

The Age Dispersion of Workers and Firm Productivity: A Survey Approach

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Abstract

This paper investigates a tentative finding in recent literature that the age dispersion of workers matters for average firm productivity. The reason is not related to differences in the workers' age specific productivity levels. Rather it is that workers of different ages are complementary in their effects on average firm productivity. The approach is an econometric study for Australia using the only publicly available matched employee-employer data which is extracted from the AWIRS 95 survey, along with data from a small online pilot survey conducted for the purposes of this study. The results support the tentative suggestion from prior studies, using somewhat different methodologies, that a more widely dispersed workforce by age is positive for productivity. This may have implications for human resource management of firms and for public policy, for example in relation to immigration.

JEL Classification: J000; J010; J100

1. Introduction

The national economic burden of population ageing depends mainly on the effect of ageing on two variables: the employment to population ratio and labour productivity. Most attention in economic analyses and policy discussion has focused on the employment to population ratio. Much less is known about the effect of ageing on labour productivity. This article provides econometric evidence on a link between ageing and labour productivity that has only recently begun to receive attention in the literature: substitution by firms among workers of different ages.

The effect of population ageing on labour productivity is ambiguous according to the extant literature (see, section 2 below). Hence most projections of the macroeconomic effects of population ageing assume a zero net effect of ageing on total factor productivity as a baseline scenario.¹ Australian examples include the

¹ The seminal model of the macroeconomic effects of population ageing is Cutler *et al.* (1990). Since then a vast literature has developed with features such as endogenous fertility, overlapping generations and dynamic stochastic general equilibrium analysis. See, Creedy and Guest (2007) for a volume of more recent papers.

three Intergenerational Reports (Commonwealth of Australia, 2002, 2007, 2010). In these models labour productivity is assumed to be affected only by assumptions about the relative human capital levels of older and younger workers. It is assumed that a workforce with a higher share of middle age workers is more productive due to their higher human capital; and moreover, that the relative productivity of workers by age is assumed to be independent of the respective age shares of the workforce. In other words, if 50 year olds are found to be on average twice as productive as 20 year olds, this will be assumed to hold no matter how the proportion of 50 year olds and 20 year olds in the workforce changes. That is, the elasticity of substitution of workers by age is infinite.

This standard assumption is clearly unrealistic because it doesn't account for complementarities between workers of different ages. Examples of complementary age-dependent skills include the physical strength and facility with new technology of young workers complementing the skills of older workers in managing people, multi-factorial decision-making and mentoring of younger workers.² Intuitively therefore, the marginal product of a young worker depends on how many older workers they are working with, and analogously for the marginal of an older worker. The literature is now beginning to challenge the assumption of perfect substitution of workers by age. Evidence from calibrated dynamic macroeconomic models suggests that the degree of substitutability between workers of different ages can significantly affect aggregate labour productivity (Guest, 2005; Prskawetz, Fent and Guest, 2007). These studies suggest that the ageing workforce over coming decades could generate a productivity dividend – in the order of five to 20 per cent of GDP in total spread over several decades. A productivity dividend of this magnitude would substantially offset the national economic burden of population ageing due to the declining ratio of workers to consumers.

However, these empirical estimates depend critically on a range of assumptions in the typically highly aggregated macroeconomic models. Additional econometric evidence at the level of the firm would be helpful, which is the aim of this paper. The particular question here is whether the degree of dispersion of workers by age has an impact on productivity of the firm. The degree of dispersion of the age distribution is measured here by the coefficient of variation. This does not measure the complementarities among particular age groups but rather the effect of the overall degree of dispersion of the workforce by age on productivity.

The remainder of the paper is organised as follows. Section 2 reviews the literature on ageing and productivity then section 3 provides some basic theory on the relationship between the age distribution of workers and labour productivity. Section 4 describes the data and econometric methodology, including some comparative summary statistics for data from the pilot survey, Australian Workers Industrial Relations Survey (AWIRS) and the Australian Bureau of Statistics (ABS). Section 5 discusses the econometric results and section 6 concludes the paper.

² See, Guest and Shacklock (2005) for a discussion of the management literature on relative skills of younger and older workers.

2. Population Ageing and Labour Productivity: the Extant Literature

It is reasonable to conclude from the extant empirical and theoretical studies that the effect of ageing on productivity at the macro level is ambiguous (see, Creedy and Guest, 2007, for a collection of papers; and for earlier discussions of the literature see, Birdsall, Kelley and Sinding, 2001, and Mason, 2001). This literature recognises a range of mechanisms through which population ageing could affect labour productivity – some positively and some negatively. On the positive side for example, the higher human capital of middle-aged workers suggests that a higher share of middle-aged workers would boost average labour productivity (Day and Dowrick, 2004, for example). The resulting higher incomes tend to raise the opportunity cost of having children which lowers fertility and further raises the share of middle aged workers and hence productivity and incomes. This is essentially the virtuous circle in the model of Becker, Murphy and Tamura (1990), where lower fertility and higher productivity growth are negatively correlated and self-reinforcing. A virtuous circle can also arise between ageing and growth to the extent that the ageing is due to rising longevity. Ehrlich and Lui (1991) for example argue that increasing longevity leads parents to invest more in their children's education so that they will have the means to support them in their old age. The greater human capital investment results in increasing growth. It is also possible that a shortage of workers in the future would raise the relative price of labour and therefore encourage innovation and capital investment. And lower congestion in cities may imply less diseconomy of scale and hence higher growth. For Australia, Guest and Swift (2008) found empirical evidence of a negative long run relationship between fertility and productivity. This suggests that, to the extent that ageing arises from lower fertility, an ageing population would be associated with higher productivity.

On the negative side, a smaller youth share of the population may reduce innovation embodied in new technology. Lower population growth could further reduce economies of scale and also decrease the chance of new technological discoveries through fewer absolute numbers of workers (Jones, 2002). Any such negative effect on the rate of discovery of ideas can be compounding, as knowledge begets knowledge which is emphasised in the endogenous growth school of thought led by Lucas (1988) and Romer (1990). Given this ambiguity, most projections of the macroeconomic effects of population ageing assume a zero net effect of ageing on total factor productivity as a baseline scenario.³ Australian examples include the three Intergenerational Reports (Commonwealth of Australia, 2002, 2007, 2010).

At the micro (firm) level, a number of European studies have used matched employer-employee data sets to investigate the link between the age distribution of workers and productivity. Göbel and Zwick (2010) use German data from 1997-2005 and find that mixed age work teams have a positive impact on relative productivity of both old and young employees. Lallemand and Rycx (2009) apply Belgian data

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between 1995 and 2003 and conclude that a higher share of young workers in a firm is positive for value added per worker. Prskawetz *et al.* (2006) find that productivity is lower in firms that have a higher share of either younger or older workers compared with firms whose share of workers in the middle age group is higher, based on a cross section of Austrian manufacturing and mining firms in the year 2001. These studies do not however apply a direct measure of the dispersion of the age distribution, which is done here.

3. The Age Distribution of Workers and Labour Productivity: Basic Theory

Consider a production function of general form (suppressing time subscripts):

$$Y = A(K, L^*) \quad (1)$$

where A is the level of total factor productivity, K is the capital stock, and L^* is a CES index of labour inputs:

$$L^* = \left[\sum_{i=1}^n \alpha_i L_i^\rho \right]^{1/\rho} \quad (2)$$

where L_i is labour of age i , α_i is the productivity weight of labour of age i for $i=1$ to n age groups, capturing for example age-specific human capital, and ρ is a parameter that represents the flexibility, or versatility, of L_i , meaning the degree to which L_i can substitute for any other input, L_j . The marginal product of L_i is given by:

$$\frac{\partial Y}{\partial L_i} = \alpha_i \frac{\partial Y}{\partial L^*} \frac{\partial L^*}{\partial L_i} = \alpha_i \frac{\partial Y}{\partial L^*} \left(\frac{L^*}{L_i} \right)^{1-\rho} \quad (3)$$

Hence the marginal product of L_i depends on the productivity weight, α_i , but also, in the general case where $\rho \neq 1$, on the share of L_i in L^* which in turn depends on the age distribution of the workforce. This implies, for example, that the output produced by employing an additional 50 year old depends on the share of 50 year olds already in the workforce.

The elasticity of substitution of L_i in the labour index, L^* , is equal to $1/(1-\rho)$. This elasticity is infinite in the special case where ρ approaches 1; in that case the labour index is simply additive: $L^* = \sum_{i=1}^n \alpha_i L_i$ and the marginal product of L_i is therefore:

$$\frac{\partial Y}{\partial L_i} = \alpha_i \frac{\partial Y}{\partial L^*} \quad (4)$$

which is independent of the age distribution of the workforce. This assumption of infinite elasticity among labour inputs by age is the implicit assumption in most macroeconomic modelling of population ageing.

A question can be asked: what difference does this assumption make given

the likely changes in age shares of the workforce that are projected over the coming decades? One approach is to calibrate production functions where the elasticity of labour substitution by age is finite, then run simulations of the output effects of projected changes in the workforce age distribution (Guest, 2005; Prskawetz, Fent and Guest, 2007). The results of these studies suggest that the magnitude of the effect on average labour productivity is likely to be non-trivial. This study adopts an alternative approach by econometrically estimating the relationship between labour productivity of firms and their workforce age distributions using matched employee-employer data. The particular property of the age distribution to be investigated is the degree of dispersion of the age distribution; that is, whether a more widely or narrowly dispersed workforce by age affects productivity at the firm level.

4. Data and Econometric Methodology

The econometric methodology here is a single equation cross section logit regression. It is important to note two potential limitations of this approach. One is the possibility of endogeneity of the age indicators given that productivity can affect the age distribution (Aubert and Crepon, 2006; Göbel and Zwick, 2010). For example, new plants in start up firms tend to embody the latest and most productive technology; and when they hire workers they tend to get the younger workers since these are the workers on the job market and also the ones attracted to the new technology. So productivity and age distribution can be simultaneously determined. Prskawetz *et al.* (2006), however, were not able to find evidence for endogeneity bias for their data. Some, but not all, studies have adopted techniques to allow for possible endogeneity (Göbel and Zwick, 2010). The other potential limitation is that firm differences that are not taken into account here may affect the link between productivity and firm productivity. An example is the industrial relations regime (Göbel and Zwick, 2010). Some studies have therefore adopted a panel regression approach with fixed firm effects. Current data limitations for Australia do not allow this approach.

The AWIRS Data

The first of the two data sets for this study were extracted from the Australian Workplace Industrial Relations Survey data of 1995 (AWIRS 95), which is the only publicly available data for Australia that allows a matching of the age distribution of workers of firms with indicators of productivity.⁴ Indeed Jensen (2010) has argued that Australia has lagged comparable countries in failing to invest in the creation of comprehensive matched employee-employer data sets. Loundes (1999) applied the AWIRS 95 data to investigate a range of influences on workplace productivity but did not consider the age distribution.

The AWIRS 95 data were obtained by application from The Australian Social Science Data Archive. The data were originally collected from a random sample of 2001 Australian workplaces by Reark Research, between September 1995 and

⁴ The Australian Bureau of Statistics has data on employees by age at the level of industry sector but not at the level of the firm. The Household Income and Labour Dynamics in Australia (HILDA) data include the industries and occupations of the surveyed households but does not provide matching data on the output of those firms.

January, 1996 under the auspices of the Commonwealth Department of Industrial Relations as a follow up to the first survey (AWIRS 90) conducted in 1989-90. The AWIRS actually consists of a number of surveys. The two surveys used in this study were the management survey, which was by personal interview with managers, and the employee survey, which was by self-administered questionnaire distributed to a randomly selected sample of employees within each workplace. For this study, the latter survey provided data for control variables relating to characteristics of employees. However, the fact that it was by random sample of employees rather than all employees is a limitation for the purposes of this study. Firms with less than 10 employees were dropped from the sample, as were firms where data was missing on other relevant variables. This reduced the usable sample size to 723 observations.

Although the focus of the AWIRS survey was not on firm performance, there is one survey question on firm productivity in relation to the firm's competitors, which can be used for the present study. This question was: 'In your opinion, how does the level of labour productivity here compare with your major competitors?' Responses consisted of points on a five-point Likert scale: 1 = 'A lot higher', 2 = 'A little higher', 3 = 'About the same', 4 = 'A little lower', 5 = 'A lot lower', and 6 = 'Don't know'. These responses were recoded in reverse order so that 1 to 5 represented low to high productivity. Hence, a positive coefficient in the regression indicates a positive effect on the productivity indicator.

The Pilot Survey Data

The AWIRS 95 data are now 15 years old. In the meantime considerable technological change has occurred in Australian workplaces that may have influenced the relationship between the age distribution of workers and firm productivity. Consequently a pilot online survey of Australian businesses was conducted in 2010 for this study. Firms were restricted to those with at least 10 employees, which yielded 239 usable responses from a total sample frame of 6122 that was drawn from the manufacturing, retail, hospitality wholesale and distribution industry sectors.⁵ These four industries together accounted for 30.9 per cent of employment within Australia in 2009 (Australian Bureau of Statistics, 2010). The sample frame was purchased through a commercial database supplier, ImpactLists.

An electronic survey tool, Limesurvey, was chosen over a pen and paper version due to lower costs. This allowed the survey to be developed with unlimited responses, real time reports, follow up emails and downloadable responses to varying data formats including Excel. The survey instrument (appendix A) was kept as short and simple as possible in order to elicit a good response rate, bearing in mind that it was a pilot online survey. The questions on employee characteristics were restricted to age, gender, education levels, migrant status and length of tenure at the current workplace. Unlike the AWIRS survey, the pilot survey did not ask for information on 'labour productivity' directly. The AWIRS data were collected by interview with selected managers in person, which provides an opportunity to clarify concepts. The pilot survey on the other hand was an online survey where there was little opportunity to clarify concepts and little control over the identity or position held by the respondents.

⁵ After removing from the sample frame all non-responses (after follow-up phone contact), incomplete responses and businesses with 10 or more employees.

The view was taken that more reliable and comparable data would be obtained by using less technical terminology that is readily understood. Hence instead of 'labour productivity' the survey asked for indicators of 'performance' of the business in relation to competitors. A seven point Likert scale was used rather than a five point scale in the AWIRS 95 survey. The question was: How would you rate the performance of your business over the last three years, relative to your competitors in terms of: 1. Gross sales revenue (all sales inclusive of GST); 2. Gross margin on sales; 3. Cost control; 4. Customer satisfaction. The relevant indicator of output is gross sales (item 1). The other variables were included in order to distinguish gross sales from other performance concepts, and also to provide additional information for possible supplementary research questions (which are ignored here). One limitation here is that because output is not the same as labour productivity it is not possible to draw conclusions about labour productivity from the pilot survey data. However, the data on output are 'relative to competitors' which helps to restrict the comparison to organisations of roughly comparable size and number of workers. Hence comparisons of output are likely to be correlated with comparisons of output per worker. Nevertheless, the limitation is acknowledged. Appendix B provides further details of the survey methodology in relation to established practice.

Econometric Methodology

The dependent variable is the firm's relative productivity (see above). The key independent variable of interest is the degree of dispersion of the age distribution of workers. This is measured by the coefficient of variation, applying the standard adjustment for grouped data:

$$CV = \frac{\sqrt{Var - n^2/12}}{\bar{x}} \quad (5)$$

where CV is the adjusted coefficient of variation, *Var* is the variance of the age distribution using the mid-point of each age categories to apply to the number of people in that category for the purpose of calculating the mean age, *n* is the number of years in a given age category (for example *n*=5 for an age category 25-29), and $\bar{x}$ is the mean age.

A number of other independent variables that could affect productivity according to standard theory were included as controls. The proportion of workers with post secondary education, *psed*, was included as an indicator of the average human capital level of workers. Other control variables are the proportion of workers who are females, *fem*, migrants (defined as not born in Australia), *mig*, and older workers (defined as over 55 years of age). The older workers share was included in order to capture potential differences between older and younger workers in, for example, their facility with new technologies. The share of older workers is not necessarily captured by the measure of the age distribution. Finally, a measure of workforce size, *size*, was included as a rough proxy for scale effects on productivity. A sensitivity analysis was conducted by estimating alternative models where one or more of these variables were omitted.

The full model to be estimated is (where i is the index of firms):

$$Prod_i = \beta_1 CV_i + \beta_2 psed_i + \beta_3 mig_i + \beta_4 fem_i + \beta_5 over55_i + \beta_6 size_i + \mu_i \quad (6)$$

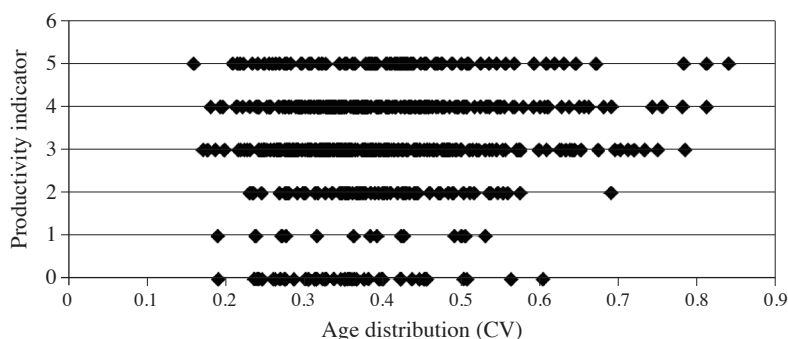
This is an ordered dependent variable regression which was estimated as a logit model using the procedure in the software package *Eviews*.

5. Results

Tables 1 and 2 report descriptive statistics for each of the two data sets. The responses on productivity relative to competitors are skewed to the right (that is, higher productivity) in both data sets. For the AWIRS 95 data, only 14 per cent of firms rated their productivity below their competitors while 48 per cent had higher productivity than their competitors. For the pilot survey data, 12 per cent of firms reported lower productivity and 33 per cent of firms reported at least 'slightly above average' productivity. The mean number of workers in the AWIRS 95 data is significantly smaller because the survey only applied to a sample of workers in the workplace (as explained above). The age distributions, female workforce shares and post-secondary education shares for the two data sets are similar to the corresponding statistics for the whole Australian workforce (Australian Bureau of Statistics, 2010).⁶

Figures 1 and 2 are 'scatter plots' of the age distribution (CV) and productivity indicator for the AWIRS 95 data and pilot data respectively. Casual inspection of these figures suggests a somewhat positive relationship between the two variables in both cases. This is borne out in the results of the econometric estimation to which we now turn.

Figure 1 - Age Distribution and Productivity, AWIRS 95 Data



⁶ Data comparison with whole Australian workforce according to Australian Bureau of Statistics (2010).

	Female Participation %	Born Overseas %	Post Secondary Education %
Pilot study 2010	31.57	24.12	52.96
AWIRS 1995	44.49	27.09	45.62
Australian Bureau of Statistics 2009	45.48	25.6	49.9

Table 1 - Descriptive Statistics, AWIRS 95 Data

Mean Age Shares	Productivity	Frequencies	Female Share	Not Born Aust.	Post Sec. Educ.	Total No. of Workers
15-20	1	18	Mean 0.4403 St. dev. 0.1082	Mean 0.2489 St. dev. 0.0978	Mean 0.5155 St. dev. 0.1016	Mean 15,2755 St. dev. 0.0996
21-24	2	97				
25-29	3	311				
30-34	4	281				
35-39	5	117				
40-44						
45-49						
50-54						
55 & over						

Table 2 - Descriptive Statistics, Pilot Survey Data

Mean Age Shares	Output	Frequencies	Female Share	Not Born Aust.	Post Sec. Educ.	Total No. of Workers
15-24	1	3	Mean 0.3053 St. dev. 0.1855	Mean 0.2855 St. dev. 0.2009	Mean 0.4636 St. dev. 0.2971	Mean 55,0556 St. dev. 64,2517
25-34	2	7				
35-44	3	18				
45-54	4	57				
55-64	5	71				
65 & over	6	70				
	7	8				

Figure 2 - Age Distribution and Output. Pilot Data

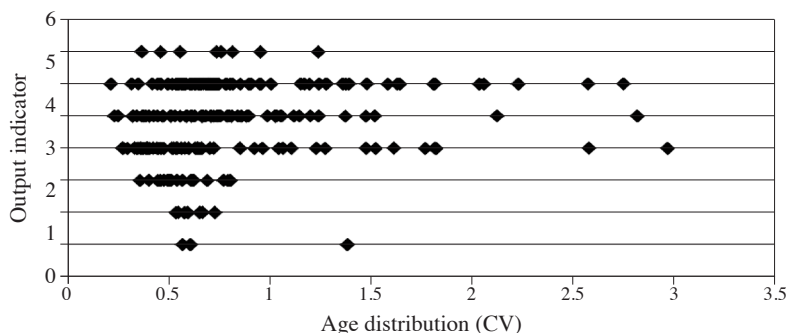


Table 3 reports the econometric results for the AWIRS 95 data. Model 1 is the estimation of (6). Models 2, 3, 4, 5 and 6 are progressively parsimonious models. The key null hypothesis is $\beta_i=0$ where β_i is the coefficient on *CV*. The *p* values indicate that this hypothesis can be rejected at the five per cent significance level in all models, and the coefficient is also positive in all models indicating a positive effect of a wider age distribution on the productivity variable. The only control variable that is statistically significant at five per cent is the workforce share aged over 55; the coefficient negative and significant at one per cent in the two models in which this is included. However, the share not born in Australia is negative and significant at ten per cent. It is also noteworthy that the size of the workforce does not seem to matter; the suggestion being that the age distribution affects productivity in both small and large firms (bearing in mind that all firms in our sample had at least 10 workers). In all models the LR statistic rejects the null hypothesis that all the slope coefficients are zero.

Table 3 - The AWIRS 95 Data. Specifications of Logistic Regression

Dependent variable is productivity relative to competitors. (p values are in parentheses)						
	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
CV (age dist.)	1.652028	1.835074	1.597779	1.681107	1.599055	1.656077
P value	(0.0141)	(0.0035)	(0.0103)	(0.0069)	(0.0078)	(0.0058)
Female share	0.227599	0.226602	0.336220	0.319034	0.327207	
P value	(0.3593)	(0.3614)	(0.1702)	(0.1931)	(0.1809)	
Post sec edu	0.107163	0.157854	0.156004	0.148064		
P value	(0.7176)	(0.5841)	(0.5880)	(0.6075)		
Not born Aust.	-0.725849	-0.717398	-0.799445			
P value	(0.0585)	(0.0615)	(0.0366)			
Over 55 pop share	-2.211954	-2.254766				
P value	(0.0076)	(0.0064)				
Size of workforce	0.010245					
P value	(0.4531)					
LR statistic	22.07833	21.51421	14.04565	9.692374	9.428628	7.637027
P value	(0.001172)	(0.000647)	(0.007151)	(0.021370)	(0.008966)	(0.005718)

Table 4 reports the corresponding results for the pilot survey data, which are similar to those in Table 3. The coefficient on CV is positive in all models and significant at one per cent except in Model 1 where the p value is 0.106. Again the control variables are not significant, including in this case (unlike table 3) the workforce share aged over 55. The overall significance of most of the models is not as strong for the pilot data as for the AWIRS data with the LR statistic being significant at five per cent for Models 5 and 6 only.

Table 4 - The Pilot Survey Data. Specifications of Logistic Regression

Dependent variable is output (sales revenue) relative to competitors. (p values are in parentheses)						
	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>
CV (age dist.)	0.496679	0.348201	0.364722	0.354906	0.360356	0.351737
P value	(0.1055)	(0.0185)	(0.0132)	(0.0155)	(0.0137)	(0.0153)
Female share	0.248321	-0.223750	-0.180852	-0.166739	-0.174002	
P value	(0.5094)	(0.5494)	(0.6267)	(0.6534)	(0.6391)	
Post sec edu	0.220624	-0.229227	-0.156519	-0.125070		
P value	(0.3636)	(0.3442)	(0.5046)	(0.5879)		
Not born Aust.	0.310078	0.305728	0.262998			
P value	(0.3761)	(0.3827)	(0.4502)			
Over 55 pop share	0.882735	0.890632				
P value	(0.2337)	(0.2295)				
Size of workforce	0.001246					
P value	(0.6806)					
LR statistic	8.732766	8.427527	6.982855	6.412439	6.118806	5.898932
P value	(0.189174)	(0.134195)	(0.136797)	(0.093180)	(0.046916)	(0.015150)

In summary, the econometric analysis suggests that a more widely dispersed workforce by age has a positive effect on productivity. The intuition is that a more widely dispersed age distribution facilitates complementarities among workers of different ages. This result is supported with perhaps somewhat more confidence for the AWIRS 95 sample than for the pilot sample.

6. Conclusions: Implications for Firms and Policy Makers

Taken together, these results provide support for the suggestion from prior empirical and theoretical studies that the age distribution of the workforce matters for productivity. The particular property of the age distribution considered here is the degree of dispersion of workers by age. If, as the results suggest, a more widely dispersed workforce by age is positive for productivity, there are implications for both human resource management of firms and for public policy.

The suggestion here that firms could benefit from a wider mix of ages of their workforce, tends to be echoed in the human resource literature (surveyed in Guest and Shacklock, 2005). Although younger workers come with higher human resource costs (hiring, training), their ability to assimilate new technology, creativity, strength, hearing and vision, all tend to complement the advantages of older workers such as

experience, multi-factorial decision-making capacity and stability of older workers. However, a wider age mix of workers may present challenges (Patrickson and Ranzijn, 2004; Walker, 1997). For example, inter-generational differences in lifestyle patterns, family circumstances, career experiences and expectations could make aged-mixed teamwork more difficult.

For public policy, one implication that warrants further research relates to immigration policy. Immigrants are younger on average than resident workers. This suggests that an increase in immigration would widen the dispersion of workers by age in firms, which according to the results here, would positively impact productivity. We know for example that some industries have relatively old workforces, such as nursing and higher education. So far the concern with this has been the impending shortage of workers as older workers retire. This study implies that it may not be just the shortage of workers that is an issue with an ageing workforce, but the shift in the age dispersion. It is not obvious, however, that an ageing workforce would imply a more narrow age dispersion in all industries. The retail industry for example currently has a young workforce; population ageing may lead to a higher proportion of older workers in retailing and a wider age dispersion. Nevertheless, immigration could be directed not only at those industries facing shortages of workers but those industries facing a narrow age dispersion.

There is enough evidence here and from prior studies using alternative approaches to warrant further research on the impact on productivity of the degree of dispersion of workers by age at the firm level. The main problem with both the AWIRS 95 data and the pilot survey data is that the firm specific productivity indicators are subjective indicators of productivity relative to competitors and measured on an ordinal scale. More objective and cardinal productivity measures would allow more confidence in the econometric results regarding various determinants of productivity. This underlines the need for a major investment in Australia in a comprehensive matched employee-employer data set; as Jensen (2010) argues (noted above), Australia has fallen behind comparable countries in failing to create such data sets.

Appendix A

Below is the survey instrument for the pilot study.

Investigating the link between firm performance and the age mix of workers.

Welcome to this online survey. We are investigating the link between the age mix of the workforce and the performance of firms. This information will help us to better understand the implications of an ageing workforce.

Your time and effort in completing this short survey of six questions is much appreciated.

The identity of your organisation and the name of the survey respondent will remain confidential. The survey does not ask for any personal information. This survey is designed so you can stop and start as needed.

If at any time during this survey you need to contact the researchers, please email: labprod@griffith.edu.au

The following link provides the contact details of the researchers and relevant information regarding your agreement and participation to proceed with the survey: splupload/surveys/12369/Survey%20doc%20-%20Research%20Info%20Sheet%20V3-1.pdf

For further information on ethics guidelines for this survey please refer to the link below: www.griffith.edu.au/or/secure/booklet/humans/booklet_21/

Your time and help with this study is greatly appreciated. Thank-you.

There are six questions in this survey

1. Does your organisation employ 10 or more people?

This includes all management and employees of the business that are employed on a permanent full time or part time basis.

If your business employs less than 10 people on the above basis, we thank-you for your time however, your input will not be required for the next steps.

Please choose **only one** of the following:

- Yes
- No

2. How many of your staff are in the following age groups?

(Please count all staff including managers. If there is no staff in an age group, record '0')
[Only answer this question if you answered 'Yes' to question '1']

	Male	Female
15-24 years of age		
25-34 years of age		
35-44 years of age		
45-54 years of age		
55-64 years of age		
65 years and over		

This includes full time and permanent part time employees.

For example, if you have 3 employees in the 55-64 years of age category, with 2 males and 1 female, then in the second last horizontal row place a 2 in the first column for male and 1 in the second column for female.

* Please place a zero in any dimension where there are no employees meeting this category.

3. How many staff have the following education levels? *

[Only answer this question if you answered 'Yes' to question '1']

	<i>Secondary</i>	<i>TAFE/University</i>
15-24 years of age		
25-34 years of age		
35-44 years of age		
45-54 years of age		
55-64 years of age		
65 years of age and over		

If staff attended formal education up to High School, then they fall into the 'Secondary' category or if staff have TAFE, College or University education they they will be in the 'TAFE/university' category according to their corresponding age group.

* Please place a zero in any dimension where there are no employees meeting this category.

4. How many years of relevant experience in this industry does each employee have?

[Only answer this question if you answered 'Yes' to question '1']

	<i>0-5 years of experience</i>	<i>6-15 years of experience</i>	<i>15 or more years of experience</i>
15-24 years of age			
25-34 years of age			
35-44 years of age			
45-54 years of age			
55-64 years of age			
65 years of age and over			

For example, if there are 20 employees and 5 have 10 years experience, with 2 of these employees aged 35 and two aged 45 and one aged 65, then they would be counted in 3 separate boxes according to their age group.

* Please place a zero in any dimension where there are no employees meeting this category.

5. How many staff were born overseas?

[Only answer this question if you answered 'Yes' to question '1']

	<i>Born overseas</i>
15-24 years of age	
25-34 years of age	
35-44 years of age	
45-54 years of age	
55-64 years of age	
65 years and over	

This includes all staff not born in Australia relative to their age group.

For example, if there is one person born in Japan aged 32, then they would be counted in the '25-34 years of age' group as would be if you had a 28 year old employee who was born in New Zealand. If these are the only employees of the age group born outside of Australia, then a 2 would be placed in the '25-34 years of age'.

* Please place a zero in any dimension where there are no employees meeting this category.

6. How would you rate the performance of your business over the last 3 years, relative to your competitors in terms of?

(Please be objective and note the this information will remain confidential. Refer to the imbedded link to the Information Sheet and Privacy Statement)

[Only answer this question if you answered 'Yes' to question '1']

Please choose the appropriate response for each item:

	Poor	Well below average	Slightly below average	Average	Slightly above average	Well above average	Excellent
1. Gross sales revenue (all sales inclusive of gst)							
2. Gross margin on sales							
3. Customer satisfaction							
4. Cost control							

Please be assured no financial figures will be requested at any time for this survey. It is a comparison of how you see your business against your competitors.

Submit your survey.

Thank you for completing this survey.

Appendix B

The table below lists some techniques to enhance survey response rates (adapted from Anseel, Lievens, Schollaert and Choragwicka (2010, pp. 336-337). A tick in the middle column indicates that this activity was conducted in the pilot survey.

<i>Effective techniques for enhancing response rates</i>	<i>Firm performance survey adherence</i>	<i>Evidence</i>
Advance notice	✓	Precursor email.
Follow up non-respondents	✓	Non-respondents sent a reminder two weeks after original sent.
Monetary of gift incentive	✓	Prize draw of \$200 Amazon gift certificate for respondents
Relevancy to survey population	✓	Firm performance related to variables.
Personalisation	✓	All surveys sent with personalised introduction and invited to contact researchers throughout the survey. Unique email address setup for all survey correspondence.
Preservation of anonymity	✓	Clearly explained in the survey through linked ethics and information documents that anonymity of respondents would be maintained.
University sponsorship	✓	LimeSurvey supported by the host University with relevant logos on survey.
Mailed	✗	Emailed online survey selected.
Internet technology (pros and cons considered)	✓	Pros of costs, time, data support and in the data analysis stage eliminates possible bias or error hence outweighing the printing and posting option

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