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The Employer Age-Wage Effect: Evidence from Matched Employer-Employee Data

by

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Abstract

This paper uses a large matched employer-employee data set for Sweden to study the relationship between firm age and individual wages, systematically addressing a variety of possible explanations for observing a firm-age wage effect. Results show considerable heterogeneity across years, along segments of the firm age distribution and across industries. A positive and significant firm age-wage premium, robust to a number of control variables, is found in 1995. This effect is not found for 1987 and 1991, two periods characterised by different business cycle conditions than 1995. The relationship between firm age and wages is not monotonic; rather it varies along segments of the firm age distribution. It also differs systematically across different sectors of the economy. A positive firm age effect is found only in the manufacturing sector. Finally, taking into account that larger firms are also older firms, results show that inclusion of firm age does not alter the positive effect of firm size on wages.

Keywords: Wages; firm age; firm size; matched employer-employee data
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1 Introduction

"Is it possible that the size-wage premium is really a relationship between employer age and wages?" (Brown and Medoff (1989), pp. 1056-1057).

A number of studies have found wages to be distributed in a manner that cannot be explained by differences in productivity or by observable and unobservable human capital characteristics. Instead, wages seem to be systematically related to a variety of firm and industry characteristics. One much studied example is the size-wage premium.[1] Studies on a number of different countries and time-periods have reported that employees in large firms systematically earn more than those in small firms (for an exposition of the firm size-wage literature, see Oi and Idson (1999)). For instance, Brown *et al.* (1990) report that for the US, hourly wages in firms with more than 500 employees were 35 percent above wages in firms with less than 25 employees. Despite several attempts to explain the size-wage premium, the proposed explanations only explain a minor part of the premium.

Related to firm size is firm age. Obviously, larger firms are also older firms. A natural question then is how wages are related to firm longevity. Older firms have, on average, characteristics that differ systematically from younger firms. Observable differences between firms with different ages may then lead to a systematic relationship between employer age and wages.

There are several reasons for expecting a positive association between firm age and wages. New firms have by definition employees with low levels of firm tenure. In contrast, employees in older firms have, on average, longer tenure and possibly longer experience. This implies that a positive firm age-wage correlation is due to a sorting mechanism and not a pure firm-age effect. Another channel between firm age and wages goes through prof-

[1] Other non-competitive characteristics that have been found related to wages are industry (see e.g. Dickens and Katz (1987) and Kreuger and Summers (1988)) and unionization (see e.g. Freeman and Medoff (1984)).

itability. Passive learning models suggest that it takes time for new firms to become profitable (see Jovanovic (1982)). This implies a positive relationship between firm age and profits. If, as several studies have found, wages are related to profits through a rent-sharing mechanism, then a positive firm age premium may in fact be due to systematic differences in profitability (see e.g. Hildreth and Oswald (1997) for evidence on rent-sharing). Further candidates for a causal effect of employer age on wages include capital-skill complementarities, systematic sorting of skilled workers into older firms, and differences in firm survival rates, employer stability and working conditions between young and old firms.

Evidence on the effect of firm age on wages is mainly based on data for the US manufacturing sector. Early studies generally found wages to be positively correlated to employer age (see Brown and Medoff (2003) for a summary of these studies). For instance Troske (1998), estimating plant-level regressions of log average wages on plant age, finds that wages are approximately 20 percent higher in plants that are older than 15 years than for plants that are less than five year old. These studies do not, however, control for firm differences in employee characteristics. Sorting of workers with different human capital have explained some of the pay differentials associated with other firm characteristics, for instance firm size. Troske (1999) finds that controlling for worker characteristics and estimating individual wage regressions, the plant age effect disappears.

The most comprehensive study to date on the relationship between firm age and wages is Brown and Medoff (2003). Using survey data for the US on circa 1,000 individuals (telephone interviews), they find that observable worker characteristics fully explain the firm age-wage premium. Controlling for a set of employee characteristics, Brown and Medoff report that the relationship between age and wages is negative over much of the firm age distribution. Their tentative conclusion, given the limited sample,

is that the relationship between firm age and wages is U-shaped. Wages fall as age increases, but the opposite relationship is found for older firms.

The purpose of this paper is to study the effect of firm age on wages, using a large employer-employee dataset for the entire private sector in Sweden. The data consist of very detailed information on approximately 170,000 employees. These data are then matched with balance sheet data for the employing firms through the Swedish system of corporate registration numbers. The information on firm age originates from register-based direct information on the exact date of firm formation and ranges from one to 101 years in business. Using detailed information on individual and firm characteristics, this paper will systematically address a variety of possible explanations for a firm age-wage effect. Given the high correlation between firm age and firm size, this paper will also address the question asked by Brown and Medoff (1989); is it firm age or firm size that matters? More specifically, how is the estimated coefficient for firm size affected by the inclusion of firm age in individual wage regressions? In addition to controls for worker characteristics, the matched data make it possible to control for balance-sheet information on firm profitability and capital intensity. Use of objective measures for firm profit and capital intensity have not previously been used in studies on the firm age-wage relationship.[2]

Given that the data cover the entire private sector, a careful study on differences between the service and the manufacturing sectors regarding the firm age-wage relationship will be presented. Furthermore, the analysis is carried out for three time periods that are characterized by very different business cycle conditions. Since previous studies are based on a single year, this paper address the question of whether the effect of firm age on wages differs across years. In sum, by using disaggregated data, this study

[2] Oi and Idson (1996) and Brown and Medoff (2003) stresses the importance of controlling for profits when estimating the impact of firm age on wages.

can analyze the effect of employer age on wages for individuals with comparable productivity characteristics and for firms with comparable observable characteristics.

The results show considerable heterogeneity across years, along segments of the firm age distribution and across industries. For 1995, a positive relationship between firm age and individual wages is found. This relationship is robust to the inclusion of a variety of variables that might explain the firm age-wage premium.

In 1991 a positive relationship, robust to the inclusion of individual human capital characteristics turns insignificant when firm characteristics such as profits and firm size are added. Hence, for this year, differences in firm characteristics can fully explain the firm age-wage premium.

The results for 1987 are mixed. Separate inclusions of a variety of individual and firm characteristics lead to an insignificant effect of firm longevity on wages. However, inclusion of all the relevant control variables in the same wage equation gives rise to a negative and significant firm age effect.

Further results include (i) a strong heterogeneity concerning the effect of firm age on wages at different parts of the firm age distribution. Behind the results summarized above are marked differences in the firm age elasticity at different segments along the age distribution. These differences also seem to differ across years, and (ii) clear differences between the manufacturing and service sectors. A positive firm age-wage premium is only present in manufacturing, whereas the negative relationship found for 1987 is only present in the service sector.

The remainder of the paper is organized as follows. Theoretical links between employer age and individual wages are presented in Section 2. Section 3 describes the data and the empirical set-up. The results are presented in Section 4. Finally, the paper is concluded in Section 5.

2 Explanations for a Firm Age-Wage Relationship

There exist several explanations for why firm age is related to individual wages. These can be divided into those stressing the importance of different firm characteristics and those that are based on differences in individual human capital accumulation. Many of the explanations for a systematic relationship between firm age and wages are identical to the explanations for a positive firm size-wage correlation. In fact, the strong correlation between how long a firm has been in business and firm size makes it difficult to distinguish between a firm size and a firm age effect. By definition, very large firms have, on average, been in business for quite a long time. Hence, observing a positive firm size and wage relationship might in fact be a positive firm age- wage relationship.

A natural explanation for a systematic correlation between firm age and wages is that individuals in young and large firms have different observable characteristics. One such difference is tenure within the firm. By definition, young firms cannot have employees with long tenure. Since tenure generally turns out positive and significant in individual wage equations, the difference in average individual tenure between firms of different age may provide one explanation for observing higher wages in older firms. In addition, individuals in older firms are also likely to have longer labor market experience. This human-capital explanation implies that the firm age-wage correlation is the result of not controlling for the employees' tenure and experience.

It may also be the case that older firms employ more skilled workers. If capital intensity is higher in old firms and there exists capital-skill complementarities, then these firms will employ more high-skilled workers (see Hamermesh (1980)). Furthermore, if old capital-intensive firms use technologies that rely on standardization and teamwork, then old firms will demand a more high-skilled

homogenous work-force (see Oi (1983)).[3] This in turn, implies a systematic sorting of high-skilled workers into older (and on average) larger firms.[4] The capital intensity-skill explanation means that it is important to control for the capital-labor ratio and the skill-mix of the firms.

Another reason for observing higher wages in more mature firms has to do with profitability. If it takes time for firms to make profits, then one will observe systematic differences in profitability and, hence, in ability to pay between young and old firms. One model that explain such differences in profitability across firms of different ages is Jovanovic (1982). Jovanovic emphasizes the selection effects associated with passive learning about initial conditions. New entrants are equipped with different efficiency parameters which are unknown to the entrepreneur at the date of entry. Over time the entrepreneur updates its true efficiency and the plants relative efficiency gradually becomes known. Firms that accumulates favorable information about their relative efficiency expand, while plants with poor performance eventually decide to leave the market. New plants go through a shake-out period that eventually reveals their long-term profitability. Unprofitable firms exit and are selected out of the population of mature firms. Profitable firms survive to maturity and eventually settle down to relatively stable employment levels. Hence, the Jovanovic model has empirical implications for the relationship between firm age, profitability and wages.

A number of studies have found that wages are positively correlated with profits through a rent-sharing process (see e.g. Hildreth and Oswald (1997)). If older firms are more profitable and employees extract part of the rents created, then a positive effect of

[3] Evidence of sorting of workers by ability across firms with different technological intensity is found in a recent paper by Luque and Miranda (2000) using matched employer-employee data for the US manufacturing sector. They find that the most technological intensive plants hire the most skilled workers.

[4] Older firms may also have more skilled managers that employ more skilled workers with higher wages (Oi (1983)).

firm age on wages can be due to differences in profitability.

A positive relationship between firm age and profits on the one hand and wages on the other can also depart from the notion of fair wages. According to the Akerlof and Yellen (1990) model, employees withdraw effort, hence becoming less productive, if their wage is lower than the "fair" wage. This means that older, more profitable firms have incentives to share profits with their employees. As stressed by Brown and Medoff (2003), the claim of inability to pay higher wages is more credible for young firms with unknown expectations of long-run profitability, than for more mature firms. In sum, the discussion on firm age and profitability implies that it is crucial to control for firm profits.[5]

Differences in failure rates and thus employment stability between young and old firms can also affect the firm age-wage relationship. Several studies have found a negative relationship between plant age and plant failure (see e.g. Dunne *et al.* (1988, 1989) and Davis and Haltiwanger (1991)). The fact that the risk of layoff due to plant closing is significantly higher in new firms may influence wages in several ways. On the one hand, a higher risk for young firms to fail can be seen as a negative job characteristic, well known to both employers and employees. A compensating wage differential argument would then call for younger firms to compensate employees for the higher risk of layoff by offering a wage premium, implying a negative relationship between firm age and wages. A similar argument can be based on the desire of risk-averse employees to insure against the risk of becoming unemployed (see Malcomson (1996) for a summery of the literature on individual employment contracts).

On the other hand, old firms with secure employment prospects may be more willing to invest in firm-specific on-the-job training and offer more opportunities for advancements within the firm.

[5] The necessity of including information on profits is stressed in Oi and Idsons (1999) contribution to the latest Handbook of Labor Economics in which they, in an appendix, discuss the relationship between wages and firm age.

This, in turn, can influence the mix of workers that the firm employs, leading to higher demand for high-skilled, high-ability workers and, thus leading to higher average wages in older firms in comparison to younger firms (see Brown and Medoff (2003) for explicit theories). Also, the more insecure and unstable jobs at young firms may attract a certain group of workers that themselves are unstable and more prone to quit jobs. This implies that firms do not need to pay a wage premium for these workers to compensate for a higher layoff risk. Furthermore, individuals willing to accept unstable jobs may themselves be less skilled. Taken together, this means that wages, in equilibrium, are lower in new firms than in old ones (see Evans and Leighton (1989)).

Finally, working conditions may systematically differ between firms with different age. For instance, older firms may be systematically found in certain industries that offer certain working conditions. The sign of the correlation between working condition and firm age is, however, not clear. Controlling for detailed industry and occupational codes is one way to provide information on the validity of the working condition argument.

3 Data and Empirical Specification

The data on individuals originate from the Swedish Level of Living Surveys (LNU) in 1991, a representative survey of non-agricultural workers aged 18-64. Each individual has a unique organization-number, mapping each worker to his or her employer. These firms then form the basis of the Swedish Establishment Survey (APU). By matching the organization number for the firms in APU with employment data from Statistics Sweden, information on all individuals working in these firms sometime during 1987, 1991 or 1995 is available.[6] Individuals working in non-agricultural private APU-establishments in 1987, 1991 and 1995 constitute the worker

[6] For detailed description of the Swedish Establishment Survey (APU), see le Grand *et al.* (1996).

data set. Each year contains approximately 170,000 employees in the private sector.

For these individuals, rich information is obtained by matching data from several Swedish data sources. Data on wages and job characteristics are provided by Statistics Sweden (*SCB*) and from data collected by the Swedish Trade Union Confederation (*LO*) and the Swedish Employers' Confederation (*SAF*). Information on employment, including total labor market experience and seniority, originates from the Swedish Employment Register. Data on individual characteristics such as age and gender are from the Population Census from *SCB* (*Registret över totalbefolkningen*). Detailed information on education, including grades from high school, are from the Swedish Education Register (*Utbildningsregistret*). See the Appendix for a detailed description of the data.

The unique organization number for each employing firm is utilized to match the individuals with balance sheet data for the firms where they work. Balance-sheet information is available for the period 1987-1996. Before matching individuals and firms, those firms in the balance-sheet data that are observed for less than two years or with less than 2 employees are removed. The balance-sheet data for 1991 and 1995 are transformed into four-year averages.[7] Since balance-sheet information is not available before 1987, the 1987-estimations use profits for 1987. Annual profits after capital depreciation per employee is used as a measure of firm performance. This direct measure of firm performance has not previously been used to investigate the relationship between firm age and wages.

As a measure of capital intensity, value of equipment per employee is used. Finally, from the balance sheet data, register-based direct information on firm age, ranging from 1 to 101 years, is available. Register-based data on firm age has not been available

[7] The reason for this is twofold. First, measurement errors in variables, such as profits per employee, are reduced when four-year averages are uses. Second, due to high variability in both firm performance variables and firm size, four-year averages yield a better measure of long-run profitability, removing transitory variation in profits.

in previous studies.

I use the following specification to study the relationship between employee age and individual wages:

$$\ln w_{it} = \alpha + \beta_0 \ln AGE_{J(i,t),t} + \mathbf{X}_{it}^{'}\beta_1 + \mathbf{F}_{J(i,t),t}^{'}\beta_2 + \mathbf{S}_{J(i,t),t}^{'}\beta_3 + \varepsilon_{it}, \tag{1}$$

where w_{it} is the full-time equivalent monthly wage for worker i at time t; $AGE_{J(i,t),t}$ denotes firm age in firm J that employs worker i in period t $(= 1987, 1991, 1995)$; $\mathbf{X}_{it}$ is a vector of individual characteristics including gender, education, labor market experience, labor market experience squared and tenure; $\mathbf{F}_{J(i,t),t}$ is a vector of firm characteristics such as firm size, profits per employee, capital intensity and industry affiliation and $\mathbf{S}_{J(i,t),t}$ is a vector of firm averages of the skill mix of the work force, accounted for by including the share of the work force in the firm that (i) have attended at least long upper secondary school (ii) have more than 5 years of labor market experience, (iii) have more than 3 years of tenure, and (iv) are women, respectively. Finally, ε_{it} is the random error term.

A question to investigate is if the firm age-wage relationship differs between different parts of the firm age distribution. To do so I estimate a spline function model to allow for a more flexible relationship. The spline model has kinks at firm ages 21 and 65 in 1995, corresponding to the 1:st and 3:rd quartiles of the firm age distribution.[8] The following spline function will be estimated (see Greene (1997), section 8.2.6):

$$\begin{aligned} \ln w_{it} \;=\; & \alpha + \beta_0 \ln AGE_{J(i,t),t} + \sum_{k=1}^{2} \eta_k [D_k(\ln AGE_{J(i,t),t} - \ln AGE^{*}_{kJ(i,t),t})] + \\ & + \mathbf{X}_{it}^{'}\beta_1 + \mathbf{F}_{J(i,t),t}^{'}\beta_2 + \mathbf{S}_{J(i,t),t}^{'}\beta_3 + \varepsilon_{it}, \end{aligned} \tag{2}$$

[8] The corresponding kinks in 1987 and 1991 are at {27, 65} and {30, 71}, respectively.

where $AGE^*_{kJ(i,t),t}$ is the age of the firm at the $k´$th quartile (1:st and 3:rd), and D_k=1 for $AGE_{J(i,t),t} > AGE^*_{kJ(i,t),t}$ and zero otherwise.

This specification reflects the possibility that the elasticity of wages with respect to firm age might differ between different segments of the firm age distribution. Hence, the firm age elasticity will be β_0 up to the first quartile, $\beta_0 + \eta_1$ between the first quartile and the third quartile, and finally $\beta_0 + \eta_1 + \eta_2$ above the third quartile.

A potential problem in estimating individual wage equations on individual- and firm variables is that observations may be correlated within firms. This arises since firm age is the same across all individuals in the same firm. Standard OLS may then produce standard errors that are downward biased. This, in turn, overstates the level of significance of the explanatory variables that do not vary across individuals within the same firm. To account for group effects, all equations are adjusted for within-firm error correlations (see Moulton (1990)).

4 Results

To begin the analysis, column 1 in Table 1 report results on the effect of firm age on individual wages in 1987, 1991 and 1995, respectively. This simple specification corresponds to estimating equation (1) without any control for worker and firm characteristics, i.e. setting $\mathbf{X}$=$\mathbf{F}$=$\mathbf{S}$=0. Results show that individual wages are higher in older firms. The estimated coefficients range from 0.017 in 1991 to 0.034 in 1995. These elasticities are similar in magnitude to the size-wage effects obtained for Sweden (see Albaeck *et al.* (1998)).

Table 1. Effects of firm age on wages. Including measures of individual characteristics. OLS estimates for 1987, 1991 and 1995. Dependent variable is log monthly wage. Robust standard errors corrected for within-firm error correlation in parentheses.

	1	2	3	4
	1987			
Log firm age	.019***		.006	
	(.006)		(.005)	
Individual characteristics	NO		YES	
R^2	0.05		0.50	
N	171,327		160,959	
	1991			
Log firm age	.017***	.016*	.010*	.010*
	(.009)	(.009)	(.005)	(.006)
Seniority		.005***	.001	.001
		(.001)	(.000)	(.002)
Log firm age*Seniority				-.000
				(.001)
Individual characteristics	NO	NO	YES	YES
R^2	0.04	0.06	0.43	0.43
N	175,033	173,236	172,290	172,290
	1995			
Log firm age	.034***	.029***	.017***	.019***
	(.008)	(.008)	(.005)	(.007)
Seniority		.005***	.002***	.003
		(.001)	(.000)	(.002)
Log firm age*Seniority				-.000
				(.000)
Individual characteristics	NO	NO	YES	YES
R^2	0.04	0.05	0.45	0.45
N	178,582	176,824	176,334	176,334

Notes: *** indicate significance at the 1%-level and * at the 10%-level. Individual characteristics corresponds to control for gender, education, experience and experience squared. All equations include control for industry affiliation, corresponding to 14 industries. Estimating column 1 in 1987 on the same sample as in column 2 yields no change in the estimated coefficient on log firm age.

As stressed in Section 2, one possible explanation for observing a positive firm age-wage effect is systematic differences in tenure among employees in young and old firms. This explanation is

taken into consideration in column 2 by adding individuals' tenure at the current employer.[9] If variation in seniority is behind the positive relationship between firm age and wages, then the inclusion of seniority should make the coefficient for firm age insignificant or highly reduced. Results, however, indicate that firm age is still positive and significant, with only a slight reduction in the coefficient value. Note that the t-value imply that the firm age coefficient is only significant at the 10-percent level in 1991.

In column 3, a variety of human capital characteristics are added to account for individual differences in education, experience and gender. Adding these human capital characteristics lead to a statistically significant reduction in the coefficient for log firm age in 1995. Both in 1991 and 1995, the elasticities are reduced by around 50 percent when individual differences in human capital are accounted for. Moreover, in 1987, the firm age variable is now insignificant, implying that differences in human capital accumulation between individuals in firms with different age is responsible for the positive and significant effect of firm age presented in column 1. Finally, in column 4 an interaction term between firm age and seniority is added. This term is not, however, statistically significant either in 1991 or in 1995.

Next I turn to investigating how firm characteristics such as profitability and size affect the firm age-wage relationship. If profits systematically vary with firm longevity, then estimating the effect of firm age on wages without taking into account the variation in firm profits would bias the results. Specifically, a positive firm age-wage effect would instead be due to systematically higher profits in older, more mature firms.

Column 1 in Table 2 present results when profits per employee is added. This variable is positive and highly significant in all years. The inclusion of profits has a large effect on the coefficient for log firm age. The firm age variable is now statistically

[9] No information on seniority is available in 1987, so the analysis is carried out for 1991 and 1995.

Table 2. Effects of firm age on wages. Including measures of firm profitability and firm size. OLS estimates for 1987, 1991 and 1995. Dependent variable is log monthly wage. Robust standard errors corrected for within-firm error correlation in parentheses.

	1	2	3
		1987	
Log firm age	.002	-.006	-.009*
	(.005)	(.005)	(.005)
Profits/Employee	.039***		.025*
	(.014)		(.010)
Log Firm size		.014***	.014***
		(.003)	(.003)
Individual characteristics	YES	YES	YES
R^2	0.50	0.51	0.51
N	160,959	160,959	160,952
		1991	
Log firm age	.005	-.000	-.002
	(.005)	(.004)	(.004)
Profits/Employee	.045**		.028
	(.02)		(.02)
Log firm size		.017***	.016***
		(.003)	(.003)
Individual characteristics	YES	YES	YES
R^2	0.43	0.44	0.44
N	172,290	172,288	172,288
		1995	
Log firm age	.016***	.015***	.013**
	(.005)	(.006)	(.006)
Profits/Employee	.014***		.015***
	(.005)		(.005)
Log firm size		.005**	.006**
		(.002)	(.003)
Individual characteristics	YES	YES	YES
R^2	0.45	0.45	0.45
N	176,334	176,333	176,333

Notes: *** indicate significance at the 1%-level, ** significance at the 5%-level and * significance at the 10%-level. Individual characteristics corresponds to control for gender, education, seniority (not available in 1987), experience and experience squared. All equations include control for industry affiliation, corresponding to 14 industries.

insignificant in both 1987 and 1991. This implies that, for 1991, variation in profits across firms can fully explainthe positive firm

age-wage effect reported in Table 1. Inspecting the correlation between firm age and profits, it turns out that this correlation is positive and significant (based on both ordinary and rank correlations). So, given a positive relationship between how long a firm has been in business and profits, it seems that the previously reported positive effect of firm age on wages in 1991 is due to not taking into account variation in profits. Note that this is the first study to include an objective measure of firm profits.

Results differ for 1995. Adding firm profitability does not affect the impact of firm longevity on wages. The coefficient for firm age remains highly significant and the coefficient value is only marginally decreased. It should be noted that wage negotiations in 1995 were made under very different economic conditions than in 1991. During the period 1991-94 Sweden experienced a very deep recession with falling GDP and unemployment increasing from 5 percent in 1991 to 15 percent in 1995. This difference in business cycle conditions may affect the results. If conditions are more secure in older, mature firms, then the turbulence of a recession may have an asymmetric impact on young and old firms, respectively. Old firms which are, on average, larger and having higher profitability than young firms may be more willing to pay higher wages. As pointed out by Brown and Medoff (2003), the inability to pay higher wages is much more credible when made by young firms then made by mature, long surviving firms. This may be especially true during an economic downturn. The issue of a heterogenous effects of firm age on wages during different economic cycles has not been investigated previously. Earlier studies are instead based on single year cross-section data only.

I now turn to firm size, accounting for the fact that older firms are also, on average, larger firms. How is the firm age variable affected by the inclusion of firm size? And, also, does there exist a positive size effect on wages after controlling for how long a firm has been on the market? In other words, is it size or age that matters?

Results are presented in column 2 in Table 2. Inclusion of firm size in the wage equation gives rise to very similar results as in the model including profits. Hence, taking into account differences in firm size leads to an insignificant coefficient for firm age in 1987 and 1991. For 1995, the firm age variable continues to be positive and significant. For all years, firm size has a positive and significant effect on individual wages. The elasticities range from 0.005 in 1995 to 0.017 in 1991.[10]

Estimating column 2, but excluding the firm age variable does not change the estimated coefficient for log firm size. Hence, firm size has its own separate effect that is robust to control for firm age, implying that it is not a result of larger firms also being older firms. To further analyze this issue, all equations in the paper have been estimated without including firm age, but including firm size. Results show that inclusion of firm age never affects the estimated coefficient for firm size. Firm size has always, with one exception, a positive and significant effect on wages.[11] So, for Sweden, the answer to Brown and Medoffs question whether the firm size-wage premium is really a relationship between firm age and wages, must be "no". The firm size premium is robust to inclusion of a variety of variables that might explain the firm size effect.

The final column in Table 2 shows results when both profits and firm size are included. Once again, the firm age variable is positive and significant in 1995, but insignificant in 1991. However, in 1987, the firm age variable turns negative and significant. This puzzling result in not easily interpreted, though it underlines the importance of studying a number of years, characterized by different economic conditions, as well as controlling for a variety of firm characteristics.

[10] Note that the elasticity in 1991 is more or less identical to the plant size elasticity obtained for Sweden in 1991 in the Albeack *et al.* (1998) study.

[11] The only exception is one specification for the manufacturing sector in 1995.

Table 3. Effects of firm age on wages. Including measures of capital intensity and workforce skill. OLS estimates for 1987 and 1995. Dependent variable is log monthly wage. Robust standard errors corrected for within-firm error correlation in parentheses.

	1	2	3	4
	1987			
Log firm age	.006	.005	.005	-.010**
	(.005)	(.005)	(.005)	(.005)
(Capital/Labor ratio)/100	.0007		.0006	.0004
	(.0005)		(.0006)	(.0005)
Workforce skill	NO	YES	YES	YES
Profits/Employee				.024**
				(.010)
Log Firm size				.014***
			(.014)	(.003)
Individual characteristics	YES	YES	YES	YES
R^2	0.50	0.51	0.51	0.51
N	160,959	160,959	160,952	160,952
	1995			
Log firm age	.017***	.013***	.012**	.009*
	(.005)	(.005)	(.005)	(.005)
(Capital/Labor ratio)/100	.0003***		.0003***	.0002***
	(.0001)		(.0009)	(.0001)
Workforce skill	NO	YES	YES	YES
Profits/Employee				.012**
				(.005)
Log Firm size				.007**
				(.003)
Individual characteristics	YES	YES	YES	YES
R^2	0.45	0.46	0.46	0.46
N	176,334	176,334	176,334	176,333

Notes: *** indicate significance at the 1%-level, ** significance at the 5%-level and * significance at the 10%-level. All equations include the same set of individual characteristics and control for industry affiliation as in Tables 1 and 2. Workforce skill corresponds to control for workers' experience, seniority (not available in 1987), education and gender at the firm level. F-tests for the joint insignificance of the workforce skill variables are rejected in all equations in which they are included. F-tests for the joint insignificance of the industry dummies are rejected in all equations.

Next, the hypothesis that older firms pay higher wages because of systematic differences in worker skills is examined as well as the existence of capital-skill complementarities. Results are presented in Table 3.

Looking first at the results for 1995, I find, in line with the capital-skill complementary hypothesis, that individual wages are positively correlated to the capital-labor ratio (K/L). This result is identical to, among others, Troske (1999) and Arai (2003). Inspecting the coefficient for firm age, results show that the inclusion of K/L does not affect the firm age-wage relationship. Firm age continues to be positive and significant with only a small reduction in magnitude. Hence, the positive firm wage premium in 1995 is not due to capital-skill complementarities.

In column 2, firm differences in work force skill is added. If the capital intensity is higher in old firms, then older firms will also employ more high-skilled employees. Results in column 2 indicate that the inclusion of work force skill has no impact on the firm age-wage premium. Although the estimated elasticity is somewhat lower (compare 0.013 with 0.017 in column 3 in Table 1), the difference is not significantly different from zero. This result is robust for including both K/L and work force skill (column 3) as well as profits and firm size (column 4). Quantitatively, the coefficient of 0.009 in the full model (column 4) indicates that a one standard deviation increase in log firm age is associated with an increase in wages by 1 percent.

Again, the results for 1987 are mixed. Log firm age is insignificant in columns 1-3, but turns negative and significant in the full model (column 4). Results for 1991, not reported in the paper, show that the coefficient for firm age is never statistically significant when firm characteristics are added.[12]

To explore the possibility that employment instability and working conditions affect reported results I have re-estimated all equations with proxies for these variables. As a proxy for employment

[12] These results can be obtained from the author upon request.

instability I add a variable that captures firm specific unemployment risk. This variable is equal to the fraction of individuals at the firm that have experienced unemployment during the period 1992-94. For 1995, it thus represents expected firm specific unemployment risk under adaptive expectations.[13] As a proxy for working conditions individual wage equations including a detailed industry classification of over 400 4-digit industries are estimated. An implicit assumption is that working conditions are fairly similar within these detailed industry cells.

Adding controls for these firm and industry characteristics have no impact on the effect of firm age on wages or on the other included explanatory variables. These results, not reported in the Tables, can be obtained from the author upon request.

A question to investigate is if the firm age-wage relationship differs between different parts of the firm age distribution. Brown and Medoff (2003) report a non-monotonic relationship between firm age and wages. They find that the wage-age relationship is U-shaped, with wages falling as age increases, but that the relationship is reversed among older firms. However, given their limited number of observations (around 1,000 observations), the spline equations cannot be estimated very precisely. With this in mind, Table 4 shows results on estimating a spline function model, to see if a U-shaped relationship can be found in Swedish data. The spline model has kinks at firm ages corresponding to the 1:st and 3:rd quartiles of the firm age distribution. Results on this specification, holding different individual and firm characteristics constant, are presented in columns 1 and 2.

Consider first the results for 1995. The results presented in Table 4 show no U-shaped relationship between firm age and wages. Instead for 1995, the age-wage relationship is first increasing, thereafter having a decreasing segment and finally for firms above the upper quartile of the age distribution, the relationship

[13] As information on individual unemployment history is only available for the period 1992-94, the firm specific unemployment risk can only be used in the 1995 specifications.

Table 4. Effects of firm age on wages. OLS estimates using spline functions for 1987 and 1995. Dependent variable is log monthly wage. Robust standard errors corrected for within-firm error correlation in parentheses.

	1	2
	1987	
Log firm age	.021**	.001
	(.010)	(.005)
Log firm age (1:st quartile)	-.059**	-.048***
	(.033)	(.018)
Log firm age (3:rd quartile)	.194***	.189***
	(.072)	(.059)
Log firm size		.014***
		(.002)
Individual characteristics	YES	YES
Firm characteristics	NO	YES
Workforce skill	NO	YES
R^2	0.50	0.52
N	160,959	160,952
	1995	
Log firm age	.045***	.037***
	(.012)	(.011)
Log firm age (1:st quartile)	-.067***	-.068***
	(.025)	(.024)
Log firm age (3:rd quartile)	.096	.094
	(.059)	(.058)
Log firm size		.007***
		(.003)
Individual characteristics	YES	YES
Firm characteristics	NO	YES
Workforce skill	NO	YES
R^2	0.45	0.46
N	176,334	176,333

Notes: *** indicate significance at the 1%-level, ** significance at the 5%-level and * significance at the 10%-level. All equations include the same set of individual characteristics and industry affiliation as in Tables 1-3. Workforce skill corresponds to control for workers' experience, seniority (not available in 1987), education and gender at the firm level. F-tests for the joint insignificance of the workforce skill variables are rejected in all equations in which they are included. F-tests for the joint insignificance of the industry dummies are rejected in all equations.

is again positive.

Studying the individual segments in more detail, it seems that the positive and significant effect of firm age on individual wages in 1995, presented in Tables 1-3, originates from a strong positive effect for the youngest firms (< 21 years). This individual segment is statistically significant in all equations presented in Table 4. For firms in the middle segment, we even observe a negative and significant firm age-wage relationship. For the oldest firms ($>$ 3:rd quartile), the effect is not statistically different from zero.

For 1987, the positive firm age effect obtained with no control for firm- or individual characteristics seems to stem from a positive effect for the youngest and the oldest firms. Behind the insignificant effect when controlling for worker characteristics is a positive and significant effect for the youngest and oldest firms combined with a negative and significant effect in the middle segment. However, the positive segment is not strong enough, thus leading to an insignificant effect in total. Finally, the negative and significant effect obtained in the final columns of Tables 2 and 3 seem to originate from a statistically negative effect for firms between the lower and upper quartiles of the firm age distribution.

In sum, the results obtained for the spline models suggest strong heterogeneity concerning the effect of firm age on wages, both in relation to points in time and differences across different parts of the firm age distribution. Behind the results obtained in Tables 1-3 are clear differences in the elasticity of wages with respect to firm age at different segments of the distribution. These differences are not constant over time, but instead they seem to vary across different time periods, characterized by different business cycle conditions.

Finally, results on estimating separate equations for the manufacturing and service sectors are presented in Table 5. There are reasons to believe that the firm age effect may systematically differ between these sectors. For instance the size of the firm,

Table 5. Effects of firm age on wages. Separate estimations for the Manufacturing and Service sectors. OLS estimates for 1987 and 1995. Dependent variable is log monthly wage. Robust standard errors corrected for within-firm error correlation in parentheses.

	1	2	3	4	5	6
	1987					
	Manufacturing			Service		
Log firm age	.018**	.008	-.005	.020**	.000	-.016***
	(.008)	(.007)	(.006)	(.008)	(.005)	(.006)
Log firm size			.015***			.011***
			(.004)			(.003)
Individual characteristics	NO	YES	YES	NO	YES	YES
Firm characteristics	NO	NO	YES	NO	NO	YES
Workforce skill	NO	NO	YES	NO	NO	YES
R^2	0.03	0.47	0.48	0.09	0.58	0.59
N	130,372	121,636	121,636	40,955	39,323	39,316
	1995					
	Manufacturing			Service		
Log firm age	.045***	.023***	.014**	.011	.007	.002
	(.010)	(.007)	(.007)	(.014)	(.007)	(.007)
Log firm size			.005			.007**
			(.004)			(.003)
Individual characteristics	NO	YES	YES	NO	YES	YES
Firm characteristics	NO	NO	YES	NO	NO	YES
Workforce skill	NO	NO	YES	NO	NO	YES
R^2	0.04	0.42	0.43	0.05	0.51	0.53
N	124,343	123,329	123,329	54,239	53,005	53,004

Notes: *** indicate significance at the 1%-level, ** significance at the 5%-level and * significance at the 10%-level. All equations include the same set of individual characteristics and industry affiliation as in Tables 1-4. Workforce skill corresponds to control for workers' experience, seniority (not available in 1987), education, gender and age at the firm level. F-tests for the joint insignificance of the workforce skill variables are rejected in all equations in which they are included. F-tests for the joint insignificance of the industry dummies are rejected in all equations.

capital intensity and the mix of employees are systematically different between these two sectors. The question is then if these differences can explain some of the differences in results obtained for the different time periods. Furthermore, earlier evidence on the existence of a firm age wage premium is, with the exception of Brown and Medoff (2003), solely based on evidence on manufacturing data.

Interestingly, very strong results on sector heterogeneity can be seen in Table 5. For 1995, the positive and significant impact of firm age on wages, presented in earlier tables, is only present in the manufacturing sector. In the service sector, no statistically significant effect is found. This implies that it is in manufacturing with firms that are, on average, larger and more capital intensive, that a firm age-wage premium is present.

For 1987, results are very different. From the table it is clear that the negative effect, found in full model before, originates from the service sector. In column 6, the coefficient for log firm age is negative and statistically significant as opposed to the similar specification in manufacturing (see column 3). Hence, sector differences seem to play an important role as an determinant of the relationship between firm age and individual wages.

5 Summary and Conclusions

Studies on a number of different countries and time-periods have reported that employees in large firms systematically earn more than those in smaller firms. Related to firm size is firm age. Obviously, larger firms are also older firms. A natural question then is how wages are related to firm longevity. Older firms have, on average, characteristics that differ systematically from younger firms. Observable differences between firms with different ages may then lead to a systematic relationship between wages and employer age.

This paper studies the effect of firm age on wages, using a large

and detailed employer-employee dataset for the entire private sector in Sweden. Using detailed information on individual and firm characteristics, this study systematically address a variety of possible explanations for a firm age-wage effect as well as addressing the question if the size-wage premium is really a relationship between employer age and wages. The analysis is carried out for three time periods, characterized by very different business cycle conditions. Since previous studies are based on a single year, this paper also address the question of whether the effect of firm age on wages differs across year.

The results show considerable heterogeneity across years, along parts of the firm age distribution and across sectors of the economy. For 1995, a positive relationship between firm age and individual wages is found. This relationship is robust to the inclusion of a variety of variables that might explain the firm age-wage premium.

In 1991 a positive relationship, robust to the inclusion of individual human capital characteristics, turns insignificant when firm characteristics such as profits and firm size are added. So for 1991, differences in firm characteristics fully explain the firm age-wage premium.

Finally, for 1987 results are mixed. Separate inclusions of a variety of individual and firm characteristics lead to an insignificant effect of firm longevity on wages. However, inclusion of all the relevant control variables in the same wage equation give rise to a negative and significant firm age effect.

Results also show strong heterogeneity concerning the effect of firm age on wages at different segments of the firm age distribution. The positive firm age-wage premium in 1995 seems to originate from a very strong effect for young firms, whereas the negative effect in 1987 is due to a negative relationship for firms in the middle of the firm age distribution. These results show that the firm age-wage relationship is not monotonic, a result in line with Brown and Medoff (2003). However, the exact nature of the

relationship is rather complex, and a general U-shaped relationship, found in Brown and Medoff, is not found in the data used here.

Finally, estimating separate equations for manufacturing and service show that the positive firm age effect for 1995 is found only in manufacturing. In the service sector which consists of, on average, smaller and less capital-intensive firms, no effect of firm longevity on wages can be traced. In contrast, the negative firm age-wage relationship found in the full model in 1987 originates from the service sector, whereas the corresponding specification in manufacturing shows an insignificant coefficient for firm age.

Concerning the relationship between firm age and firm size, results indicate that inclusion of firm age does not affect the impact of firm size on wages. Also after controlling for the fact that, on average, larger firms are also older firms, firm size continues to be an economically important determinant of wages. The firm size-wage premium is robust to the inclusion of a variety of variables that may explain this premium. The message of these results is that, in the end, it seems to be size and not age that matters.

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Appendix: Data Description

Individual characteristics:
Wages: Monthly pre-tax full-time equivalent wages in 1990 prices (using CPI) based on Swedish Trade Union Confederation (*LO*) and the Swedish Employers' Confederation (*SAF*) wage data and completed with the income registers from Statistics Sweden (*SCB*).
Gender and Age are from SCB's Population Census (*Registret över totalbefolkningen*).
Education level dummies are based on 2 digit level of the Swedish Education Nomenclature (SUN-codes) from the Swedish Education Register (*Utbildningsregistret*). These are *Elementary School* (less than 9 years), *Compulsory School* (9 years), *Upper Secondary School* (less than 3 years), *Upper Secondary School* (3 years) , *Post Secondary School* (less than 3 years), *University Undergraduate Studies* (3 years or more, not including graduate studies) and *University Graduate Studies*.
Experience is number of years on the labor market according to the Employment Register (*Sysselsättningsregistret*).
Seniority is number of years at the establishment based on tracing the individual back to 1986 in the Employment Register (*Sysselsättningsregistret*). The variable is left censored at 5.5 years. Individuals with more than 6 years of seniority are given the mean seniority in Sweden according to the Level of Living Survey, i.e. 16 years.

Firm characteristics
Firm age refers to number of years in business. Available for the period 1987-95 (MM Partners).
Profits (Swedish kronor) are defined as annual profits after capital depreciation. Available for the period 1987-95 (MM Partners).
Firm size refers to number of employees according to the Employment Register (*Sysselsättningsregistret*). Available for 1987, 1991 and 1995.

Capital/labor ratio is defined as value of equipments per employee. Available for the period 1987-95 (MM Partners).

Industry characteristics
Industry dummies are based on the 2-digit SIC (*SNI69* and *SNI92*). Own classification of 14 industries.

Table A.1. Sample Means.

	1987			1991			1995		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Individual characteristics:									
Log monthly wage:	171 455	9.49	.27	175 033	9.48	.26	178 582	9.52	.30
Female	171 455	.27	.44	175 033	.26	.44	178 582	.29	.45
Experience	171 455	15.39	9.18	175 033	16.91	9.97	178 582	19.46	10.26
Seniority				173 326	7.91	6.66	176 824	10.32	6.93
Education level:									
Elementary School < 9	161 083	.18	.39	174 069	.16	.36	178 084	.11	.32
Compulsory School $=9$	161 083	.16	.37	174 069	.16	.36	178 084	.13	.33
Upper Secondary School < 3	161 083	.32	.47	174 069	.35	.48	178 084	.34	.47
Upper Secondary School $=3$	161 083	.16	.37	174 069	.16	.37	178 084	.17	.37
Post Secondary School	161 083	.09	.29	174 069	.11	.31	178 084	.14	.35
University undergraduate	161 083	.07	.26	174 069	.08	.28	178 084	.11	.31
University graduate	161 083	.004	.06	174 069	.004	.06	178 084	.006	.08
Firm characteristics:									
Log firm age	171 333	3.63	.73	175 033	3.62	.85	178 582	3.44	.92
Profits/Employee, 100.000 SEK	171 455	.25	.32	175 033	.27	.34	178 582	.33	.63
Log firm size	171 448	7.62	2.04	175 031	7.34	1.80	178 581	7.18	1.67
Capital/labor ratio	171 455	541.1	1493	175 033	519.2	2008	178 582	785.8	2491

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