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Working Paper

How much does a year off cost? Estimating the wage effects of employment breaks and part-time periods

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Non-technical Summary

Human capital accumulated on the job is considered one of the main determinants of an individual's wage rate. There are good reasons why wage-effective human capital responds to discontinuities in the employment pattern. First, due to technical progress and innovations in the work process, human capital acquired in previous years of employment may become obsolete after an interruption, if this knowledge is not maintained and updated during absence. Second, since participation in vocational training programs is generally much lower among part-time employees, skill obsolescence may also apply to part-time periods. For these reasons, discontinuities in the employment pattern not only imply an interruption in the accumulation of human capital, but may also cause a depreciation of the stock built up in the past and may therefore be responsible for severe wage cuts. However, research on the long-term impact of part-time periods, in contrast to employment breaks, is still in its infancy.

In this paper, we estimate the return to effective experience, taking into account both the duration and the timing of non-work and part-time spells. Our approach stands out by an undemanding specification of effective experience in the wage equation. In order to consider the duration and the timing of discontinuities, only two additional parameters must be estimated, these being the respective depreciation rates of interruptions and working time reductions. We draw on the German Socio-Economic Panel that provides detailed retrospective information on the individual employment biography. Potential selection problems are circumvented by estimating the wage rate, the participation decision and hours worked by simultaneous Maximum Likelihood.

Estimation results suggest that the individual wage rate is substantially affected by the preceding employment pattern. If individual heterogeneity with respect to industry sector and job position is accounted for, the estimated depreciation rates of human capital fall from over 50 percent to 33 percent for a one-year break and zero percent for part-time work. This could be interpreted as an indication for segregation in the labor market - that is, women who anticipate their discontinuous employment biography are more likely to be found in sectors and job positions that exhibit flat wage profiles in order to reduce the financial consequences of employment breaks and part-time spells. A one-year break at age 30 results in a wage reduction of barely DM 0.2 per hour, prolonging that break by another two years leads to an additional loss of almost one German mark. The timing of the discontinuity also matters: While the three-year break right at the beginning of the employment career is associated with a wage cut of hardly 1 percent, postponing the interruption by ten years raises the penalty to 9 percent for the wage rate of a 45-year old working woman. We therefore conclude that traditional wage estimations that do not control for depreciation underestimate the return to effective experience.

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Abstract
Discontinuities in the employment profile are supposed to cause wage cuts since they imply an interruption in the accumulation of human capital as well as a depreciation of the human capital stock built up in the past. In this paper, we estimate the return to effective experience, taking into account both the timing and the duration of non-work and part-time employment spells. Estimation results for German women suggest that deviations from full-time employment are associated with significant wage cuts owing to the depreciation of human capital. Postponing the discontinuity leads to a further fall of the wage rate. Controlling for individual heterogeneity with respect to industry sector and job position decreases the estimated depreciation rates. This we interpret as an indication for segregation in the labor market. We conclude that traditional wage estimations that do not control for depreciation underestimate the return to effective experience.

JEL classifications: J24, J31

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1 Introduction

Human capital accumulated on the job is considered one of the main determinants of an individual's wage rate. According to the wage equation set up by Mincer (1974), job experience or human capital are included with a linear and a quadratic term. One stylized fact is that the resulting wage-experience profile is hump-shaped. The explanatory variable human capital is often measured by schooling and the number of years spent in employment. However, the traditional measure of human capital has its weak points. For the lack of retrospective employment data, actual work experience is often approximated by potential work experience, defined as age minus years of schooling minus school entrance age. However, this proxy is especially inaccurate for women, whose employment patterns are characterized by various employment discontinuities. As a result, estimates of the return to female job experience are downward biased.

Even if information on actual years in employment is available, the concept of aggregated experience does not take into account that the stock of general human capital accumulated over time may be affected by an employment break or part-time spell. Conventional measures of either potential or actual experience are inadequate proxies for job-related skills - particularly for women with career interruptions. Due to technical progress and frequent innovations in the work process, general human capital acquired in previous years of employment may become obsolete after a break, because this knowledge is not maintained and updated during the leave in most cases. Since participation in vocational training programs is generally much lower among part-time employees, skill obsolescence may also occur with respect to part-time periods. Furthermore, employees in contingent jobs are more likely to be assigned to routine jobs that do not make use of the available human resources. These reflections suggest that there may be a depreciation of human capital due to employment breaks and part-time spells. As a result, the timing and frequency of non-work and part-time spells have an effect on the role of skill depreciation during home time. Therefore, long-term human capital effects associated with deviations from the standard full-time career path should also be considered, particularly when estimating female wage rates.

In economic literature, the decay of human capital has been neglected for a long time. The effect of employment breaks on earnings was first investigated by Mincer und Polachek (1974) for women in the U.S.. From simple OLS regressions, they conclude that wage cuts due to periods out of work can be attributed to an interruption in the accumulation of human capital as well as a depreciation or atrophy of the human capital stock built up in the past. However, these results are at risk of being biased, because unobserved worker characteristics can be correlated with both intermittent labor force participation and wages. A number of studies tackle this problem by estimating fixed-effects models using panel data (Mincer and Polachek 1987, Mincer and Ofek 1982, Sundt 1987 as well as Licht and Steiner 1991). More recent analyses on the impact of intermittencies are provided by Kim and Polachek (1994) as well as Light and Ureta (1995) using US data, Gupta and Smith (2000) for Denmark and Albrecht et al. (1998) for Sweden. Whereas Gupta and Smith simply use the presence and number of children as a proxy for employment interruptions, Kim and Polachek introduce the number of years spent not working as a home-time variable in the wage equation. After controlling for heterogeneity and endogeneity associated with home time affected by a low wage rate, they detect an increase in skill atrophy. Light and Ureta account for intermittency in the work history in the most flexible way. In their wage equation, they include a set of variables that measure the fraction of time worked during each year of a career. They also draw special attention to the timing of interruptions. A major drawback of their specification, however, is the large number of parameters to be estimated, which requires a large number of observations.

The impact of employment breaks on the income profile of German women has been investigated by Galler (1991) and Licht and Steiner (1992) among others. Thereby, Licht and Steiner focus on the duration of non-employment spells. They find a catch-up effect of human capital following a break that partly offsets depreciation. Galler, who also considers the sequence of full-time spells, part-time periods and interruptions in the wage determination, observes this wage catch up only for formerly part-time employees who take up a full-time position again. Full-time experience gathered prior to a break has a weaker impact on the wage rate than that following a discontinuity. However, to our knowledge, the impact of the exact timing of interruptions has not yet been investigated explicitly for Germany.

Moreover, research on the long-term human capital effects of part-time periods, in contrast to employment breaks, is still in its infancy. To our knowledge, Ferber and Waldfogel (1998) are the first and only authors trying to date the long-term impacts of part-time employment so far. They use 15 years of data from the NLSY to examine the wage effects of nontraditional employment and nontraditional work experience. The return to part-time experience of men is basically zero, while for women, the return is strongly positive, provided that they worked part-time voluntarily in the past. In contrast, negative effects emerge for the return to involuntary part-time experience of women. Furthermore, the results indicate that nontraditional employment reduces the probability of having health or pension coverage, irrespective of when the individual changed to a full-time job. These results are rather robust even if unobserved heterogeneity is controlled for by estimating a fixed effects model. All other existing empirical studies focus on the wage differentials of current part-time and full-time employees. Among the German studies, Schwarze (1998), for instance, concludes that the gross hourly wage rates of

German employees with marginal jobs who are not covered by social security are about 15 percent below those for comparable full-time jobs. Using a simultaneous wage-hours model, Wolf (2000) finds significant wage cuts for women working less than 20 hours per week. There are no significant differences among those jobs with 20 to 38 hours, though. Kaukewitsch and Rouault (1998) compare the part-time gap between Germany and France, and Bardasi and Gornick (2000) analyze the monetary consequences of part-time employment among women across five industrialized countries, among others, in Germany. Both studies conclude that the observed wage differential remains substantial after controlling for measurable worker and job-related characteristics. Also the majority of studies on other countries come to the conclusion that jobs with less hours are paid a lower hourly wage rate.

In this paper, we focus on the magnitude of human capital depreciation due to discontinuities in the employment pattern caused by both employment breaks and part-time spells. We are particularly interested in the impacts of part-time periods and employment breaks on the returns to preceding work experience. In light of the differing employment patterns of women and men, these depreciation rates may be an explanation for the observed wage differential between women and men. Another important question motivating our investigation is the impact of the timing of employment discontinuities on the individual income profile. Provided that there is a depreciation of accumulated human capital during part-time periods and employment breaks, the timing of these events becomes a crucial determinant of the resulting wage effects. In this setting, the gender specific employment patterns are decisive for the observed wage differential between women and men. As a result, traditional wage estimations that do not control for depreciation would underestimate the return to effective experience.

Therefore, we estimate the return to effective work experience - allowing for human capital depreciation and accounting for the timing of intermittencies. Our approach stands out by an undemanding specification of effective experience within the wage equation in terms of parameters to be estimated. To consider the duration and the timing of discontinuities, only two additional parameters have to be estimated - the atrophy rates of breaks and working time reductions. Considering previous empirical evidence that hourly wage rates depend on current working hours, we also control for these effects using a linear spline function. Potential selection problems are circumvented by simultaneous Maximum Likelihood estimation of the wage rate, the participation decision and hours worked. We use data from the German Socio-Economic Panel, that provide detailed retrospective information on the individual employment biography. Despite common knowledge that general human capital is an important determinant of an individual's wage rate, this effect seems to be rather small for low-skilled women in Germany (Boockmann and Steiner 2000). Subsample wage regressions for low-skilled women even suggest that there are no significant returns to experience. Therefore, we restrict our analysis to high-skilled women.

The paper proceeds as follows: in Section 2, the data used are described and average female life-cycle patterns - including employment breaks and part-time periods - are presented to give an idea of the relevance of these events for women's work lives. Section 3 gives an outline of the econometric model. Particular attention is given to the specification chosen to incorporate human capital depreciation in the wage equation. The estimation results are discussed in Section 4 and a simulation of specific employment patterns of women and their wage effects is conducted in Section 5. The paper concludes with a summary of the main findings and some remarks on potential points of departure for further research in this field.

2 Data set and description

We use data from the German Socio-Economic Panel (GSOEP)[1] to explore the relationship between past employment patterns and present wage rates. The GSOEP is an individual household micro-data panel and provides extensive information about various individual as well as household characteristics, which are required for the analysis of labor force participation and wage income. The empirical results presented in this paper are based on 1998 data from the West German sub-sample of the GSOEP. Though it would be interesting to do a comparable analysis for East German women as well, whose employment patterns and wage rates still differ substantially from those of West Germans. Unfortunately, the number of observations, in particular the occurrence of part-time spells, is too small to generate convincing results.

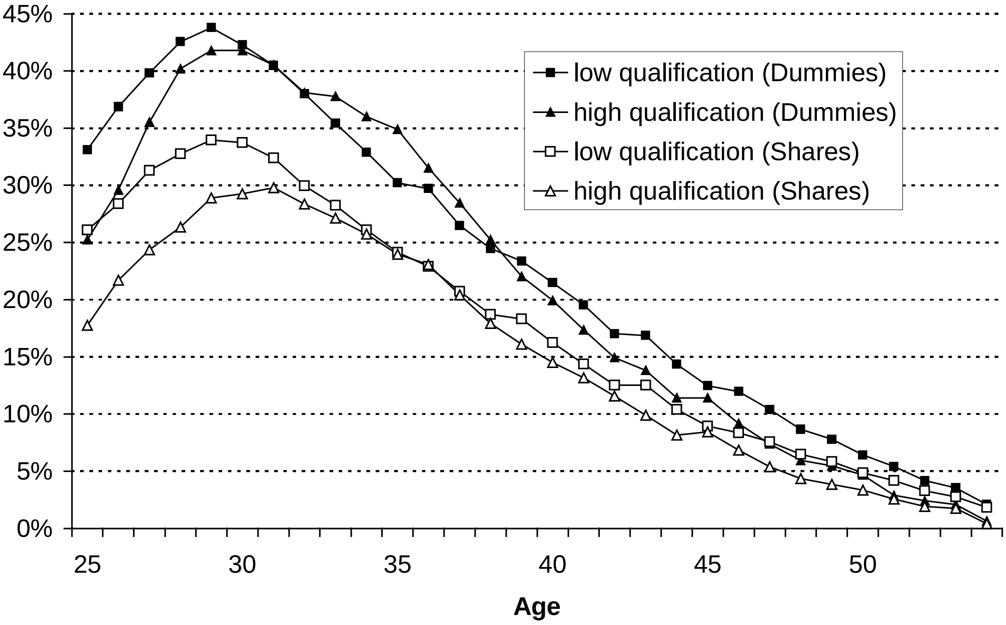
An important feature of the GSOEP data is that it provides detailed information on each individual's work history. Every respondent is asked about his or her labor market status in every single year starting from age 15. This way, any part-time periods or employment breaks due to unemployment, formal parental leave, or a withdrawal from the labor market beyond these reasons can be traced back.

Our analysis is restricted to German women not younger than 30 and not older than 55 years of age. This sample definition guarantees that, generally, the working life period after completed education has already started and prevents the results from being excessively affected by retirement behavior. As we are only interested in the determinants of the wage income of employees, all self-employed are dropped, as well as all those working in the farming sector. Observations with missing data on

[1] For more information on the GSOEP see Wagner, Burkhauser and Behringer (1993) and Projektgruppe Sozio-oekonomisches Panel (1995).

any of the explanatory variables have also been removed. The remaining observations are divided into two samples - one covering women with a low qualification level, the other including educated women with a college degree, either from a vocational college, a technical college or from a university. The latter sample is used to analyze the wage effects of different employment patterns in the Maximum Likelihood estimation. This final sample consists of 560 women. Sample characteristics are provided in Table 2 in the Appendix.

Figure 1: Employment breaks over the life cycle



Note: Shares of employed women in West Germany in 1998 (weighted and unweighted) who experienced an employment break at a given age by level of qualification.
Source: GSOEP 1998, authors' calculations.

Figure 1 and Figure 2 illustrate the relevance of the two main discontinuities in women's work lives, namely employment breaks and part-time spells. The first figure shows the percentage of currently employed women who did not work at a given age. These women are either unemployed, house wives, or retired. In other words, they do not accumulate labor market-related human capital. On the basis of retrospective work history data, we calculate the age-specific "break-probability" for every age between 25 and 54.[2] These percentages are broken down by qualification level. The illustration further differentiates between the pure incidence of a break

[2] It should be noted that, since the samples include all women aged 30 to 55, the total number of observations on which the shares are based on diminishes continuously with increasing age. Separate cohort profiles did not reveal significantly different employment break behavior. We therefore chose to pool all age groups.

(dummy curve) in each year of the life cycle on the one hand, and the corrected incidence weighted by the approximated length of that break[3] (share curve) on the other.

One interesting feature is the difference in employment breaks between low and high skilled women. Whereas the graphs representing the pure incidence of a break do not differ remarkably by qualification, both having their maximum points at age 29 [4], the share curves reveal greater deviations at these younger ages. As for weighted employment breaks, the graph representing qualified women reaches its maximum at age 32, about three years later than the share curve of all low skilled women. The distance between the two graphs is also greater than between the dummy curves. This is particularly true for earlier life stages up to the age of 32. One conclusion from this observation might be a higher labor market fluctuation among higher qualification levels accompanied by more non-employment spells. Hence, the substantially smaller numbers for the weighted non-work spells suggest that these periods out of the labor force seem to be relatively short.

Figure 2 presents the occurrence of a part-time employment period as well as the weighted incidence of part-time work over the life cycle. Again, the percentages are broken down by education level. According to Figure 2, female employment patterns also differ with respect to part-time spells. However, we see the reverse picture regarding the differences between skill groups. The highest percentage of women working part-time is realized at age 34 for higher qualified (22 percent) and age 32 for lower qualified women (19 percent). We can conclude that both based on the dummy curve and the share curve, graduates are more likely to experience part-time periods than the low-skilled.

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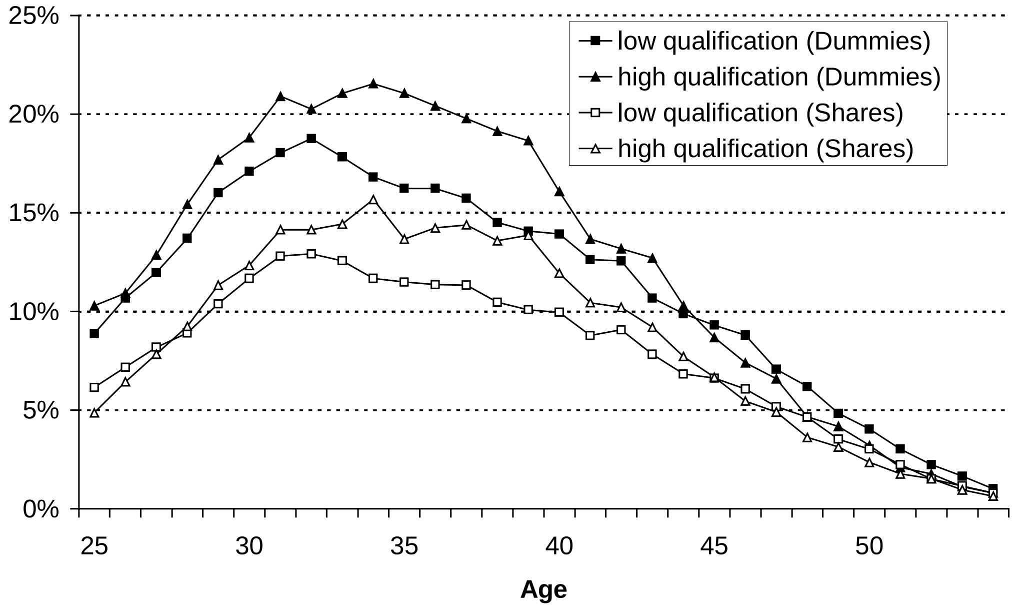
[3] The length of the employment break is approximated based the assumption that each of the multiple activities within one year have the same duration. If, for example, a woman reports that she was both employed and unemployed at the age of 30, we assume that each status lasted half a year.

[4] 44% of women without a degree experience a break at that age compared to 42% of the graduates.

Figure 2: Part-time periods over the life cycle.



Note: Shares of employed women in West Germany in 1998 (weighted and unweighted) who experienced a part-time period at a given age by level of qualification.

Source: GSOEP 1998, authors' calculations.

In sum, there appears to be different timing in employment patterns between qualification levels. Higher qualified women seem to choose shorter breaks that are more often followed by part-time periods than their lower qualified counterparts. This may reflect the attempt by high-skilled women to minimize the effects on wages and career prospects due to a child birth. As a result, we might expect periods of non-employment and the corresponding financial consequences to be of greater importance for the wage level of high-skilled than that of low-skilled workers.

3 The econometric model

We estimate the effect of human capital depreciation on the wage rate by applying a simultaneous model for the determination of wages, working hours and labor market participation. Instead of using a Tobit model of the supply of labor, we estimate the hours and the participation equation separately to account for differing effects of the explanatory variables on the decision whether to work or not, and on the number of working hours. In order to estimate the hours effect on wages, we include a spline function of working hours in the wage equation. The following model enables us to evaluate the atrophy rates of experience due to employment breaks and part-time spells.

3.1 Wage rate

We estimate a single Mincerian-type wage equation on effective experience for all employees, irrespective of whether they are currently working full-time, part-time or any other number of hours.[5] We use two alternative definitions of the log gross hourly wage rate of employed women, differing in the inclusion of fringe benefits, such as performance bonus, holiday pay, Christmas bonus or the 13th salary. We do so because it is suspected that (part of) the return to work experience might not be reflected in the regular wage payment, but in additional compensations provided to the employee. In this setting, we would expect that the explanatory power of experience is higher if the dependent variable includes fringe benefits, which we approximate by the reported amounts of the previous year. It is particularly interesting whether the effects of human capital returns and depreciation differ with respect to the dependent variable chosen, i.e. wages with or without fringe benefits.

We choose the following specification of the wage equation:

$$(1) \qquad \ln w = \alpha_0 \cdot QL + \alpha_1 \cdot eEXP + \alpha_2 \cdot eEXP^2 + \sum_{k=1}^{L} \left[\pi_k + \lambda_k (h - H_{k-1}) \cdot D_k \right] + \varepsilon \, .$$

The coefficient α_0 measures the wage effect of a university degree QL. Extending the Mincerian wage equation, we estimate the return to effective experience (*eExp*), defined in the next section, given by α_1 and α_2. In order to assess the impact of weekly working hours on wages without imposing too much structure a priori, we use a linear spline function, which provides a flexible but simple approach (Suits et al. 1978).[6] H_k with $k \in \{1,...,L\}$ are the frontiers of the different segments of the function, so-called knots, and h denotes the weekly working hours. D_k, with $k \in \{1,...,L\}$, are dummy variables whose values are equal to one for all observations such that $H_{k-1} \leq h < H_k$ and 0 otherwise. In order to obtain a continuous wage-hours

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5 We do not include tenure as a proxy for firm-specific human capital because of severe endogeneity problems. Employees whose abilities match very well with the requirements of their job tend to be more productive, earn higher wages and are less likely to quit their firm than workers who have not found such a good match. Apart from that, it remains an open question whether firm-specific human capital creates additional wage growth (Altonji and Williams 1997, Dustmann and Meghir 1998).

6 Most of the previous studies suggest that hours affect the wage quadratically, which arises from the fixed costs of work on the one hand and the declining marginal productivity at high hours on the other hand (Barzel 1973). However, Wolf (2000) showed that a quadratic polynomial is not appropriate to describe the shape of the wage-hours profiles of German women. Using a more flexible specification of the relation between working hours and wages allows a better adaptation to the data.

profile, we constrain the values of the coefficients π_k for $k \geq 2$ so that $\pi_k = \pi_{k-1} + \lambda_{k-1}\left(H_{k-1} - H_{k-2}\right)$. The unexplained part of the hourly wage rate is captured by the error term ε. The assumptions on the properties of the error term ε and all other residuals of the model are given below.

On the one hand, there are good reasons to include job position, firm size and industry sector, because they are suspected to be important determinants of the individual wage rate. Apart from that, the estimate of human capital depreciation may be affected by missing variables. If, for example, the probability of discontinuous employment patterns is higher for women with low earnings, such as service workers or employees in lower job-positions, the sector or job specific wage differential is partly captured by the wage effects attributed to employment breaks and part-time spells. On the other hand, including additional explanatory variables involves the risk of an endogeneity problem, because women may choose their jobs anticipating their future employment patterns and the corresponding wage effects. As a result, the estimated wage effects of discontinuous employment patterns may still be biased in such a specification. Being aware of these adversities, we alternatively estimate the following extended wage equation:

$$(1a)\quad \ln w = \alpha_0 \cdot QL + \alpha_1 \cdot eEXP + \alpha_2 \cdot eEXP^2 + X'\alpha_{2+n} + \sum_{k=1}^{L}\left[\pi_k + \lambda_k (h - H_{k-1}) \cdot D_k\right] + \varepsilon,$$

where X is the vector of n additional explanatory variables, and α_{2+n} denotes the corresponding parameters to be estimated. The additional explanatory variables refer to the current job only and do not enable us to distinguish among atrophy processes in different industry sectors or job positions. The notation of the other variables corresponds with equation (1).

3.2 Depreciation of human capital

Most studies on the determination of wages use actual work experience measured as the sum of years actually spent in paid employment, or potential experience, as an explanatory variable in the wage equation. They thereby neglect any depreciation of experience due to skill obsolescence during an employment discontinuity. Depending on the specific employment pattern, however, the stock of human capital accumulated in earlier years may be less useful and productive today than that of previous periods. Presumably, *effective* experience does not necessarily correspond to *actual* experience if the employment path is characterized by employment breaks or part-time spells. In this case human capital depreciation is responsible for the deviation between effective and actual experience. Therefore, we explicitly take into account human capital depreciation by using effective work experience as an explanatory variable in the wage equation.

The idea of effective experience is that periods in which the person has worked for pay are summed up after being adjusted by the occurrence and duration of employment breaks and part-time spells in any of the subsequent years. In our setting, the depreciation of experience depends on the timing and the duration of discontinuities. In principle, our specification has two very tempting properties which coincide with expectations derived from economic theory: (1) the later the employment break or part-time period takes place in the life cycle, the greater the absolute gap will be between actual and effective experience at any time after the discontinuity has taken place, (2) the longer the deviation from standard full-time employment is, the higher the depreciation of accumulated human capital, that is, the smaller effective experience will be.

The concept of effective experience is formalized by the following formula that provides the stock of effective experience (*eEXP*) at time *T* according to:

(2) $$eEXP_T = \sum_{t=0}^{T-1}\left(\prod_{s=t}^{T-1}(1-(\delta_{part}D_s^{part}+\delta_{olf}D_s^{olf}))\right) F_t \, .$$

F_t denotes the fraction of time spent in employment in year t. The fraction equals one if the individual is in full-time employment all year and takes the value one half for continuous part-time employment. If a woman holds both a full-time and a part-time job within the same year, the share amounts to 0.75. Provided that a woman did not work in year t, F_t is equal to zero. That is, F_t captures the actual accumulation of human capital prior to any depreciation. The share of each year the individual does not work full-time is measured by D_{part} and D_{olf} for part-time and out-of-the-labor-force periods, respectively. These are equal to one if the particular activity has taken place all year and zero otherwise. Again, the length of multiple employment status is approximated by assuming that each activity has the same duration. δ_{olf} and δ_{part} are the depreciation rates of non-employment and part-time periods.

For an illustration consider a 30-year old woman who has been working full time from age 25 to 28 and has been on parental leave during the past year (at age 29). Due to this employment break, her human capital, accumulated during the preceding four years, is adjusted by the factor (1-δ_{olf}). Assuming a depreciation rate δ_{olf} of say 50 percent, effective experience would only amount to two years.

The actual size of the discounting factor is determined in a simultaneous estimation of the wage rate and the rate of return on discounted experience. That is, the depreciation rate is determined endogeneously through the impact of interruptions of the normal (i.e. full-time) work pattern, be it part-time periods or employment breaks. This way, we can evaluate the amount of human capital depreciation due to discontinuities in the work history.

However, it should be noted that the coefficient estimates for δ_{part} and δ_{olf} do not necessarily measure the sole effect of human capital depreciation but may also indicate a stigma effect of lower attachment to the labor market. We are not able to identify the importance of both effects. Apart from this, the financial consequences may differ across industry sectors, occupations or job positions. Hence, it would be illuminating to estimate group-specific atrophy rates. Due to the limited number of observations in our sub-sample, we refrain from this extension. Assuming that women anticipate their employment patterns and the corresponding wage cuts and therefore choose jobs with flat wage profiles and generally lower wage rates, these differences are partly captured by the additional explanatory variables in the wage equation (1a).

3.3 Participation

The decision to enter the labor market P is modeled by a binary choice approach. The equation of the continuous latent variable is given by:

(3) $$P^* = Z'\psi + v,$$

where ψ presents the parameter vector to be estimated and v the error term. Given involuntary unemployment, the actual non-participation cannot be interpreted strictly as an individual decision. Thus, the vector Z' of exogenous variables contains factors which determine both the labor supply, such as qualification and the number of small children, and the labor demand, such as regional dummy variables. P^* is unobservable but relates to the observable dichotomous variable P (participation status) as:

$$P = \begin{matrix} 0 \text{ if } P^* \leq 0 \\ 1 \text{ if } P^* > 0 \end{matrix}$$

3.4 Working hours

We assume that people choose among all possible numbers of working hours, not only between part-time and full-time work. Therefore, we use a linear specification with actual weekly working hours as a dependent variable,

(4) $$h = Y'\beta + u$$

where Y is a vector of explanatory variables and β the parameter vector to be estimated. The error term u is added to the deterministic part of the hours function. We decided to use a very rich and comprehensive specification of the reduced form equation of hours worked, so that it is consistent with almost any structural labor supply model, or at least it provides a good approximation. The vector Y also includes variables describing the household context, such as the number of children, marital status and other household income. These covariates capture both the opportunity costs of working and, to some extent, the effect of taxation on labor supply. Thus, the coefficients of this equation should not be interpreted in a structural way.

3.5 Properties of the error terms and identification

The error terms of the three equations (e,u,v) are assumed to be trivariate, normally distributed with mean zero and covariance matrix Σ. The variance of v $\left(\text{Var}(v)=\Sigma_{3,3}\right)$ is normalized to one. The three covariances between the error terms are determined by the simultaneous Maximum Likelihood estimation.

A few remarks on the identification of the three equations have to be made. We estimate reduced-form equations of the participation and the hours equation. The wage function is the only structural equation. In principle, the model is identified by the functional form, but we further insert several exclusion restrictions in the hours and participation equation. First, we include family characteristics, such as the number of children, in the labor supply equations. Thus, it is assumed that children affect the mother's wage rate only through her employment breaks, which are captured by the discounted experience (see section 3.2). Information about children living in the household enters the hours and the participation equation in two different ways.[7] Second, marital status, husband's net wage income and other household income are excluded from the wage equation. In contrast to the wage equation, we do not use discounted years of employment in the participation and hours equation. Instead, we use potential experience in order to avoid endogeneity problems. Furthermore, we add a proxy for the fixed costs of working, measured by a dummy variable that indicates whether at least one member of the household is in need of care.[8] We also include regional dummy variables in order to capture

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[7] At this point, we refer to Browning (1992). For the participation function, we use one variable indicating the age of the youngest child and another for the number of children in the household. This specification serves as a measure of the time needed for the children. In the hours equation, we use the number of children by age groups, because the age structure is more likely to measure the fiscal burden of the children in the household.

[8] Persons who care for their old parents or other relatives face high entrance costs to the labor market, because they must pay for a geriatric nurse or a retirement home, which can be extremely expensive according to the state of health.

differences in labor demand. Finally, an individual's taste for work[9] and the degree of disability are incorporated into the labor supply model.

4 Estimation results

Regressions are run on four different specifications of the structural wage equation. Model 1 represents the reference case that accounts for depreciation rates on employment breaks and part-time periods. The dependent variable is the logarithm of the gross hourly wage rate including fringe benefits. The coefficient estimates of dummy variables can therefore be interpreted in terms of a percentage increase or decrease of the wage rate. In Model 2, the definition of the dependent variable ignores any fringe benefits to test whether returns to work experience or differences in human capital due to depreciation are reflected in extra benefits or other compensations, apart from the regular wage payment. In Model 3, the gross hourly wage rate (including fringe benefits) is estimated using the traditional specification of actual work experience that counts the raw sum of years spent in employment (though weighted by full-time and part-time spells). This approach ignores the impact of discontinuities in the employment profile. Model 4 is an extension of Model 1 in that it additionally controls for firm size, industry sector and job position. These variables are supposed to capture part of the individual heterogeneity which is correlated with both wages and exogenous regressors such as employment breaks or part-time periods. If, for example, employees in lower job positions have more intermittent labor force participation and lower wages, then estimates of the wage effect of employment breaks or part-time spells might be picking up the job position and not only the earnings power losses caused by discontinuous employment patterns.

The coefficient estimates of the structural wage equations are presented in Table 1. Estimation results of the reduced-form participation and hours equations of Model 4 are provided in Table 3 in the Appendix.

[9] The variable "*taste for work*" is created by running a factor analysis on answers to the question "How important for your well-being and contentment is ...". Among the topics which are evaluated by the individuals are (1) your work, (2) income and (3) career or professional success. These three items are used to create a factor named "taste for work".

Table 1: Estimation results

	Model 1		Model 2		Model 3		Model 4	
	Coeff.	T-stat.	Coeff.	T-stat.	Coeff.	T-stat.	Coeff.	T-stat.
Constant term	3.071	29.90	3.023	29.83	2.944	29.14	3.371	33.05
D1[a] (1-15h)	-0.033	-3.49	-0.032	-3.59	-0.030	-3.20	-0.024	-3.05
D2 (16-20h)	0.081	8.12	0.074	7.61	0.072	7.24	0.029	3.41
D3 (21-25h)	0.017	2.36	0.019	2.79	0.018	2.52	0.028	4.70
D4 (26-38h)	-0.017	-4.10	-0.014	-3.60	-0.006	-1.66	-0.019	-5.27
D5 (39-41h)	-0.075	-5.39	-0.064	-4.77	-0.081	-5.83	-0.065	-5.65
D6 (42-60h)	0.010	1.98	0.008	1.52	0.013	2.53	0.009	2.05
(post-)graduate	0.297	16.19	0.293	16.58	0.322	17.17	0.152	8.57
Experience[b]	0.020	9.21	0.018	8.55	0.012	5.96	0.020	12.16
Experience ^{2}/100	-0.023	-5.88	-0.021	-5.47	-0.010	-3.09	-0.025	-9.03
δ_{part}	0.657	5.47	0.684	5.52	-	-	0.000	0.00
δ_{olf}	0.553	6.14	0.547	5.68	-	-	0.331	6.95
Low/mid civil serv.	-	-	-	-	-	-	0.166	4.79
Executive civil s., profess., managerial	-	-	-	-	-	-	0.299	16.32
<5 employees	-	-	-	-	-	-	-0.226	-8.89
5-20 empl.	-	-	-	-	-	-	-0.058	-2.78
200-2000 empl.	-	-	-	-	-	-	0.095	5.15
>2000 empl.	-	-	-	-	-	-	0.064	3.20
energy, mining	-	-	-	-	-	-	-0.236	-4.90
metal industry	-	-	-	-	-	-	-0.138	-2.23
other industry	-	-	-	-	-	-	-0.632	-13.18
trade, service	-	-	-	-	-	-	-0.460	-14.36
transportation	-	-	-	-	-	-	-0.302	-6.23
banking	-	-	-	-	-	-	-0.311	-7.18
education, health	-	-	-	-	-	-	-0.230	-7.95
public service	-	-	-	-	-	-	-0.268	-8.07
other sectors	-	-	-	-	-	-	-0.506	-3.97
$\rho_{\text{wage, hours}}$	-0.008	-0.08	-0.047	-0.46	0.053	0.61	0.093	0.80
$\rho_{\text{wage, participation}}$	0.181	1.55	0.202	1.66	0.047	0.42	-0.074	-0.48
$\rho_{\text{hours, participation}}$	-0.530	-6.79	-0.532	-6.84	-0.495	-5.97	-0.478	-5.20
Ø Log Likelihood	-3.10		-3.07		-3.11		-2.95	

Note: [a] D1 to D7 denote the different sections of the spline-function (see section 3.1). [b] Model 1, 2 and 4 use effective experience, defined in section 3.2. Model 3 contains the weighted sum of years in employment.

Source: GSOEP 1998, authors' calculations.

According to the first three models, employees with a university degree earn about 30 percent higher wages than other qualified women. The coefficient estimate of the extended model suggests only a 15 percent mark-up for university education. This change in the coefficient is partly taken up by the job position. Executive civil servants, professionals and managerials earn 30 percent higher wages than employees in lower positions. The impact of working hours on wages approximated by the spline-function are illustrated by wage-hours profiles in Figure 4 in the Appendix. Due to the limited number of observations, we do not estimate the knots in the spline-function and opt for five kinks. The first knot is set at 15 hours, which is the threshold for marginal jobs. Other knots are defined at 20 and 25 hours, to distinguish among part-time jobs with different amounts of working hours, and at 38 hours. The last knot (41 hours) separates standard full-time employment from overtime hours. Very striking is the peak at 25 hours per week. These part-time employees earn significantly higher wages than standard full-timers. This result also holds if wage cuts due to previous part-time spells are ignored (Model 3), so it cannot be attributed to the correlation between past and current part-time work. Also surprising is the downward slope between 38 and 41 hours. Even when using a couple of other specifications for the spline-function, the peaks at 25 hours and the dip around 40 hours remain unchanged. However, when controlling for job and firm characteristics as in Model 4 , the hours-wage differences are less pronounced.

The hourly wage rate increases with effective experience (see also Figure 5 in the Appendix). Ignoring fringe benefits, the return is slightly smaller. This result supports our hypothesis that work experience is, to some extent, remunerated by extra benefits and not only by regular payments. Since the experience measure is not adjusted for previous employment breaks and part-time periods in Model 3, one would expect that returns to this measure of human capital are lower. In fact, the experience-wage profile in Model 3 is much flatter than in the other three specifications (see Figure 5 in the Appendix).

The parameters determining the depreciation of human capital due to employment breaks δ_{olf} or part-time spells δ_{part} are highly significant in both simple models (1 and 2). In other words, given that experience is rewarded by the employer, discontinuities in the employment path do matter. After an employment break of one year, for example, the accumulated years in employment must be adjusted by about 55 percent. An additional year in part-time work further reduces effective experience by 66 percent.

If we allow for wage effects of firm size, industry sector or job position (Model 4), the estimates of δ_{olf} and δ_{part} turn out somewhat smaller. The atrophy rate of human capital amounts to 33 percent due to a year out of paid labor and zero percent for a part-time spell of the same length. This implies that apart from the slower accumulation of human capital, part-time jobs do not cause a long-term financial burden. It is interesting to note that this result matches with the findings of Ferber and Waldfogel (1998) for US women. Even though, one should keep in mind that part-time employment reduces pension benefits correspondingly and may also impede the access to social benefits.

In this last model the wage rate differs significantly with respect to job position, firm size and the industrial sector of the employee. As expected we observe sector-specific wage differentials and a wage increase with growing firm size. These explanatory variables capture a great share of the human capital depreciation estimated above. That is, discontinuous employment patterns seem to be related to specific low-wage occupational status, branches or even firms; be it that women whose work histories are characterized by discontinuities finally end up with those jobs, or that they choose jobs at the start for which skill obsolescence and accompanying wage cuts are not expected to be of severe magnitude. It could be concluded that women who anticipate the exposition to skill depreciation choose occupations with low costs for labor market intermittency.

The pecuniary effects of employment breaks and part-time spells on the wage rate can be derived from the coefficient estimates on discounted experience, δ_{olf} and δ_{part}. How much the duration and the timing of deviations from continuous full-time employment matter, is best illustrated by simulations of different employment patterns based on estimation results for the extended Model 4.

5 Wage simulation for selected employment patterns

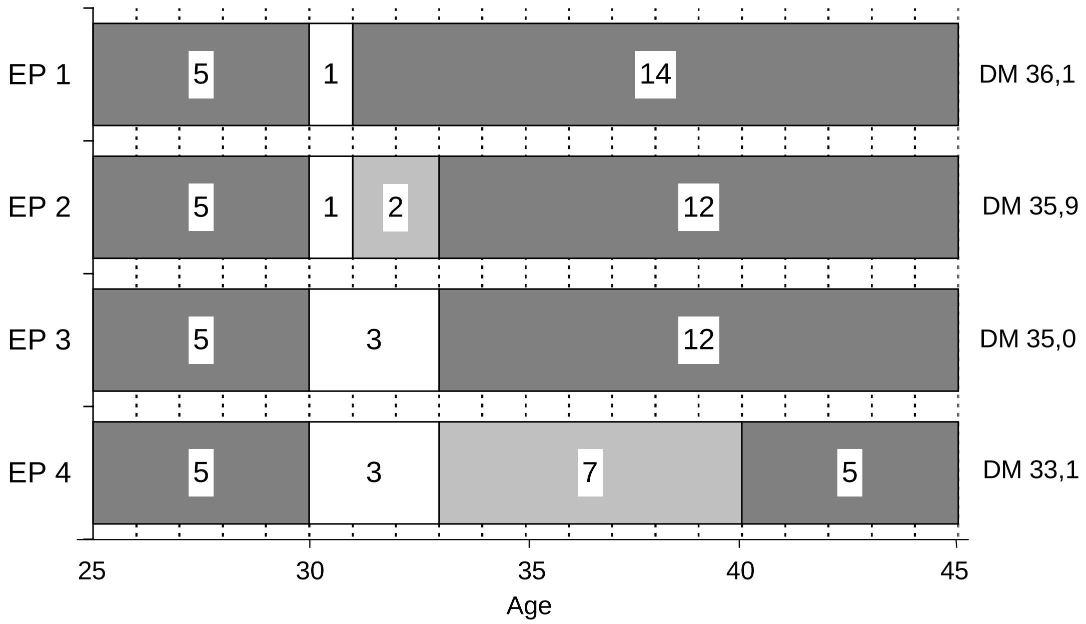
To demonstrate the wage effects of employment breaks and part-time spells, let us now turn to five different employment profiles *(EP).* These profiles differ by (1) *type* (break or part-time spell), (2) *duration* and (3) *timing* of employment discontinuities. Based on the depreciation rate of 33 percent for non-employment and 0 percent for part-time spells, we can compute effective human capital and the resulting wage rate for these hypothetical work histories.

As a benchmark pattern, we predict the hourly wage rate of a 45 year old woman who holds a college degree. Provided that she has continuously been working full-time during the past 20 years, her estimated hourly wage rate amounts to 36.2 DM.

Figure 3 illustrates the impact of the duration of a deviation from full-time employment is illustrated. The employment profile represented by the top bar in Figure 3 *(EP 1)* differs from the benchmark pattern in that it contains a one-year employment break at age 30, for example due to child birth. Depreciation of the human capital accumulated prior to that break causes a wage cut of DM 0.16.

The employment patterns *EP 2* and *EP 3* illustrate the specific effects of two additional years out of work in comparison with subsequent part-time employment. Whereas the total wage reduction of a break plus additional part-time spells makes up only DM 0.44, staying out of the labor force altogether results in a cut of more than one German mark. Hence there seems to be an incentive to take up a part-time job instead of staying home for a longer time which goes beyond the foregone earnings of these years.

Figure 3: The duration effect of alternative employment patterns on wages



Note: Dark grey sections of each employment pattern denote years in full-time employment, light grey indicate part-time spells and white sections employment breaks. The corresponding wage rate is computed by $w = \exp\left[f(QL, eEXP, X, h) + \frac{1}{2}\,\mathrm{var}(\varepsilon) \right]$, for a 45-year old woman who falls into the reference categories of all binary variables.
Source: Simulations based in the simultaneous wage-hours model with fringe benefits (Model 4).

The last exemplary employment pattern illustrates the effect of a prolonged part-time spell following a three-year leave. *EP 4* adds seven years of part-time employment to the employment break shown in *EP 3*. The woman represented here stops working for pay at age 30 and reenters the labor market 3 years later. At the time when the child leaves primary school, the mother shifts from part-time to full-time employment.[10] Compared to the more career-oriented mother *EP 1*, the more traditional mother ends up with almost DM 3 less per hour at age 45.

This represents the wage effects of a rather typical employment profile of German women who have given birth to a child. According to the formal parental leave scheme that provides job security and means-tested benefits for three years, most women choose to leave their job for that time period. Many of them subsequently return to a part-time job, partly because limited child-care facilities often do not allow mothers to stay in full-time employment. However, this transition is not without its problems. Legally, businesses are not obliged to offer a part-time job to women who return from parental leave.[11] Consequently, many women have to change their employer in order to reach their preferred work hours, even if this entails a significant cut in wages.

In terms of the resulting wage rate, the latter employment profile appears to reflect the work history of an average woman of our sample most appropriately. Based on average shares of out-of-the-labor-force and part-time spells presented in Figure 1 and Figure 2, an hourly wage rate as low as DM 32.6 would result for a 45 year old average woman.

After having studied hypothetical wage profiles differing by the duration of the discontinuity, Figure 4 now illustrates the timing effect of a three-year employment break on the wage rate of a 45 year old woman. The two graphs represent the absolute human capital effect (left axis) and the relative wage effect (right axis) of an intermittency depending on the age at which the break starts. The relative wage effect measures the wage rate of a 45 year old woman with a three-year employment interruption at a given age as a percentage of the benchmark wage income of a continuously full-time employed woman. This fraction of the benchmark wage is derived from the effective human capital after applying the depreciation procedure.

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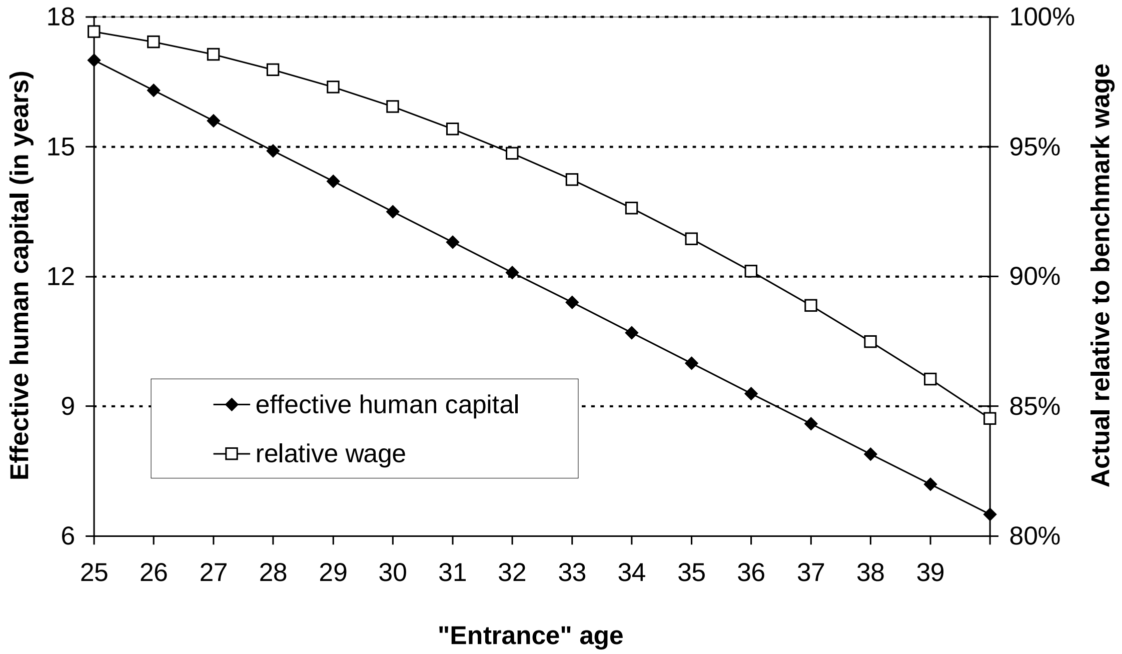
[10] In practice, this woman would still have to organize some sort of child care, because school schedules in Germany are generally not compatible with the working hours of a full-time job. However, high skilled women are more likely to pay for these services than to stay at home.

[11] As of January 2001, the new parental leave policy will provide a legal entitlement to work part-time during a three year parental leave period. Generally, this applies to all employees in firms with more than 15 employees.

Figure 4: The timing effect of a three-year employment break



Source: Simulations based in the simultaneous wage-hours model with fringe benefits (Model 4).

Both curves are downward sloping. This indicates that the timing of the employment break matters quite a bit. An early interruption causes a smaller wage cut than a later one. Whereas the three-year break at age 25 results in a wage cut of 1 percent, postponing that break by five years results in a wage reduction of 3.5 percent. This point of the curve corresponds to *EP 3* of Figure 3. If the child break is postponed by ten years, effective human capital falls to 10 years while the resulting wage income makes up 91 percent of a continuously full-time employed woman. Women who take a leave at age 40 have to accept a wage penalty of 15 percent, this equals a wage cut of DM 5.4 per hour compared to *EP 2* and DM 5.5 compared to the continuously full-time employed (benchmark) woman. Of course, this outcome is triggered by the difference in total experience prior to the leave. The later the break takes place, the higher the accumulated amount of human capital is and thus the greater is the wage cut due to depreciation of past experience. In accordance with our results, Gerlach (1987) found that wages of German women fall with the length of time spent on the job prior to the first leave, using work experience and employment breaks at different points in life as explanatory variables. That is, the wage penalty is most pronounced for later breaks when a higher amount of human capital has already been accumulated, which is then at risk to depreciation.

6 Discussion

In this paper, we estimate the return to effective work experience. By considering effective experience, we explicitly take account of human capital depreciation due to part-time periods and employment breaks, and particularly the timing of these deviations from full-time employment. The estimation results suggest that the wage rate is substantially affected by the individual employment history. Deviations from full-time employment are associated with significant wage cuts. However, the timing of discontinuities plays a crucial role. The correct answer to our question on how much a year off would cost should therefore be: It depends on when it takes place.

While a three-year break at age 30 after five years of full-time employment results in a wage cut of more than 1.2 DM per hour for a 45 year old working woman, postponing the interruption by 5 years leads to an additional fall in hourly income by 1.8 DM. Part-time periods, however, are not associated with significant wage penalties except for the accompanying lower increase in the human capital stock. The typical female employment biography, that is, an employment break followed by part-time work, results in a substantially lower wage rate, this being an important determinant of the observed wage differential between women and men.

As a result, previous studies that estimate the return to job experience by including the sum of years while ignoring discontinuities underestimate the true return to experience. A comparison of the return to years in employment versus our measure of effective experience reveals a much steeper experience-wage profile of effective work experience for German women.

It would now be interesting to know whether different types of employment breaks, such as maternal leave versus unemployment spells, are associated with differing rates of human capital depreciation. Albrecht et al. (1998), for instance, distinguish various types of career interruptions and conclude that the negative wage effect cannot only be attributed to the depreciation of human capital. Moreover, they find different impacts of formal parental leave and additional home care on subsequent labor income. According to their results, men face higher wage reductions than women from which they deduce a signaling function of discontinuous employment profiles with respect to the individual's career orientation that particularly hits men.

Since information on the type of career interruption is not available in our sample of the GSOEP, this question must be left to future research. Matching the detailed monthly employment status provided by the GSOEP would have meant a remarkable reduction of the sample size due to panel mortality. Since we restrict our analysis to highly qualified women the final sample is already very limited. With more detailed information on job transitions following or accompanying a deviation from full-time employment, one could further test the hypothesis mentioned above that the high depreciation rate of part-time spells can at least partly be explained by employer or even occupational changes towards lower paying jobs. Furthermore, one could differentiate between occupations and estimate respective depreciation rates, for instance for teachers, engineers and other groups.

Appendix

Table 2: Descriptive statistics of the explanatory variables

Variable	Mean	Std. Dev.	Min	Max
Age	40.21	6.93	30.00	55.00
D1[a] (1-15h)	0.11			
D2 (16-20h)	0.15			
D3 (21-25h)	0.08			
D4 (26-38h)	0.28			
D5 (39-41h)	0.30			
D6 (42-60h)	0.08			
Potential work experience	12.29	7.56	0.00	35.83
Vocational degree	0.69	0.46	0.00	1.00
University/college degree	0.31	0.46	0.00	1.00
Employed	0.65	0.48	0.00	1.00
Caring	0.05	0.29	0.00	2.00
Factor: taste for work	1.21	9.38	-15.01	29.29
Husband's net wage income (in log)	2.91	2.47	0.00	13.50
Other household net income (in log)	0.84	1.62	-6.98	22.20
Number of children < 3 years of age	0.17	0.44	0.00	3.00
Number of children age 4–10	0.44	0.77	0.00	4.00
Number of children age 11-16	0.37	0.63	0.00	4.00
Dummy child < 16 years	0.56	0.50	0.00	1.00
Number of children < 16 years	0.98	1.14	0.00	9.00
Age of youngest child	4.30	5.29	0.00	16.00
Berlin (East+West)	0.05	0.21	0.00	1.00
Schleswig-Holstein, Hamburg	0.05	0.21	0.00	1.00
Lower Saxony, Bremen	0.14	0.34	0.00	1.00
North-Rhine Westphalia	0.32	0.47	0.00	1.00
Hesse	0.09	0.29	0.00	1.00
Rhineland-Palatinate, Saarland	0.07	0.25	0.00	1.00
Baden-Württemberg	0.12	0.32	0.00	1.00
Bavaria	0.17	0.37	0.00	1.00
Degree of disability in %	2.17	11.99	0.00	100.00
Married	0.75	0.44	0.00	1.00
Actual work hours	19.80	17.07	0.00	60.00
Firm-size <5	0.06	0.25	0.00	1.00
Firm-size 5-20	0.11	0.31	0.00	1.00

Table 2 continued				
Firm-size 200-2000	0.15	0.36	0.00	1.00
Firm-size >2000	0.14	0.35	0.00	1.00
Mechanical/chemical/electrical engineering	0.06	0.24	0.00	1.00
Energy, mining	0.03	0.16	0.00	1.00
Metal industry	0.01	0.12	0.00	1.00
Other industry	0.03	0.16	0.00	1.00
Trade, service	0.14	0.34	0.00	1.00
Transport	0.03	0.18	0.00	1.00
Banking	0.04	0.19	0.00	1.00
Education, health	0.54	0.50	0.00	1.00
Public service	0.13	0.34	0.00	1.00
Other sectors	0.00	0.05	0.00	1.00
Net wage rate with fringe benefits (log)	3.29	0.40	1.79	4.08
Net wage rate, no fringe benefits (log)	3.22	0.38	1.74	4.01

Note: [a] D1 to D7 denote the dummy variables of the spline-function (see section 3.1).
Source: GSOEP 1998, authors‘ calculations.

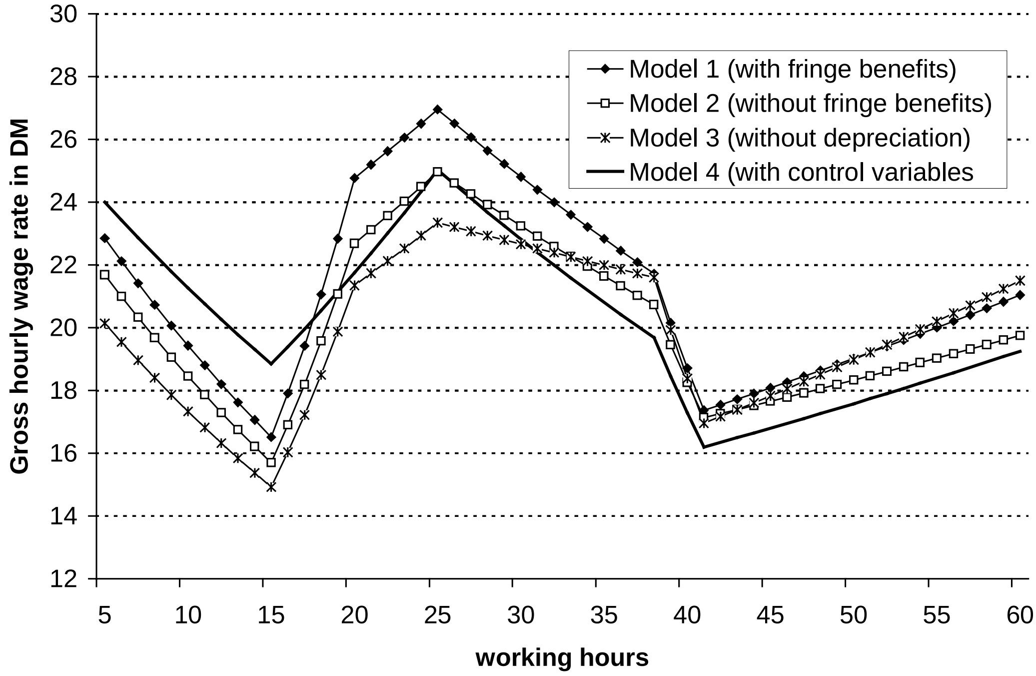
Table 3: Estimation results of the auxiliary equations (model 4)

Hours equation			Participation equation		
	Coeff.	T-value		Coeff.	T-value
Constant term	35.847	38.16	Constant term	-0.298	-0.25
Number of children < 3 years of age	-3.983	-3.54	Child < 16 years of age	-2.396	-16.25
Number of children age 4–10	-2.732	-5.33	Age of youngest child	0.144	13.86
Number of children age 11-16	-3.304	-8.20	Number of children < 16 years of age	0.075	1.70
University/college degree	1.221	2.46	University degree	0.087	1.31
Potential work experience	0.182	1.72	Age	0.127	2.16
Potential work experience squared	-0.390	-1.26	Age ^{2}/100	-0.201	-2.86
Husband's net wage income	-0.361	-1.94	Husband's net wage	-0.548	-8.26
Husband's net wage income squared	0.018	1.25	Husband's net wage^{2}	0.088	6.61
Other household income	-0.493	-1.84	Other household income	0.022	0.67
Other household income squared	-0.051	-1.51	Other household income^{2}	-0.008	-2.00
Married	-2.058	-3.08	married	0.012	0.12
Caring	-1.495	-1.66	Caring	-0.181	-1.95
Taste for work	-0.189	-6.45	Taste for work	-0.031	-9.82
Degree of disability	0.119	4.44	Degree of disability	-0.018	-7.01
			Berlin	0.328	2.05
			Schleswig-Holstein, Hamburg	0.789	4.79
			Lower Saxony, Bremen	-0.011	-0.13
			Hesse	0.163	1.54
			Rhineland-Palatinate, Saarland	-0.241	-2.06
			Baden-Württemberg	-0.128	-1.39
			Bavaria	0.056	0.66
Log Likelihood value:					-2.95 (see Table 1)

Note: [a] D1 to D7 denote the different sections of the spline-function (see section 3.1).

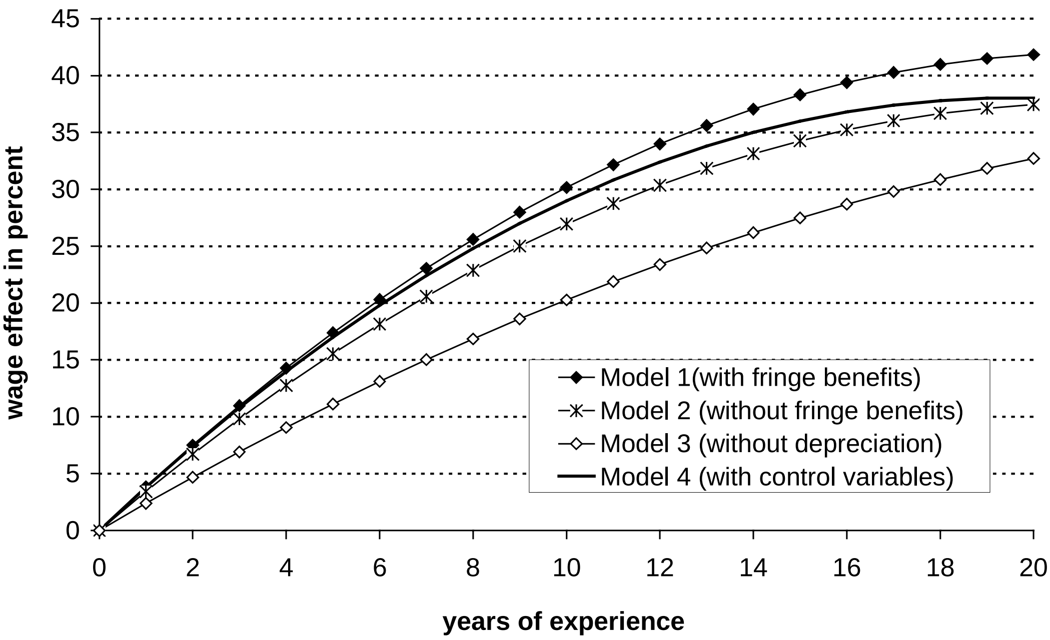
Source: GSOEP 1998, authors‘ calculations.

Figure 4: Wage-hours profiles of alternative models



Source: Authors' calculations based on estimation results presented in Table 1.

Figure 5: Experience-wage profiles of alternative models



Source: Authors' calculations based on estimation results presented in Table 1.

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