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Mette Ejrnæs
Astrid Kunze

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Mette Ejrnæs† and Astrid Kunze††

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Abstract:

We use a rich longitudinal data set for West Germany to disentangle the wage effects for female workers around first birth. Data on daily real wages reveal a dip in women's real wages shortly before giving birth and a drop of 10 to 20 percent after finishing maternity leave and returning to the labour market. To pinpoint what drives the movement in wages around the first birth, we analyse the wages of women, taking into account the potential correlation of the duration of individual interruptions due to parental leave with other unobserved individually specific factors and non random sample selection. In order to identify the causes of the movements in wages we exploit the panel structure of the data, regional variations in access to child care and female unemployment rates, as well as policy changes, which increased the maximum duration of parental leave from 6 months to 3 years.

JEL codes: C23, J13, J31.

Key words: female wages, panel data, instrumental variable estimation.

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

†† Norwegian School of Economics and Business Administration, Bergen, and IZA, Bonn, astrid.kunze@nhh.no.

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1 Introduction

The fact that women earn less after having children is called the child penalty and has been examined in a number of articles. With few exceptions most studies find the existence of a child penalty. While this fact seems well established, it is less clear how the wage gap arises.

To motivate our analysis we start by showing movements in wages for women around the time of the first birth. To do this we use the German IABS sample[1] from which we have selected a sample of young women who gave birth to their first child within the sample period. To highlight the wage effects around first birth we have sorted the data according to date of first birth. In Figure 1, mean wages[2] are shown for unskilled, skilled and graduate women.[3] 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 while the positive numbers on the x-axis refer to the number of years after the first birth. As the graph clearly points out, there are strong wage effects around the first birth. This graph also shows that for unskilled and graduates, this fall in wages begins prior to giving birth.

[figure 1]

This raises three main issues that we address in this study. First, what is produc-

[1] **I**nstitut für **A**rbeitsmarkt und **B**erufsforschung **S**ample (more detals on the sample will be provided later).

[2] The wages are defined as the logarithm of daily wages. Only wages corresponding to full time employment are included.

[3] The definition of education groups is such that unskilled and low skilled are labelled unskilled. The group of skilled contains apprentices (vocationally skilled) and graduates contains individuals with a university degree.

ing the fall in wages before birth.[4] Second, what factors account for the dramatic fall in wages after maternity leave. Third, is the earnings profile flatter after giving birth than before and if so, what accounts for this flatter profile.

The starting point of our analysis is the human capital theory model of Becker (1964) and Mincer (1974). To analyse movements in wages we use a framework similar to the one used by Jacobson, LaLonde and Sullivan (1993) in their study of earnings losses for displaced workers. The key parameters are the return to work experience and the loss from interruptions. In order to identify these parameters, taking into account unobserved heterogeneity and non-random sample selection, we make use of the panel structure of the data and use lagged variables as instruments as suggested by Arellano and Bond (1991). We also exploit policy changes that increased the maximum duration of parental leave several times from 6 months in the mid 1980s to 3 years in the 1990s. Finally, we also use regional variations in female unemployment rates and child care provision to help to identify the parameters of the model.

The main source of data, is the IABS data for 1975 to 1995. The IABS is the equivalent social security earnings data in the U.S. and, as such, contains particularly reliable information about wages and work histories. From this data set we extract a sample of young females, aged 20 to 39. All of them are followed over their entire career from the beginning onwards. This data sample offers particular advantages for this type of analysis, because first, we can measure actual work experience before and after the interruption as well as the duration of the interruption. Second, we can control for difference in education, age, firm change and occupation. Third, we can observe a large number of workers

[4]The fact that wages/earnings drop prior to an interruption is also found in other branches of the literature; for interruptions due to training see Ashenfelter (1978) and for interruptions due to displacement see Jacobson, LaLonde and Sullivan (1993).

over a long period of time that includes the first interruption due to maternity leave. For more than 25,000 females we observe wages before first birth, and for approximately 10,000 we observe wages both before and after birth. In addition, we observe females who remain childless (about 1,800) and we use the observations in order to compare the wage profiles of mothers and women who remain childless.

The paper is organised 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 data description and section 5 presents the econometric model. Section 6 discusses the estimation results and finally, in section 7, we conclude.

2 Previous evidence

Most of the studies examining effects of maternity leave and children have been concerned with the effects on labour supply and the timing of births. Only a few empirical studies investigate the impact of maternity leave and having children on the individual wage process. The most common approach for analyse the wage effect of having children has been to estimate a child penalty, i.e. comparing the wages of women with children to those of childless women when controlling for observed characteristics. The difference in wages is often called the family gap. Although the evidence is mixed, most studies find a significant child penalty. A significant child penalty is found for the US (see Anderson, Binder and Krause (2002) and Waldfogel (1998)), for the UK (see Joshi, Paci and Waldfogel (1999)) and for Canada (see Phipps, Burton and Lethbrigde (2001)). On the other hand no evidence of a child penalty is found for Denmark (see Datta Gupta and Smith (2002) or for Sweden (see Albrecht et al., 1999))[5].

[5]For more details on these studies see Appendix A, table A1 at the end of this paper.

In the literature different hypotheses for the existence of a child penalty have been offered. One potential explanation for the lower wages of mothers is that women with children have *interruptions to their labour market* career due to a maternity leave spell. The interruption will result in less work experience of mothers compared to childless women. In Waldfogel (1998), this problem is addressed by using actual experience instead of potential experience, but she still finds a significant child penalty for women. A similar approach is used to study Danish women in Datta Gupta and Smith (2002), who do not find evidence for a child penalty. Furthermore, it has also been suggested that interruptions could have negative effects on earnings. These negative effects can be explained by depreciation of the human capital (Mincer and Polachek (1974)). Albrecht et al. (1999) analyse the effect of an interruption on subsequent earnings using Swedish data. They find negative effects for an interruption, and, furthermore, they find that there are different effects of different kinds of interruptions. Interruptions due to unemployment cause greater losses than interruptions due to maternity leave and child care. In Kunze (2002) negative effects of interruptions are found for young women in Germany. The effect of interruptions due to maternity leave are greater than for interruptions due to unemployment.

A second hypothesis explains the child penalty by *heterogeneity* among women. The underlying idea is that women have different abilities, which are often unobserved, or differing productivity and these characteristics may be correlated with fertility. In Lundberg and Rose (2000), they find that, prior to their first birth mothers earn nine percent 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 like taste and ability.

The choice of sector or type of job has also been suggested as a possible determinant of the child penalty. If women with children choose to work in sectors

or types of job that are, in general, characterised by lower payment, yet perhaps also by a more family friendly working environment, this will lead to a child penalty. In Joshi, Paci and Waldfogel (1999) the child penalty is examined for two cohorts of British women. Their results show that mothers have lower wages than childless women. By using the Oaxaca decomposition they find that part of the family gap can be attributed to part time employment. Yet, even among full time employed women there is evidence of a child penalty. The issue of the choice of sector has been examined by Nielsen et al.(2001). They examine the wage effects of career interruptions in a model where the choice of the private versus the public sector is endogenous. By using data on Danish women, they find small wage effects in the public sector while there are no effects in the private sector.

In a recent study of Anderson et al. (2002) the three hypotheses mentioned above are considered empirically using panel data for the US. They find that the child penalty varies across education groups. Furthermore, they show that part of the child wage penalty can be explained by differences in human capital variables such as differences in labour market experience, interruptions to labour market career and choice of sector and occupation. These variables account for about 30-60 percent of the differences, while the remaining part is unexplained. Hence, the unexplained child penalty is estimated to range between 0 to 8 percent.

A closely related explanation 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. This leads to lower earnings compared to similar childless women. 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 (1998) and Phipps, Burton

and Lethbridge (2001) find that returning to the same employer after maternity leave actually has a positive effect on wages, but this might be because staying with the same employer actually acts as a kind of insurance against income loss. Furthermore, Waldfogel (1998) finds that the size of wage loss due to taking maternity leave depends on whether the woman was covered by a maternity leave scheme.

The fifth hypothesis suggested by Becker (1985) and Hersch and Statton (1997) to explain the child penalty is that *women with children invest less effort and are, hence, less productive.* This hypothesis is investigated by Phipps, Burton and Lethbrigde (2001) who argue that the more time women spend on housework and child care, 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 child penalty declines, but remains significant. Related to this hypothesis is the *discrimination* hypothesis, which suggests that employers pay women with children less because they think they are less productive.

The final hypothesis that we discuss in this section 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 there are also some which investigate the impact of wages on fertility (see Moffitt (1984) and Heckman and Walker (1990)). In these studies higher levels of wages seem to have a negative impact on fertility. However, none of these studies examines whether shocks to the wage process have an impact on the timing of births.[6] 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

[6] 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 a age-specific average of female hourly wages is used.

in their labour market careers might postpone having children or choose not to have children. Such behaviour would imply that wages start to fall even before maternity leave.

This paper examines the child penalty by focussing on the forces that drive the wage movements around the first birth. Our analysis builds on a human capital model and we will take account of alternative explanations. In the analysis we explicitly control for duration of interruptions, choice of sector and job mobility. Furthermore, we allow the wage process to differ between mothers and childless women. We also explicitly take account of the heterogeneity between women who remain childless and women who have children, by performing separate analyses of women who remain childless and women will have children. However, regarding the hypothesis relating to the lower productivity of mothers, we can only provide indirect evidence, since no measure of productivity is available. The last hypothesis suggesting that the fertility may be endogenous to the wage process cannot be examined directly. What we do here, is to examine how much of the fall in wages before the maternity leave can be attributed to women changing their behaviour prior to the interruption. An "unexplained" dip in wages can then be seen as evidence that the fertility is endogenous to the wage process.

3 Institutions and policy changes

The German maternity and parental leave reforms

It has often been claimed that Germany has one of the most generous parental leave and benefit policies.[7] For the period 1975 to 1995, two laws are most relevant for the description of the maternity and parental leave system. These are the

[7] For an international comparison see Blau and Kahn, 1995.

maternity protection law (*Mutterschutzgesetz*) and the federal child-rearing benefit law (*Bundererziehungssgeldgesetz*). Additionally, the law protecting against wrongful dismissal (*Kündingungsschutzgesetz)* applies.

Only since 1979 have employed mothers been eligible for maternity leave and benefits.[8] From 1979 to 1985, only mothers could take leave, while since 1986 fathers have been able to take legally protected leave as well. For fathers, still, taking parental leave is the rare exception; in 97 percent of all cases it is the mother who takes parental leave.

The term *protected leave* implies that the mother has the option to return to a job comparable to the job held before pregnancy; hence, the employer must hold the job available until the protected leave expires and cannot fire the worker during this period. Usually during the first six months of maternity leave, compensation may be paid in the form of wage and health benefits by the firm and the State. Afterwards the employer-employee relation is on hold and the employee cannot make any claims for wage payments.

From 1980 until 1985, regulations were based on the *maternity protection* law ("Mutterschutzgesetz"). It contains four main regulations: First, women cannot be dismissed during pregnancy and until 4 months after delivery. Second, mothers must not work 6 weeks before and 8 weeks after delivery (the *maternity protection*). Third, mothers are entitled to 4 months protected maternity leave after the *maternity protection* period. Fourth, mothers are entitled to 6 months of maternity benefits after childbirth. In 1986 the federal child-rearing benefit law ("Bundeserziehungsgeldgesetz") took effect replacing the concept of maternity leave with the concept of parental leave. Durations of maternity or parental leave, are summarised in Table 1.

[8] For comparison, in the U.S. the Family and Medical leave Act of 1993 was introduced much later.

[table 1]

Several key policy changes during the 1980s and up to the mid 1990s can be summarised in three points: First, in 1986 the switch from a pure maternity leave system to a parental leave system took place. Additionally, non-working parents became eligible to receive benefits as well. Second, in 1991 protected leave was extended to three years. Third, maternity and parental leave benefits changed with respect to the duration.

Until 1986, in order to be eligible for maternity benefits mothers had to be employed (and not self employed). Since 1986, all mothers and fathers can claim benefits; including unemployed and not working parents.

In the federal child-rearing benefit law, as well as in subsequent amendments to the law, the period of protected leave was sequentially extended as was the period of entitlement to benefits. They are listed in Table 1. For instance, from 1986 to 1988 the parental leave was extended to 8 months, and entitlement to benefits to 10 months, which includes two months of *maternity leave*. However, eligibility for the full duration of benefits based on the child-rearing benefit law is means tested.

These policy changes are particularly useful for identification of wage effects, since it is obvious that they affect the duration of maternity leave. One could speculate whether these changes in the maternity leave system also affected the wages of women, since it may add an extra cost on the employer. However, studies of the gender gap in Germany show that the mean gender gap is stable over the period indicating that women wages were not affected. Furthermore, the changes in the law apply to children born after a certain date in the near future. Hence, given the imperfect expectation about having children, one may claim that individuals will not change their behaviour regarding having children

because of an expected extended parental leave. Although parents can change the duration of the parental leave in the range of the maximum leave granted by law at the time of birth of their children, they cannot take direct advantage of the policy change.[9]

4 The data

To study wage movements around child birth we use the regional file of the IAB employment sample (IABS)[10] for West Germany for the period 1975 to 1997.[11] The IABS is a 1 percent random sample drawn from the event history data file of the social security insurance scheme, the employment statistics, collected by the German Federal Bureau of Labour. The fact that the data was 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 percent of 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.[12]

The data, however, is not without limitations. The main shortcomings, which are due to the lack of information about hours of work, will be compensated by focusing on full time workers.[13] Furthermore, we use supplementary survey

[9] However, one may argue that they can plan to have a second, further, child due to the improved legal framework. We cannot take this into consideration given our data.

[10] IABS in abbreviation for the **I**nstitut für **A**rbeitsmarkt und **B**erufsforschung **S**ample.

[11] We use only wages from the period 1980-1995

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

[13] 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.

data in order to analyse variations in hours of work. Another caveat of the wage data in the IABS is the lack of information about income components. We show with data from the German Socio Economic Panel (GSOEP) that this is another interesting aspect to the analysis of family gap.

A unit of observation in the IABS is a spell reported for every change related to the working and non-working status. An individual record may therefore contain multiple spells sorted by calendar dates 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 positions within the firm or changes firm, the employment spell ends and a new 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, which means that all spells are ended at the end of the year. If the employee is still employed in the same job at the beginning of the year, a new employment spell starts. This implies that an employment spell cannot exceed one year.

Furthermore, in the data non-working status is distinguished into interruptions and unemployment. Interruptions indicate that the employer-employee relationship is on hold, yet the contract is still valid. In this case no wage payments are made. These interruptions are used to identify maternity leave for women.[14][15] Unemployment is reported in cases where unemployment insurance or unemployment assistance is received. Every other status that does not fall in either of these categories results in a gap in the individual's record, and will be counted in

[14] More generally, interruptions may be reported if a worker is absent for a longer period due to health problems, for example. We assume that this does not apply in a significant number number of cases for childbearing age women.

[15] The IABS does contain some information on number of children. However, the quality of the variable is very poor for women, as it has also been admitted by the data producer. Hence, we refrain from using this variable.

this study as not working.

The sample selection.

From the IABS we generate a sample of young female workers whose post-schooling work history is observed from the beginning. We distinguish between three skill levels: *Unskilled workers, skilled workers and graduates. Unskilled workers* are defined as those with 9 or 10 years of compulsory schooling[16] and having no additional training at all, or having shorter education, that is less than 2 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 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, in particular, since the 1970's. 60-70 percent 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 to 4 years, or a university degree, 4 to 6 years.

In this paper, we focus in the estimation on maternity leave in association with first birth. Therefore, our main sample consists of women for whom we observe an interruption due to maternity leave. More particularly, we only include 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 first birth, but observations after the second birth, if observed, are eliminated. Hence, we exclude effects of second, and further births.

In order to evaluate the results further, we borrow from the program evaluation literature. For that we define a comparison sample consisting of females who have

[16] Unfortunately, we cannot distinguish in the data whether individuals graduate after 9 or 10 years of schooling from the Hauptschule or Realschule.

no children. This sample is further restricted such that only women who where observed that they are childless by age 35 are included.[17]

The variables

In order to generate complete work histories we assume that graduates are not older than 23 in 1975, and everybody else is not older than 16 in 1975. We generate the variable age at entry into first employment in order to control for unobserved heterogeneity in schooling. Wages in the IABS are reported on a daily basis and 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 percent of wages are topcoded. For unskilled and skilled, only 0.2 percent of the wages are topcoded.

As a result of the sample design in this study we observe complete work histories in the data that allow us to observe the accumulation process of human capital as well as wages from the beginning. In our analyses, the main variables are the log of wages, and the work history variables, *work experience,* and, the interruption due to birth of the first child.[18] In fact we count the total length of the interruption including parental leave and related to the birth of the first child. This increases the variation in our interruption variable compared to the parental leave duration stated by law.

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

[18] For a complete list of the variables see Appendix A2.

4.1 Descriptive statistics

Table 2 shows summary statistics for our sample separately by education group.[19] The first four columns refer to our main sample, namely those women for whom we observe the first birth. The last column refers to the comparison group, which is defined as women who do not have children by the age of 35. For our main sample we distinguish between the wage spells before the first birth (column 1) and after the first birth (column 4). In particular, we focus on the last spell before birth (column 2) and the first spell after first birth (column 3). The table shows that unskilled women have their first child around age 24, while the age is 25 for skilled and 29 for graduates. The table also shows that, on average,

unskilled and skilled have between 4 and 5 years of experience before the interruption, while the graduates have a bit less, around 3.75 years. Turning to the third and fourth columns the numbers refer to wage spells after first birth. First, the number of individuals suggests that not all women return to full time work after giving birth. From the statistics on the total time out, we find that the duration of the interruption is around one and a half to two and a half years for all education groups. The table also confirms a drop in wages around the first birth for all education groups.

[table 2]

The last column reports summary statistics for the control group. From the last column it is seen that the control group is older for all education groups, which is due to how the group is defined. The control group has more experience and less time out of work. To examine whether the group of women who remain

[19] The distribution on education groups shows that graduates seem to be underrepresented. The reason for this is that civil servants are not included in the sample.

childless have different unobserved characteristics than women who have children, we compare their entry wages. The entry wages clearly show that the entry wages for women who remain childless are much higher than for women who later will have children. This finding confirms the result of Lundberg and Rose (2000).

To analyse the direct impact of the interruption due to maternity leave we compare wages in the last spell before the interruption due to maternity leave and wages in the first spell after the interruption. Since not all women in our sample return to full time work after giving birth, we start by providing more summary statistics for women who return to work.

4.1.1 Return to work

In figure 2 the average probability of return to full time work is shown for the sample period. The lowest line in the figure shows the probability of returning to full time employment after less than one year interruption in connection with parental leave. The middle line refers to the probability of returning to full time employment within two years after the birth and the upper line refers to the probability of returning within three years. The figure shows that the probability of return within three years after the interruption was about 70 percent in the beginning of the 1980s and had declined to about 50 percent at the beginning of the 1990s. The graph also shows that until the mid 1980s more than half of women who do return do so within the first year after the interruption and only very few return between the second and the third years after the interruption. Moreover, the figure also shows that the major reforms of the maternity leave system in 1986 and 1991 were associated with a decrease in the probability that a woman returns to full time employment within three years.

[Figure 2]

In table 3 we compare characteristics of women who do not return to the labour force within three years to those who return to part time and those who return to full time. All summary statistics refer to the last spell before the interruption. The last column shows that for unskilled workers, 67.1 percent return to full time work, whereas 56.9 percent of the skilled and 60.2 percent of the graduates return. For all education groups, around 20 percent do not return within three years. In general, those who do not return have less experience and had a lower wage compared to those who return to either part or full time work. Those who return to part time work are, in general, older, have more experience and earn higher wages prior to the birth, compared to those who remain in full time employment before and after birth.

[table 3]

4.1.2 The drop

For those women who return to work we can compare wages in the last spell before the interruption with wages in the first spell after the child birth. It turns out that more than 50 percent receive a lower wage when they return to work. The average loss in wages is reported in Table 4. In the first column we report the average loss for all workers. We mainly focus of those who return to full time work, but for comparison we also report the loss for both those returning to part time and full time work. The loss (in real terms) for those who return to full time work is 9.7 percent for unskilled workers, 24.3 percent for skilled workers and 16.9 percent for graduates. The numbers show clearly that unskilled workers have a substantially smaller loss than the other groups. Given this big loss, we also compute the losses in nominal terms. The findings reveal similarly considerable decreases in nominal wages (7.4 percent for unskilled, 21.9 percent for skilled and

14.9 percent for graduates). If we only consider those women returning to the same firm after the interruption, the loss is even bigger for skilled workers and graduates. The last column refers to women who return to the same firm and the same occupation. For these women we think that they are likely to return to exactly the same job that they left for maternity leave. However, the loss is still of the same size.

[table 4]

Reduction in working hours

Since we compare daily wages the drop may partly be due to a reduction in working hours. However, we are only considering full time employment which means that these women worked at least 35 hours per week both before and after the interruption. Unfortunately we do not have access to information about the numbers of working hours in the IABS sample, so it is difficult to tell exactly how much a reduction in hours contributes to the loss.

[table 5]

In order to provide more information about the big wage loss, we exploit alternative data sources. Using survey data[20] we obtain additional information about the number of working hours in the West German states. In this data set both the official and the actual working hours are stated for 1995. We select a sample of women aged 20-39 who all report that they work full time (the official working

[20]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)

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,[21] while those with children work 39.1 hours per week.[22] Although women without children work one hour more per week, this can only explain a decrease of 2.5 percent 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 German Socio-Economic Panel (GSOEP) data. From the GSOEP we selected a 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.[23] 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 5 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, which indicates that the wage movement around the first birth is not driven by changes in working hours.

Bonus payment

To further investigate the big drop in wages around first birth we try to decompose the labour income. In Germany it is common that part of labour income is paid in different bonus schemes (e.g. 13 month payments, Christmas payments, Holiday payments). In the IABS we cannot decompose labour income into regular salary and bonus payments. Therefore, we complement the IABS data with data from GSOEP which contains detailed information about regular salary and bonus

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

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

[23] More details about the data are provided in appendix A3.

payments.

Again we focus on a subsample of women aged 20-39. In order to decompose labour income we focus entirely on those women who have been employed full time for the whole year. For these women we find that bonus payments amount to about 4 percent of the total labour income.

[table 6]

Table 6 shows the labour income for women with and without children. From the table it is seen that women with children earn about 10 percent less than women without children. However, from the table we can see as well that the decrease in labour income is not equally distributed between regular salary and bonus payment. While the regular salary is about 9 percent lower for women with infants, their bonus payments are 25 percent lower (a more detailed analysis of the earned income is shown in appendix A3). For women with older children the differences between bonus payments and regular payments is even more pronounced.[24]

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. Additional explanations for the drop could be that firms illegally pay mothers less when they return after maternity leave. Nevertheless, since very few cases of women going to court are known to us for Germany it is difficult to tell the importance of this discriminatory behaviour. What seems to be a likely explanation is that women may change working schedule, such that before maternity leave their working schedule included evenings, nights and weekends whereas afterwards they work more during regular working hours. Hence, they may lose extra pay for work during irregular hours.

[24] For women with children aged 2 and above the regular salary is about 7 percent lower than childless women, while the bonus payments are 30 percent lower.

5 The econometric framework

In this section we specify a statistical framework to summarise the evidence on earnings growth and earnings losses around first birth. This specification is intended to estimate short and long run wage effects preceding first birth as well as after returning to work.

The wage equation presented in this paper is based on the classical human capital model (see Becker (1964) and Mincer (1974)). Wages are determined by a simple model:

$$lnw_{it} = x_{it}\beta + \epsilon_{it} \tag{1}$$

where

$$\epsilon_{it} = \nu_i + u_{it}. \tag{2}$$

We regress the logarithmic wage on a set of controls, x_{it}, including human capital variables such as experience, but variables that measure depreciation of human capital are also included. The subscript i indicates the individual and t refers to the employment spell. The error term includes an individual specific component that captures unobserved individual specific characteristics, such as ability or motivation, an individual specific component that may vary over time and measures the quality of a worker firm match that is assumed to have zero mean.

In order to describe wage growth we transform equation (1) into first differences.

$$\Delta lnw_{it} = \Delta x_{it}\beta + \Delta\epsilon_{it} \tag{3}$$

where

$$\Delta\epsilon_{it} = \Delta u_{it}. \tag{4}$$

This leads to the elimination of all individual specific observed and unobserved components. In the empirical analysis we will focus entirely on the growth equation.

The specification

For the empirical implementation, we specify wage growth equations where we allow for different effects of the controls in each of the three different phases: the pre-birth phase, the intermediate phase and the after birth phase. This is done by constructing three sets of variables denoted pre birth, interruption and after birth. These variables are constructed such that

$$\Delta x_{it}^{P} = \begin{cases} \Delta x_{it} \text{ if } t \text{ prior to first birth} \\ 0 \text{ otherwise} \end{cases},$$

$$\Delta x_{it}^{I} = \begin{cases} \Delta x_{it} \text{ if } t-1 \text{ prior to first birth and } t \text{ is after first birth} \\ 0 \text{ otherwise} \end{cases}$$

$$\Delta x_{it}^{A} = \begin{cases} \Delta x_{it} \text{ if } t-1 \text{ after first birth} \\ 0 \text{ otherwise} \end{cases}.$$

Furthermore, we include some variables that are specific for each phase. For the pre birth phase, in line with Jacobson, LaLonde and Sullivan (1993), we allow wages to decline even before the interruption, by including dummy variables.[25] We specify a dummy variable for the three years period prior to first birth in order to capture the dip: PB_{it}.[26] Moreover, we allow the impact of some of the controls to be different in the period three years prior to child birth. In the interruption phase, the duration of the interruption, M_{it}, is included as a regressor. Finally, we include time dummies, D_{it}, and dummies for industries F_{it}

$$\Delta \ln w_{it} = \Delta x_{it}^{P}\gamma^{P} + \Delta x_{it}^{I}\gamma^{I} + \Delta x_{it}^{A}\gamma^{A} + PB_{it}\alpha_0 + PB_{it} * \Delta x_{it}^{P}\alpha_1 \qquad (5)$$

[25] Different specifications have been tried but the dip seems to start around three years before the interruption.

[26] We have also tried more general specifications but this seems to capture the effect.

$$+M_{it}\tau + \Delta D_{it}\delta + \Delta F_{it}\beta + \Delta u_{it}.$$

Although we start out with this general specification we will in the final specification restrict some of the controls to have the same impact in each phase.

The key parameters of interest in equation (5) are the return to work experience and the effect of interruption in connection with child birth and unemployment. From human capital theory, it follows that the coefficient on the experience variable should be positive, capturing returns to investment. If human capital depreciates while not working on the job,[27] then an interruption following the birth of the child may induce a drop in wages and we expect wage growth to be negatively affected by the duration of parental leave. The same effect should also be found for unemployment spells. In this specification, we exclude tenure from the equation assuming that only general human capital acquisition affects wages. This has the advantage of reducing the potential number of endogenous variables.

Furthermore, mismatching may play a role in the determination of an individual's wages. Since we estimate the wage formation in the beginning of the labour market careers of young women, we expect these women to improve their match by changing firms. Therefore, we model wage growth to be affected by occupation or firm changes. We include dummies for this type of behaviour. Furthermore, in the application, changing occupation or firm can have a different impact if it is immediately before an interruption. The reason for doing this is because one of the explanations for the family gap is that women choose jobs or firms which pay less but are more family friendly. In order to investigate whether women actually start choosing these jobs prior to the interruption, we consider that changing job or firm could have a negative impact on the wage process.

When estimating the wage equation there are two well-known problems: the en-

[27] Mincer and Polachek (1974).

dogeneity of the experience and interruption variables and the sample selection problem. Both problems arise because labour supply is likely to be endogenous to the wage process. This implies that the error term in equation (3) is likely to be correlated with the variables of interest; in particular, the experience variable and the interruption variables (for unemployment and maternity leave).[28] A commonly used approach in this type of model is the instrumental variable estimation. We deal with these two issues by applying a two step method described in Wooldridge (2002). In the first step we correct for the sample selection bias by using the inverse mill's ratio, and in the second step instruments for the endogenous variables have been applied.

Instruments:

The richness of the IABS data provides us with a number of suitable instruments for labour supply. First, we use lagged levels of the work experience variable, the work experience variable squared and unemployment as instruments, assuming that $E[x_{t-s}|(\Delta u_{it})] = 0$, where $s > 1$.[29] Furthermore, we use age at entry into labour market, age and first differences in potential experience. Moreover, since we estimate wage equations for mothers, we use instruments particularly related to the labour force participation of mothers. That is we use information about the parental leave period. In the sample period there have been a number of changes in the parental leave system which provide us with an excellent instrument.[30] As can be seen in figure 2, the duration of observed leave is highly correlated with the official maximum duration of parental leave. We also use the availability of child care facilities in the region as an instrument for the duration of interruption associated with maternity leave. As an additional instrument for unemployment

[28] If it depends only on individual-specific effects, estimation of the first difference equation is not affected.

[29] see Arellano and Bond (1991).

[30] See the discussion of the instrument in section 3.

we use the regional unemployment rate. Furthermore for the after birth phase we also use the age of the child as an instrument.[31] Other studies have pointed out the problem of weak instruments. By allowing the instruments to vary across these three phases we can exploit the instruments more efficiently. For a detailed description of the instruments see appendix A4.

6 Estimation Results

In this section we discuss the estimation results obtained from the specification discussed above. We estimate the model for a sample of women who all give birth and on a sample of women who remain childless. The sample used for the estimations is a trimmed version of the data described in the data section.[32]

6.1 Estimation for women who give birth

In table 7 the estimates of the three phase model are shown. For comparison we have also estimated a model where we only correct for the sample selection bias and the estimates are reported in the first three columns.

The remaining three columns in table 7 refer to the IV-First Difference corrected for sample selection bias estimation. Moving from the FD estimate to the IV approach has the expected implications of the estimates: the losses due to interruptions are increasing and the return to experience is mainly declining. In the following we will concentrate on the IV-FD estimates.

[Table 7]

[31] Dummy variables for child aged 0-3, 4-6 and 7 to 10 are used.

[32] We have eliminated all observations where $|\Delta \ln w| > 1$.

The pre-birth phase (the dip)

The estimated return to experience is positive, but decreasing in the level of experience. The return from increasing the level of experience from three to four years[33] is 4.0 percent for unskilled, 4.5 percent for skilled and 4.5 percent for graduate. Our estimates of the return to experience are in line with what others have found.[34]

In this phase we estimate the impact of an interruption due to unemployment. The estimates indicate that for skilled and graduate women, unemployment does not have a significant impact on the wage formation. For unskilled workers we find the opposite. Spells of unemployment seem to have a strong negative and significant impact on their wages. The estimate suggests that unskilled women lose around 24.7 percent from one year of unemployment.[35]

In the estimation we have included a dummy variable for the three years prior to the interruption. This variable is not negatively significant for any of the groups, suggesting that there is no "unexplained dip" in the wage process prior to birth.[36] However, for the skilled group we find that those changing occupations within three years before giving birth experience a negative effect of about 0.8 percent, whereas, changing occupations, in general, has a positive impact on wages.[37] An explanation for this is that prior to giving birth, women choose jobs that pay less but instead offer a family friendly work environment. We do not find any negative effect of changing firms prior to the interruption for any of the three groups, and

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

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

[35] The effect of unemploymenet is rather unprecisely determined.

[36] In fact there is a small positive effect for skilled women.

[37] The effect is calculated as the general effect from changing occupation 2.7-3.5=-0.8

graduates seem actually to benefit from changing firms prior to birth.

The Interruption (the drop)

In the specification used the wage effects of an interruption are determined by the duration of the interruption and whether the women change firms or occupations in connection with the interruption. In the present specification the loss is determined by the duration of the interruption.[38] The estimates indicate that wages are declining around the first birth for all three groups, but the size of the decline varies. For unskilled women and graduates, the loss associated with a one year interruption is 3.4 percent and 3.9 percent, while for skilled women the loss is about 14.7 percent. Moreover, the estimation results also show that especially for unskilled women changing firm in connection with child birth has a strong negative effect on wages. A similar result was found for the US (see Waldfogel (1998)) and for Canada (see Phipps, Burton and Lethbridge (2001)). This suggests that staying with the same employer may act as a kind of insurance against income loss of unskilled mothers, while it does not have the same impact for skilled or graduate mothers.

The post birth phase (the recovery)

To illustrate the return to experience after giving birth, we calculated the return to experience from increasing the level from three to four years of experience: the return is 4.7 percent for unskilled women, 6.8 percent for skilled women and 5.4 percent for graduates. A formal test for having the same return to experience before and after birth is rejected for unskilled and skilled but not for graduates. The estimated return to experience after giving birth is higher than before giving birth for all groups.[39] This means that we find evidence for a rebound effect

[38] Different specifications of the duration have been tried, but the estimated loss associated with one year interruption is very robust across different specifications.

[39] This result holds for all plausible values of experiences.

especially for skilled women, although the rebound effect is small. In figure 3 we illustrate the rebound effect, by showing the predicted wages for three women entering the labour market at age 19 and work full time until age 30 except for one year of parental leave. We assume that one woman gives birth at 21, one at 25 and the last at 30. The figure shows that the rebound effect is stronger for those giving birth earlier.

[figure 3]

Moreover, we also find that the loss due to an interruption of unemployment has strong negative implications for the wages of mothers. For skilled mothers this is in contrast to the pre birth phase where no significant effects of unemployment were found.[40] If we compare the decline in wages of an interruption due to child birth with an interruption due to unemployment (after giving birth), we find that for all three groups, the loss is bigger for an interruption due to unemployment. The estimates of the inverse mill's ratio are negative for all education groups, indicating negative selection. An explanation for this finding could be that it is mainly mothers who have to work for financial reasons who return to full time employment.

Furthermore, we find that changing firms or occupations has a positive impact on wage growth for all three education groups, although the effects are insignificant for graduates. This result is in accordance with the idea that early in the career workers improve their match by changing firm.

To sum up, we recover three wage effects around first birth, although they seem to arise in distinctive ways for the different education groups. First, we find that the entire dip in wages prior to the child birth can be attributed to changes in

[40] We cannot exclude the possibility that the different impact of unemployment before and after birth is caused by differences in age.

labour market career characteristics of the women or the job, in particular changing occupations prior to birth seems to explain the dip for skilled women. Second, the drop around first birth arises for unskilled women primarily if they change occupations or firms in connection with child birth, while for skilled women the drop is almost entirely associated with the duration of the interruption. Furthermore, our estimation results confirm that skilled women are those who suffer from the greatest wage cut due to child birth. The third wage effect is associated with the recovery phase. For all three education groups we do find signs of recovery although the rebound effect is small. Moreover, for skilled women and graduates the damaging effect of unemployment is stronger in the post birth period than in the pre birth period.

Furthermore, what we find is that the impact of an interruption on the labour market careers depends of the duration of the interruption. This provides evidence for the hypothesis concerning human capital depreciation (see Mincer and Polachek (1974)). However, the fact that we also find that the cause and the timing of the interruption has an impact on the size of the decline in wages suggests that the hypothesis on human capital depreciation can only partly explain the findings. Our findings are in accordance with the findings of Albrecht et al. (1999), who find that interruptions of unemployment are more damaging than interruptions due to maternity leave.

6.2 The comparison sample

In order to evaluate whether women with and without children face different wage processes, in this section we present a comparison between the two groups.

We define the comparison group as women who remain childless until the age

of 35.[41] We find that the group who remains childless has higher entry wages; unskilled women who remain childless earn on average 20 percent more than women who later have children. For skilled workers the difference is 25 percent and for graduates 19 percent (see table 2). This suggests that even before the interruption, groups differ.[42] This provides evidence for the hypothesis that part of the family gap is due to heterogeneity.

Comparison between women with and without children

Before turning to the estimation of the wage equation for the comparison group we compare simple means of wages. To make the comparison we use matching based on the propensity score method.[43] We have selected a sample of skilled women who have their first child at the age of 25 and return to full time employment after an interruption of less than a year. Using the propensity score method we select out of the comparison group a sample of skilled women who are comparable in terms of work experience, unemployment, number of jobs, number of firms and industries for each age. The mean wages of the two groups are shown in figure 4. The figure shows that there are only small differences in the wages of the comparison group and the pre birth group up to the age 24. At age 25, the year they give birth, wages are lower than for the comparison group. Furthermore, it is seen that the large difference in wages between the comparison group and the group of women giving birth at age 25 cannot be explained by differences in observables.

[41] As mentioned earlier, we cannot exclude the possibility that women in this sample give birth later than 1995 when the observation window ends.

[42] A similar result is found for the US. Lundberg and Rose (2000) found the difference to be nine percent.

[43] In this exercise we do not attempt to estimate a "treatment" effect, because it is unlikely that the conditional indepencence assumption is fulfilled in our context. This is only done to show the differences between the two groups, when controlling for observable characteristics.

[figure 4]

Estimation results

To examine how wages develop we estimate a wage equation. The wage equation is the same as the previous one, with the exception that all the variables relating to the birth of a child are left out. The instruments applied for this sample are the same as for the first sample except for instruments directly related to labour supply of mothers. The estimations results in Table 8 show that the return to experience is positive and decreasing in the level of experience. The return to experience for childless women is lower than the return of mothers.

[table 8]

In table 7 and 8, if we compare the loss due to spells of unemployment, we find that for unskilled women, women who remain childless have the greatest loss due to unemployment.[44] For skilled and graduate women who remain childless the loss due to unemployment is larger than for mothers prior to birth, but smaller than the post birth period. Another difference between the childless women and women who have children is that the gain from changing firms is larger for the childless women. Finally, in this sample we find that the parameter of the inverse mill's ratio is small and insignificant for all education groups.

One of the striking results from this comparison suggests that women who remain childless have a very different wage process than childless women who are going to have children. Although figure 4 did not show much difference in the levels for women aged around 20-24,[45] the estimation results show four major differences.

[44] For unskilled women, who are having children the loss due to unemployment is not changing before and after giving birth.

[45] The main reason why we did not find large differences is because the sample of women giving birth is highly selected in the sense that it is only those who return to full time work within one year.

First, the wages of women who become mothers increase faster due to work experience and second, spells of unemployment have a less servere impact on wages, except for unskilled workers. These two effects are offset by the fact that women who remain childless have higher entry wages and that they are more likely to change firms, and the impact of changing firms is larger which results in an increase in wages.

7 Concluding remarks

In this paper we investigate wage effects for women in West Germany around first birth using data for the period 1975-1995. Simple descriptives on wages for a sample of women in their 20s up to 39 reveal that shortly before giving birth, a dip in the wage profile is observed. On return to work, that is after exiting for an extended parental leave period, wages drop further by approximately 10 to 20 percent. The goal of our analysis is to shed light upon what explains these effects. More particularly, we want to identify factors that cause this big drop. We set up a simple wage regression framework. The key parameters of interest are the return to work experience and the effect of the interruption itself. In addition to IV estimation results from wage growth equations, we present estimates of the wage process using a sample of women who remain childless.

The main results from our analyses are that the dip is in fact quite small, yet the drop in wages after return to work remains substantial. The effects differ in size as well as in terms of the driving factors across the educational distribution. The dip can be entirely contributed to changes in other controls. For skilled women, we find only a dip associated with occupation changes which may mean that workers change to different careers, perhaps offering more non-pecuniary utility, which is unobserved by our data.

For the drop, again, we find that the wage movement arises differently for different educational groups. For unskilled women, a considerable part of the loss is associated with firm mobility, while for skilled women the loss is mainly determined by the duration of maternity leave. The drop is not significant in the upper part of the educational distribution. A possible explanation for the differences between education groups is that for the unskilled, the way to keep high human capital and high wages, is to remain with the firm. This effect is less important for skilled women and graduates since they have higher stocks of general human capital. This indicates that unskilled women, in particular, are protected by the German parental leave scheme against wage cuts since it guarantees that they can return to the same firm and the same job. For all education groups we find a rebound effect, although it is small.

Comparison of entry wages and wage profiles for our sample of women before and after first birth with women who remain childless reveals that unobserved heterogeneity accounts for a large extent of the differences in wages as well as mobility. While future mothers profit most from relatively high returns to experience and have high levels of job stability, childless women would do more job shopping and gain more through improvement in their job matches.

How women's wages are affected by child birth has an impact on a number of issues concerning women's labour market behaviour. These results are to our knowledge the first results that examine in detail the wage movements around first birth as well as the causal factors that drive wage profiles of women with children and childless women.

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A Appendix

A.1 Empirical studies of the family gap

Table A1.1: Empirical studies of the family gap

Study	Waldfogel, 1998	Joshi, Paci and Waldfogel, 1999	Phipps, Burton and Lethbridge, 2001	Anderson, Binder and Krause 2002
Data	Panel	Cross sections	Cross sections with retrospective information	Panel data
Country	US	US and UK	Canada	US
Dep. variable	log wage	log wage	log income	log wage
Est. of family gap	Children	Children	Interruptions/children	Children
Explanatory. var.	Exp., edu, race	Exp., edu., parttime parental social status	Exp., parttime, housework, interruption	Exp, edu., occup., married parttime, time out
Estimation method	Fixed effect/ First differences	Heckman and OLS	OLS	OLS/Fixed effect

Study	Albrecht, Edin, Sundström and Vroman, 1999	Datta Gupta and Smith 2002	Nielsen Simonsen, and Verner, 2001
Data	Cross sections and Panel data	Panel data	Panel data
Country	Sweden	Denmark	Denmark
Dep. variable	log wage	log wage	log wage
Est. of family gap	interruptions	Children	
Explanatory var.	Exp., edu,married,time out unempl..	Exp, edu,married, region	exp, educ, sector
Estimation method	OLS/Fixed effect	Random or Fixed effect and Heckman's selection model	Endogenous selection of public/private sector

In table A1.1 the studies examining the family gap have been summarised. These studies provide measures of the family gap. In all studies a wage equation is estimated, except in Phipps, Burton and Lethbridge, 2001, where an equation for income was estimated. The data used in these studies are either panel data or cross sections data and therefore the estimation methods also vary. However, only two studies deal with the sample selection bias arising from the fact that

wages are only observed for individuals working. Furthermore, studies differ in their approach to estimate the family gap. While in some of the studies the family gap is measured by estimating the impact of children, others estimate the impact of an interruption due to maternity leave.

A.2 Data Appendix

A.2.1: 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 3-digit occupation variable (Code 0-117)
work 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	accumulated length of spells (day/month/year) in interruption
other interruptions	(gaps in individual records)/365)	summarise residual group of non-work
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, X-mas and Vacation bonus, profit share, premium, other bonues
Total Labour Income	total labour income	Regular income+bonus payments

A.3 Additional evidence from the GSOEP data

Given that we find the big drop in wages around the first birth we would like to investigate how much of the drop can be attributed to a decrease in working hours. To do this we have drawn in information from an alternative data source,

namely the German Socio-Economic Panel Study GSOEP.[46] This data set, which is a large panel of the German population, contains information about both actual and official working hours. 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.

In the questionnaire actual and official working hours are reported for a particular week. We use this information to select a sub sample of full time workers, as those who report that their official working hours exceeds 35 hours. The actual working hours for this group is 42 hours per week.

A.3.1 The effect of infants on actual working hours

To investigate the effect of infants on actual working hours, the sample is split according to whether there is an infant in the household (see table A3.1).

Table A3.1: Impact of children for full time working women

	Children in the household		
	No children	Infants (0-1 years old)	Children (above 2)
Official working hours	39.36	39.26	39.21
Actual working hours	42.14	42.08	42.14
No obs.	1311	219	980

This means that the evidence from GSOEP does not provide any reason to believe that the big drop in wages around the first birth can be explained by a decrease in actual working hours.

[46] We use 17 waves of the GSOEP (1984-2000). We only focus on women living in the former West Germany.

A.3.2 Bonus payment

To further investigate the big drop in wages around the first birth we try to decompose labour income. In Germany it is common that part of labour income is paid in different bonus schemes (e.g. 13 month payments, Christmas payments, Holiday payments). In the IABS we cannot decompose the labour income into regular salary and bonus payments. Therefore we complement the IABS data with data from GSOEP.

In the GSOEP detailed information regular salary and bonus payments are available. Again we focus on a subsample of women aged 20-39. In order to decompose labour income we focus entirely on those women who have been employed full time for the whole year. For these women we find that bonus payments amount to about 4 percent of total labour income.

Table 6 in the main text shows the labour income for women with and without children. To complement the table we estimate a fixed effect model. The model we estimate is given by

$$y_{it} = \alpha_0 + \alpha_1 \text{child}_{it} + \alpha_2 \text{age}_{it} + \mu_i + \varepsilon_{it},$$

where y_{it} is the salary or bonus payment discounted by the consumer price index and child_{it} is an indicator of children present in the household.[47] Given the very few births we observed in the data,[48] the estimates are not very precisely determined.[49] In table A3.2 the estimation results are reported. What we find is that the birth of a child lowers both the regular salary and the bonus payments. On average, the regular annual salary drops by 819 DM (measured in 1995 prices).

[47] In this fixed effect model the age effect and the year effect is confounded. This means that the coefficient to age can be interpreted as a year effect.

[48] We observe only 74 birth where the mother has been working full time before and after the birth.

[49] A specification where we distinguish between infants and older children have been tried, but the results do not change substantially.

This is about 1.4 percent of the annual salary. For the annual bonus payment the drop is about 539 DM, which is about 20 percent of the bonus payment.

Table A3.2: Fixed effect estimation

	Regular salary		Bonus Payment	
	estimate	std err	estimate	std. err
Presence of children	-819	3,144	-539	318
Age	-1,148	244	178	25
Constant	93,704	7,356	-2,463	745
No obs.	1549		1549	

There are two main findings from the analyses with GSOEP. First, using GSOEP we find a decrease in wages when a child arrives. The decrease is smaller than in the IABS, but this may be due to the fact that we cannot control properly for experience. Furthermore, given the small data set we cannot directly measure the drop, but can only compare those with children to those without children. Second, we find that part of the drop in earnings is due to a drop in bonus payments.

A.4 Description of the instruments

In addition to the standard instruments used for wage equations such as age, lagged levels of experience and of unemployment, potential experience and regional unemployment rates (see Table A4.1), we use a number of additional instruments which are particularly relevant for the labour supply of mothers. These additional instruments are related to the availability of child care facilities in the region and the institutional setting for maternity leave.

Table A4.1: List of instruments

Variable Name	Definition	Source/Construction
regional unemployment rates	number of unemployed/labour force	from Labour Office, Nürnberg on local labour office level (180) merged on regional level
age at entry into training	proxy for schooling between school and apprenticeship training	IABS/constructed from age at first spell for skilled
age of child	age in years of first child	IABS/own construction, year minus year of beginning of interruption
Parental leave policy change variable	months of parental leave	own construction from various sources, see Fig. 2

Availability of child care facilities by region

As an additional instrument for female labour supply we use variation in the availability of child care supply. For this purpose we have collected information from the German Statistical Office about the number of places per 1000 children for three age groups: 0-3 years old, 3-6 years old and 6-10 years old. The first group corresponds to 'Kinderhort'(childcare), the second group corresponds to kindergarden age and the third group to elementary school age where after school care is measured by this variable. We have data for the years 1986, 1990 and 1994 on the state level. In West Germany, there are 10 states excluding Berlin which cannot be used since it is not distinguished in East and West Berlin in the general statistics on child care. The 10 states are 1: Schleswig-Holstein, 2: Hamburg, 3: Lower Saxony, 4: Bremen, 5: North-Rhine Westfalia, 6: Hessen, 7: Rheinland-Palatinia, 8: Badenwürtenberg, 9: Bavaria, 10: Saarland. The IABS contains a 5 digit regional code and the first two digits corrspond to the state that we use to merge the information.

As we can see from the raw data (see Table A4.2), variation in child care facilities is almost negligible across years, yet significant across regions. In order to have

data for the period corresponding to our IABS sample we assume that child care supply was the same during 1981-1985 as in 1986, and in 1995 we set values equal to 1994. For years in between years we assume a linear trend.

Table A4.2: Summary statistics on child care supply

Variable		Mean	Std. Dev.	Min	Max	Observations
places	overall	22.56942	31.21044	3.713671	118.7626	N = 30
0- 3 year old	between		31.08063	6.157206	108.7595	n = 10
	within		8.643351	.7982946	55.43244	T = 3
places	overall	770.5613	175.4643	460.015	1082.061	N = 30
3-6 year old	between		160.3132	525.0438	1008.291	n = 10
	within		82.82414	612.2832	919.0045	T = 3
places	overall	59.95359	58.7677	14.1894	211.8449	N = 30
6-10 year old	between		57.15524	19.25649	201.6663	n = 10
	within		20.30299	-26.57971	109.4137	T = 3

Source: German Statistical Office. See text for more details.

B Appendix: Tables and Figures

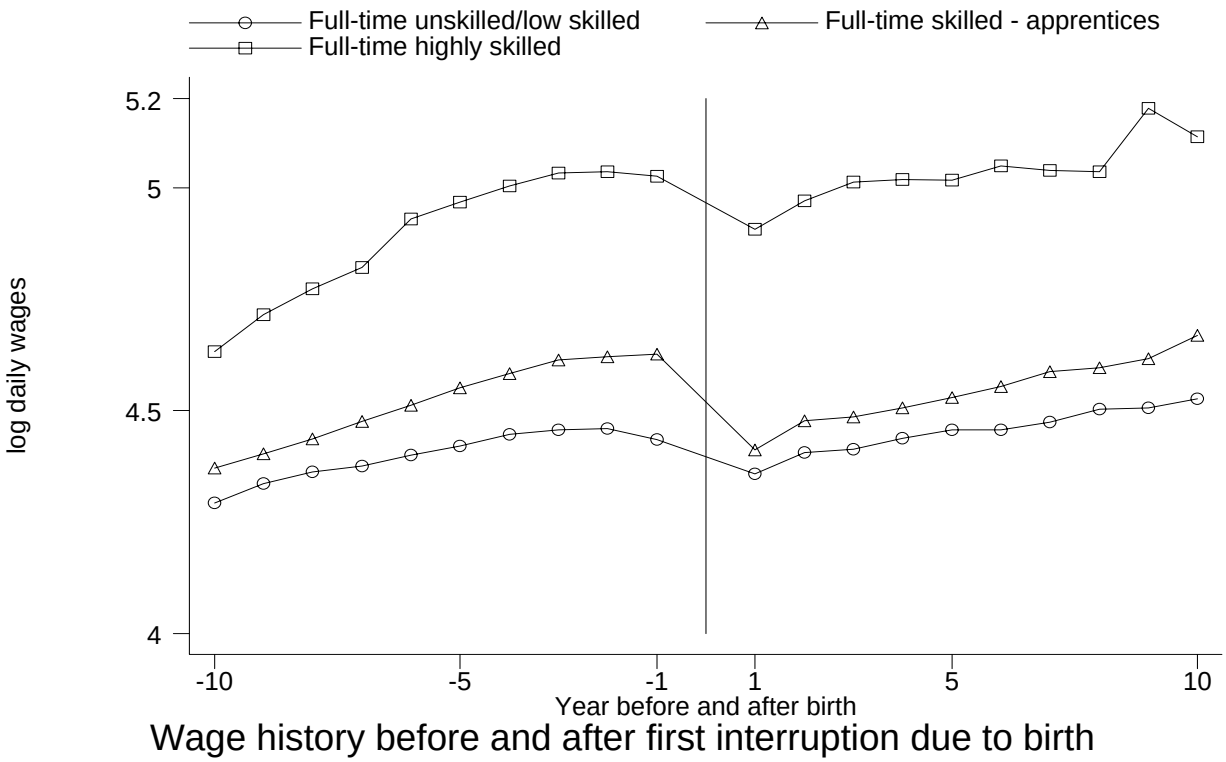
Full-time unskilled/low skilled
Full-time skilled - apprentices
Full-time highly skilled
log daily wages
5.2
5
4.5
4
-10
-5
-1
1
5
10
Year before and after birth
Wage history before and after first interruption due to birth

Figure 1:

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

Table 2: Descriptive statistics - full time female workers excluding second births

Variable	Sample of women with one birth				Comparison
	Before 1st Birth	Spell before 1st Birth	Spell after 1st Birth	After Birth	
			Unskilled		
age	22.83 (3.58)	24.16 (3.75)	24.56 (3.72)	26.28 (4.07)	29.40 (4.34)
number of firms	0.87 (1.35)	0.88 (1.36)	0.98 (1.39)	1.39 (1.77)	1.20 (1.49)
number of occupations	0.67 (1.11)	0.70 (1.14)	0.82 (1.19)	1.12 (1.47)	0.90 (1.21)
unemployment (yrs)	0.15 (0.51)	0.17 (0.56)	0.23 (0.62)	0.38 (0.81)	0.39 (0.94)
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)
experience (yrs)	3.30 (3.21)	4.33 (3.53)	4.53 (3.29)	5.87 (3.76)	7.33 (5.06)
log(wage)	4.41 (0.42)	4.47 (0.44)	4.35 (0.55)	4.43 (0.47)	4.67 (0.42)
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)
number of firms	0.95 (1.33)	1.07 (1.41)	1.22 (1.46)	1.50 (1.66)	1.08 (1.54)
number of occupations	0.52 (0.94)	0.60 (1.01)	0.71 (1.08)	0.89 (1.25)	0.62 (1.14)
unemployment (yrs)	0.10 (0.36)	0.12 (0.41)	0.19 (0.49)	0.26 (0.58)	0.26 (0.69)
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)
experience (yrs)	3.37 (3.00)	4.93 (3.30)	5.13 (3.12)	6.16 (3.51)	7.37 (4.88)
log(wage)	4.54 (0.39)	4.66 (0.40)	4.38 (0.62)	4.51 (0.52)	4.78 (0.35)
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)
number of firms	0.78 (1.12)	0.91 (1.14)	0.98 (1.13)	1.30 (1.77)	0.86 (1.13)
number of occupations	0.44 (0.82)	0.49 (0.85)	0.53 (0.89)	0.61 (1.05)	0.45 (0.77)
unemployment (yrs)	0.09 (0.31)	0.11 (0.36)	0.15 (0.42)	0.22 (0.54)	0.27 (0.76)
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)
experience (yrs)	2.48 (2.59)	3.75 (2.80)	4.14 (2.61)	5.71 (3.61)	4.50 (4.02)
log(wage)	4.94 (0.43)	5.06 (0.40)	4.86 (0.67)	5.00 (0.57)	5.12 (0.37)
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: Standard errors are reported in parentheses. The sample includes records before and after the first birth, excluding periods after a second interruption. The control 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.

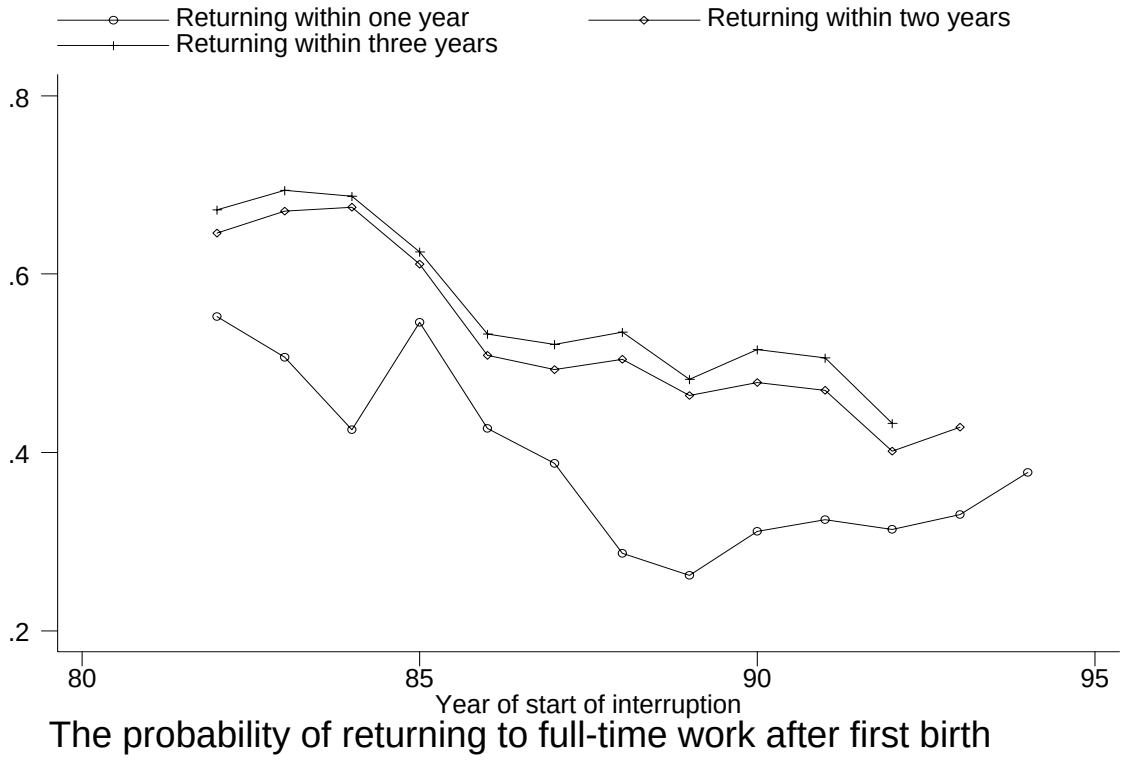
Returning within one year
Returning within two years
Returning within three years
.8
.6
.4
.2
80
85
90
95
Year of start of interruption
The probability of returning to full-time work after first birth

Figure 2:

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

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

Notes: Excluded are individuals not returning within three years and starting leave after 1992. The total number of women working in full-time work before interruption is 19293. We drop from those 5257 who start leave after 1992 and 492 who do not return within three years.

Table 4: 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: 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 5: 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. obs.	77	77	77

Notes: Data source: Sample of 20-40 year old women from German Socio Economic Panel, own calculations.

Table 6: 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. obs	819	71	690

Notes: Data source: Sample of 20-40 year old women from German Socio Economic Panel, own calculations.

Table 7: The 3-phase model estimates in first differences for the sample of women who give birth, IABS 1981-1995

	FD-estimates			IV-FD estimates		
	Unskilled	Skilled	Graduates	Unskilled	Skilled	Graduates
	Wage growth before first birth					
ΔExperience	0.039*	0.048*	0.044*	0.044*	0.050*	0.061*
	(0.004)	(0.002)	(0.007)	(0.015)	(0.007)	(0.012)
$\Delta\text{Experience}^2$	-0.001	-0.008*	-0.001*	-0.001	-0.001*	-0.001
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
ΔUnemployment	0.018	-0.018	-0.035	-0.247*	-0.091	-0.205
	(0.015)	(0.012)	(0.054)	(0.098)	(0.069)	(0.179)
Firm change within 3 years	-0.003	-0.003	0.042	-0.005	-0.004	0.055*
before mat. leave	(0.014)	(0.005)	(0.022)	(0.020)	(0.008)	(0.027)
Occupation change within 3	0.009	-0.027*	-0.005	0.018	-0.035*	-0.002
years before mat. leave	(0.015)	(0.007)	(0.036)	(0.020)	(0.009)	(0.038)
Within 3 years before	0.002	0.011*	0.007	-0.002	0.008*	-0.001
mat. leave (DIP)	(0.003)	(0.001)	(0.006)	(0.005)	(0.002)	(0.006)
	Wage over the interruption in connection with first birth					
Duration of interruption	-0.051*	-0.126*	-0.058*	-0.035*	-0.147*	-0.039
	(0.009)	(0.005)	(0.020)	(0.014)	(0.009)	(0.025)
Firm change* (mat. leave)	-0.023	-0.024	0.027	-0.089*	-0.021	0.002
	(0.034)	(0.016)	(0.067)	(0.039)	(0.018)	(0.074)
Occ. change*(mat.leave)	-0.009	-0.016	-0.065	-0.041	-0.022	-0.079
	(0.037)	(0.021)	(0.094)	(0.039)	(0.022)	(0.097)
	Wage growth after first birth					
ΔExperience	0.049*	0.063*	0.022	0.062*	0.091*	0.047
	(0.005)	(0.005)	(0.022)	(0.017)	(0.010)	(0.026)
$\Delta\text{Experience}^2$	-0.001*	-0.002*	0.001	-0.002*	-0.003*	0.000
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)
ΔUnemployment	-0.048*	-0.089*	-0.209*	-0.244*	-0.355*	-0.201
	(0.020)	(0.020)	(0.085)	(0.146)	(0.145)	(0.472)
	Other controls					
Firm change	0.037*	0.056*	0.024	0. 072*	0.066*	0.028
	(0.008)	(0.003)	(0.015)	(0.015)	(0.006)	(0.020)
Occupation change	0.007	0.016*	0.022	0.022	0.027*	0.034
	(0.009)	(0.005)	(0.024)	(0.012)	(0.007)	(0.027)
Inverse Mill's Ratio	-0.030*	-0.043*	-0.011	-0.055*	-0.057*	-0.035
	(0.011)	(0.005)	(0.020)	(0.012)	(0.005)	(0.022)
ΔYear dummies	Yes	Yes	Yes	Yes	Yes	Yes
ΔIndustry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of observation	19,439	73,847	3798	19,439	73,847	3798

Numbers in brackets are robust standard errors

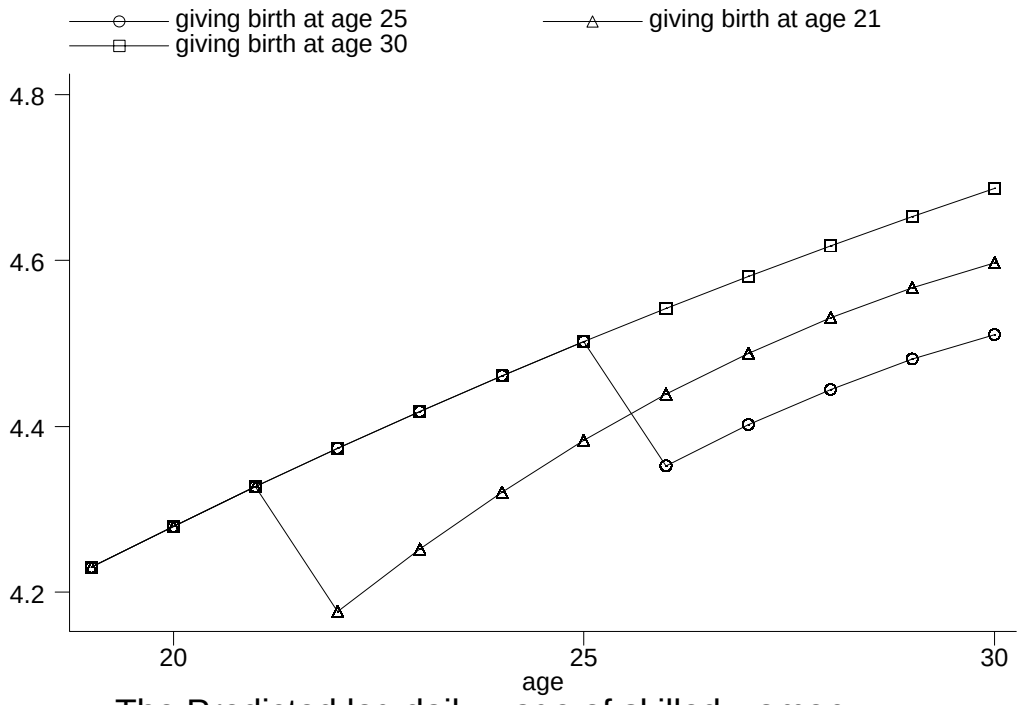
giving birth at age 25
giving birth at age 21
giving birth at age 30
4.8
4.6
4.4
4.2
20
25
30
age
The Predicted log daily wage of skilled women

Figure 3:

Table 8: Model Estimates in First Differences for the sample of women who do not give birth, IABS 1981-1995

	FD-estimates			IV-FD estimates		
	Unskilled	Skilled	Graduates	Unskilled	Skilled	Graduates
	Wage growth					
ΔExperience	0.039*	0.019*	0.029*	0.037*	0.020*	0.018
	(0.007)	(0.006)	(0.012)	(0.010)	(0.006)	(0.011)
$\Delta\text{Experience}^2$	-0.001*	-0.000*	-0.000*	-0.002*	-0.001*	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ΔUnemployment	-0.066*	-0.047*	-0.003	-0.380*	-0.253*	-0.154*
	(0.018)	(0.019)	(0.025)	(0.088)	(0.073)	(0.066)
	Other controls					
Firm change	0.042*	0.046*	0.022*	0.101*	0.075*	0.042*
	(0.010)	(0.007)	(0.012)	(0.017)	(0.010)	(0.014)
Occupation change	0.008	-0.000	0.021	0.043*	0.017*	0.038
	(0.012)	(0.007)	(0.019)	(0.016)	(0.010)	(0.020)
Inverse Mill's Ratio	0.022	0.003	0.018	0.007	-0.002	0.014
	(0.020)	(0.008)	(0.020)	(0.020)	(0.008)	(0.021)
ΔYear dummies	Yes	Yes	Yes	Yes	Yes	Yes
ΔIndustry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Number of observation	10,34	19,634	3,954	10,347	19,634	3,954

Numbers in brackets are robust standard errors

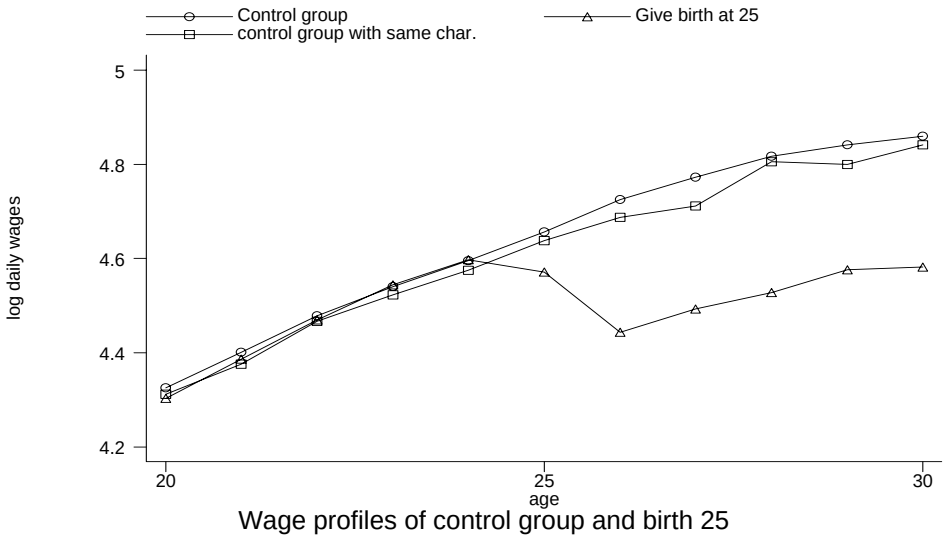
Control group
Give birth at 25
control group with same char.
log daily wages
5
4.8
4.6
4.4
4.2
20
25
30
age
Wage profiles of control group and birth 25

Figure 4: