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Abstract

Previous research has found that mothers earn less than childless women; this parenthood effect helps explain gender inequality as well. Although U.S. women's educational levels and engagement in the labor market have changed over the last several decades, most studies do not analyze variation in the motherhood penalty over time. We know surprisingly little about how the labormarket status of mothers has evolved or whether the role of motherhood in shaping labor-market outcomes for women has changed over the last few decades. This paper uses data from the U.S. Panel Study of Income Dynamics (PSID), one of the only nationally representative datasets that contains a measure of actual labor-market experience, to examine the evolution of the motherhood penalty in recent years. We estimate the wage gap between mothers and childless women for three time periods: 1986-95, 1996-2004, and 2006-14. We find that the motherhood penalty remains quite stable over time, and may have worsened for mothers with one child. While the gross gap in pay between childless women and mothers of two or more children has narrowed, it has only done so because mothers' have increased their investments in human capital, such as education and workforce experience. Differential selection into motherhood does not explain these findings, as fixed effects models provide similar results. Our findings may thus confirm that changes mothers can make – in their human capital investment, as well as in their employment patterns – may not be enough to create real change. Policies aimed at supporting mothers' employment may be a necessary next step, if we hope to lower the motherhood wage penalty in the United States.

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Motherhood Penalties in the U.S., 1986-2014

Introduction

Previous research has found that mothers earn less than childless women (Budig and England 2001; Budig and Hodges 2010, 2014; Waldfogel 1997). Lower wages for mothers makes a substantial difference to many families. Mothers working full-time earn approximately 71% percent of what fathers earn, even as more than 70% of families rely on income from a working mother (Williams-Baron, Anderson, and Hegewisch 2017). Although women's educational levels and engagement in the labor market have changed over the last several decades, most studies do not analyze variation in the motherhood penalty over time. We know surprisingly little about how the labor-market status of mothers has evolved or whether the role of motherhood in shaping labor-market outcomes for women has changed.

The only previous study to examine changes in the motherhood penalty in the U.S. over time found that, controlling for differences in demographic characteristics, educational attainment, labor-market experience, and stable personal characteristics, the penalty was statistically unchanged between 1975-85 and 1986-98 (Avellar and Smock 2003). In contrast, a study using Norwegian data found that, controlling for differences in demographic characteristics, educational attainment, and potential labor-market experience, and comparing workers in the same occupation with the same employer, the motherhood penalty in Norway declined substantially over the same period. The authors of the second study attribute the improvement in the relative wages of Norwegian mothers to an expansion in work-family policies between 1979 and 1996 (Petersen, Penner, and Hogsnes 2014).

There are a number of reasons to think that the motherhood penalty in the U.S. may have persisted beyond the late 1990s. This country has not committed to expanding work-family policies to anywhere near the extent of most other wealthy countries (Gornick and Meyers 2005). For example, there is no federal commitment to paid parental leave, and limited commitment to publicly funded preschool relative to other wealthy countries. This may mean that U.S. mothers may find it more difficult to balance work and care, which could harm their experience, productivity, and subsequent wages. In addition, progress towards gender equality seems to have stalled in the late 1990s. While the ratio of women's to men's earnings rose steeply from 62 percent in 1979 to 77 percent in 1993, it has hovered around 81 percent since 2005 (U.S. Department of Labor 2017).

On the other hand, even absent extensive work-family policies, there are reasons to think that the motherhood penalty may have declined. Women's labor force participation rate has risen dramatically, from less than 33 percent in 1948 to 57 percent in 2015, as men's labor-force participation rate has fallen from more than 87 percent to 69 percent (U.S. Department of Labor 2017). Women's labor force participation rate is particularly high during their childbearing years, between the ages of 25 and 54, and substantially lower at younger and older ages. Indeed, the labor force participation of mothers of children under 18 has risen from 47 percent in 1975 to 70 percent in 2015, and is thus higher than for other groups of women (U.S. Department of Labor 2017). This may mean that recent cohorts of mothers have higher levels of experience than previous cohorts, which may lead them to earn higher wages. Employers may also have revised their expectations about the relative productivity of mothers and

childless women and may be less inclined than in the past to discriminate against mothers in hiring, promotion, and pay.

This paper uses data from the Panel Study of Income Dynamics (PSID), one of the only nationally representative datasets that contains a measure of actual labor-market experience, to examine the evolution of the motherhood penalty in recent years. We estimate the wage gap between mothers and childless women for three time periods: 1986-95, 1996-2004, and 2006-14. The earliest time period in our study is roughly comparable to the latest time period in Avellar and Smock (2003). The more recent time periods allow us to consider how the motherhood wage penalty has continued to evolve over time.

While much previous research has focused on the portion of the motherhood penalty that might plausibly be attributed to discrimination in wage setting, we take a broader view. First, we use pooled OLS regressions to estimate the wage gap between mothers and childless women controlling only for demographic differences. The resulting estimates quantifies wage inequality between mothers and childless women from all sources, including any effects of motherhood on women's investments in their human capital. Next, we estimate the wage gap controlling for demographics and measures of human capital, including educational attainment and labor-market experience. This second set of estimates quantifies wage inequality between mothers and childless women net of observable differences between the groups. This allows us to understand the role of education and experience in shaping wage inequalities. Finally, we use fixed effects regressions to estimate the wage gap controlling for both observable differences and stable unobservable differences, and consider selection into the labor force by using imputed wages.

We find that the motherhood penalty remains quite stable over time, and may have worsened for mothers with one child. While the gross gap in pay between childless women and mothers of two or more children has narrowed, it has only done so because mothers' have increased their investments in human capital. It also does not appear that differential selection into motherhood explains these findings, as fixed effects models provide similar results.

Background

While wages among childless men and childless women have been converging, most studies suggest that mothers earn substantially less than childless women (Anderson, Binder, and Krause 2003; Benard and Correll 2010; Budig and England 2001; Budig and Hodges 2010; Correll, Benard, and Paik 2007; Glauber 2008; Killewald and Gough 2013; Lundberg and Rose 2002; Sigle-Rushton and Waldfogel 2007; Waldfogel 1997).

This penalty may be due to mothers' reduced experience, although studies are not conclusive. For example, Budig and England (2001) show a seven percent per-child penalty, using data from the National Longitudinal Survey of Youth (NLSY). They argue that only one-third of this penalty can be attributed to lost experience. Yet, using data from the PSID, Lundberg and Rose (2000) suggest that experience plays a key role, arguing that mothers only face penalties when they interrupt their employment due to care responsibilities. The effect of experience on wages may vary. Looking at women across the earnings distribution, Budig and Hodges (2010, p. 724) suggests that reduced experience account for almost half of the motherhood penalty felt by high-earning women, but "virtually none" of the penalty felt by low-earning women; difference in work-effort explains the variations for low-earning women. More recently, Killewald and Gough (2013) argue, using NLSY data,

that while mothers appear to alter employment hours, job traits, and tenure in ways similar to fathers (whose wages increase), mothers experience a substantial wage penalty.

This penalty may also relate to employers' perceptions of mothers' productivity. Employers may perceive mothers to be less committed, less competent, less productive, and therefore less deserving of high wages. Research based on both a laboratory experiment and a real-world audit study with actual employers, find that mothers are offered salaries 7.9% less than childless women, while actual prospective employers called mothers back for interviews half as often as they did childless women (Correll et al. 2007, p. 1333). Another study, based on nationally representative survey data, finds that mothers are no different than childless men and women, and similar to or even more engaged than fathers on pro-work dimensions (Kmec 2011). This research suggests that employers' perceptions of mothers as less committed to work may help account for the motherhood penalty, even when there do not appear to be warranted reasons to discriminate against mothers.

There are fewer studies exploring how the motherhood penalty has changed over time. Avellar and Smock (2003) compare two cohorts of U.S. women in NLS-YW (1975-1985) and NLSY (1986-1998), to examine whether the motherhood penalty has changed as mothers have entered the labor market in greater numbers. Although women in the earlier cohort have less work experience than those in the later cohort, mothers in both cohorts experience lower wages, with no significant difference between cohorts. They argue that children continue to decrease wages for mothers, despite mothers' increasing levels of work experience. They conclude that the motherhood penalty remains a critical contributor to gender inequality in the workplace.

On the other hand, Petersen, Penner, and Høgsnes (2014) use matched data on Norwegian private-sector white collar workers from 1979 to 1996, and find that the motherhood penalty is reduced over this time period. In the first period (1979-87), mothers experience lower wages, with each child adding to the penalty so that a mother of three children earns 6 percent less than a comparable childless woman. However, this effect reduces for the second period (1988-93), and almost entirely disappears in the most recent period (1994-6). They examine the historical expansion of work-family policies during this period, and argue that the disappearance of the motherhood penalty in Norway coincides with the adoption of family-friendly policies. Referring to Avellar and Smock's (2003) findings, they argue that while cultural values around mothers' employment in Norway and the U.S. have become more supportive, the absence of family-friendly policy in the U.S. helps explain the continuing motherhood penalty.

Using data from the PSID, we examine a longer time period (1987 to 2013) to replicate Avellar and Smock's analysis with more recent data. This allows us to consider whether the relationship between motherhood and wages has changed in the U.S., despite the absence of work-family policies. The PSID also includes a good measure of labor force experience, allowing us to consider the role of education and experience in any changes in the motherhood wage penalty.

Much previous research on the motherhood penalty has focused on the "unexplained" component of the penalty: the component not accounted for by measurable differences between mothers and childless women (for example, differences in human capital endowments or job characteristics), or by differences in stable personal characteristics (for example, pre-existing differences in conscientiousness or career ambition). Interest in the unexplained component of the motherhood penalty is motivated primarily by concerns about labor-market discrimination. Discrimination occurs when a mother is paid less than an equally productive childless woman, simply because she is a mother. Accordingly, to assess

the extent of discrimination, researchers attempt to compare the wages of mothers and childless women with similar labor-market characteristics.

The focus of this paper is broader. Motherhood may depress wages through many channels, and lower wages increase the economic vulnerability of families with children regardless of the mechanism. At the same time, determining the relative importance of different reasons for the wage gap matters for understanding social change and for efforts to reduce inequality. The goals of this paper are thus twofold. First, we aim to consider whether the wage gap for motherhood has changed over time. Second, we aim to understand the relative impact of education and experience in the wage gap for motherhood over time.

Data

We use data from the Panel Study of Income Dynamics (PSID) to examine the relationship between motherhood and wages over three time periods: 1986-95, 1996-2004, and 2006-14. We chose to use the PSID because it provides nationally representative data for the years in question and includes longitudinal work histories that allow us to construct measures of lifetime labor-market experience. PSID interviews were conducted every year from 1968 to 1996 and every other year beginning in 1997. Each wave of interviews collected information about participants' employment and income in the preceding calendar year. After the move to biennial data collection, each wave also collected limited information about participants' employment and income in the calendar year before the preceding year, which would not otherwise have been covered. Unfortunately, our preferred measure of hourly wages was not included in this supplemental data collection. Our analysis sample thus includes observations from interviews conducted in every year from 1987 to 1996, which provide data for every year from 1986 to 1995, and observations from interviews conducted in odd years from 1997 to 2015, which provide data for even years from 1996 to 2014.

We chose the 1986-95, 1996-2004, and 2006-14 time periods for continuity with Avellar and Smock (2003), whose analysis of intertemporal changes in the motherhood penalty ends with the 1986-98 period, and to extend the intertemporal comparisons in that study to recent years. We cut the data between 1995 and 1996 because there were some changes to the PSID between the corresponding survey years (1996 and 1997), including the addition of an immigrant sample, a corresponding revision of the sampling weights, and the move from annual to biennial data collection. This led to one 10-year period and two 9-year periods. We pool data across years in each period to obtain samples of sufficient size to answer our research questions.

Our analysis sample for each of the three study periods draws from the PSID core sample. The core sample comprises people selected as part of the initial PSID sample of just under 5,000 nationally representative households in 1968, their offspring (children, grandchildren, and so on), and the current co-residents (including spouses and cohabiting partners) of these initial PSID families. With the use of the PSID sampling weights, the core sample is representative of the U.S. population, excluding post-1968 immigrants and their offspring.

Our analysis samples for the 1996-2004 and 2006-14 periods additionally draw from the PSID immigrant sample. The immigrant sample was added over the course of the 1997 and 1999 waves of interviews to represent post-1968 immigrants to the U.S. and their offspring. Together, the core and immigrant samples are representative of the entire U.S. population. We include members of the immigrant sample

in our analysis samples to maximize the size of our samples in the second and third study periods, when the number of observations is limited due to biennial data collection, and to represent the experiences of all major demographic groups in the contemporary U.S., including immigrants from Latin America and Asia.

The PSID core and immigrant samples contain 137,193 person-year observations from adult female heads and wives (a group which includes unmarried cohabiting partners of heads) between 1986 and 2014. To focus on prime-age workers, we restrict our analysis sample to observations from women between the ages of 25 and 54 who were employed in the calendar year before their PSID interview. We exclude observations from women who were self-employed and observations from unpaid family workers, agricultural workers, and members of the armed forces. In addition, because our preferred measure of hourly wages is available only for workers who were paid hourly or salaried, we restrict our sample to wage and salary workers. Excluding observations from women younger than 25 from our sample has the benefit of eliminating most observations from full-time students and minimizing the probability that the educational attainment of the women in the sample, which was not consistently updated by the PSID, changed during the years over which we observe them. While many previous studies of the motherhood penalty have focused on women younger than 50, including observations from women up to age 54 in our sample allows us to capture effects of motherhood that may emerge over a longer period after birth.

After applying all sample restrictions and excluding observations with missing values of variables in our regression models, our analysis sample includes 24,998 person-year observations from 4,985 women in the 1986-95 period, 12,598 person-year observations from 4,353 women in the 1996-2004 period, and 13,346 person-year observations from 4,853 women in the 2006-2014 period. In the analyses that follow, we apply the PSID sampling weights to obtain nationally representative estimates and cluster standard errors at the person level.

Characteristics of mothers and childless women

We classify women as mothers if the PSID childbirth and adoption history file indicates that they have given birth or adopted a child. Our measure of motherhood is a set of three indicator variables identifying women with one, two, and three or more children. We prefer this discrete measure of motherhood to a continuous measure (the number of children) because few mothers in recent decades have had large families and because the effect of motherhood on wages is unlikely to be linear in the number of children.

Our wage measure is the log of a worker's regular hourly rate of pay. This measure is available only for wage and salary workers and, beginning in 1997, only for odd years. Wage and salary workers comprise over 80 percent of civilian non-agricultural employees in each year for which the measure is available. An alternative wage measure, which is available for every year, is annual labor income divided by annual hours of work. While using this alternative measure would double the size of our estimation samples for the second and third study periods, it would also introduce additional measurement error. We are particularly concerned that the computed wages of mothers may be biased upward around the time of birth. A preliminary analysis showed that the reported work hours of mothers fell proportionally more, on average, than their reported earnings in the year of birth, resulting in an apparent but probably spurious increase in their wages.

Our human capital measures are educational attainment and labor-market experience. We classify educational attainment by the highest degree a woman had earned at age 25: a high school degree or less, some college, or a bachelor's degree or more. We treat education as time-invariant after age 25 because the PSID rarely updated its education records after individuals first entered the sample, leading to inconsistent measurement error in the time-varying education measure.[1]

We measure labor-market experience as years of full-time and part-time work. In each survey year, the PSID asked women joining the panel as heads or wives how many years they had worked and how many years they had worked full time since they were 18 years old. In 1985, the PSID asked these questions of all heads and wives, including heads and wives who had joined the panel in previous years. Following Blau and Kahn (2013), we use the year of the latest report of cumulative experience (1985 if the woman joined the panel before 1985, and the year she joined the panel otherwise) as a base year. We compute cumulative experience in each year after the base year using the responses to annual or biennial survey questions about employment in the one or two calendar years before the survey. Specifically, we add one year to our measure of part-time experience for each year between the base year and the focal year that a woman worked in the labor market less than 1500 hours. We add one year to our measure of full-time experience for each year she worked 1500 hours or more.

We classify women as black, white, or some other race; and as never married, currently married, or previously married. Previously married women include women who are divorced, widowed, or separated. We code marital status using data from the PSID marriage history file, which provides complete annual data for each of the time periods in this study.

Table 1 presents estimates of the average wage, demographic characteristics, and human capital endowments of mothers and childless women in each of the three periods. Mothers earned less than childless women (an average wage of $12.78 versus $15.91) in the 1986-95 period. The average wage of mothers increased by $2.44 between the 1986-95 and 1996-2004 periods, but because the average wage of childless women increased by $3.47, mothers continued to earn less. The average wage of mothers increased by another $1.10 between the 1996-2004 and 2006-14 periods, while the average wage of childless women stagnated. This relative gain by mothers, however, was not enough to close the gap with childless women: in the 2006-14 period, mothers earned an average of wage of $16.32 compared with an average wage of $19.54 for childless women.

[Table 1 about here]

Mothers are, in general, older than childless women, which simply reflects that for those who become mothers, motherhood occurs later in a woman's life course. There are some racial differences between mothers and childless women over time. The proportion of both groups who were white declined from the earliest period to the latest, while the proportion who were black remained stable and the proportion who were some other race increased. In each period, mothers were less likely than childless women to be white and more likely to be black, with all but one of these differences reaching statistical significance. Mothers were more likely than childless women to be married in the earliest period, but the proportions of mothers and childless women who were married were statistically indistinguishable in the middle and latest periods. In each period, mothers were less likely than childless women to be never married and more likely to be previously married.

We are particularly interested in the human capital endowments of mothers over this time. In each period, mothers had lower levels of education than childless women: mothers were more likely than childless women to have a high school degree or less and less likely to have a bachelor's degree. On the other hand, the educational attainment of both mothers and childless women increased from 1986-95 to 2006-14, and the gains by mothers were especially pronounced. While the percentage of childless women with a high school degree or less fell from 36 in the earliest period to 29 in the latest, the percentage of mothers fell from 62 to 45. At the same time, the percentage of both mothers and childless women with a bachelor's degree increased by between 11 and 12 percentage points. That both mothers and childless women were more educated in 2006-14 than 1986-95 is consistent with evidence that women overall increased their educational attainment relative to men over the last half century (DiPrete and Buchmann 2006, Goldin 2006). The results in Table 1 suggest that both mothers and childless women contributed to this trend in recent decades but that mothers contributed more than childless women and, consequently, may have improved their labor-market productivity relative to childless women.

In contrast with the results for education, mothers had higher levels of labor-market experience than childless women. In each period, both the average full-time experience and the average part-time experience of mothers exceeded those of childless women, with all but one of these differences reaching statistical significance. While we would expect the greater experience of mothers to increase their relative wages, all else equal, mothers had more experience than childless women mainly because they were older. In each period, the difference in the average ages of mothers and childless women exceeded the difference in their average years of experience. On the other hand, mothers increased their experience more rapidly than childless women between 1986-95 and 2006-14. While the average full-time experience of childless women was statistically unchanged from the earliest period to the latest, the average full-time experience of mothers increased by almost three years; and while the average part-time experience of childless women was statistically unchanged, the average part-time experience of mothers increased by one year. To the extent that mothers' relative gains in human capital between 1986-95 and 2006-14 improved their relative labor-market productivity or discouraged discrimination against them, these gains may also have reduced the motherhood wage penalty.

Evolution of the motherhood gap

To quantify the total extent of wage inequality between mothers and childless women, including inequality due to labor-market discrimination against mothers, reductions in market-oriented human capital due to motherhood, and inequality from other sources, we begin by estimating the gross motherhood wage penalty in each period. Specifically, we estimate a pooled OLS regression of the log wage on indicator variables for having one, two, and three or more children. Under a straightforward transformation (described below), the coefficients on the indicator variables give the percentage wage gap between each group of mothers (mothers of one, two, and three or more children) and childless women. To control for shifts in the demographic composition of mothers and childless women over time, we control for age, race, and marital status. We do not control for education or labor market experience; in this specification, we allow wage differences due to differences in human capital to accrue to motherhood.

To quantify the extent of wage inequality between mothers and childless women net of differences in human capital, and to assess the contribution of human capital to the wage gap in each period, we

estimate two additional specifications. First, we estimate the motherhood wage penalty controlling for both demographics and education. Second, we estimate the penalty controlling for demographics, education, and quadratic functions of full- and part-time labor-market experience. Comparing the estimates from the first of these additional specifications with estimates of the gross motherhood penalty provides a measure of the contribution of human capital to the latter: the larger the reduction in the magnitude of the estimates across specifications, the larger the contribution of education and labor-market experience to wage inequality between mothers and childless women.

Table 2 shows the estimated coefficients from these regressions. Figure 1 shows the gross and net wage penalties for one, two, and three or more children in percentage terms, where each penalty is derived from the corresponding coefficient in Table 2 as *penalty* = e^{coefficient}-1. Considering first the wage penalty for one child, the gross penalty was 16.9 percent ($e^{-0.185}$-1 = 16.9) in 1986-95 and 17.3 percent in 2006-14. The penalty net of differences in education was 9.5 percent in 1986-95 and 14.5 percent in 2006-14; and the penalty net of differences in education and labor-market experience was 8.2 percent in 1986-95 and 13.7 percent in 2006-14. The increases in the point estimates of the net wage gaps between the earliest period and the latest, as illustrated in Figure 1, suggest an economically significant deterioration – rather than an improvement – in the pay of mothers of one child relative to childless women with comparable human capital. In other words, in the earliest period, education and experience explained more of the wage gap between childless women and mothers. These changes, however are not statistically significant at conventional levels.

Turning to the penalties for two children, we see that the gross penalty was 24.5 percent in 1986-95 and 18.8 percent in 2006-14. The penalty net of education was 17.8 percent in 1986-95 and 15 percent in 2006-14. Perhaps most interestingly, the penalty net of both education and labor-market experience was almost identical – between 12.5 and 12.6 percent – in 1986-95 and 2006-14. The decline in the gross wage gap between the earliest period and the latest suggests an economically significant (although not statistically significant) improvement in the pay of mothers of two children relative to childless women. That this improvement disappears when we control for education and labor-market experience suggests that the relative wage gains of mothers were due to their relative gains in human capital: as mothers of two children improved their education and labor-market experience, over time, the gross gap between their wages and the wages of childless women appears to have decreased. Meanwhile, however, the net gap – the gap due to factors other than human capital, possibly including labor-market discrimination against mothers or unobservable differences in labor-market productivity between mothers and childless women – remained stable.

The results for mothers of three or more children are similar to those for mothers of two children. The gross penalty for three or more children declined from 35.9 percent in 1986-95 to 31.1 percent in 2006-14, although this change was not statistically significant. When we control for education, the penalty was 26.9 percent in 1986-95 and 24 percent in 2006-14 – a smaller reduction. When we control for both education and labor-market experience, the penalty for three or more children does not change much, as in the penalty for two children. This net penalty was 18 percent in 1986-2005 and 17.5 percent in 2006-14. In other words, when comparing women with the same level of education and experience, mothers with three or more children see a stable wage penalty over time.

We would expect that, as mothers gain human capital in the form of education and labor-market experience, we would see a decrease in gross wage penalty for motherhood. To the extent that

improvements in mothers' labor-market investments improve employers' perceptions of mothers as workers and reduce discrimination against them, we might also expect to see a decrease in the net wage penalty. For mothers of one child, our results run contrary to these optimistic expectations. The gross wage penalty for one child remained stable between 1986-95 and 2006-14, and the wage penalty net of human capital differences may have increased. For mothers of multiple children, however, our results paint a more positive picture. We observe an economically significant but statistically non-significant trend toward lower gross wage penalties for multiple children between 1986-95 and 2006-14. However, to the extent that this trend reflects a true change, it appears to be driven by mothers' more-rapid gains in human capital compared with childless women between the earliest period and the latest. While we do not observe declines in the net penalties for multiple children over time, these penalties remain stable. Taken together, these results suggest that mothers have gained economic ground in recent decades as a result of their own labor-market investments but that other (unmeasured) obstacles to wage parity remain.

Our results suggest that both education and labor-market experience matter to reducing the wage penalties for motherhood. It appears, however, that the relative importance of these forms of human capital differs among mothers depending on the size of their families. For mothers with one child, education is particularly important. Mothers with one child saw a gross wage gap of 17.3 percent in 2006-14. This gap is reduced to 14.5 percent when we control for education. Controlling for experience also leads to a smaller gap, of 13.7 percent, but the largest difference is driven by education. Yet for mothers of multiple children, who may be more likely to have lower levels of experience than childless women with the same characteristics, experience plays a larger role. For example, the gross gap for mothers with three children was 31.1 percent in 2006-14. This gap is reduced to 24 percent when we control for education, and 17.5 percent when we control for education and experience – suggesting that both are important for mothers of multiple children.

Selection into motherhood and the labor force

This paper takes a broad view of the motherhood penalty, estimating not just the net penalty but the gross penalty, which incorporates wage losses due to mothers' lower levels of education labor-market experience. We take this broad view because we aim to quantify the economic disadvantage associated with motherhood from all sources, including but not limited to the disadvantage from current labor-market discrimination against mothers. Ideally however, we would like to exclude from our estimates of the motherhood penalty any wage differences between mothers and childless women that are not due to the expectation or realization of motherhood. If, for example, women who are more conscientious and hard-working are more likely to become mothers, then the wages of childless women may understate the counterfactual wages of mothers. In this case, estimates that do not exclude the (positive) effect of mother's pre-existing productivity advantage on their wages would understate the motherhood penalty.

To assess the direction and magnitude of any bias in our estimates from selection into motherhood, we compare the coefficients from the full regression model described in the preceding section (controlling for demographics, education, and labor-market experience) with the coefficients from the same model estimated under fixed effects rather than pooled OLS. Adding individual fixed effects to the model controls for stable differences between women that may affect their labor-market productivity. (Because the fixed effects absorb the effects of stable personal characteristics, the time-invariant

control variables in the pooled OLS model, race and education, drop out of the fixed effects model.) In the example above, adding individual fixed effects would control for the greater conscientiousness and diligence of women who become mothers compared with women who do not. An increase in our estimates of the motherhood penalty under fixed effects compared with pooled OLS would suggest that mothers are positively selected on characteristics that improve labor-market productivity, as in the example. A decrease in our estimates would suggest that mothers are negatively selected.

A second source of potential bias in the estimates presented above is differential selection of mothers and childless women into the labor force. Ideally, we would like to estimate the gap in wage offers between mothers and childless women, including women who are not employed (and thus do not have measured wage offers) when we observe them. A well-established method for adjusting estimates of wage gaps for differential selection into the labor force is the Heckman selection correction (Heckman 1979). However, as noted in Blau and Kahn (2006), the identification assumptions underlying this technique are often implausible. We thus follow an alternative method proposed by Blau and Kahn in their analysis of the gender wage gap: where possible, we impute a woman's unobserved current wage as her most recent past wage observation within a four-year window of the current year. Comparing the coefficients from regressions estimated on samples with and without the imputed wages allows to assess the impact of labor-force selection on our estimates. An increase in our estimates of the motherhood penalty when adding the imputed wages would suggest that employed mothers are positively selected relative to employed childless women. A decrease in our estimates would suggest the opposite.

This method of correcting for selection into the labor force has two limitations. First, we are not able to recover a wage observation for every woman we observe out of the labor force. Adding the imputed wages increases our coverage of the target population (women between 25 and 54 years old) from 73 to 77 percent for childless women and from 60 to 64 percent for mothers. Second, because the method assumes that a woman's current earning potential is the same as her earning potential in the year from which we recover her wage observation, it will obscure any effect the transition to motherhood may have on the wages of mothers we observe out of labor force and for whom we recover a wage observation from a year prior to the birth. This second limitation is especially problematic for fixed effects estimation because it implies that including the imputed wages in the estimation sample for a fixed effects regression would cause attenuation bias in the resulting estimates of the motherhood penalty. In light of this problem, we consider selection into motherhood separately from selection into the labor force, estimating a fixed effects regression on the sample without imputed wages and an additional pooled OLS regression on the sample with imputed wages.

Selection-adjusted wage penalties for one, two, and three or more children on log wageTable 3 shows estimates of the motherhood penalty adjusted for selection into motherhood and the labor force. For purposes of comparison, Panel A of Table 3 repeats the estimates from the final regression model Table 2, which controlled for demographic characteristics, education, and labor-market experience but did not adjust for selection into motherhood or the labor force. Panel B shows estimates from the fixed effects model, which adjusts for selection into motherhood. Comparing the coefficients in Panel B with those in Panel A, we find that controlling for stable differences between mothers and childless women increases estimates of the motherhood penalty for all mothers, regardless of family size. This pattern is relatively stable over time. That the fixed effects estimates are larger (more negative) than the pooled OLS estimates suggests that mothers are *positively* selected with respect to unobservable characteristics that

are positively correlated with earning potential – a finding consistent with the results of some but not all previous research (Avellar and Smock 2003, Lundberg and Rose 2000).

Panel C of Table 3 shows estimates from the pooled OLS model estimated on the sample with imputed wages, which adjusts for selection into the labor force. In general, the coefficients in Panel C are similar to those in Panel A, suggesting that differential selection of mothers and childless women into the labor force is not a source of serious bias in our estimates of the motherhood penalty. Given, however, that we were unable to impute wages for a non-negligible fraction of potential workers (either because they were persistently non-employed or because they were persistently employed in jobs excluded by our sample restrictions), this finding should be viewed as tentative rather than conclusive.

Conclusions

We consider how motherhood may depress wages through a variety of channels. Rather than only focusing on the unexplained component of the wage gap between mothers and childless women, we also attend to how human capital endowments may explain the penalty. Over the period under study, women, and mothers, have improved their educational levels, as well as their workplace experience. This might suggest that the wage penalty for motherhood should have been reduced over time, but it has not been.

Our findings show that, between 1986-95 and 2006-2014, the gross gap for mothers of one child remains steady – rather than being reduced. When we control for education and experience, it appears that the wage penalty has increased from about 8% to about 14%, for mothers of one child. As mothers have improved their education and experience over time, this has not mitigated the wage gap. Over the same period, mothers of multiple children appear to see a reduction in the wage gap, although this reduction disappears once we control for education and experience. For mothers with the same level of education and experience, the wage gap has held steady over this period, at between 12% and 13% for mothers of two children and between 17% and 18% for mothers of three or more children. We also find that education makes a larger difference in narrowing the gap for mothers with one child, where experience is more influential for mothers of two or more children. As we use fixed effects models to control for selection into parenthood, or use imputed wages to control for selection into the labor force, we continue to find substantial pay gaps between childless women and mothers with the same characteristics. Mothers' investment in human capital has paid off. But there remain stubborn differences in pay between childless women and mothers.

Our findings are similar to those of Avellar and Smock (2003), who found no change in the motherhood penalty between 1975-1985 and 1986-1998. Yet, given changing patterns around gender and work, and the tremendous influx of mothers into the U.S. labor force, it is important to recognize how intractable the motherhood wage penalty appears to be. While Norwegian data finds a narrowing in the motherhood penalty from 1979 to 1996, this narrowing occurred in the presence of more generous work-family policies, aimed at helping parents reconcile employment and care (Petersen et al. 2014). These policies may signal greater cultural support for maternal employment, or may substantively improve opportunities for mothers in the workforce, as well as improved levels of experience and productivity due to less work-family conflict.

Our findings may thus confirm that changes mothers can make – in their human capital investment, as well as in their employment patterns – may not be enough to create real change. Policies aimed at

supporting mothers' employment may be a necessary next step, if we hope to lower the motherhood wage penalty (Boeckmann, Misra, and Budig 2015; Budig, Misra, and Boeckmann 2016).

Notes

[1] Allowing education to change at the time of the PSID updates does not meaningfully alter our results.

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Figures

Figure 1
Wage peanlties for one, two, and three or more children compared with no children
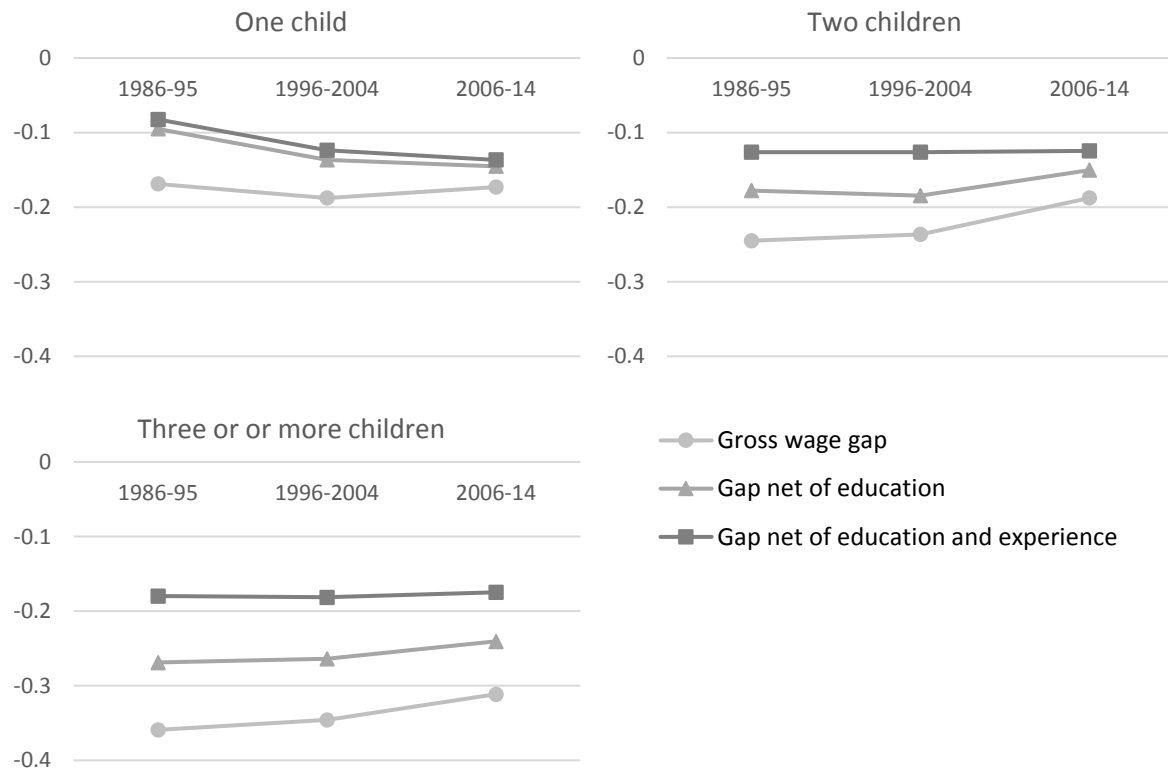
Notes: Figure presents wage penalties for mothers as a percentage of childless women's wages. Penalties were derived from the coefficients in Table 2 using the formula $penalty = e^{coefficient} - 1$.

Tables

Table 1

Estimates of mean demographic and human capital characteristics of childless women and mothers

Variable	1986-95		1996-2004		2006-14	
	Childless	Mothers	Childless	Mothers	Childless	Mothers
Wage	15.91	12.78*	19.38†	15.22*†	19.54‡	16.32*†‡
	(0.43)	(0.21)	(0.65)	(0.28)	(0.49)	(0.31)
Age	33.69	39.47*	35.67†	41.18*†	34.90‡	41.04*‡
	(0.38)	(0.19)	(0.43)	(0.21)	(0.41)	(0.22)
White	0.89	0.84*	0.85†	0.81†	0.85	0.80*‡
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Black	0.11	0.15*	0.10	0.16*	0.10	0.16*
	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Other race	0.01	0.01	0.04†	0.03†	0.05‡	0.04†‡
	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.01)
Currently married	0.69	0.74*	0.70	0.73	0.79†‡	0.76
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Never married	0.19	0.02*	0.19	0.02*	0.12†‡	0.02*
	(0.02)	(0.00)	(0.02)	(0.00)	(0.01)	(0.00)
Previously married	0.13	0.24*	0.10	0.25*	0.09	0.23*
	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
High school or less	0.36	0.62*	0.31†	0.53*†	0.29‡	0.45*†‡
	(0.03)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Some college or associate degree	0.25	0.20	0.24	0.23†	0.21	0.24‡
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Bachelor's degree or more	0.39	0.18*	0.45†	0.24*†	0.50‡	0.30*†‡
	(0.03)	(0.01)	(0.03)	(0.01)	(0.02)	(0.01)
Full-time experience	12.33	13.17	14.35†	15.66*†	13.20†	16.11*‡
	(0.40)	(0.23)	(0.43)	(0.25)	(0.42)	(0.26)
Part-time experience	2.97	3.86*	3.15	4.43*†	3.38	4.87*†‡
	(0.17)	(0.13)	(0.18)	(0.14)	(0.15)	(0.16)
Observations	4,746	20,252	2,228	10,370	2,985	10,361

Notes: Sample is person-year observations from women age 25 to 54 with wage or salary earnings, excluding the self-employed, agricultural workers, unpaid family workers, and members of the armed forces. Standard errors are shown in parentheses and are clustered by person. *Mean for mothers is statistically different from mean for childless women, $p < 0.05$. †Estimate is statistically different from previous period, $p < 0.05$. ‡Estimate is statistically different from first period, $p < 0.05$.

Table 2
Wage penalties for one, two, and three or more children

Control variables	Number of children	1986-95	1996-2004	2006-14
Age, race, marital status	One	-0.185*	-0.208*	-0.190*
		(0.036)	(0.041)	(0.042)
	Two	-0.281*	-0.270*	-0.208*
		(0.033)	(0.038)	(0.038)
	Three +	-0.445*	-0.424*	-0.373*
		(0.035)	(0.041)	(0.040)
Above + education	One	-0.100*	-0.147*	-0.157*
		(0.034)	(0.039)	(0.040)
	Two	-0.196*	-0.204*	-0.163*
		(0.031)	(0.037)	(0.036)
	Three +	-0.313*	-0.306*	-0.275*
		(0.034)	(0.040)	(0.039)
Above + experience	One	-0.086*	-0.132*	-0.147*
		(0.033)	(0.038)	(0.039)
	Two	-0.135*	-0.135*	-0.133*
		(0.030)	(0.036)	(0.036)
	Three +	-0.198*	-0.200*	-0.192*
		(0.034)	(0.040)	(0.039)
Observations		24,998	12,598	13,346

Notes: Table presents coefficients from pooled OLS regressions of log wage on indicator variables for having one, two, and three or more children. The comparison group is childless women. Sample is person-year observations from women age 25 to 54 with wage or salary earnings, excluding the self-employed, agricultural workers, unpaid family workers, and members of the armed forces. Standard errors are shown in parentheses and are clustered by person. Full results from the last specification can be seen in Table A1 in the appendix. *Estimate is statistically different from zero, $p < 0.05$. No changes in coefficients between adjacent periods or between the first and third periods are statistically significant at the 5-percent level.

Table 3

Selection-adjusted wage penalties for one, two, and three or more children on log wage

	Number of children	1986-95	1996-2004	2006-14
Panel A: No selection adjustment	One	-0.086*	-0.132*	-0.147*
		(0.033)	(0.038)	(0.039)
	Two	-0.135*	-0.135*	-0.133*
		(0.030)	(0.036)	(0.036)
	Three +	-0.198*	-0.200*	-0.192*
		(0.034)	(0.040)	(0.039)
Observations		24,998	12,598	13,346
Panel B: Adjustment for selection into motherhood	One	-0.177*	-0.201*	-0.193*
		(0.034)	(0.040)	(0.043)
	Two	-0.233*	-0.214*	-0.197*
		(0.032)	(0.038)	(0.037)
	Three +	-0.351*	-0.336*	-0.325*
		(0.035)	(0.041)	(0.039)
Observations		24,998	12,598	13,346
Panel C: Adjustment for selection into the labor force	One	-0.092*	-0.139*	-0.153*
		(0.034)	(0.038)	(0.037)
	Two	-0.131*	-0.144*	-0.132*
		(0.030)	(0.037)	(0.035)
	Three +	-0.197*	-0.208*	-0.203*
Observations		26,081	13,655	14,891

Notes: Table presents coefficients from regressions of log wage on indicator variables for having one, two, and three or more children. The comparison group is childless women. Unadjusted coefficients were estimated by pooled OLS using the full set of control variables (age, race, marital status, education and labor-market experience) and the sample described in the notes to Table 2. Coefficients adjusted for selection into motherhood were estimated by fixed effects using the subset of control variables that vary over time (age, marital status, and labor-market experience) and the same sample. Coefficients adjusted for selection into the labor force were estimated by pooled OLS using the full set of control variables and an expanded sample with the wages of some labor-market non-participants imputed using past wages. *Estimate is statistically different from zero, $p < 0.05$. No changes in coefficients between adjacent periods or between the first and third periods are statistically significant at the 5-percent level.

Appendix

Table A1
Full results: Effect of having one, two, and three or more children on log wage

Regressors	1986-95 Period 1	1996-2004 Period 2	2006-14 Period 3
1 child	-0.086*	-0.132*	-0.147*
	(0.033)	(0.038)	(0.039)
2 children	-0.135*	-0.135*	-0.133*
	(0.030)	(0.036)	(0.036)
3+ children	-0.198*	-0.200*	-0.192*
	(0.034)	(0.040)	(0.039)
Age	0.033*	0.010	0.032*
	(0.011)	(0.013)	(0.015)
Age squared	-0.000*	-0.000	-0.000*
	(0.000)	(0.000)	(0.000)
Black	-0.137*	-0.062*	-0.090*
	(0.024)	(0.029)	(0.034)
Other race	0.034	-0.061	-0.046
	(0.091)	(0.072)	(0.054)
Never married	0.093*	-0.043	0.003
	(0.041)	(0.045)	(0.037)
Previously married	0.006	-0.057*	-0.111*
	(0.023)	(0.027)	(0.031)
Some college or associate degree	0.223*	0.217*	0.235*
	(0.026)	(0.030)	(0.033)
Bachelor's degree or more	0.491*	0.478*	0.520*
	(0.028)	(0.030)	(0.033)
Full-time experience	0.037*	0.034*	0.037*
	(0.004)	(0.005)	(0.005)
Full-time experience squared	-0.001*	-0.000*	-0.000*
	(0.000)	(0.000)	(0.000)
Part-time experience	-0.002	0.001	-0.001
	(0.006)	(0.007)	(0.007)
Part-time experience squared	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)
Intercept	1.408*	2.001*	1.593*
	(0.195)	(0.233)	(0.255)
Observations	24,998	12,598	13,346

Notes: Table presents results from pooled OLS regressions of log wage on variables listed. Sample is person-year observations from women age 25 to 54 with wage or salary earnings, excluding the self-employed, agricultural workers, unpaid family workers, and members of the armed forces. Standard errors are shown in parentheses and are clustered by person. *Estimate is statistically different from zero, $p < 0.05$.