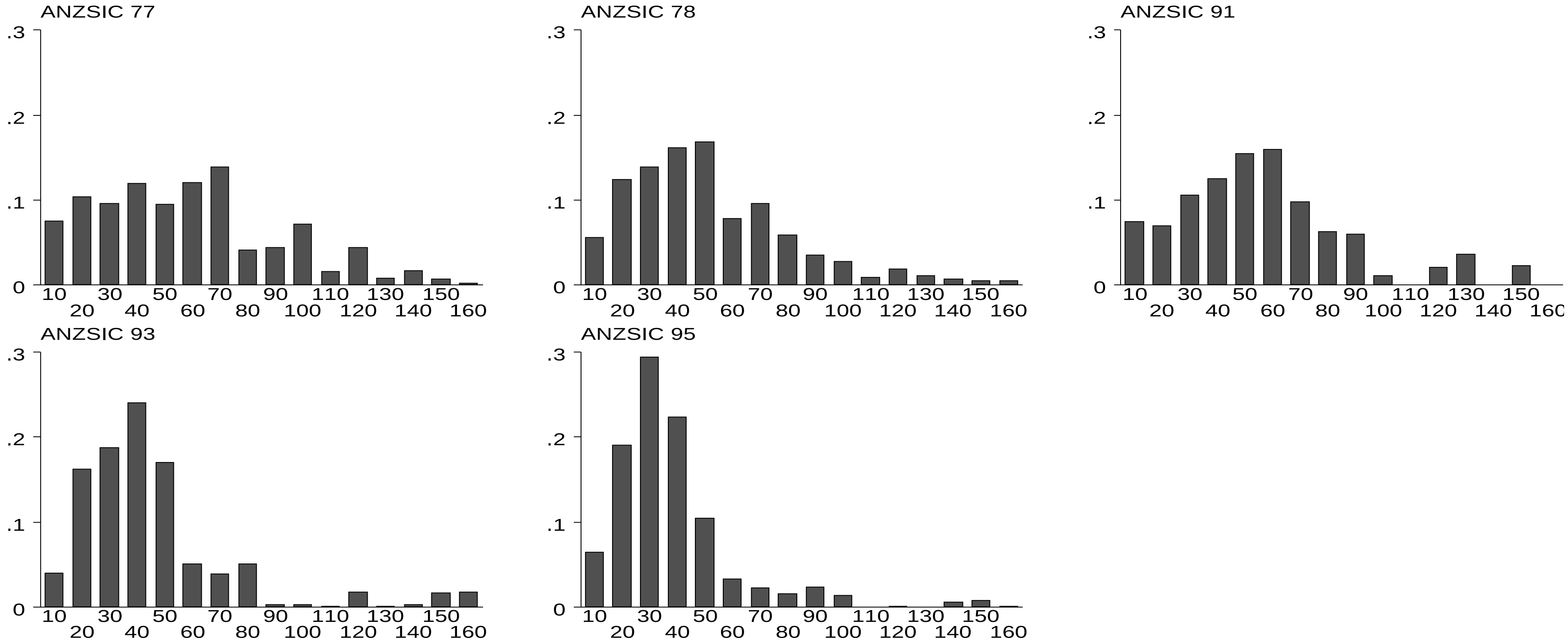
Histograms of labour productivity by industry (cont)



Histograms of labour productivity by industry (cont)



Histograms of labour productivity by industry (cont)



Appendix 3 Histograms of labour productivity by firm age