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# Changes in the Gender Wage Gap and The Returns to Firm Specific Human Capital

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# Do Gender Differences in Returns to Tenure Matter Anymore?

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Abstract

If employers believe females are more likely to separate from a job than males, efficient cost sharing of on-the-job-training implies that females will have higher returns to tenure. Becker and Lindsay (1994) argue that this is true empirically. (1994). Updating the analysis we find that that there is no longer a difference in the probability of leaving jobs or in returns to tenure by gender. Differences in contracts to finance on the job training can no longer explain any of the "discrimination" component in the gender wage gap.

Key Words: wage differentials, gender gap, tenure

JEL Classification J71, J31

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**Section I - Introduction**

The fact that women are less likely to be hired, or may self select out of jobs requiring a lot of training, has been recognised as an important part of the male-female wage differential. Becker and Lindsay (1994) show, using Hashimoto's (1981) model of efficient cost sharing of firm specific human capital, that women that do acquire firm specific human capital should be expected to have greater returns to tenure than their male counterparts. This is because women, particularly younger ones, are likely to have greater variance of non-market productivity and hence are less likely to remain on the job long-term than men. Becker and Lindsay (1994) confirm their theoretical argument empirically for the period 1983 to 1987 using a panel of individuals constructed from the Panel Study of Income Dynamics (PSID) by showing that females who stay in jobs for more than five years have greater returns to tenure than their male counterparts.

A number of other studies that have shown that, when experience and tenure are controlled for, females have higher returns to tenure; see Hersh and Reagan (1997) for a survey. Coleman (1998), for instance, finds that females have higher returns to tenure than males using the British New Earnings Survey. Hersch and Reagan (1997) provide an alternative to the human capital model as an explanation for women having greater returns to tenure. Using a model based on Lazear (1981), where deferred compensation contracts are used to prevent workers shirking, they show that if men are expected to stay on the job longer than women, the optimal contract offered to men will have higher average wages and lower returns to tenure than the female contract.

In this paper we demonstrate using the PSID that while being male increased the probability that one would stay in a long term job (more than five years) for most of the 1980s, gender has since then played a much smaller and statistically insignificant role in predicting job attachment. This is consistent with the results of Light and Manuelita (1992) who, using the National Longitudinal Survey, found that for cohorts of young men and women born in the early fourties and fifties females were more likely than males to be quitters. For cohorts born in the early fifties this was no longer true. In analysing the returns to tenure over the period 1983 to 1992, we find differences in male and female tenure slopes to be smaller than reported by Becker and Lindsay (1994) for the period 1983-87 and we find no noticable difference in tenure slopes in 1988-92. Assuming that long term jobs are those jobs where firm specific human capital is important, the evidence that the difference in probability of staying on the job by gender is shrinking indicates that employers should now perceive women as a less risky investment. The fact that women's tenure slopes have become indistinguishable from their male counterparts is consistent with this and implies that any differential treatment of women in jobs involving the acquisition of significant amounts of human capital is fading.

An implication of the result is that wage decompositions based on differences in starting pay by gender substantially overstate "discrimination" since female stayers wages will increase faster than their male counterparts according to the human capital or Hersch and Reagan's model. We decompose the male female overall and starting wage gap over time for those who remain in their job long-term and those who do not. We find that wages converge more for those in long-term jobs. While differences in tenure slopes may have been able to explain part of the "discrimination" component of

the gender wage gap, as argued in Becker and Lindsay (1994 and 1995), this is no longer the case.

**Section II - Data Construction**

An important part of our study was to compile a data set that allowed us to identify those jobs that entail the accumulation of substantial amounts of firm specific human capital and that are thus occupied by 'stayers' rather than by 'leavers'. This was constructed in the spirit of Becker and Lindsay (1994) using observations on white household heads and their wives from the Panel Study of Income Dynamics (PSID) 1981 to 1993 main data sets and 1994 to 1996 early releases. The fundamental variable used to categorise stayer and leaver observations is the report on job tenure. In their analysis of tenure reports provided by the PSID Brown and Light (1992) point out that this variable is plagued with inconsistencies and we thus follow the methodology of Becker and Lindsay (1994) to determine whether a tenure report is consistent. Accordingly, a tenure report is deemed to be consistent if it is (1) a report of a new job, i.e., is positive but less than nineteen months, (2) lies within six to eighteen months of a previous report, or (3), in case of what is deemed to be a layoff, where the previous report is zero or missing but the current report lies within six to eighteen months of a report from two years earlier. An additional criterion we adopt is that tenure must not exceed work experience.

Our definition of observations belonging to stayers crucially depends on following the accumulation of tenure within jobs. Accordingly, any observation of employment in a job in which the person at any given point in time reaches at least five years of tenure is determined to be that of a stayer. In contrast, all those observations

of employment in jobs which terminate before the end of five years are classified as belonging to leavers. In order not to include observations on jobs that have not had the opportunity to be classified as belonging to either a stayer or leaver because they had neither been terminated nor reached our five year threshold before the end of our sample period, but at the same time also to only include observations from years which can contain observations on both stayers and leavers, we classifiy observations using data from the entire 1983 to 1996 sample but only include observations for our study up until and including 1992.

As part of our analysis we attempted to replicate the results of Becker and Lindsay (1994) for the period 1983 to 1987. We meticulously tried to re-construct their data set as described and used in their study. This essentially involved dropping all those observations on stayers and leavers in our data set for persons that had started on a job in or some time after 1983 but before 1988, yet had not left the job in question prior to 1988. While our results for this subsample were generally, although not always, qualitatively the same as those of Becker and Lindsay (1994), there were clear discrepancies quantitatively, both in terms of sample size and regression coefficients and their significance. Despite meticulous re-checking we were unable to account for these differences[2]. Given that this subsample of the data, however, essentially only includes observations on stayers who commenced their job some time before 1984 while all observations on leavers are of those who started and completed a job spell between 1982 and 1988, we, for the pooled 1983-87 sample used in this paper, decided to also include all observations in that period on those stayers and

[2] One possibility is that the wage data may divided by the CPI to a different base period in Becker and Lindsay. This would matter since annual real incomes of less than $4000 are dropped. If for example

leavers who commenced their job over the 1983 to 1987 period but who could not have been identified as such in the Becker and Lindsay study due to the lack of PSID waves subsequent to 1987 at the time. The pooled sample for the 1988 to 1992 period includes observations on all stayers and leavers for the remaining five years.

Our wage variable is the hourly wage provided by the PSID in log form, deflated to 1983 dollars using the Consumer Price Index. Experience is only reported intermittently or for new heads of households in the PSID and we thus, as suggested by the PSID manual, constructed an experience variable by iterating forwards or backwards, as necessary, from the appropriate year and considering any year in which the person in question worked at least 1,500 hours as an additional year of full-time experience. We exclude observations where the experience variable is less than the tenure variable. The education variable is a step variable grouping years of education and degrees into eight different categories and provided by the PSID for the years 1983 to 1987 and constructed accordingly for the years thereafter[3]. All other variables used in this study are as provided by the PSID.

Finally, as was done by Becker and Lindsay (1994), we only include observations of employment in which the person in that year had an income of at least $4,000 and had worked at least 1,500 hours. We differ from Becker and Lindsay in that we exclude government and agricultural workers. Descriptive statistics of these for the two pooled sub-samples are given in the Appendix.

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we use 1983 as the base period and Becker and Lindsay use 1987 then we would drop different people.

[3] We experimented with non-linear returns to education and with endogenising the education decision but with little effect on the results.

**Section III - The Role of Gender in Job Attachment**

Inherent in the use of Hashimoto's (1980) model to explain differences in tenure profiles between men and women on jobs with on-the-job-training is the assumption that, because outside offers are likely to be better for women, the probability of a woman, particularly a young one, staying on the job may be lower than for a man. Previously, Becker and Lindsay (1994) have provided empirical support for this contention for workers who started a new job in 1983. Our extended data set allows us to further investigate this issue over time. In order to do so we restrict our sample to those observations in which individuals start a new job over the entire period 1983 to 1992, break this sample into two five year intervals, and use a probit regression to examine how their characteristics affect the probability of whether they will remain in that job for at least five years for these sub-periods separately. The probit estimates for our two five year sub-periods are reported as marginal probabilities in Tables 1 and 2, respectively. As Table 1 shows, our results for the earlier pooled sample are roughly compatible to those found by Becker and Lindsay (1994) for individuals starting a new job in 1983, although our sample also includes individuals who started jobs for the 1984 to 1987 period.[4] The importance of gender in predicting whether one was likely to become a stayer was large and statistically significant; males were more likely than females to stay on their jobs for at least five years. Age also seems to serve as a significant predictor for one's attachment to a job and, as the interaction of age with the gender dummy variable suggests, this age effect is particularly strong for women. This, as already argued by Becker and Lindsay

[4] One should note that Becker and Lindsay (1994) report a sample size of almost over 3,000 for those who started a new job over the 1982 to 1983 period. Given that only about 7,000 households are interviewed in each wave, this number seems unreasonably large.

(1994), is probably because women's child-rearing responsibilities fall, and hence their labour force attachment grows, as they become older.

The results in Table 2 suggest, however, that there has been a substantial change in the role of gender as a predictor of job attachment over our sample period. The coefficient in the 1988-92 period of the male dummy variable is smaller than that for the earlier period and statistically not significant. Additionally, while age is still an important indicator of job attachment, there no longer seems to be a different age effect for women. These results thus suggest that since the late 1980s employers are unlikely to use gender to make different predictions on how long an individual will remain in the job.

**Table 1 - Probit Estimates of the Probability of Becoming a Stayer at the Beginning of a New Job: 1983-87 Sample**

| Independent Variables | dF/dx | St. Err. | Z | P>\|z\| |
|---|---|---|---|---|
| Real Wage | 0.000 | 0.000 | 2.69 | 0.007 |
| Schooling | 0.008 | 0.005 | 1.72 | 0.086 |
| Male | 0.152 | 0.048 | 2.88 | 0.004 |
| Age | 0.004 | 0.001 | 3.31 | 0.001 |
| Male*Age | -0.003 | 0.002 | -2.10 | 0.011 |
| Children | 0.022 | 0.011 | 1.93 | 0.054 |
| Male*Children | -0.026 | 0.014 | -1.86 | 0.063 |
| Married | 0.050 | 0.024 | 2.02 | 0.043 |
| Male*Married | 0.014 | 0.035 | 0.41 | 0.682 |
| observed P | .143 | | | |
| predicted P | .134 | | | |
| N = | 2,398 | | | |
| Model $\chi^2$ = | 74.03 | P > $\chi^2$ = | 0.000 | |
| Pseudo $R^2$ = | 0.0375 | | | |

**Table 2 - Probit Estimates of the Probability of Becoming a Stayer at the Beginning of a New Job: 1988-92 Sample**

| Independent Variables | dF/dx | St. Err. | Z | P>\|z\| |
|---|---|---|---|---|
| Real Wage | 0.000 | 0.000 | 2.33 | 0.020 |
| Schooling | 0.018 | 0.005 | 3.74 | 0.000 |
| Male | 0.056 | 0.053 | 1.05 | 0.293 |
| Age | 0.001 | 0.001 | 1.35 | 0.176 |
| Male*Age | -0.001 | 0.001 | -0.55 | 0.584 |
| Children | -0.002 | 0.009 | -0.18 | 0.860 |
| Male*Children | -0.005 | 0.012 | -0.44 | 0.661 |
| Married | -0.063 | 0.020 | 3.02 | 0.003 |
| Male*Married | -0.001 | 0.032 | -0.04 | 0.967 |
| observed P | .160 | | | |
| predicted P | .154 | | | |
| N = | 3,054 | | | |
| Model $\chi^2$ = | 66.62 | P > $\chi^2$ = | 0.000 | |
| Pseudo $R^2$ = | 0.025 | | | |

## Section IV - Comparison of Tenure Slopes for Job Stayers by Gender

*A. Theoretical Background*

Relying on the assumption that in general long term jobs require more firm specific human capital, Becker and Lindsay (1994) outline four hypotheses that can serve to test whether women bear a higher share of the cost of on-the-job-training:

Hypothesis 1: Wage tenure profiles of female workers employed in firms requiring firm specific human capital will rise more steeply than those of equally qualified male employees. Models of statistical discrimination, such as Lazear and Rosen (1990), argue that firms that require on the job training will hire higher ability women than

men. This implies that steeper tenure profiles could reflect the higher productivity of higher ability women. On its own, Becker and Lindsay (1994) argue, hypothesis 1 is a weak test.

Hypothesis 2: Wages of female stayers will rise with tenure more than wages of female leavers, since female stayers share the cost of firm specific training and female leavers do not. Becker and Lindsay (1994) test this hypothesis by comparing returns to tenure for early stayers, where early stayers refers to stayers with less than five years of tenure, to leavers of the same sex. Since average tenure for early stayers is almost four years for an early stayer and less than one and a half years for a leaver we question the validity of this test. Say for illustrative purposes that returns to tenure for early stayers and for leavers are 1%. A stayer's wage will have increased by over 4% by the end of four years while a leaver's wage would be expected to increase by 1.5% in the first year and a half after which he/she would typically start a new job and go back to the starting wage. A leaver's wage would never be expected to rise by more than 1.5% of the starting wage over the four years. The test may also be invalid because of the possibility of unobserved differences between stayers and leavers who as the summary statistics suggest are very different groups. For example, returns to tenure could also reflect returns to general training which would be entirely paid for by workers. If the importance of general training differed for stayers and leavers this test is invalid. The large returns to tenure for leavers (much larger than for stayers) who have average tenure of less than eighteen months could reflect returns to basic general training received on the job.

Hypothesis 3: Tenure profiles of male and female leavers will exhibit no difference since members of neither group share the cost of firm specific training.

Hypothesis 4: Sex based differences in tenure profiles will diminish with age. As women reach an age where their outside options are similar to males their tenure slopes converge. This hypothesis is tested by breaking the sample of leavers into those under forty (young) and over forty (old) years of age and testing whether tenure slopes are steeper for young women than for their male counterparts and doing the same for older men and women.

Using their sample Becker and Lindsay's (1994) results supported all four of their hypotheses. It must be pointed out, however, that the empirical predictions of the model proposed by Hersch and Reagan (1997), outlined earlier, would be difficult to distinguish from the human capital model. Not only do females have higher returns to tenure, but a worker separating from their job would be expected to suffer a reduction in earnings in both models (the reduction in earnings suffered by displaced workers is cited as evidence of the importance of specific human capital by Topel (1991). While Hersch and Reagan (1997) plausibly argue that the assumption that males and females have similar levels of human capital is unrealistic this does not mean the human capital model is wrong. If women do choose or are offered less training than men then it could be argued the observed higher returns to tenure for females understate the extent to which women are obliged to pay for a higher share of their training costs.

It must also be noted that workers could choose between general and specific human capital we might expect women with higher probabilities of leaving to opt more

for general relative to firm specific human capital since a separation is costlier to a worker with a lot of specific human capital. Since human capital theory predicts the worker paying for all general training , higher female returns to tenure may reflect females choosing a bigger share of general relative to specific training than their male counterparts.

*B. Empirical Resullts*

As argued above we question the validity of hypothesis 2. To test the remaining hypotheses we ran several log wage regression specifications to determine and compare the returns to tenure for stayers and their appropriate sub-samples for our two sample periods. The full regression results for male and female stayers are reported in the Appendix.[5] A similar set of regressions were also run for old (over 40 years of age) and young stayers, for early and late stayers and for leavers (early stayers are in the first five years of tenure).[6]

Using our regression results we tested the hypothesis that the difference in tenure slopes was equal to zero for each of the above regressions. The differences in returns to tenure and the t statistics for these tests are reported in Table 3.

[5] The log wage regressions used in the tables below included industry dummies, although the coefficients and standard errors are not reported here. Becker and Lindsay (1994) also included age and age squared in their regressions. Given that experience and tenure with the employer are controlled for we could not see a good theoretical rational for controlling for age. Age and experience are highly correlated.

[6] Descriptive statistics for young and old stayers by sex and sub-sample are also provided in the Appendix.

**Table 3* - Difference in Tenure Coefficient between Female and Males[7]**

| | Sample | Male | Female | Difference | t-stat. Difference |
|---|---|---|---|---|---|
| Stayers | 1983-87 | 0.014 | 0.015 | 0.001 | 0.450 |
| | | (0.001) | (0.002) | (0.002) | |
| Stayers | 1988-92 | 0.013 | 0.013 | 0.000 | 0.015 |
| | | (0.001) | (0.002) | (0.002) | |
| Young Stayers | 1983-87 | 0.020 | 0.033 | 0.013 | 3.114 |
| | | (0.002) | (0.004) | (0.004) | |
| Young Stayers | 1988-92 | 0.016 | 0.016 | 0.000 | 0.068 |
| | | (0.002) | (0.003) | (0.004) | |
| Old Stayers | 1983-87 | 0.012 | 0.009 | -0.003 | -1.092 |
| | | (0.001) | (0.003) | (0.003) | |
| Old Stayers | 1988-92 | 0.012 | 0.012 | -0.000 | -0.050 |
| | | (0.001) | (0.002) | (0.002) | |
| Early Stayers | 1983-87 | 0.039 | 0.039 | 0.000 | 0.003 |
| | | (0.008) | (0.010) | (0.013) | |
| Early Stayers | 1988-92 | 0.011 | 0.025 | 0.013 | 1.113 |
| | | (0.008) | (0.009) | (0.012) | |
| Leavers | 1983-87 | 0.066 | 0.055 | -0.011 | -0.789 |
| | | (0.009) | (0.011) | (0.014) | |
| Leavers | 1988-92 | 0.031 | 0.028 | -0.003 | -0.224 |
| | | (0.010) | (0.009) | (0.014) | |

*Standard Errors in Parenthesis

[7] These regressions are reported in detail in Appendix 1. We differ from Becker and Lindsay (1994) since Government and agricultural workers are excluded and age and age squared are excluded as regressors. Given that experience and tenure are controlled for we do not see a good theoretical rationale for including age. Age and experience are highly correlated. These modifications leave the qualitative results unchanged.

**Table 4[*] - Difference in Tenure Coefficient between Female and Males reported in Becker and Lindsay (1994)**

| | Sample | Male | Female | Difference | t-stat. Difference |
|---|---|---|---|---|---|
| Stayers | 1983-87 | 0.0143 (0.0011) | 0.0196 (0.0018) | 0.0053 (0.0021) | 2.5124 |
| Young Stayers | 1983-87 | 0.0115 (0.0022) | 0.0305 (0.0034) | 0.019 (0.0041) | 4.6917 |
| Old Stayers | 1983-87 | 0.0151 (0.0012) | 0.0156 (0.0023) | 0.0005 (0.0026) | 0.1927 |
| Early Stayers | 1983-87 | 0.0337 (0.0117) | 0.0725 (0.0014) | 0.0388 (0.0186) | 2.0825 |
| Leavers | 1983-87 | 0.0470 (0.0088) | 0.0512 (0.0098) | 0.0042 (0.0132) | 0.3189 |

*Standard Errors in Parenthesis

Our results show that in the earlier period the result that tenure slopes were steeper for women are much weaker than in Becker and Lindsay (1994). By contrast, returns to tenure are very similar for males and females in the latter period and we fail to reject the null of parameter equality for all the regression specifications. To further investigate this matter we pooled our two samples and included year dummies and year dummies interacted with the tenure variable; these are shown in Table 4.[8] The results indicate that while the returns to tenure for male stayers remained relatively stable over our sample period, those of female stayers fell substantially, to result in an overall convergence of the two.

[8] The coefficient estimates and their standard errors for the year dummies are not reported here but are obtainable from the authors.

**Table 5 - Estimates of Tenure Effects for Stayers, by Sex**

| | Male | | Female | |
|---|---|---|---|---|
| Intercept | 1.197 | (0.035) | 0.905 | (0.066) |
| Experience | 0.024 | (0.002) | 0.020 | (0.002) |
| $Experience^2$ | -0.005 | (0.000) | -.000 | (0.000) |
| Tenure83 | 0.015 | (0.001) | 0.023 | (0.006) |
| Tenure84 | 0.012 | (0.002) | 0.016 | (0.006) |
| Tenure85 | 0.012 | (0.001) | 0.017 | (0.004) |
| Tenure86 | 0.015 | (0.002) | 0.017 | (0.003) |
| Tenure87 | 0.017 | (0.002) | 0.017 | (0.003) |
| Tenure88 | 0.014 | (0.002) | 0.014 | (0.003) |
| Tenure89 | 0.013 | (0.002) | 0.012 | (0.003) |
| Tenure90 | 0.011 | (0.002) | 0.013 | (0.003) |
| Tenure91 | 0.011 | (0.002) | 0.009 | (0.003) |
| Tenure92 | 0.010 | (0.002) | 0.011 | (0.002) |
| Schooling | 0.157 | (0.003) | 0.150 | 0.005 |
| Children | -0.004 | (0.004) | -0.033 | (0.007) |
| Married | 0.026 | (0.015) | 0.004 | (0.014) |
| $R^2$ | 0.401 | | | 0.394 |
| N = | 6,104 | | | 2,930 |

It was demonstrated in Table 3 that our data supports Hypothesis 3 in both periods and Hypothesis 4 in the earlier period. Tenure slopes for older males and females and leavers are practically identical in both sub periods. In the later period young females still have steeper tenure slopes than young males but the differences are much smaller quantitatively and the t statistics from the test of parameter equality suggest that the differences are statistically insignificant.

As noted earlier, we were unable to replicate Becker and Lindsay's results quantitatively and in particular there results for early stayers differ from ours. The generally higher returns to tenure for early relative to late stayers indicates that returns to tenure are non-linear. The fact that gender differences in returns to tenure are large and statistically significant for young workers (in the 1983-87 period at least), but not for early stayers supports the human capital interpretation of the difference in returns to tenure over Hersch and Reagan's (1997) model. In summary we do not find support for hypothesis 1 in either period. Hypothesis three and four are supported in the first period. In the later period only hypothesis 3 is supported.

**Section V - The Male Female Wage Differential for Stayers and Leavers**

A question that naturally arises from the analysis is whether differences in tenure profiles are important in terms of explaining the male female wage differential. Becker and Lindsay (1994) and Becker and Lindsay (1995) argue that differences in starting pay by gender significantly overstate the gender pay gap since low female starting pay reflects higher female training costs. We can see from the results in Tables 3 and 4 that our results indicate that differences in tenure slopes are not important in terms of understanding the gender pay gap. To illustrate this in a rough and ready way, consider an identical male and female stayer starting in identical jobs. The female gets a lower starting salary than the male. How much of this difference in starting pay could be explained by differences in tenure slopes where the female catches up in time . The biggest differences in tenure slopes are for young stayers who are aged around 32 on average. The results in Table 3 indicate that for 1983-87 at most about a 9%

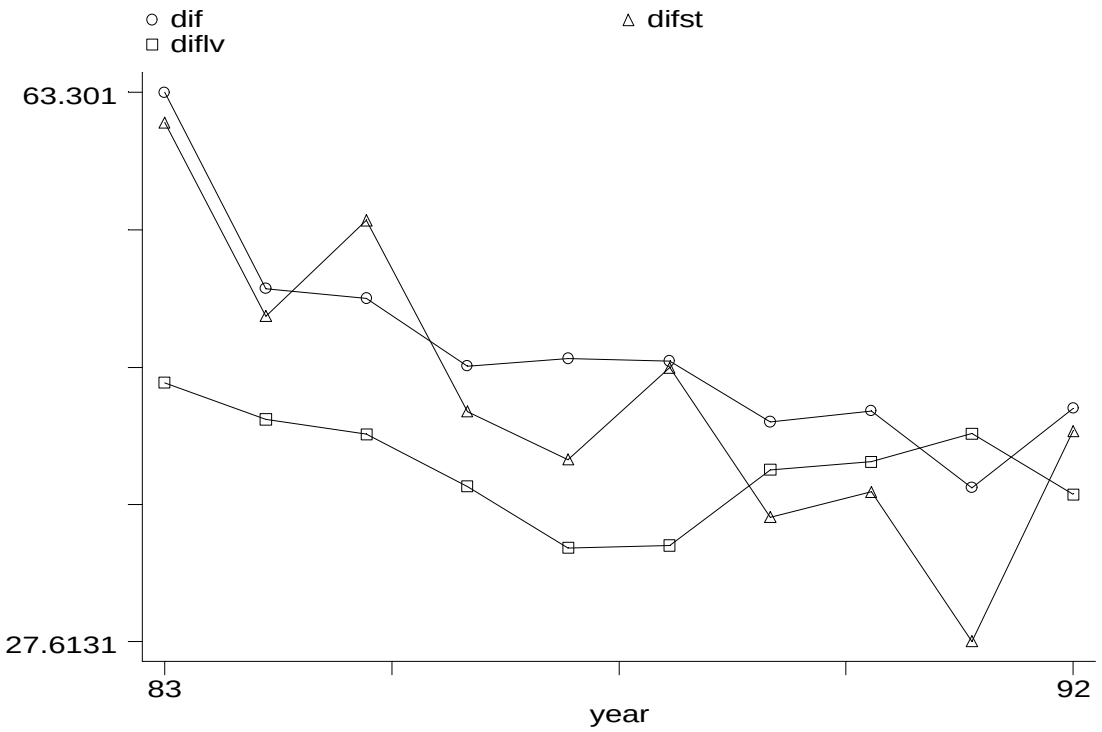
starting pay differential could be explained away (1.3% for eight years when the workers become old and tenure slopes converge). While Becker and Lindsay's (1994 and 1995) results for early stayers could explain a wage differential of about 16% at most between male and female starters. All of our results indicate that returns to tenure have no role in explaining gender wage differentials in the later period

In the earlier period gender wage differentials are similar for all stayers and stayers who are starting on the job (that is in their first 18 months of tenure). If the convergence of tenure slopes reflects a reduction in the higher risk of hiring women stayers, then starting pay should converge also. While we look at wage decompositions below to examine this issue, ultimately the small number of starting stayers in particular, means that we cannot have confidence in the changes in average wages for starting stayers that we observe. An alternative approach is to compare stayers with leavers since there are more observations in these groups. We would expect the leaver gender wage gap to fall by less than for stayers if some of the stayer wage gap is explained by differences in returns to tenure which are falling.

The descriptive statistics for stayers and leavers by gender provided in the Appendix indicate that stayers are fundamentally different from leavers. Stayers tend to be on average older, more experienced, more educated and have a greater incidence of marriage than leavers. There are, however, also significant differences even within the two samples. Male stayers, for example are on average, older, more experienced, more educated and have a greater incidence of marriage than women. In Figure 1 we Graph the male female wage differential by year for all stayers and starting stayers. As can be seen, the wage differential has fallen for all groups over time but more so for leavers than stayers. In the analysis below the data are pooled into two groups 1983-

87 and 1988-92. This is not desirable as Figure 1 shows considerable variation within these sub-periods. Unfortunately this choice along with the small number of regressors was dictated by the small sample size of starting stayers in particular.

Figure 1: Gender Wage differential for Stayers and Leavers over Time




Of course, constructing simple means even over time is only a crude way of comparing differences in pay between males and females. As the large literature on pay discrimination has shown, differences in individual characteristics go some way in explaining wage differentials. The decompositions in the tables below are based on regressions of log wages on experience, education and tenure for male and female, by stayers and leavers. The regressions for starting stayers excludes tenure The regressions are of the form:

$$W_m^t = X_m^t b_m^t + V_m^t \quad (1)$$

$$W_m^t = X_f^t b_f^t + V_f^t \quad (2)$$

where W is the log wage X a vector of characteristics, β a vector of returns to the characteristics and V an error term. One can then use the Oaxaca (1973) decomposition to break down the wage differential into two parts: a component that is due to differences in returns to characteristics (βs.) and a component explained by differences in characteristics (Xs), evaluated at the non-discriminatory price[9]:

$$\Delta \overline{W}^t = \Delta \hat{b}^t \overline{X}_f^t + \hat{b}_m^t \Delta \overline{X} \quad (3)$$

One can also examine the change in the wage differential over time. Following Schmidt (1998) the change in the wage differential between time period 0 and 1 can be decomposed into four parts:

$$\Delta\overline{W}^1 - \Delta\overline{W}^0 = \overline{X}_f^0{}'(\Delta\hat{b}^1 - \Delta\hat{b}^0) + (\overline{X}_f^1 - \overline{X}_f^0)'\Delta\hat{b}^1 + (\Delta\overline{X}^1 - \Delta\overline{X}^0)'\hat{b}_m^0 + \Delta\overline{X}^1{}'(\hat{b}_m^1 - \hat{b}_m^0) \quad (4)$$

The four terms measure the effect of changes in the difference in wage structure between males and females over time on the change in the male female wage

differential, the impact of changes in the baseline (female) characteristics on the change in the male female wage differential, the effect of changes in the difference in characteristics between males and females over time on the change in the male female wage differential, and the impact of changes in the baseline (male) prices on the change in the male female wage differential, respectively. Schmidt (1998) develops a method to calculate the variances of the components of the Oaxaca decomposition and we extend this in Appendix2 to calculate standard errors for each of the components of the above decomposition [10].

1983-87 Stayers: Oaxaca Decomposition

| Total | Price | Quantity |
|---|---|---|
| 0.388 | 0.311 | 0.077 |
| (0.013) | (0.013) | (0.003) |

1983-87 Leavers: Oaxaca Decomposition

| Total | Price | Quantity |
|---|---|---|
| 0.317 | 0.274 | 0.044 |
| (0.015) | (0.016) | (0.004) |

1983-87 Starting Pay Stayers: Oaxaca Decomposition

| Total | Price | Quantity |
|---|---|---|
| 0.359 | 0.300 | 0.058 |
| (0.041) | (0.042) | (0.008) |

[9] There is a literature discussing the wage structure that should be chosen to represent the non-discriminatory price, see Oaxaca and Ransom (1994). We opt for the most common course of adopting the male price.

[10] A limitation in the analysis for calculating the standard errors is the underlying assumption that the X's are fixed. We will see later that in some cases the changes in mean characteristics in the second and third component of the decomposition have large standard errors and are statistically insignificant.

1983-87 and 1988-92 Stayers: Schmidt Decomposition

| $S_1b$ | $S_2b$ | $S_3b$ | $S_4b$ | $S_5b$ |
|---|---|---|---|---|
| -0.054 | -0.061 | -0.001 | 0.003 | 0.006 |
| (0.017) | (0.018) | (0.001) | (0.001) | (0.004) |

1983-87 and 1988-92 Leavers: Schmidt Decomposition

| $S_1b$ | $S_2b$ | $S_3b$ | $S_4b$ | $S_5b$ |
|---|---|---|---|---|
| -0.030 | -0.055 | 0.014 | 0.007 | 0.005 |
| (0.021) | (0.022) | (0.003) | (0.001) | (0.005) |

1983-87 and 1988-92 Starting Pay Stayers: Schmidt Decomposition

| $S_1b$ | $S_2b$ | $S_3b$ | $S_4b$ | $S_5b$ |
|---|---|---|---|---|
| 0.023 | -0.012 | 0.004 | 0.021 | 0.011 |
| (0.055) | (0.057) | (0.004) | (0.004) | (0.017) |

1983-87 and 1988-92 Stayers: Change in Average Characteristics

| | 1983-87 | 1988-92 | Change |
|---|---|---|---|
| Male | 2,944 | 3,160 | 7.3% |
| (Observations) | | | |
| Experience | 18.28 | 18.27 | -0.01 |
| | (0.20) | (0.17) | (0.26) |
| Education Index | 5.26 | 5.35 | 0.09 |
| | (0.03) | (0.03) | (0.04) |
| Tenure | 10.20 | 9.61 | -0.59 |
| | (0.16) | (0.14) | (0.21) |
| Female | 1,109 | 1,821 | 64% |
| (Observations) | | | |
| Experience | 15.05 | 14.84 | -0.21 |
| | (0.26) | (0.20) | (0.33) |
| Education index | 4.94 | 5.09 | 0.14 |
| | (0.04) | (0.03) | (0.05) |
| Tenure | 7.90 | 7.64 | -0.25 |
| | (0.18) | (0.15) | (0.24) |

Standard errors in parenthesis.

1983-87 and 1988-92 Leavers: Change in Average Characteristics

| | 1983-87 | 1988-92 | Change |
|---|---|---|---|
| Male (Observations) | 1,636 | 1,830 | 12% |
| Experience | 11.96 | 13.01 | 1.05 |
| | (0.22) | (0.22) | (0.31) |
| Education Index | 5.12 | 5.13 | 0.01 |
| | (0.04) | (0.04) | (0.06) |
| Tenure | 1.16 | 1.22 | 0.07 |
| | (0.03) | (0.02) | (0.04) |
| Female (Observations) | 1,151 | 1,693 | 47% |
| Experience | 8.54 | 9.78 | 1.25 |
| | (0.20) | (0.18) | (0.27) |
| Education index | 5.16 | 5.07 | -0.10 |
| | (0.04) | (0.04) | (0.06) |
| Tenure | 1.18 | 1.22 | 0.04 |
| | (0.03) | (0.02) | (0.04) |

Standard errors in parenthesis.

1983-87 and 1988-92 Starting Stayers: Change in Average Characteristics

| | 1983-87 | 1988-92 | Change |
|---|---|---|---|
| Male (Observations) | 247 | 287 | 16% |
| Experience | 12.81 | 13.51 | 0.70 |
| | (0.60) | (0.53) | (0.80) |
| Education Index | 5.37 | 5.57 | 0.20 |
| | (0.10) | (0.10) | (0.14) |
| Female (Observations) | 97 | 203 | 109% |
| Experience | 10.40 | 9.96 | -0.44 |
| | (0.70) | (0.50) | (0.86) |
| Education index | 5.14 | 5.27 | 0.13 |
| | (0.14) | (0.09) | (0.17) |

Standard errors in parenthesis.

While the wage gap for starters does not fall as we would expect the standard error terms on the Schmidt decomposition for starting stayers indicate that the numbers are very unreliable. The tables for stayers and leavers are consistent with our story. The stayer wage gap falls by more than for leavers and this does not seem to be driven by differences in changes in characteristics.

**Section VI - Conclusion**

Our analysis of the gender wage gap and returns to firm specific human capital shows that there have been significant changes since the early 1980s. Firstly, the likelihood that a woman is a more risky investment for job specific human capital investment has been falling. Additionally, returns to tenure for females on long-term jobs, are converging to those of their male counterparts, while for most of the 1980s they had been higher. Differences in returns to tenure can no longer explain part of the male female differential in starting pay.

## Appendix 1 - Descriptive Statistics and Regression Estimates

### Descriptive Statistics for Stayers, by Sex and Sample

| | 1983-87 | | | | 1988-92 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Male | | Female | | Male | | Female | |
| ln(Real Wage) | 2.39 | (0.44) | 2.01 | (0.41) | 2.32 | (0.50) | 1.99 | (0.45) |
| Age | 37.96 | (10.45) | 38.72 | (11.0) | 38.30 | (9.55) | 38.61 | (10.30) |
| Experience | 18.27 | (10.61) | 15.04 | (8.79) | 18.26 | (9.76) | 14.84 | (8.42) |
| Tenure | 10.44 | (8.29) | 7.89 | (6.17) | 9.61 | (7.95) | 7.64 | (6.31) |
| Schooling | 5.26 | (1.61) | 4.94 | (1.38) | 5.35 | (1.60) | 5.09 | (1.42) |
| Children | 1.20 | (1.19) | 0.82 | (1.04) | 1.26 | (1.23) | 0.84 | (1.02) |
| Married | 0.87 | (0.33) | 0.60 | (0.49) | 0.86 | (0.35) | 0.70 | (0.46) |
| N = | 2,944 | | 1,109 | | 3,160 | | 1,821 | |

### Descriptive Statistics for Leavers, by Sex and Sample

| | 1983-87 | | | | 1988-92 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Male | | Female | | Male | | Female | |
| ln(Real Wage) | 2.06 | (0.50) | 1.75 | (0.44) | 2.03 | (0.55) | 1.74 | (0.48) |
| Age | 31.89 | (8.99) | 31.20 | (9.03) | 33.49 | (9.39) | 33.76 | (9.12) |
| Experience | 11.96 | (9.08) | 8.54 | (6.88) | 13.01 | (9.22) | 9.79 | (7.20) |
| Tenure | 1.16 | (1.06) | 1.18 | (1.01) | 1.23 | (1.04) | 1.23 | (1.00) |
| Schooling | 5.12 | (1.63) | 5.16 | (1.43) | 5.13 | (1.71) | 5.06 | (1.46) |
| Children | 0.98 | (1.10) | 0.76 | (1.03) | 1.06 | (1.19) | 0.95 | (1.15) |
| Married | 0.76 | (0.43) | 0.52 | (0.50) | 0.72 | (0.45) | 0.64 | (0.48) |
| N = | 1,636 | | 1,151 | | 1,830 | | 1,693 | |

**Descriptive Statistics for Stayers, by Age and Sex: 1983-87**

| | Old | | | | Young | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Male | | Female | | Male | | Female | |
| ln(Real Wage) | 2.49 | (0.47) | 2.00 | (0.42) | 2.35 | (0.42) | 2.02 | (0.41) |
| Age | 50.58 | (7.01) | 50.92 | (6.98) | 31.86 | (4.88) | 31.43 | (4.80) |
| Experience | 30.73 | (7.77) | 22.36 | (9.34) | 12.26 | (5.17) | 10.67 | (4.51) |
| Tenure | 16.70 | (10.55) | 11.42 | (7.65) | 7.06 | (4.80) | 5.79 | (3.75) |
| Schooling | 4.89 | (1.82) | 4.52 | (1.42) | 5.45 | (1.46) | 5.19 | (1.30) |
| Children | 0.75 | (1.02) | 0.35 | (0.72) | 1.42 | (1.21) | 1.10 | (1.11) |
| Married | 0.90 | (0.31) | 0.55 | (0.50) | 0.86 | (0.34) | 0.63 | (0.48) |
| N = | 959 | | 415 | | 1,985 | | 694 | |

**Descriptive Statistics for Stayers, by Age and Sex: 1988-92**

| | Old | | | | Young | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Male | | Female | | Male | | Female | |
| ln(Real Wage) | 2.40 | (0.55) | 1.96 | (0.46) | 2.28 | (0.46) | 2.00 | (0.44) |
| Age | 48.80 | (6.98) | 49.69 | (6.90) | 32.58 | (4.65) | 32.05 | (5.03) |
| Experience | 28.64 | (7.71) | 21.59 | (8.74) | 12.60 | (4.89) | 10.84 | (4.96) |
| Tenure | 14.60 | (9.92) | 10.57 | (7.92) | 6.88 | (4.79) | 5.90 | (4.28) |
| Schooling | 5.21 | (1.81) | 4.84 | (1.42) | 5.42 | (1.47) | 5.23 | (1.40) |
| Children | 0.93 | (1.13) | 0.46 | (0.79) | 1.44 | (1.25) | 1.06 | (1.08) |
| Married | 0.90 | (0.29) | 0.64 | (0.48) | 0.83 | (0.37) | 0.74 | (0.44) |
| N = | 1,116 | | 678 | | 2,044 | | 1,143 | |

**Estimates of Tenure Effect for Stayers, by Sex and Sample**

| 1983-87 | | | | | 1988-92 | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | Male | | Female | | Male | | Female | |
| lntercept | 1.28 | (0.03) | 1.13 | (0.06) | 0.10 | (0.04) | 0.87 | (0.05) |
| Exp. | 0.03 | (0.00) | 0.02 | (0.00) | 0.02 | (0.00) | 0.02 | (0.00) |
| $Exp.^2$ | -0.00 | (0.00) | -0.00 | (0.00) | -0.00 | (0.00) | -0.00 | (0.00) |
| Tenure | 0.01 | (0.00) | 0.02 | (0.00) | 0.01 | (0.00) | 0.01 | (0.00) |
| Schooling | 0.14 | (0.00) | 0.13 | (0.01) | 0.18 | (0.00) | 0.17 | (0.00) |
| Children | -0.01 | (0.01) | -0.04 | (0.01) | 0.00 | (0.01) | 0.00 | (0.01) |
| Married | 0.02 | (0.02) | 0.05 | (0.02) | 0.03 | (0.02) | 0.34 | (0.02) |
| $R^2$ | 0.38 | | 0.40 | | 0.41 | | 0.04 | |
| N = | 2,944 | | 1,109 | | 3,160 | | 1,821 | |

**Appendix 2 - Standard Errors for Components of the Schmidt Decomposition**

To simplify the notation the decomposition in (4) is rewritten as:

$$\Delta\overline{W}^1 - \Delta\overline{W}^0 = (*)(\Delta\hat{b}^1 - \Delta\hat{b}^0) + (**)\Delta\hat{b}^1 + (***)\hat{b}_m^0 + (****)(\hat{b}_m^1 - \hat{b}_f^0) \quad \text{(A1)}$$

We also define a number of vectors. If n is the number of regressors (0) is an [1, (n+1)] row vector of zeros. The vectors of estimated coefficients from the four regressions are stacked into a [4*(n+1) , 1] column vector $b=[(\hat{b}_m^1)'(\hat{b}_f^1)'(\hat{b}_m^0)'(\hat{b}_f^0)]'$.

The above decomposition and its four components can be written respectively as.

$$\Delta\overline{W}^1 - \Delta\overline{W}^0 = [(\overline{X}_m^1)'(-\overline{X}_f^1)'(-\overline{X}_m^0)'(\overline{X}_m^1)']b = S_1 b \quad \text{(A2)}$$

$$(*)(\Delta\hat{b}^1 - \Delta\hat{b}^0) = [(*)(-*)(*)(-*)]b = S_2 b \quad \text{(A3)}$$

$$(**)\Delta\hat{b} = [(**)(-**)(0)(0)]b = S_3 b \quad \text{(A4)}$$

$$(***)\hat{b}_m^0 = [(0)(0)(***)(0)]b = S_4 b \quad \text{(A5)}$$

$$(****)(\hat{b}_m^1 - \hat{b}_f^0) = [(****)(0)(0)(****)]b = S_5 b \quad \text{(A6)}$$

Next we define the variance covariance matrix for b as V(b). The estimated variance for the five terms above is then SiV(b)Si' where 1=1..5.

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