What is driving the family gap in women's wages?*

Mette Ejrnæs† and Astrid Kunze‡

September 2006

Abstract

This paper investigates sources of family gap using rich German data for the mid 1970s to 1990s. We specify a flexible regression framework to identify indirect effects of first birth on wages through human capital accumulation and mobility before and after birth. We deal with unobserved heterogeneity, endogeneity of the duration of leave related to birth and the non-random decision of return to work after childbirth. For identification we exploit policy changes of the parental leave system, availability of child care and local unemployment rate. The analysis of mothers shows substantial negative selection and negative wage effects through human capital and mobility. The comparison of entry wages and wage processes for mothers and other women reveal significant differences in the wage processes. All these factors vary before and after birth and education groups.

JEL codes: C23, J0, J1, J13, J16, J3, J31, J38.

Key words: female wages, human capital, public policy, parental leave, panel data, instrumental variable estimation.

*We are grateful to James Albrecht, Martin Browning, Joni Hersch and Kenneth Troske for helpful comments.

†Center for Applied Microeconometrics, University of Copenhagen, Mette.Ejrnes@econ.ku.dk.

‡Corresponding author: Norwegian School of Economics and Business Administration, Helleveien 30, N 5045 Bergen, and IZA, Bonn, Astrid.Kunze@nhh.no.

1 Introduction

A notable feature of labour markets is the family gap which is the wage differential between women with and without children (see Waldfogel 1998a). Empirical evidence of the family gap suggests that part of the total wage differential can be explained by differences in labour market characteristics between women with and without children. After holding experience and other standard labour market characteristics constant, studies in the USA and the UK have found that the family gap varies widely between 0 and 10 per cent for the first child, and is even higher for second or later children (see Lundberg and Rose, 2000; Anderson et al., 2002; Waldfogel, 1998a; Korenman and Neumark, 1992). In the literature alternative explanations of the family gap have been offered. Generally, it is agreed that unobserved heterogeneity between mothers and women who never will have children drives part of the family gap, but not the entire gap. Studies indicate in fact that wages drop for women when they return to the labour market after childbirth (e.g. Anderson et al. 2002 and Waldfogel 1997). Further detailed analyses of these processes leading to family gap are still needed to find more conclusive answers.

The goal of this study is to give a comprehensive picture of what drives the wage loss related to children. We extend models in the literature in two ways. First, we consider a more flexible wage regression to model the indirect effects of childbirth (through leave and mobility). We model the short- and long-run effects of leave related to childbirth, human capital accumulation and mobility on wages. This approach relates to and extends the studies by Mincer and Polachek (1974), Stratton (1995) and Lundberg and Rose (2000). We focus on first births and model the wages of mothers in such a way that the effects of human capital as well as mobility can vary before, around and after birth. Furthermore, wage effects are also allowed to be heterogeneous across education groups. Second, since it might be too restrictive to model heterogeneity between mothers and non-mothers only by a shift in the level of wages, we allow for different impacts through human capital.

From the literature on the direct effects of children on wages, we know that, to identify

the family gap, it is crucial to control for actual measures of work histories and to take unobserved heterogeneity into account (see Waldfogel (1998a)). Similar problems occur when focusing on mothers and identifying the indirect effects of children; e.g., the impact of duration of maternity leave. Mothers with short interruptions associated with childbirth and mothers with long interruptions may differ in unobserved ways. A related problem, which to our knowledge no studies have explicitly dealt with, is that not all women return to work after the birth of a child, which may lead to the analysis of a non-random sample of women with children and with a job.[1] To address these problems, we exploit longitudinal data to apply first-differences estimators and, as an innovative feature, we apply an IV estimation technique. For identification, we exploit policy changes of the parental leave system, the availability of childcare and the local unemployment rate.

Our longitudinal data stem from register data provided by the **I**nstitut für **A**rbeitsmarkt und **B**erufsforschung **S**ample (Institute for Employment Research), IABS, and cover the period 1975–1997. Our data sample has several advantages for our analysis. First, we observe the human capital accumulation process over their entire career, from the beginning, and we can observe when the first interruption related to childbirth and maternity leave occurs and for how long the interruption lasts. Second, the data set of young women is large enough to perform separate analyses on women for whom we observe the first interruption due to childbirth. For more than 19,000 females we observe wages before first birth, and we observe wages both before and after birth for approximately 11,000 women. Hence, we can use a more homogenous sample of women than previous studies have used and focus on the mean effect of the interruption condition on having a child. Third, the size of data sample allows us to model heterogeneity in the human capital accumulation process by analysing education groups separately. Fourth, the IABS contains information on the firm of employment, in addition to occupation and industry. These can be used to control for

[1] In Stratton (1995), Waldfogel (1998a) and Datta Gupta and Smith (2002), the standard Heckman method is used to control for selection in the wage regression, but these studies do not explicitly focus on the selection of return to work after maternity leave.

heterogeneity in wages and measure mobility specifically, which are important for modelling the human capital accumulation process. We focus on a sample of young women from West Germany, aged 20–39. We split the sample of women into two groups: women with a child (mothers) and childless women (non-mothers). By comparing the results of the two samples, we can derive some crude conclusions regarding the direct child effect. For both subsamples we focus on full-time workers to minimize the impact of adjustment of hours of work. The issue is investigated further by using an additional data set: the German Socio Economic Panel (GSOEP).

Our main results show that the family gap develops very differently across education groups. The family gap for skilled mothers is mainly determined by the duration of career interruption: one year interruption causes on average a decrease in real wages of 7 per cent. For unskilled mother, family gap arises because the return to experience after giving birth is much lower than before, while for graduate mothers childbirth only has a minor impact on wages. Our study also documents that non-mothers have a very different wage process than mothers even before they give birth. These differences add to the family gap. An additional result of our study is that taking account of the non-random selection back to full time work in the wage model of mothers is important for two reasons: First, it affects the estimated size of the family gap and, second, it reveals that those women who actually return are also those women who experience the largest family gap.

The paper is organized as follows. Section 2 contains a short review of the literature. Section 3 describes institutional features of the maternity and parental leave schemes in Germany. Section 4 contains the description of the data. Section 5 provides descriptive results. Section 6 presents the econometric model. Section 7 discusses the estimation results, and finally, in section 8, we present our conclusions.

2 Hypotheses for the family gap

In the literature, different hypotheses for the existence of a family gap have been offered. One hypothesis explains the family gap by heterogeneity among women, especially between mother and non-mothers. Lundberg and Rose (2000) find that, prior to the first birth, mothers earn 9 per cent less than women who remain childless. To deal with this aspect, most of the studies apply a fixed effects estimator in order to remove unobserved characteristics such as taste and ability (e.g., see Waldfogel (1997), Anderson et al., 2002, 2003).

The second hypothesis states that women with children have interruptions to their labour market career because of their maternity leave spell and thereby have less work experience. Waldfogel (1998a) uses actual experience instead of potential experience and still finds a significant family gap for women. A similar approach is used in Datta Gupta and Smith (2002), who do not find evidence of a family gap for Danish mothers. Furthermore, it has been suggested that interruptions in themselves could have negative effects on wages because of depreciation of the human capital (Mincer and Polachek (1974)). Mincer and Polachek (1974, 1978) and Stratton (1995) estimate the depreciation rate to be about 2 per cent per year. Lundberg and Rose (2000) show that earnings are lowered by 5 per cent because of first birth, but the effect goes to zero for continuously working mothers. Albrecht et al. (1999) analyse the effect of an interruption on subsequent earnings using Swedish data. They find an interruption has negative effects.

The choice of sector or type of job has also been suggested as a possible reason for the family gap. If mothers choose to work in sectors or types of jobs that are, in general, characterized by lower payments but, perhaps, also by a more family friendly working environment, this will lead to a family gap. Joshi, Paci and Waldfogel (1999) show that only part of the family gap of British mothers can be attributed to part-time employment. Nielsen et al. (2004) develop a model with endogenous choice between the private and public sector. They find small wage effects in the public sector and negative effects in the private sector in Denmark. In Anderson et al. (2002), the three hypotheses mentioned above are consid-

ered empirically using panel data for the USA. They find that the family gap varies across education groups and that part of the family gap can be explained by differences in human capital variables. These variables account for about 30–60 per cent of the differences, and the remaining part is unexplained. Hence, the unexplained family gap is estimated to range between 0 and 8 per cent. Ellwood, Wilde and Batchelder (2004) additionally show large long run effects of childbirth on wages; they find particularly large losses, 15-20 percent, for high ability women in the USA.

A closely related hypothesis is that job-mobility of mothers is relatively low. If mothers are less likely to search for new jobs because of high search costs, for example, they may remain in jobs that are a bad match and only slowly improve the quality of their job match. Since the fertility period often clashes with the early career, the loss due to motherhood might depend on the timing of childbirth in relation to the labour market career. However, Waldfogel (1998a) and Phipps, Burton and Lethbridge (2001) find that returning to the same employer after maternity leave actually has a positive effect on wages and the size of wage loss due to taking maternity leave depends on whether the woman was covered by a maternity leave scheme through the firm.

The final hypothesis concerns the fact that fertility could be endogenous to the wage process. A number of studies have found that the fertility decision is affected by the previous labour supply and that higher levels of wages have a negative impact on fertility (see Moffitt (1984)) and Heckman and Walker (1990)). However, none of these studies examines whether shocks to the wage process has an impact on the timing of births.[2] The idea is that women who are not promoted or do not succeed in making a good job match may instead choose to have a child, or that women who are successful in their labour market careers might postpone or choose not to have children. Such behaviour would imply that wages start to fall even before maternity leave.

[2]In Moffitt (1984), fertility is assumed to be affected by the female wage only at entrance into marriage. In Heckman and Walker (1990), individual wages are not used in the estimations but, instead, an age-specific average of female hourly wages is used.

We relate to the existing literature by incorporating all the hypotheses into the empirical model in which we analyse short- and long-run wage effects of labour market behaviour around the first birth.[3] We use actual experience before and after birth and allow human capital to depreciate during maternity leave. We control for different type of job and for sector. Furthermore, we explicitly control for mobility and analyse the impact of mobility at different life phases. We also allow wages to start to decline prior to first birth. It should be pointed out that our model allows for much more heterogeneity than the previous studies. Women who will have children might differ from women who remain childless. To deal with this type of heterogeneity, previous studies have included an individual specific effect in the wage regression. However, there are a number of reasons to believe that heterogeneity between mothers and non-mothers not only affects the levels of wages but also the impact of human capital. We allow for such differences by estimating the wage regression separately on a sample consisting only of women where we observe the first birth (sample of mothers) and on a sample of women who remain childless (sample of non-mothers). Furthermore, we also model that the unobserved individual specific effect and the impact of human capital may change in connection with childbirth. Finally, we estimate the wage regression for each education group separately.

3 Institutions: the German parental leave reforms and childcare

International comparisons suggest that Germany, together with the USA and the UK, are countries with a large family gap. It has been suggested that part of the explanation for

[3] An alternative hypothesis not considered in our paper is that women with children invest less effort and, hence, are less productive (see Becker (1985) and Hersch and Stratton (1997)). This hypothesis is investigated by Phipps, Burton and Lethbridge (2001) who argue that the more time women spend on housework and childcare, the less energy they have for their labour market careers. By including numbers of hours spent on unpaid work in the estimation, they find that the family gap declines, but remains significant.

the family gap in Germany is related to the long periods of maternity leave and the low provision of childcare (see Waldfogel (1998b)). Germany introduced six months of maternity leave with benefit payments in 1979 and has increased the duration of leave to three years in 1991. In 97 per cent of all cases, it is the mother who takes parental leave, even though since 1986 fathers can take leave as well.[4] An important feature of the parental leave system is that, during leave, the mother has the option of returning to a job comparable to the job held before pregnancy (protected leave). Hence, the employer must hold the job available until the protected leave expires and cannot dismiss the worker during this period. Another feature of the system is that, during the first six months of leave, compensation is paid in the form of wage and health benefits by the firm and the state.[5] Entitlement to benefits beyond six months has been extended several times since 1986, but is means-tested. Only relatively few parents are eligible. Because of maternity and parental leave, the employer–employee relation is on hold and the employee cannot make direct claims for wage payments. By law, it is forbidden for mothers to work six weeks before and eight weeks after delivery (the maternity protection period).

An overview of the development of the durations of maternity or parental leave granted by law are summarized in Table 1. These are the periods within which mothers can take advantage of a guaranteed workplace. One sees that, for instance, from 1979 to 1986, the leave was extended by four months, from a total of six months to ten months. By the end of 1991, protected leave was granted for three years and has since been constant.

[Table 1]

The coverage of public-provided childcare is very low in Germany. In 1986, the average number of slots for children aged 0–3 years was 10 slots per 1000 children. In 1994, this number had increased to 17 slots per 1000 children (source: German Statistical Office).

[4] For comparison, in the USA, the Family and Medical Leave Act was introduced in 1993. For more details see Waldfogel (1998a).

[5] This also applies to non-working mothers since 1986. Benefits are paid at a low flat rate and independent of pay.

Although the overall provision is very low, there are substantial differences across regions, with some regions providing childcare for about 10 per cent of the children aged up to three years.

4 The data

We extract a sample from the regional file of the IAB employment sample (IABS)[6] for West Germany for the period 1975–1997.[7] The IABS is a 1 per cent random sample drawn from the event history data file of the social security insurance scheme and the employment statistics, collected by the German Federal Bureau of Labour. The fact that the data were collected for administrative purposes is an obvious advantage and makes the data particularly reliable. The IABS contains all workers in West Germany who have had at least one employment spell that is covered by the social security insurance scheme. As a result, all dependent employees in the private sector are included; i.e., about 80 per cent of the total employment in West Germany. Not included are civil servants, self-employed, unpaid family workers and people who are not eligible for benefits from the social security system.[8]

Individual records in the IABS are organized in spells with the calendar date of the start and end. A spell is reported for every change related to the employment and non-employment status. An individual record may therefore contain multiple spells within a year. An employment spell is defined as the period the employee holds a particular position in a particular firm. If the employee changes position within the firm or changes firm, the employment spell ends and a new spell starts. For each spell, characteristics of the job, firm, occupation and the average daily wage over the spell are reported. Moreover, the firm has to report this information by 1 January each year. If the employee is still employed in the same job at the beginning of the year, a new employment spell starts. This leads to individual records with at least one spell per year, if employed, and no employment spell exceeding 1

[6] IABS is an abbreviation for the **I**nstitut für **A**rbeitsmarkt und **B**erufsforschung **S**ample.

[7] We use only wages from the period 1980–1995.

[8] For more details, see Bender et al. (1996).

year.

We generate the variable actual experience by accumulating days of work per year for each individual. To identify interruptions due to maternity/parental leave, we make use of the fact that, technically, every birth leads to a period of not working for the mother. Hence, this is the minimum interruption period reported by the employer and is registered.[9] Interruptions are reported when the employee holds an employment contract with a firm but does not work and, hence, does not receive wages. These non-working periods can be distinguished in the data relating to unemployment. Unemployment is reported in cases where unemployment insurance or unemployment assistance is received. Every status that is not in either of these categories leads to a gap in the individual's record, and will be counted in this study as not working.

The data sample

From the IABS, we generate a sample of female workers aged 20–39 whose post-schooling work history is observed from the beginning and who are full-time employed.[10] A well-known result in the literature on the family gap is that part of the gap is explained by the fact that women with children work fewer hours than women without children. By focusing on full-time workers, we minimize the impact of hours of work, which is not included in the IABS.[11]

We distinguish between three education groups: unskilled workers, skilled workers and

[9] More generally, interruptions may be reported if a worker is absent for a longer period because of health problems, for example. We assume that this does not apply in a significant number of cases for childbearing-age women. The IABS does contain some information on number of children. However, the quality of the variable is very poor for women, and this has been admitted by the data producer. Hence, we cannot include this variable.

[10] Hence, we exclude those who do not start work in a job covered by the social security system after education, and are never in full-time work. Furthermore, we exclude those who start working after education and drop out to non-work or part-time work years before having a child. We expect these to be workers with very low wages or high household wealth. They do not help to explain typical labour market behaviour and, hence, would not add to our analyses.

[11] Full-time is defined as 35 hours per week in the IABS. We keep records of full-time workers until their first part-time job in our sample.

graduates. Unskilled workers are defined as those with nine or 10 years of compulsory schooling[12] and having no additional training at all, or having a shorter education that is less than two years of vocational training or college. Skilled workers are defined as those who have undertaken vocational training within the German dual-system apprenticeship programme and have had 10 years of schooling (intermediate schooling degree). This is a vocational training programme that combines school and work-based educational programmes. This has been the main route into the labour market in Germany, particularly since the 1970s; 60–70 per cent of all workers fall into this category. Graduates are those with 12 or 13 years of schooling and who achieved a technical college degree (3–4 years) or a university degree (4–6 years). In order to generate complete work histories, we assume that graduates are not older than 23 years in 1975, and everybody else is not older than 16 years in 1975.

We split the sample of women into two groups: women with a child, i.e., those for which we observe an interruption associated with childbirth in the data (mother sample); and childless women for which we do not observe an interruption during their labour career (non-mother sample). Specifically, we focus on women who give birth to their first child after labour market entry in our sample period. For these women, we include wage spells before and after the first birth, but observations after the second birth, if observed, are eliminated. Hence, we exclude effects of second and later births. We restrict the sample of non-mothers further such that we only include women who are still childless by age 35.[13]

Wages in the IABS are highly reliable given that they are checked by both data collectors and employees. They are topcoded, as is the case with most administrative data. However, wages in our sample are virtually unaffected by the topcoding; for graduates, we find that only 4.5 per cent of wages are topcoded. For unskilled and skilled, only 0.2 per cent of the wages are topcoded.

In our analyses, the main variables are the log of wages, and the work history variables,

[12] Unfortunately, we cannot distinguish in the data whether individuals graduate after nine or 10 years of schooling from the Hauptschule or Realschule.

[13] We acknowledge that some of these women may have children later than 35.

work experience, and the interruption due to birth of the first child. In fact, we count the total length of the interruption and include parental leave and extended non-working periods related to the birth of the first child. This increases the variation in our interruption variable compared with the parental leave duration stated by law. For a complete list of the variables, see Appendix A1.

As a supplement to these data, we also use survey data from the German Socio Economic Panel (GSOEP). These data are used to investigate the issues about working hours and bonus payments. The GSOEP is a household-based survey data set collected since 1984. We use 17 waves from 1984 until 2001 for West Germany. Panel members aged 16 years or older are asked demographic questions relating to the interview year and a series of labour market questions relating to the previous year. The specific information we use is that respondents give information on income components received in each month of employment, and hours of work distinguished into actual hours of work and official hours of work. To construct a sample as similar as possible to the IABS sample, we select women aged 20–39 who were living in the former West Germany and who have been employed full time. In order to maximize numbers of observations, we used the panel until 2001, instead of cutting off in 1995, and used all individual records instead of constructing complete work histories as in the IABS. This gives us a sample of 1845 women and 7285 observations in total. Using the number of children variable in the GSOEP, we can distinguish childless women and women with children. These data are not without shortcomings. First, the number of observations is much smaller and, second, these data are believed to contain more measurement errors because the data are collected from a survey.

5 Descriptive statistics

To highlight the wage effects around first birth, we show in Figure 1 for our sample of mothers mean wages sorted according to the date of birth. Means are presented separately for each education group. The vertical line represents the year in which maternity leave is taken:

the negative numbers on the x-axis refer to the number of years before the first birth and the positive numbers on the x-axis refer to the number of years after the first birth. As the graph clearly shows, there are strong wage effects around the first birth. First, we observe a dip in wages before birth for unskilled workers and graduates.[14] Second, wages fall more dramatically on return to work after birth, but then seem to recover. Third, although general patterns are similar, slopes in experience before birth as well as the wage drop on return to work differ. More precisely, the mean drop, as reported in table A2.1 in appendix A2, is highest for the skilled, 25 per cent, and lowest for the unskilled, 9 per cent. Although these decreases appear very high, they are confirmed by looking at nominal wages, and would be around one-third higher if returns to part-time work were included.

[Figure 1]

Panel A in Table 2 shows summary statistics on the careers for our samples of mothers, the main sample[15] The table shows that unskilled women have their first child around age 24, whereas the age is 25 for skilled and 29 for graduates. Unskilled and skilled women have 4–5 years of experience before the interruption, and graduates have a little less, around 3.75 years. The average duration of the interruption measured by the total time out of work is around one year for skilled and unskilled mothers and a little lower for graduate mothers.

The data reveal patterns of mobility that are consistent with the incentives set by the parental leave scheme. We measure firm and occupational mobility. Generally, firm mobility is around 13-19 per cent. Just before birth is goes down to 5-6 per cent. Furthermore, we find high firm stability by after-before birth comparison. 80 per cent return to the same firm after birth, which holds across all education groups. One should note that since all women are covered by the national maternity leave scheme, in the following regression analyses we do need to consider non-random selection in and out of firms that offer maternity leave schemes,

[14] A similar dip is found prior to interruptions because of displacement (Jacobson et al. (1993)) and training (Ashenfelter (1978)).

[15] The distribution of education groups shows that graduates are under-represented. The reason for this is that civil servants are not included in the sample.

as is the case in the USA and the UK.[16] We also find great stability of occupational careers. This is less surprising for skilled workers in Germany whose qualifications are closely related to occupational careers. Note that our measure of mobility excludes switches to part-time work.

[Table 2]

5.1 Return to work

From the numbers of individuals reported in table 2 we see that not all women return to full-time work after giving birth. Figure 2 shows in more detail the average probabilies of returning to full-time work for our sample. We distinguish between a return to full-time employment after an interruption connected with childbirth of less than one year, within two years after the birth and within three years. The probability of returning within three years after the birth was about 70 per cent in the beginning of the 1980s and had declined to about 50 per cent at the beginning of the 1990s. Until the mid-1980s, more than half of the women who did return, did so within the first year after the birth and only very few returned between the second and the third years of the interruption. The graph also shows kinks at the points in time when the major reforms of the maternity leave system in 1986 and 1991 took action. These reforms were associated with a decrease in the probability of a woman returning to full-time employment within three years, and an extension in the average duration of the interruption.

[Figure 2]

We also compare characteristics of women who do not return to the labour force within three years with those who return to part-time and those who return to full-time work in Table 3. All summary statistics refer to the last spell before the interruption. We find that unskilled women are more likely to return to full-time work than skilled and graduates. For

[16] See Hashimoto, Percy, Schoellner, and Weinberg (2004).

all education groups, around 20 per cent do not return at all within three years. Across all education groups, those who do not return are a negatively selected group. They have less experience and had lower wages compared with those who return to either part- or full-time work. More surprisingly, descriptives show that those who return to full-time work earned lower wages prior to the birth, are younger and have less experience than women who return to part-time work. This pattern applies to all education groups.

[Table 3]

5.2 Reduction in working hours

Since we can only compare daily wages in the IABS data, the drop in wages around the first birth may be partly due to a reduction in overtime. Unfortunately, we do not have access to information about the actual number of working hours in the IABS sample, and so it is difficult to tell exactly how much a reduction in hours contributes to the loss. As a robustness check of our results, we exploit alternative data sources, which can provide information about the actual working hours. In the survey data set, both the official and the actual working hours are stated for 1995.[17] We select a sample of women aged 20–39 who all report that they work full time (the official working hours are at least 35 hours per week). Then, we compare the actual working hours of those who have children with those without children. On average, the sample without children work 40.1 hours per week,[18] whereas those with children work 39.1 hours per week.[19] Although women without children work one hour more per week, this can only explain a decrease of 2.5 per cent in daily wages. This suggests that only a small part of the wage loss is due to a reduction in working hours. Similar evidence is found using the GSOEP data. From the GSOEP data, we selected a

[17] The survey data were collected by the IAB, Nürnberg and distributed by the Central Archive Unit in Cologne (Zentralarchiv): Erwerbswünsche und Erwerbsverhalten von Frauen in Ost und Westdeutschland, 1995 (in English: Desired Work and Working Behaviour of Women in East and West Germany in 1995).

[18] This number is the average number of working hours based on 480 childless women.

[19] This number is the average number of working hours based on 332 women with children.

sample of women aged 20–39, for whom the birth of their first child is within the sample period. Furthermore, we limit the sample to women who report that their official working hours are above 35 hours both before and after the birth. The advantage of the GSOEP is that we can follow the same women; this means that we can also investigate whether the dip in wages prior to the interruption is due to a reduction in hours (caused by the pregnancy). Table 4 provides the actual and official working hours for those women one and two years prior to the birth and the first year after they return to work. The table shows no changes in actual working hours around the first birth among full-time workers, which indicates that the wage movement around the first birth is not driven by changes in working hours.

[Table 4]

5.3 Bonus payment

To shed more light on the driving forces of the wage movement around first birth, we decompose labour income. In Germany, it is common that part of labour income is paid in different bonus schemes (e.g., "13th month" payments, Christmas payments, holiday payments). Hence, by not working the whole year, workers may forgo part of these bonuses. We use the GSOEP sample because the IABS does not contain such detailed information. The GSOEP data allow us to decompose labour income into regular salary and bonus payments.[20] We focus on women who have been employed full time for the whole year and, for these women, we find that bonus payments amount to about 4 per cent of the total labour income.

[Table 5]

Table 5 shows the labour income for women with and without children. From the table, it can be seen that women with children earn about 10 per cent less than women without

[20] We cannot decompose wages into regular salary and bonus payments; therefore, we use annual labour income.

children. However, from the table, we can also see that the decrease in labour income is not equally distributed between regular salary and bonus payment. The regular salary is about 9 per cent lower for women with infants, but their bonus payments are 25 per cent lower. For women with older children, the differences between bonus payments and regular payments is even more pronounced.[21] The figures in the table indicate that part of the drop in wages around the first birth is due to a substantial decrease in bonus payments. However, this cannot explain the entire drop in wages.

A third explanation for the drop may be that women may work during evenings, nights and weekends before they have children, whereas, after giving birth, women concentrate their working hours during daytime and weekdays. Since work during evenings, nights and weekends normally pays a higher wage, this change in working behaviour will lead to a drop in wages for women before and after childbirth.

6 The econometric framework

In this section, we specify an econometric framework to estimate short- and long-run wage effects of labour market behaviour around the first birth. The wage model is based on the human capital model (see Becker (1964) and Mincer (1974)), but we allow the model to be more flexible in several aspects. First, the functional form allows that the return from experience and the impact on mobility can vary over different life phases: before first birth, in relation to the return decision, and after first birth. This extends the approaches by Mincer and Polachek (1974), Lundberg et al. (2000) and Stratton (1995). Second, like Jacobson et al. (1993) who model wages for workers around displacement, we allowed wages to decline just before and after the interruption. Third, we allow effects to vary across education groups. Anderson et al. (2002) has documented differences with respect to the direct child penalty across education groups, which captures heterogeneity in the human

[21] For women with children aged two years or older, the regular salary is about 7 per cent lower than childless women, and the bonus payments are 30 per cent lower.

capital accumulation and the depreciation process. Finally, we take into account unobserved heterogeneity, as well as non-random selection of the decision to return to work after the first birth. In the empirical analyses, we estimate the wage model in first differences to address individual specific time invariant effects, and we employ a three-step estimator to control for non-random return to work after birth and endogeneity of the duration of the leave variable.

Assume that a woman i gives birth at the end of time period t_i^P and is working in period $t < t_i^P$.[22] Furthermore, let t_i^A be the period she returns to full-time work after birth, where $(t_i^P < t_i^A)$. For simplicity, once she is back in work she stays working in periods $t > t_i^A$. Let w_{it} denote the wage of a woman i in period t. Wage payments are observed for every period t, except for the periods between t_i^P and t_i^A since leave is unpaid.

We specify wage equations where coefficients are allowed to vary across the three phases: the pre-birth phase $(t \leq t_i^P)$, the return to work phase $(t = t^A)$ and the after birth phase $(t > t^A)$. The wage equations in levels for each phase are as follows.

$$\ln w_{it} = X_{it}\beta^P + \mu_i + \varepsilon_{it} \quad t \leq t_i^P \tag{1}$$

$$\ln w_{it} = X_{it^P}\beta^P + (X_{it} - X_{it^P})\beta^I + \delta m_{it} + (\mu_i + \gamma_i) + \varepsilon_{it} \quad t = t_i^A \tag{2}$$

$$\ln w_{it} = X_{it^P}\beta^P + (X_{it^A} - X_{it^P})\beta^I + (X_{it} - X_{it^A})\beta^A + \delta m_{it} + (\mu_i + \gamma_i) + \varepsilon_{it} \quad t > t_i^A \tag{3}$$

The first equation states the wage profile before first birth. Wages are determined by a vector of observed controls, X; e.g., experience. The second equation specifies wages in the return phase; i.e., the first period after the woman returns to work after maternity leave. In addition to wage effects caused by the controls in X, we allow for a potential wage loss through leave, through depreciation of human capital, where δ is the rate of depreciation. To model this, we include the duration of the interruption connected with birth, m. The third equation states the wage profile after the first birth. Since we model wages only until the second birth, wages are again determined by observed controls in X and the duration

[22] We assume that the timing of fertility is exogenously given. We acknowledge that this is a strong assumption, but finding a valid instrument for timing of fertility is difficult (see Ellwood et al (2004) for a nice discussion of instruments for fertility).

of leave. Additionally, in all equations, we include an individual specific effect that is time invariant, and a disturbance term ϵ with mean zero and constant variance. The individual effect μ_i captures general unobserved ability or preferences for work, which may be correlated with some of the included controls in X.

In extension, we consider that the unobserved individual effect can change after birth and the change may differ across mothers. To capture the change in the individual specific effect, a second individual effect γ_i is added after birth. One can motivate this extension by considering that, for example, among highly motivated career-orientated women, some may become less motivated whereas others are almost unaffected. Furthermore, it is likely that those who become less motivated after birth are also those who do not return to full-time work after maternity leave. This leads to the next issue, namely, that we only observe the last two equations if a woman returns to work after birth, and the decision to return is likely to be non-random. Furthermore, this makes the duration of leave endogenous since this is a censored variable for those not returning. Estimating equations (2) and (3) without taking account of the selection problem will yield biased estimates of the coefficients for the controls during the return phase.

Before continuing, we show that the standard approach, where the model is estimated in first difference, does not take this problem into account. Let s_{it} be an indicator, such that $s_{it} = 1$ if the woman i returns to work after an interruption at the time t connected with childbirth. The model in first differences is given by:

$$\Delta \ln w_{it} = \Delta X_{it/}\beta^P + \Delta\varepsilon_{it} \quad t \leq t_i^P \tag{4}$$

$$\Delta \ln w_{it} = \Delta X_{it/}\beta^I + \delta m_{it} + \gamma_i + \Delta\varepsilon_{it} \quad t = t_i^A, s_{it} = 1 \tag{5}$$

$$\Delta \ln w_{it} = \Delta X_{it/}\beta^A + \Delta\varepsilon_{it} \quad t > t_i^A, s_{it} = 1, \tag{6}$$

where $\Delta \ln w_{it_i^A} = \ln w_{it_i^A} - \ln w_{it_i^P}, \Delta X_{it_i^A} = X_{it_i^A} - X_{it_i^P}$.

Hence, the individual fixed effects cancel out in the first and the last equation, but γ_i remains in the second equation.

To deal with non-random selection of returning to work after maternity leave and the

endogeneity of the duration of leave, we need to complete the model by adding two equations: one equation describing the return to work after maternity leave (selection equation) and one equation of the endogenous variable. The two equations are given by:

$$m_{it} = Z_{it}\tau + v_{2it} \quad s_{it} = 1 \tag{7}$$

$$s_{it} = 1_{\{Z_{it}\rho + v_{3it}\}}, \tag{8}$$

where Z is a set of instruments. The instruments we are using exploit changes in the rules of maternity leave, regional variation of the availability of childcare and regional variation in unemployment rates. The crucial assumptions of the model are:

$a)$ $E(\Delta\varepsilon_{it}|\Delta X_{it}) = 0 \quad t \leq t_i^P$

$b)$ $E(\Delta\varepsilon_{it}|\Delta X_{it}, s_{it} = 1) = 0 \quad t > t_i^A$

$c)$ $(\Delta\varepsilon_{it_i^A}, \gamma_i, v_{2it}, v_{3it})$ is independent of Z_{it} and has mean of zero

$d)$ $v_{3it} \sim N(0,1)$

$e)$ $E(\gamma_i|v_{3it}) = \phi v_{3it}$.

Assumptions a) and b) state that the change in the controls is an exogenous variable, both before and after giving birth. These assumptions imply that changes in experience are exogenous variables, which means we ignore labour supply effects other than those connected with childbirth. This means, for example, that we assume that unemployment is not correlated with the time varying shock, ε_{it}.[23] Assumption a) seems a little problematic given that young childless women have a very high participation rate. Additionally, the level of unemployment in our sample is low. Moreover, conditional on the fact that a woman returns to work after birth (the non-random selection effect that we model), a woman may again decide in every period after birth whether to work or not; the latter may again induce non-random selection, which we neglect. However, notice that we can allow experience to be correlated with the individual specific effect (as preferences for work). Assumption c) states that Z_{it} is a valid set of instruments. This assumption will be discussed in detail below. Assumption d) is the usual distributional assumption that implies that the selection equation is a probit model.

[23] Variation in the change in experience could be caused by unemployment.

The last assumption allows that the individual effect may have an impact on whether the woman returns to full-time work or not. If, for example, ϕ is positive, it can be interpreted as those who are most likely to return are also those who have high productivity after birth.

Choice of instruments

We use three sets of exclusion restrictions for identification. First, we exploit changes in the legislation of maternity leave. During our observation period, the protected period has been extended a number of times. As shown in the previous section, these changes are correlated with the probability of mothers deciding to return to full-time work. In order to use the policy reform as an instrument, we need to verify that this reform did not affect the wages of mothers. The critical point is whether firms, as a response to the increased labour costs through the extension of parental leave, lowered wages of mothers. Since firm are constraint by existing contracts, firms may have illegally paid mothers less when they returned after maternity leave. However, very few cases of mothers going to court are known to us for Germany. Furthermore, the overall gender wage gap did not increase during this period. The instrumental variable we define is the duration of the protected period the woman is entitled to, which depends on the year and month she gives birth. To use this instrument efficiently, we have transformed the variable into five dummy variables and control for child care availability. Hence, we argue that the choice of the duration of leave depends on legislation changes given the availability of childcare. Second, we use regional and time variation of the availability of childcare. The instrumental variable we define is the number of slots for children aged up to three years per 100 children in that age group. Third, we use the local unemployment rate, which has also been used as an instrument for labour supply (for an overview, see Neumark and Korenman (1994)). However, in this particular context, we expect a high local unemployment rate to have a positive impact on the probability of returning to work within the protection period, because then the job in the firm is guaranteed.

Estimation procedure

We apply a three-step estimation procedure to the wage model in first differences. First,

we estimate a probit model (equation (8)) for the decision to return to full-time work after first birth. Here, we use all women observed during the pre-birth phase until entry into leave. As regressors, we include all instrumental variables plus the exogenous variables from the pre-birth phase. On the basis of these estimates the inverse Mills ratio ($\hat{\lambda}_i = \lambda(Z_{it}\hat{\rho})$) is calculated. Second, we estimate an auxiliary reduced form equation for the endogenous variable duration of leave, where we also include the predicted inverse Mills ratio. The regressors are the same as in step one otherwise. This is an approach adopted from Wooldridge (2002, pp. 567–568). Third, the predicted residuals from this regression are then added to the main equation, which includes controls for the three phases. It is estimated by OLS, which gives the TSLS estimator and is generally consistent, given that the exclusion restrictions are valid. To examine the validity of the instruments, we perform a test for weak instruments and a Sargan test for over-identification.

In the empirical implementation, we also allow effects to vary during the three years prior to birth.[24] More particularly, we estimate the following regression:

$$\begin{aligned}
\Delta \ln w_{it} \;=\; & \alpha_1^P(1_{t\leq t^P}\Delta x_{it}) + \alpha_2^P(1_{t\leq t^P}\Delta x_{it}^2) \\
& + \alpha_3^P(1_{t^P-3<t<t^P}) + \alpha_4^P(1_{t^P-3<t<t^P}\text{firm change}_{it}) + \alpha_5^P(1_{t^P-3<t<t^P}\text{occup. change}_{it}) \\
& + \delta_1^I(1_{t=t^A}m_{it}) + \delta_2^I(1_{t=t^A}\text{firm change}_{it}) + \delta_3^I(1_{t=t^A}\text{occup. change}_{it}) \\
& + \beta_1^A(1_{t>t^A}\Delta x_{it}) + \beta_2^A(1_{t>t^A}\Delta x_{it}^2) \\
& + \zeta_1(\text{firm change}_{it}) + \zeta_2(\text{occup. change}_{it}) + \text{year dummies} + \text{industry dummies} \\
& + \gamma_i 1_{t=t^A} + \Delta\varepsilon_{it},
\end{aligned}$$

where x_{it} is labour market experience. The variables firm change$_{it}$ and occup. change$_{it}$ are indicator functions for a change of firm or occupation between t and $t-1$.[25] These variables are included in order to capture the effect of mobility. The parameter of the models are: α parameters refer to the pre-birth phase, δ parameters to the return phase, β parameters to the after birth phase, and finally, ζ parameters are for general controls. We have also tried

[24] Different specifications have been tried, but the main results hold.

[25] Exact definitions of the variables are given in Appendix Table A1.1.

a non-linear term in the duration of interruption but the results were almost unchanged.[26] This specification is estimated on the sample of mothers, where we define mothers who do not return to full-time work within three years after giving birth as non-returners. The more parsimonious model is estimated by OLS for the non-mother sample.

7 Estimation results

7.1 Estimation for mothers

The estimation results of the probit model (see Table 6) show that, even when labour market characteristics are held constant, the result shown in Figure 2 remains; that is, the probability of returning to full-time work decreases with the expansion of the parental leave policy. Moreover, the coefficient of the regional unemployment rate is positive and significant for all education groups. This result is consistent with the hypothesis that, in periods with high unemployment, mothers are more likely to return (within the protection period) in order to keep their job, whereas, with low unemployment, the option to return to the job is less valuable. The variable measuring the availability of childcare is only significant and positive for skilled women. A joint test for the explanatory power of the instruments shows that the instruments are highly significant in all cases. In Table 7, we present the estimation results of the duration of interruption connected with the birth.[27] The test for weak instruments clearly shows that the instruments do explain the variation in the duration of the interruption.

[Table 6]

[Table 7]

[26] We have tried using dummy variables and a polynomium instead of including the duration as a linear function. Furthermore, we have also tried to include a dummy for childbirth and the duration of the interruption.

[27] The result in this estimation is not easy to interpret since the estimated inverse Mills ratio is included.

In Table 8, the IV estimation results for the three-phase wage model are presented, using the estimated inverse Mills ratio based on the results from Table 6 and including the residual from the auxiliary regression in Table 7. Statistical tests confirm the significance of the inverse Mills ratio[28] and we can reject the exogeneity hypothesis of the duration variable.[29] Results document negative selection into full-time work, as found earlier in the descriptives, see Table 3. If we ignore the selection and estimate our model by first differences losses are still as high as 8–21 per cent for a one-year interruption (see Table A2.2 in Appendix A2), whereas, if we account for selection and the endogeneity of the duration variable, these numbers fall to 0–7 per cent.[30] Negative selection in our model implies that those mothers who discover negative changes in their unobserved individual characteristics (like productivity or preferences for work) after birth are also more likely to return to full time work.[31] A possible explanation for these somehow surprising findings is that mothers with high productivity after birth go into part time work.

[Table 8]

A comparison of the indirect effects of the first child shows large differences between the education groups. Most compelling effects of children are found for skilled mothers, the largest education group. Here, we find negative effects due to mobility even prior to birth. Changing occupation three years prior to birth has a negative effect of about 0.4 per cent; whereas, changing occupations, in general, has a positive impact on wages.[32] An

[28] Both Waldfogel (1998a) and Datta Gupta and Smith (2002) perform an analysis where sample selection into work is taken into account. They do not find that the results change. Stratton (1995) finds that the depreciation rate even increases when she controls for sample selection. However, these studies do not explicitly focus on the return decision after childbirth and use data for countries (USA and Denmark) with a higher labour force participation of mothers.

[29] The robust Sargan test for over-identification is not rejected for any of the education groups.

[30] The remaining estimates show little change when we correct for selection back to work.

[31] Changes in unobserved characteristics are modelled in our econometric framework as γ_i (see section 6). Assumption e) implies that the coefficient of the inverse Mills ratio,ϕ, relates to the correlation between the error term in the selection equation,ν_{3it}, and γ_i.

[32] The effect is calculated as the general effect from changing occupation 1.8 – 2.2 = –0.4.

explanation for this could be that, prior to birth, women choose jobs that pay less but instead offer a family friendly work environment. We find a very small "unexplained dip" at 0.5 per cent three years prior to birth.[33] A relatively strong effect of children for skilled mothers is associated with the interruption connected with childbirth. Here, we find that wages decrease by almost 7 per cent for one year of interruption. Compared with previous international studies, the rate of depreciation is very high for skilled German mothers. Furthermore, we find an indirect effect of children for skilled mothers through a decreasing return from experience after birth. Before birth, the return from increasing the level of experience from three to four years is 6.4 per cent, but the equivalent number after birth is 5.6 per cent.[34] Our estimates of the return due to experience are in line with what others have found.[35] This means that there is no rebound effect; in fact, it is the opposite.[36]

For unskilled mothers, a wage loss related to first child arises if their change of firms is connected with birth; wages seem to decrease 7 per cent, although the estimate is not significant. Similar results were found for the USA (see Waldfogel (1998a)) and for Canada (see Phipps, Burton and Lethbridge (2001)). This suggests that staying with the same employer may act as a type of insurance against income loss of unskilled mothers, but it does not have the same impact for skilled or graduate mothers. We also find that the return from experience falls after giving birth. The return from increasing the level of experience from three to four years is 6.1 per cent before birth and only 2.6 after birth. Therefore, the family gap for unskilled mothers does not arise immediately but increases over the years after the first birth.

[33] Lundberg and Rose (2000), Waldfogel (1998a) and Ellwood et al. (2004) have also examined if there is a dip prior to birth. Neither of the these studies found a significant effect.

[34] For this sample, the average level of experience for all education groups is between 2 and 3.3 years.

[35] For comparison, Dustmann and Meghir (2002) find that the return from experience for young male Germans with a completed apprenticeship starts from about 7 per cent and drops to 1.5 per cent within four years.

[36] These effects however do not take account of the fact that some women may have a second birth after the end of the observation window which is another source of non-random sample selection.

The graduate mothers do not experience a wage loss related to birth;[37] there is no loss in connection with childbirth, and if anything, the return from experience increases after birth. This result is somehow surprising, since one would expect a higher depreciation of human capital for this group. It is in line, however, with Anderson et al. (2002), who found almost no family gap associated with one child for college graduates in the USA.[38]

7.2 Estimations for non-mothers

In order to evaluate differences between mothers and non-mothers wage, we present a comparison between the two groups. Descriptives presented in Panel B Table 2 reveal that the entry wages for non-mothers are much higher than for women who will later have children; unskilled non-mothers earn on average 20 per cent more than women who have children later. For skilled workers, the difference is 25 per cent and for graduates 19 per cent. Hence, mothers and non-mothers even with the same formal education are different from the beginning of careers. Similar evidence for unobserved heterogeneity was as well shown for the USA in Lundberg and Rose (2000), who find however smaller differences at 9 per cent.

We estimate the same wage equation as for mothers, with the exception that all the variables relating to child birth are omitted. The estimation results from first difference estimation in Table 9 show that the return from experience is positive and decreases with the level of experience. The return from experience for unskilled non-mothers is lower than the return for unskilled mothers before they give birth but is higher than their return after they return to work. For skilled women, non-mothers always have lower return from experience, whereas the opposite is the case for graduates.[39] Another difference between non-mothers

[37] None of the variables associated with childbirth are significant (neither from a statistical nor from an economic point of view).

[38] Anderson et al. (2002) found that a considerable family gap was associated with having two or more children for female college graduates in the USA; however, it could be entirely explained by the interruption connected with childbirth.

[39] We tested whether experience profiles are significantly different. The F-test statistics are as follows: for unskilled 12.9, for skilled 781.3 and graduates 28.7. For the skilled differences are weakly significant.

and mothers is that the gain from changing firms is smaller for the non-mothers. Hence, the comparison of entry wages and wage growth suggests that non-mothers have a very different wage process than do mothers before they have children.

[Table 9]

8 Concluding remarks

In this paper we have applied a flexible wage regression framework to analyse the sources of family gap. We use rich longitudinal data on women in West Germany for the mid 1970s to the late 1990s. Our empirical analyses extends the standard approaches in four directions. First, the model allows for more heterogeneity than previous studies. Differences between mothers and other women as well as differences across education groups are incorporated. Second, we model the indirect effects of children through the impact of an interruption connected with birth, mobility and return to experience such that the impact can vary across different phases around birth. Third, we explicitly control for the non-randomness in the decision to return to full-time work after birth and the endogeneity of the duration of leave in connection with childbirth. Finally, to identify the effect of the interruption, we use a policy reform of the parental leave system, availability of childcare and local unemployment rates as instruments.

Our study has shown several sources of family gap. Generally, we document that the sources of family gap vary across education groups and phases around birth. We show robust evidence that skilled women experience substantial wage loss directly through the duration of leave, which however is an unimportant source for the unskilled and the graduates. For the unskilled and the skilled, the family gap increases over time becauses women change after birth to jobs with lower returns to experience. Only graduates seem to catch up in terms of wages after birth. Additional sources of family gap are differences between mothers and non-mothers. While we do not model the fertility descision and hence cannot estimate directly the overall family gap, we have shown that entry wages and wage processes are very

different for these two groups. Finally, we show that the non-random selection process back to work after birth is complex and can increase family gap further. We find that raw losses look very large in our sample, and this is because those who return to full-time work have relatively less favourable labour market characteristics. As a novel aspect of sources of family gap, negative selection in our framework implies that these mothers must also experience negative changes in their unobserved individual specific characteristics.

Our results also allow us to draw conclusions regarding the design and evaluation of parental leave policies. Our analysis sheds light on two aspects of the mechanisms of parental leave policies: The first aspect is the guarantee that workers can return to the same firm within a certain period after the birth. Our empirical analysis shows that while overall firm mobility is positively related to wages, firm mobility in connection with childbirth is not. This indicates that the job guarantee is one way to fight family gap. A second, and critical, aspect of such policies is for how long the guarantee to return to the previous firm is granted. We show that losses associated with the duration of leave can be extremely large and on average not the most productive workers stay in the labour market. While our study only allows partial statements, not including e.g. effects through tax systems and dynamic labour supply, it suggests that long parental leave may have detrimental effects directly on labour market attachment and indirectly on wages.

References

[1] Albrecht, James W., Per-Anders Edin, Marianne Sundström and Susan B. Vroman (1999): Career Interruptions and Subsequent Earnings: A reexamination using Swedish Data, *Journal of Human Resources*, 34(2), pp. 294–311.

[2] Anderson, Deborah, Melissa Binder and Kate Krause (2002): The Motherhood Wage Penalty: Which Mothers Pay It and Why?, *American Economic Review*, 92(2) 354–358.

[3] Anderson, Deborah, Melissa Binder and Kate Krause(2003): The motherhood wage penalty revisited: experience, heterogeneity, work effort, and work-schedule flexibility, *Industrial and Labor Relation Review* 56(2), pp. 273–294.

[4] Ashenfelter, Orley (1978): Estimating the Effect of Training Programs on Earnings, *Review of Economics and Statistics*, 60(1), pp. 47–57.

[5] Becker, Gary (1964): *Human Capital – A Theoretical and Empirical Analysis with Special Reference to Education*, Chicago University Press, 3rd edition, 1993.

[6] Becker, Gary (1985): Human Capital, Effort, and the Sexual Division of Labor, *Journal of Labor Economics*, 3(1), pt. 2, pp. S34–S58.

[7] Bender, Stefan and Jürgen Hilzendegen, and Götz Rohwer and Helmut Rudolph (1996): Die IAB-Beschäftigtenstichprobe 1975–1990 – The IAB employment sample 1975–1990, BeitrAB 197, Institut für Arbeitsmarkt- und Berufsforschung, Nürnberg.

[8] Datta Gupta, Nabanitta and Nina Smith, (2002): Children and Career interruptions: The Family Gap in Denmark, *Economica*, 69, pp. 609–629.

[9] Dustmann, Christian and Costas Meghir (2005): Wages, Experience and Seniority, *Review of Economic Studies*, 72(1), pp.77-108.

[10] Ellwood, David; Try Wilde and Lily Batchelder (2004): The mommy track divides: The impact of childbearing on wages of women of differing skill levels, mimeo, Harvard University, March 2004.

[11] Hashimoto, Masanori, Rick Percy, Teresa Schoellner, and Bruce A. Weinberg (2004): The long and short of it: Maternity leave coverage and women's labor market outcomes, IZA DP 1207.

[12] Heckman, James J. and James R. Walker (1990): The Relation between Wages and Income and the Timing and Spacing of Births: Evidence from Swedish Longitudinal Data, *Econometrica* 58(6), pp. 1411–41.

[13] Hersch, Joni and Leslie Stratton (1997): Housework, Fixed Effects, and Wages of Married Workers, *Journal of Human Resources*, vol. 32(2), pp. 285–307.

[14] Jacobson, Louis, Robert J. LaLonde and Daniel G. Sullivan (1993): Earnings Losses of Displaced Workers, *American Economic Review*, 83(4), pp. 685–709.

[15] Joshi, Heather, Pierella Paci and Jane Waldfogel, (1999): The Wages of Motherhood: Better or Worse?, *Cambridge Journal of Economics*, 23(5), pp. 543–64.

[16] Korenman, Sanders and David Neumark (1992): Does marriage really make men more productive?, *Journal of Human Resources*, 26, pp.262–307.

[17] Lundberg, Shelly and Elaina Rose (2000): Parenthood and the Earnings of Married Men and Women, *Labour Economics*, 7(6), pp.689–710.

[18] Mincer, Jacob (1974): *Schooling, Experience and Earnings*. New York: Columbia University.

[19] Mincer, Jacob and Solomon Polachek (1974): Family Investment in Human Capital: Earnings of Women, *Journal of Political Economy*, 82(2), (supplement), pp. S76–S108.

[20] Mincer, Jakob and Solomon Polachek (1978): Women's Earnings Reexamined, *The Journal of Human Resources*, 13(1), pp. 118–134.

[21] Moffitt, Robert (1984): Profiles of Fertility, Labour Supply and Wages of Married Women: A Complete Life-Cycle Model, *Review of Economic Studies* 51(2), pp. 263–278.

[22] Nielsen, Helena Skyt, Marianne Simonsen and Mette Verner (2004): Does the Gap in Family-Friendly policy drive the Family gap?, *Scandinavian Journal of Economics*, 106(4) pp. 721–44.

[23] Phipps, Shelley, Peter Burton and Lynn Lethbridge (2001): In and out of Labour Market: Long-term Income Consequences of Child-Related Interruptions to Women's Paid Work, *Canadian Journal of Economics*, 34(2), pp. 411–429.

[24] Stratton, Leslie (1995): The Effect of Interruptions in Work Experience Have on Wages, *Southern Economic Journal*, 61(4) pp. 955–70.

[25] Waldfogel, Jane (1997): The Effect of Children on Women's wages, *American Sociological Review*, 62(2) pp. 209-217.

[26] Waldfogel, Jane (1998a): The Family Gap for Young Women in the United States and Britain: Can Maternity Leave Make a Difference?, *Journal of Labor Economics*, 16(3), pp. 505–45.

[27] Waldfogel, Jane (1998b): Understanding the "Family gap" in Pay for women with children, *Journal of Economic Perspectives*, 12(1) pp. 137–56.

[28] Wooldridge, Jeffrey M. (2002): *Econometric Analysis of Cross Section Panel Data*. The MIT Press.

A Appendix

A.1 Data appendix

A.1.1: List of variables

Variable Name	Definition	Construction
IABS sample/Main variables		
Wage	Daily wage	Income during a spell (max. 1 year) divided by number of days of work (incl. weekends)
Age	Age	Year minus year of birth
Education	Education level at entry into work	Constructed from BILD variable
Education group	Unskilled/low skilled, skilled, graduates measured at entry into work	Skilled=with 450 days of apprenticeship, graduates=tech. college/university
Firm change	1=firm stayer, 0=mover	Changes in number of firm variable
Occupation changes	1=occupation stayer, 0=occupation mover	Changes in three-digit occupation variable (Code 0-117)
Experience	Years of full-time work experience	Accumulated length of spells (day/month/year) in employment
Unemployment	(Days of unemployment)/365	Accumulated length of spells (day/month/year) in unemployment
Parental leave interruption	Days of parental leave interruption/365	Accumulated length of spells (day/month/year) in interruption
Other interruptions	(Gaps in individual records)/365	Summarize residual group of non-work
Duration of interruption	Sum of parental leave interruption and other interruptions	
Total time out of work	Total non-work time	$\sum$=(days of unemployment + days of parental leave interruption + days of gaps in the record)/365)

Variable Name	Definition	Construction
IABS sample/Main variables		
Industries	13 aggregated industry sectors distinguished (1: agriculture, gardening, energy, mining; 2: Natural products and goods production; 3: investment goods production; 4: Consumer goods production; 5: Nutrition; 6: Construction; 7: Building trade; 8: Trade; 9: Transport and communication; 10: Mainly industry's services; 11: Mainly private household's services; 12: Society related services; 13: Social security; 99: missing.	WZWG variable
GSOEP 1984–2001		
Regular salary	Annual regular salary	12*(monthly regular salary)
Bonus payments	Annual bonus payment	13th and 14th month salary, Christmas and vacation bonus, profit share, premium, other bonuses
Total labour income	Total labour income	Regular income + bonus payments

A.2 Tables

Table A2.1: Descriptive statistics on the mean wage loss in percentages
(standard errors are reported in parentheses)

	All	Firm stayer	Firm and occupation stayer
	Unskilled/Low skilled		
Full-time, Real Loss	9.7	8.8	9.0
	(.010)	(.011)	(.011)
Full- and Part-time, Real Loss	16.3	13.2	13.3
	(.009)	(.009)	(.01)
Full-time, Nominal Loss	7.4	7.1	7.3
	(.01)	(.011)	(.011)
	Skilled		
Full-time, Real Loss	24.3	25.0	25.2
	(.007)	(.008)	(.008)
Full- and Part-time, Real Loss	33.7	31.5	31.3
	(.005)	(.006)	(.006)
Full-time, Nominal Loss	21.9	23.3	23.5
	(.007)	(.008)	(.008)
	Graduates		
Full-time, Real Loss	16.9	18.2	18.4
	(.028)	(.03)	(.03)
Full- and Part-time, Real Loss	25.3	24.0	23.8
	(.02)	(.022)	(.022)
Full-time, Nominal Loss	14.9	16.8	17.0
	(.028)	(.03)	(.03)

Notes: Data Source: IABS sample of young women. The loss is calculated as the mean of the difference between the log (real wage) in the last spell before the first interruption and the first spell after the interruption. Standard errors are in parentheses.

Table A2.2: First difference estimation results of the three-phase model

	Unskilled		Skilled		Graduates	
	Controls before first birth					
ΔExperience	.081*	(.006)	.095*	(.003)	.0322*	(.010)
$\Delta\text{Experience}^2$	-.004*	(.003)	-.006*	(.001)	-.002*	(.001)
Firm change within 3 years before mat. leave	.001	(.014)	-.009	(.005)	.0001	(.029)
Occupation change within 3 years before mat. leave	.033	(.016)	-.022*	(.008)	-.011	(.044)
Within 3 years before mat. leave (DIP)	-.012*	(.003)	-.011*	(.001)	-.013*	(.006)
	Controls in connection with first birth					
Duration of interruption	-.082*	(.004)	-.212*	(.007)	-.123*	(.026)
Firm change* (mat. leave)	-.067	(.042)	-.028	(.020)	-.012	(.091)
Occ. change*(mat.leave)	-.010	(.043)	-.017	(.027)	.044	(.104)
	Controls after first birth					
ΔExperience	.010	(.008)	.012	(.006)	-.062*	(.023)
$\Delta\text{Experience}^2$	-.001*	(.004)	-.003*	(.0001)	-.001	(.001)
	General controls					
Firm change	.066*	(.008)	.090*	(.003)	.085*	(.020)
Occupation change	.005	(.010)	.014	(.005)	.025	(.035)
ΔYear dummies	Yes		Yes		Yes	
ΔIndustry dummies	Yes		Yes		Yes	
Number of observation	30,368		107,072		5,970	
Number of individuals	4,145		13,922		868	
R-squared	0.073		0.112		0.312	

Notes: IABS 1981–1995, sample of full-time working women with first birth in 1981–1992
Numbers in parentheses are robust standard errors accounting for heteroskedasticity and serial correlation.
* significant at the 5 per cent level.

B Tables and figures

Table 1: German maternity/parental leave policy, 1968–2001

Children born since...	Months of leave reserved to the mother (maternity leave)	Additional months of leave (parental leave)	Months of entitlement to maternity/parental leave benefits∗
..1968	2	0	0
..1979	2	4	6
..1986	2	8	10
..1.1.1987	2	10	12
..1.7.1989	2	13	15
..1.7.1990	2	16	18
..1.1.1992	2	34	18
..1.1.1993	2	34	24
..1994	2	34	24
..1996	2	34	24
..1.1. 2001	2	34	24

Notes: Periods are counted from the birth of the child. Maternity leave is reserved to the mother, although parental leave can be taken by the father as well since 1986.
∗ Benefits are means tested from 6th month onwards.

Table 2: Means: full-time mothers with one birth,* and comparison group of full-time non-mothers**
(standard deviations in parentheses)

Variable	PANEL A: Sample of women with one birth				PANEL B: Comparison non-mothers
	All observations before 1st birth	Last observation before 1st birth	First observation after 1st birth	All observations after birth	All observations pooled
			Unskilled		
Age	22.83 (3.58)	24.16 (3.75)	24.56 (3.72)	26.28 (4.07)	29.40 (4.34)
Experience (yrs)	3.30 (3.21)	4.33 (3.53)	4.53 (3.29)	5.87 (3.76)	7.33 (5.06)
Total time out of work (yrs)	0.66 (1.33)	0.71 (1.46)	1.74 (2.03)	2.17 (2.40)	1.74 (3.07)
Firm changes (per cent)	0.16 (0.37)	0.06 (0.24)	0.18 (0.38)	0.18 (0.39)	0.15 (0.36)
Occupation changes (per cent)	0.13 (0.34)	0.06 (0.24)	0.16 (0.36)	0.14 (0.35)	0.12 (0.32)
Log (entry wage)	4.17 (0.43)				4.37 (0.37)
Number of observations	31028	4269	2794	12784	5791
Number of individuals	5393	4269	2794	3236	513
			Skilled		
Age	23.57 (3.29)	25.44 (3.37)	26.02 (3.42)	27.22 (3.69)	29.25 (4.40)
Experience (yrs)	3.37 (3.00)	4.93 (3.30)	5.13 (3.12)	6.16 (3.51)	7.37 (4.88)
Total time out of work (yrs)	0.27 (0.82)	0.33 (0.95)	1.36 (1.68)	1.58 (1.79)	0.80 (1.90)
Firm changes (per cent)	0.16 (0.37)	0.05 (0.22)	0.19 (0.39)	0.13 (0.33)	0.12 (0.33)
Occupation changes (per cent)	0.09 (0.29)	0.04 (0.14)	0.12 (0.32)	0.06 (0.25)	0.07 (0.26)
Log (entry wage)	4.23 (0.42)				4.48 (0.34)
Number of observations	128879	14144	7411	26100	10138
Number of individuals	18653	14144	7411	7897	822
			Graduates		
Age	27.77 (3.75)	29.84 (3.37)	30.58 (3.46)	32.25 (4.04)	33.58 (4.17)
Experience (yrs)	2.48 (2.59)	3.75 (2.80)	4.14 (2.61)	5.71 (3.61)	4.50 (4.02)
Total time out of work (yrs)	1.27 (2.24)	1.29 (2.29)	2.07 (2.60)	2.05 (2.39)	1.34 (2.42)
Firm changes (per cent)	0.16 (0.36)	0.05 (0.22)	0.13 (0.34)	0.13 (0.34)	0.13 (0.33)
Occupation changes (per cent)	0.09 (0.29)	0.04 (0.20)	0.08 (0.28)	0.06 (0.24)	0.06 (0.25)
Log (entry wage)	4.69 (0.47)				4.88 (0.39)
Number of observations	7344	880	485	1652	4584
Number of individuals	1277	880	485	521	492

Notes: Data Source: IABS sample of young women. The sample includes wage and non-wage spells. Means are reported for wage spells. * The sample includes records before and after the first birth, excluding periods after a second interruption. *∗ The comparison group is defined as women who have had no child by the age of 35, conditional on the fact that we observe them in the data until age 35.

Table 3: Comparison between women who return within 3 years and those who do not return

	Log (wage) before 1st birth	Age before 1st birth	Experience before 1st birth	No. of observations (%)
	Unskilled/Low skilled			
Not return	4.371 (.020)	23.661 (.149)	3.828 (.153)	620 (19.2)
Return to full-time	4.431 (.008)	23.007 (.066)	3.902 (.065)	2162 (67.1)
Return to part-time	4.566 (.020)	24.297 (.145)	4.965 (.154)	437 (13.5)
	Skilled			
Not return	4.555 (.009)	24.774 (.067)	4.413 (.071)	2228 (22.6)
Return to full-time	4.583 (.004)	24.383 (.039)	4.348 (.038)	5617 (56.9)
Return to part-time	4.710 (.008)	25.147 (.061)	5.016 (.065)	2012 (20.4)
	Graduates			
Not return	4.952 (.046)	29.472 (.387)	3.016 (.308)	91 (19.4)
Return to full-time	4.992 (.024)	29.028 (.193)	3.637 (.153)	282 (60.2)
Return to part-time	5.034 (.036)	29.231 (.298)	3.374 (.261)	95 (20.2)

Notes: Data Source: IABS sample of young women. Excluded are individuals not returning within 3 years and starting leave after 1992. The total number of women working in full-time work before interruption is 19,293. We remove from those, 5257 who start leave after 1992 and 492 who do not return within 3 years.

Table 4: Impact of children on working hours for full-time working women

	Children in the household		
	Two years prior to the birth	One year prior to the birth	One year after the birth
Official working hours	39.14	39.03	39.25
Actual working hours	42.75	42.43	42.93
No. observations	77	77	77

Notes: Data source: Sample of 20–39 year old women from German Socio Economic Panel, own calculations.

Table 5: Labour income for full-time working women

	Children in the household		
	No children	Infants (0–1 years old)	Children (above 2)
Regular Salary (in 1995 DM)	57,833	52,503	54,094
Bonus Payment (in 1995 DM)	2,622	1,981	1,795
Total Labour income (in 1995 DM)	60,454	54,481	55,889
Bonus ratio (in percentages)	4.9	3.9	3.4
No. observations	819	71	690

Notes: Data source: Sample of 20–39 year old women from German Socio Economic Panel, own calculations.

Table 6: Selection equation: return or not return to work after birth decision[i]

	Unskilled		Skilled		Graduates	
	Controls before first birth					
ΔExperience	-.504*	(.025)	-.460*	(.012)	-.345*	(.053)
$\Delta\text{Experience}^2$	.003	(.0018)	.003*	(.001)	0.003	(.000)
Firm change within 3 years before mat. leave	-.227*	(.051)	-.127*	(.023)	-.090	(.094)
Occupation change within 3 years before mat. leave	-.057	(.056)	.051	(.029)	-.208	(0.094)
Within 3 years before mat. leave (DIP)	-.041*	(.019)	-0.068*	(.009)	-.120*	(.041)
	Instruments					
Protected leave in months (period)[ii]						
Leave=10 (1986)	-.567*	(.037)	-.455*	(.021)	-0.349*	(.124)
Leave=12 (1987–6/1989)	-.699*	(.026)	-.562*	(.014)	-0.699*	(.070)
Leave=15 (7/1989–6/1990)	-.798*	(.031)	-.622*	(.017)	-.620*	(.081)
Leave=18 (7/1990–12/1991)	-.768*	(.032)	-.609*	(.017)	-0.631*	(.083)
Leave=36 (>1991)	-1.111*	(.024)	–1.00*	(.013)	-1.056*	(.064)
No. of slots per 100 children [iii]	-0.002	(0.005)	0.011*	(0.002)	-0.008	(0.008)
Local unemployment rate	0.019*	(0.003)	0.012*	(0.001)	0.027*	(0.005)
Number of observation	30,515		110,565		5,970	
Pseudo R-squared	0.110		0.079		0.076	
LR test for weak instrument: $\chi^2_{(7)}$	2,447		6807		403	
p-value	0.000		0.000		0.000	

Notes: IABS 1981–1995. Sample of women with their first birth in 1981–1992.

[i] The binary variable is 1 if the women return to full-time employment within 3 years after giving birth.

[ii]Dummy variable for protected parental leave period. Reference is before 1986.

[iii] Number of slots of formal childcare per 100 children aged 0–3 in the region.

Numbers in parentheses are standard errors.

* Significant at the 5 per cent level.

Table 7: First stage auxiliary regression results: duration of maternity leave[i]

	Unskilled		Skilled		Graduates	
	Controls before first birth					
ΔExperience	-.097*	(.026)	-.134*	(.012)	-.095*	(.047)
$\Delta\text{Experience}^2$	.007*	(.002)	.011*	(.001)	.008*	(.004)
Firm change within 3 years before mat. leave	-.013	(.051)	-.014	(.021)	.037	(.078)
Occupation change within 3 years before mat. leave	-.027	(.055)	-.020	(.027)	-.079	(.010)
Within 3 years before mat. leave (DIP)	-.146*	(.019)	-0.151*	(.008)	-.122*	(.035)
Inverse Mills ratio	3.605*	(0.055)	2.773*	(.021)	2.284*	(.081)
	Instruments					
Protected leave in months (period)[ii]						
Leave=10 (1986)	-.093*	(.034)	-.147*	(.017)	-0.079*	(.093)
Leave=12 (1987-6/1989)	-.252*	(.022)	-.325*	(.013)	-.252*	(.051)
Leave=15 (7/1989-6/1990)	-.373*	(.029)	-.460*	(.015)	-0.364*	(.062)
Leave=18 (7/1990–12/1991)	-.433*	(.030)	-.524*	(.015)	-0.410*	(.064)
Leave=36 (>1991)	-.664*	(.022)	-.760*	(.011)	-.682*	(.046)
No. of slots per 100 children[iii]	-0.008	(0.004)	-0.001	(0.002)	0.003	(0.006)
Local unemployment rate	-0.007*	(0.024)	-0.007*	(0.001)	-0.013*	(0.005)
Number of observation	30,515		110,565		5,970	
R-squared	0.181		0.214		0.188	
$F-$test for weak instruments[iv]	143		750		42	
p-value	0.000		0.000		0.000	

Notes: IABS 1981–1995. Sample of women with first birth in 1981–1992.
[i]The duration variable is truncated at 4 years.
[ii]Dummy variable for protected parental leave period. Reference is before 1986.
[iii] Number of slots of formal childcare per 100 children aged 0–3 in the region.
[iv] The test is F distributed with 7 and no obs-8 degrees of freedom.
Numbers in parentheses are standard errors.
* Significant at the 5 per cent level.

Table 8: IV estimation results of the three-phase model in first differences

	Unskilled		Skilled		Graduates	
	Controls before first birth					
ΔExperience	.089*	(.005)	.105*	(.003)	.030*	(.011)
$\Delta\text{Experience}^2$	-.004*	(.003)	-.005*	(.002)	-.003*	(.001)
Firm change within 3 years before mat. leave	-.002	(.014)	-.012*	(.005)	.011	(.029)
Occupation change within 3 years before mat. leave	.031	(.017)	-.022*	(.008)	-.028	(.046)
Within 3 years before mat. leave (DIP)	-.011	(.003)	-.005*	(.001)	-.002	(.006)
	Controls in connection with first birth					
Duration of interruption	.010	(.019)	-.068*	(.010)	-.028	(.041)
Firm change* (mat. leave)	-.070	(.044)	.004	(.021)	-.003	(.104)
Occ. change*(mat.leave)	-.007	(.046)	-.030	(.027)	.043	(.112)
	Controls after first birth					
ΔExperience	.036*	(.002)	.080*	(.007)	.022	(.025)
$\Delta\text{Experience}^2$	-.001*	(.004)	-.003*	(.000)	-.001	(.001)
	General controls					
Firm change	.066*	(.009)	.087*	(.004)	.088*	(.021)
Occupation change	.005	(.010)	.018*	(.005)	.025	(.036)
Inverse Mills ratio	-.370*	(.054)	-.446*	(.025)	-.318*	(.095)
Residual from duration	-.003	(.009)	0.022*	(.004)	.061*	(0.019)
ΔYear dummies	Yes		Yes		Yes	
ΔIndustry dummies	Yes		Yes		Yes	
Number of observations	28,857		103,582		5,580	
Number of individuals	3,989		13,568		823	
R-squared	0.284		0.263		0.305	
Sargan test statistic[i] χ^2_4	2.92		6.16		1.43	
p-value	0.57		0.19		0.84	

Notes: IABS 1981–1995, sample of full-time working women with first birth in 1981–1992.
[i] We report the heteroskedasticity robust Sargan test statistic.
Numbers in parentheses are robust standard errors accounting for heteroskedasticity and serial correlation.
* Significant at the 5 per cent level.

Table 9: First difference estimates of the three-phase model

	Unskilled		Skilled		Graduates	
	Controls					
ΔExperience	.059*	(.007)	.038*	(.007)	.040*	(.010)
$\Delta\text{Experience}^2$	-.001*	(.000)	-.001*	(.000)	-.001*	(.000)
Firm change	.039*	(.008)	.049*	(.005)	.027*	(.013)
Occupation change	.000	(.010)	-.004	(.007)	.020	(.018)
ΔYear dummies	Yes		Yes		Yes	
ΔIndustry dummies	Yes		Yes		Yes	
Number of observations	10,347		19,637		3,954	
Number of individuals	936		1,584		425	
R-squared	0.183		0.138		0.143	

Notes: IABS 1981–1995. The sample of women without birth and working full time
Numbers in parentheses are robust standard errors accounting for heteroskedasticity and serial correlation.
* Significant at the 5 per cent level.

Figure 1: The wage movements around first birth

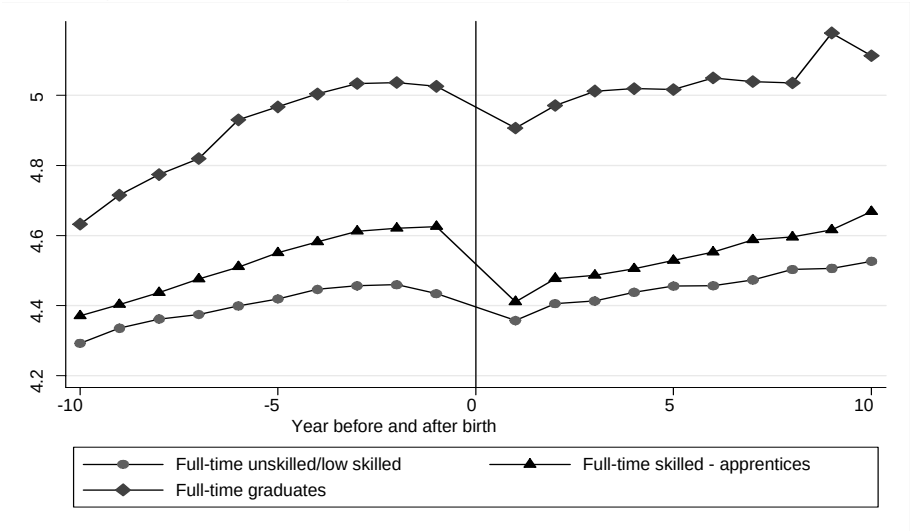

Figure 2: The probability of returning to full-time work after first childbirth