



The emergence of the motherhood premium: recent trends in the motherhood wage gap across the wage distribution

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Received: 7 October 2020 / Accepted: 18 November 2021 / Published online: 15 January 2022
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Abstract

This paper estimates recent trends in the motherhood wage gap (MWG) across the female wage distribution and explores several drivers of the trend. The result shows that the large convergence of the MWG observed on average is a high-quantile phenomenon. Maternal relative wages sharply increase at the upper wage quantiles in the mid-1990s, leading to a reversed MWG (motherhood premium) since the mid-2000s. This positive selection into motherhood among high-wage women comes from mothers who live with a husband, who have first births in their late ages, and who work for long hours. The MWG has narrowed over time with widening wage dispersion among mothers, and the MWG trend is associated with changing fertility patterns and high-wage mothers' working hours.

Keywords Motherhood wage gap · Motherhood premium · Unconditional quantile regression

JEL Classification J11 · J13 · J31

1 Introduction

The difference in wages between mothers and nonmothers, known as the motherhood wage gap (MWG), fell dramatically from an average of 8% in 1990 to 1% in 2013 in the U.S. (Pal & Waldfogel, 2016). Several factors have been mentioned as the causes

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1007/s11150-021-09594-3>.

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of the wage gap between mothers and nonmothers: mothers' reduced human capital (Mincer & Polachek, 1974) and effort at work (Becker, 1985) due to career interruption and childrearing, mothers' preference for family-friendly employment (Becker, 2009), employer discrimination against mothers, and negative selection into motherhood. A great declining trend in the MWG reveals that the differences in unobserved productivity and career attachment between mothers and nonmothers have been largely reduced over the last several decades.

However, the declining trend in the average MWG does not mean that the MWG has been equally reduced for all mothers. Although the average wage gap between mothers and nonmothers has decreased over time, the heterogeneous evolution of the MWG over the wage distribution may have ultimately resulted in increased wage disparity among mothers. Based on this motivation, I examine whether the MWG has uniformly decreased across the women's wage distribution. This paper presents a richer set of information regarding the evolution of the MWG than the previous literature, but such a broad analysis of wage trends is necessarily noncausal. As with Pal and Waldfogel (2016) and Glauber (2018), this paper does not estimate the causal effects of having children on women's wages, but rather I analyze the wage gap as "a proxy variable for differential work history and labor market attachment" (Hill, 1979) between mothers and nonmothers. In this paper, I discuss several hidden phenomena associated with the heterogeneous convergence of the MWG and examine plausible drivers of the heterogeneous MWG trend.

Although this paper does not explore causality, it is important in that it studies long-term trends in the MWG and demonstrates that there are more issues behind the converging MWG than the broad research on the MWG has covered for the last 30 years. I begin with this paper by documenting the fact that the convergent MWG is mainly driven by high-wage mothers. Interpreting the MWG trend, I find that the fertility trend and direction of the selection into motherhood have changed for high-wage women. The share of mothers among working women declines after the mid-1990s. This declining trend appears among low- and middle-wage women, but the share of women with children increases among high-wage women. While the proportion of mothers was higher among the lower-wage women until 2000, it was reversed after 2010. Additionally, the MWG at the top of the wage distribution has reversed and led to a *motherhood premium*¹ since the mid-2000s, implying positive selection into motherhood among high-wage women.

Women gradually delay their first births during the period, but the increase in women's ages at first birth is especially noticeable among high-wage women. An interesting fact is that the working hours of high-wage women who had first births at or after 30 years old have strikingly increased during the period. According to Goldin (2014), the gender wage gap in high-earning occupations is mostly caused by women's lower likelihood of working long hours due to children and large wage compensation for long work hours in the labor market. However, I find that high-wage women have been breaking the barrier to working for long hours by delaying childbirth. Motherhood and mothers' restricted working hours may no longer be a cause of the gender wage gap for high-wage women.

¹ In this paper, "wage premium" does not imply a causal effect of becoming a mother. It indicates that mothers earn higher wages than comparable nonmothers.

Motherhood penalties have been broadly studied for several decades, and researchers have mainly focused on the causal effect of motherhood. Much of the prior literature estimates the effect of motherhood by controlling for individual heterogeneity (Albrecht et al., 1999; Amuedo-Dorantes & Kimmel, 2005; Anderson et al., 2002; Avellar & Smock, 2003; Baum, 2002; Buckles, 2008; Budig & England, 2001; Hotchkiss et al., 2017; Kahn et al., 2014; Korenman & Neumark, 1990; Kühhirt & Ludwig, 2012; Loughran & Zissimopoulos, 2009; Lundberg & Rose, 2000; Stafford & Sundström, 1996; Taniguchi, 1999; Waldfogel, 1997) and finds a 2–10% maternal wage reduction after childbirth.

The fixed effects estimates, however, are still open to bias if the individual unobserved heterogeneity varies over time or the choice of childbearing depends on women's wages. To better address the endogeneity problem of childbirth, Miller (2011) uses biological fertility shocks as instruments and finds that a year delay of motherhood increases female wages by 3%. Lundborg et al. (2017) use Denmark data on in vitro fertilization-treated women and document a huge negative effect of fertility on women's hourly wages (12–13% reduction). Last, Angelov et al. (2016), Büttikofer et al. (2018), and Kleven et al. (2019) find the effect of children on women's wages exploiting event-study approaches around the first birth.

Despite extensive research on the MWG or the child effect on women's wages, few studies have considered trends in the MWG. Pal and Waldfogel (2016) first estimated a long-term trend in the MWG from 1967 to 2013 using OLS and the Current Population Survey (CPS). They show a declining trend in the MWG during the period. Expanding Pal and Waldfogel's (2016) research, Glauber (2018) describes how the MWG changes over time by women's wage level using unconditional quantile regression (UQR) and the CPS from 1980 through 2014. Killewald and Bearak (2014), Budig and Hodges (2014), and England et al. (2016) also study the effect of the number of children across the female wage distribution using the National Longitudinal Studies of Youth (NLSY), but they do not examine how the MWG distribution evolves over time. Glauber (2018) finds that the MWG has declined during the period, but the decrease is more considerable for high-wage earners than for low-wage earners. This paper supports the findings of Glauber (2018) and enriches her research in several ways.

First, this paper presents the changes in the MWG distribution in more detail by estimating the gaps from 0.05 through 0.95 quantiles, while Glauber (2018) shows the gap only at the three quantile points (0.2, 0.5, and 0.8). Second, this paper discusses phenomena accompanied by heterogeneously changing MWG beyond describing the trends. It discusses the *motherhood premium* that emerged among high-wage earners and the unique fertility patterns only shown among high-wage women. Third, this paper documents several relevant sources of the heterogeneity in the MWG trends Glauber (2018) has left for future research. I check whether there have been relevant changes in the regression sample and the factors that can be considered as having impacts on women's labor market outcomes: employment rates, nonmothers' wage level by quantiles², first birth timing, marriage, work hours and

² Changes in the composition of nonmothers at the different quantiles may affect the maternal relative wages. I will present how much the wage levels are comparable over the analysis periods by quantiles.

occupation. Among them, I find that delays in first births, increased likelihood of working long hours and marriage benefits are closely associated with the heterogeneous MWG trend.

The paper proceeds as follows. Following the introduction, I describe the data and empirical specification in the next section. Section 3 presents the new trends in the MWG across the wage distribution and interprets the results. I identify plausible sources of the wage-dependent MWG trend in Section 4 and conclude in Section 5 by summarizing findings and offering future research suggestions.

2 Data and empirical method

2.1 Data and variables

I use the CPS Outgoing Rotation Groups for 1990 through 2019. I restrict each year's CPS data to women aged 25–45, who are in prime fertility years. Each regression sample pools the data for five years to create more stable samples for observing trends. The sample excludes women who are self-employed, in military service or in school. Additionally, I exclude women whose first births were before 20 years old because teen births are very likely to affect the final education level, which is one of the important controls in the wage equation.

The dependent variable is the log of hourly wages. I use reported hourly wages if the respondents are paid hourly (58% of the sample), and I impute hourly wages for salaried workers using weekly earnings and usual work hours per week. All wages are valued in 2019 USD. The baseline control variables are motherhood status, age, age squared, five indicators of education, four indicators of race, an indicator of Hispanic ethnicity, and the marital status dummies. Women who have their own children under the age of 18 in their household are defined as mothers. Their own children include biological children, step children and adopted children. Five education indicators are less than high school, high school, some college, a four-year college education, or more than a four-year college education. The four race indicators are white, black, Asian and others. The marital status indicators are married and spouse present, married and spouse absent, separated, divorced, widowed, and never married.

Table 1 shows descriptive statistics for the labor market outcomes and control variables in the regression sample. Mothers' hourly wages increase from 1990–1994 through 2015–2019, and the gap in the sample mean wages of mothers and nonmothers is reversed in 2015–2019. Mothers were 2.58 years older than nonmothers in 1990–1994, and this gap increased to 4.02 in 2015–2019. Nonmothers are more likely to be highly educated. The gap in the ratio of highly educated women between nonmothers and mothers, which is defined as receiving a bachelor's degree, is 13 percentage points in the early 1990s and decreases to 10 percentage points in the late 2010s. The proportion of white women is more than 80% in the entire sample. The proportion of white women among nonmothers was 2 percentage points higher than that among mothers in the early 1990s but 2 percentage points lower in the late 2010s. Last, the ratio of married women living with husbands decreases over time regardless of the presence of children.

Table 1 Descriptive statistics in 1990–1994 and 2015–2019

	1990–1994				2015–2019			
	Mothers		Nonmothers		Mothers		Nonmothers	
	0.58		0.42		0.55		0.45	
	mean	sd	mean	sd	mean	s.d.	mean	s.d.
LFP	0.69	(0.46)	0.86	(0.35)	0.71	(0.46)	0.82	(0.38)
Employment	0.65	(0.48)	0.81	(0.39)	0.68	(0.47)	0.79	(0.41)
Wage	19.24	(11.69)	20.72	(11.77)	23.87	(15.46)	23.31	(14.05)
Full-time	0.73	(0.44)	0.88	(0.32)	0.80	(0.40)	0.89	(0.31)
Long-time	0.05	(0.22)	0.10	(0.30)	0.06	(0.25)	0.09	(0.29)
Age	35.8	(5.38)	33.22	(6.21)	36.61	(5.40)	32.59	(6.02)
Less HS	0.07	(0.25)	0.05	(0.22)	0.05	(0.23)	0.03	(0.17)
HS	0.55	(0.50)	0.44	(0.50)	0.35	(0.48)	0.31	(0.46)
Some Col.	0.13	(0.34)	0.13	(0.33)	0.13	(0.34)	0.1	(0.30)
BA	0.18	(0.39)	0.28	(0.45)	0.27	(0.45)	0.36	(0.48)
More BA	0.07	(0.26)	0.10	(0.30)	0.19	(0.39)	0.20	(0.40)
White	0.83	(0.37)	0.85	(0.36)	0.76	(0.43)	0.74	(0.44)
Black	0.12	(0.33)	0.11	(0.31)	0.14	(0.34)	0.14	(0.35)
Asian	0.03	(0.18)	0.03	(0.18)	0.07	(0.26)	0.08	(0.28)
Other Races	0.01	(0.10)	0.01	(0.09)	0.04	(0.19)	0.04	(0.19)
Hispanic	0.08	(0.28)	0.06	(0.24)	0.18	(0.38)	0.14	(0.35)
Husband	0.77	(0.42)	0.39	(0.49)	0.68	(0.46)	0.31	(0.46)
Never Married	0.05	(0.22)	0.43	(0.50)	0.16	(0.37)	0.56	(0.50)
Num. Children	1.88	(0.86)			1.93	(0.90)		
Age at FB	25.64	(4.10)			26.96	(4.68)		
Obs.	124,147		88,602		83,256		65,847	

The table shows the sample means and standard deviations of the regression sample by motherhood status in 1990–1994 and 2015–2019. The data are the Current Population Survey (CPS) Outgoing Rotation Groups. Samples are restricted to employed women aged 25–45. Each sample pools the data for five years. All sample means of mothers are significantly different from those for nonmothers at the 5% confidence level except for Asian and other race dummies. “LEP” stands for the labor force participation rates, “Employment” stands for the employment rates. “Full-time” refers to the proportion of full-time working women, and “Long-time” refers to the proportion of women working at least 50 h a week. The number of observations for labor force participation and employment rates is 190,426 and 121,617 for mothers and 108,666 and 83,187 for nonmothers in 1990–1994 and 2015–2019, respectively.

2.2 Empirical method: quantile estimation of the MWG

The goal of this study is to estimate the wage gap between mothers and nonmothers and to examine its trends across the wage distribution. To that end, I use the UQR method (Firpo et al., 2009)³. The baseline specification includes motherhood status (m), age (a), age squared (a^2), education (edu), race and ethnicity indicators ($race$) and marital status indicators ($mrrd$). Each regression includes year fixed effects

³ UQR estimates the effect of motherhood status on the unconditional wage distribution holding the other covariates constant, while the conditional quantile regression (CQR) method estimates the effect on the conditional wage distribution of women who have the same values for the other covariates (Porter, 2015). The CQR is not an appropriate method to compare the MWG between high-wage and low-wage earners because conditional quantiles are not comparable to each other, and the interest of this paper is to estimate the wage gap on the unconditional (or marginal) wage distribution.

because each regression sample pools the data for five-year periods.

$$\ln(\text{wage})_q = \beta_{q0} + \beta_{q1}m + \beta_{q2}a + \beta_{q3}a^2 + \beta_{q4}\text{edu} + \beta_{q5}\text{race} + \beta_{q6}\text{mrrd} + \delta_y + \varepsilon \quad (1)$$

Subscript q refers to the q^{th} quantile. The coefficient of motherhood status (β_{q1}) indicates the MWG at the q^{th} wage quantile holding the other covariates constant. δ_y indicates a set of year dummies. Work-related characteristics, such as occupation and work hours, are not included in the specification because these characteristics are very likely to be affected by the presence of children (“bad control” problem in Angrist and Pischke (2008))⁴.

Regarding the issue of not controlling for unobserved individual heterogeneity, Glauber (2018) cites previous research and states that unobserved heterogeneity accounts for 15–30% of the motherhood penalty. If β_{q1} is estimated with a large negative number, then the negative figure reflects 15–30% of unobserved individual heterogeneity. If the estimated β_{q1} decreases during the period and is not significantly different from zero, as Pal and Waldfogel (2016) and Glauber (2018) found, it can be interpreted that there is no unexplained work-related differential between mothers and nonmothers, even including individual fixed characteristics.

UQR is based on a transformation of the dependent variable into the recentered influence function (RIF): $RIF(y; q_\tau, F_Y) = q_\tau + \frac{\tau - 1 \{y \leq q_\tau\}}{f_Y(q_\tau)}$, where τ is a given quantile, q_τ is the value of the dependent variable (wage in this case) at the τ^{th} quantile, $1 \{y \leq q_\tau\}$ is an indicator function that equals 1 if the observed wage y is less than or equal to q_τ , and $f_Y(q_\tau)$ is the density of y evaluated at the τ^{th} quantile of the dependent variable y . Firpo et al. (2009) proved that OLS applied to the transformed dependent variable provides an estimate of the effect of a small increase in a covariate on the τ^{th} quantile value of the marginal distribution of the dependent variable.

UQR uses the estimated density of the dependent variable, and the results may vary depending on the choices of bandwidth and kernel (Porter, 2015). I report the main results using the Gaussian kernel and the optimal bandwidth calculated with Silverman’s formula and present the results with different kernels (Epanechnikov and uniform) and bandwidths (0.03 and 0.07) in the Online Appendix.

3 Trends in the MWG

3.1 Overview of the MWG trend

I first estimate the average MWG using OLS estimation and five-year pooled samples from 1990 through 2019. The results are shown in Fig. 1. The y-axis indicates the estimated coefficients of the motherhood status in Eq. (1). A negative value means that mothers earn lower hourly wages than nonmothers with the same observed characteristics, and the upward-sloping fitted line shows a converging MWG over time. Mothers earn 6% lower wages than nonmothers in 1990–1994, but this wage

⁴ I include marital status in the regression. This is because, in most cases, a woman’s marriage decision is made before the motherhood status is determined, and therefore the motherhood status would not affect the composition of married women.

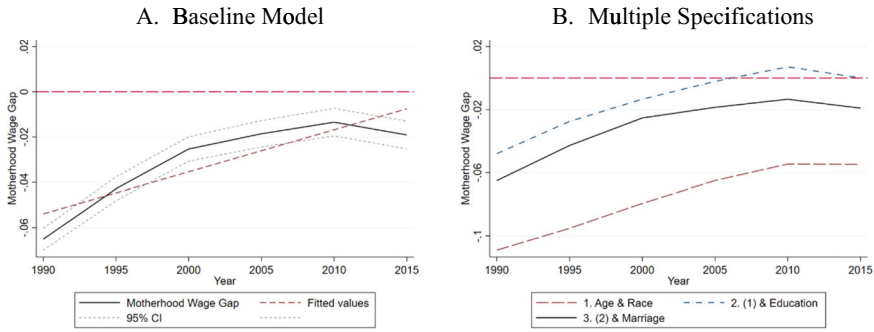


Fig. 1 Trends in the motherhood wage gap. Notes: Figures show trends in the motherhood wage gaps estimated using the OLS estimation from 1990 through 2019. The sample sizes are 149,103–212,749. The regression sample pools the data for 5 years. Panel **A** presents the results of the baseline specification with 95% confidence intervals and fitted values, which includes age, age squared, race, education, and marital status. Panel **B** presents the motherhood wage gaps with different controls. The red long-dashed line includes only age, age squared and race, the blue dash-dotted line additionally includes education and the black solid line adds marital status. All regressions include year fixed effects

gap decreases to below 2% after 2005. This declining trend in the average MWG is consistent with the main finding of Pal and Waldfogel (2016).

Figure 1B shows the MWG with different covariates. When considering only age and race, mothers earn 11% lower wages than nonmothers in 1990–1994, and this gap decreases to 5.5% in 2015–2019. By adding education in the regression, the MWG narrows to 0–5%. Including marital status moves the graph down by 1–2 percentage points in all years, which implies that the presence of a husband positively affects maternal wages⁵.

3.2 Heterogeneous trends in the MWG

Figure 2 shows the MWG across the wage distribution by year estimated with the baseline specification. The exact figures are presented in Online Appendix Table A1. The estimated coefficients are very similar even with the different kernels and bandwidths (Online Appendix Table A2). The MWG shows a U-shaped curve across the female wage distribution. Mothers would have a small wage gap with childless women at the bottom of the wage distribution. The MWG increases as the wage quantile increases, and the wage gap is reduced at the upper quantiles, which may be because high-wage mothers have more resources to reduce the time cost of raising children than middle-wage mothers.

In 1990–1994, mothers earn lower wages than nonmothers at all wage quantiles, and these are significant at the 99% confidence level. The negative MWG increases along the wage quantile until the 60th percentile, and the wage gap narrows above the 60th percentile in the early 1990s. The MWG converges toward zero over time, and a prominent convergence of the MWG occurs in the late 1990s above the 70th quantile, leading to a nonsignificant wage gap from the 90th quantile. The MWG is reduced by

⁵ This trend is similar when only full-time workers are considered even though the absolute terms of the MWG decrease. I present the estimated MWG among full-time workers in Online Appendix Fig. A1.

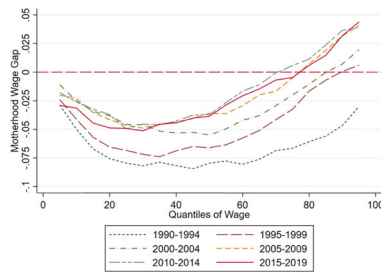


Fig. 2 Motherhood wage gap across the wage distribution by year. Notes: The figure shows the distribution of the motherhood wage gaps estimated using unconditional quantile regression. The baseline specification includes age, age squared, race, education, marital status, and year fixed effects

3.4–4.9 percentage points above the 70th wage quantile between 1990–1994 and 1995–1999 (51–120% of the 1990–1994 wage gap). The markedly converging MWG leads to a motherhood premium at the upper quantiles. Mothers at or above the 85th wage quantile earn 1.9–4.1%⁶ higher wages than nonmothers in 2005–2009. The motherhood premium observed from the 85th quantile continues until 2015–2019. The wage gap between mothers and nonmothers does not narrow after 2000 at or below the 30th quantile and after 2005 below the median. Last, the MWG becomes even larger below the 25th quantile in 2015–2019 compared with 2010–2014⁷.

The average MWG greatly falls over time, but the amount of convergence is heterogeneous by women's wages. Mothers below the 65th quantile still experience lower hourly wages than nonmothers; in particular, mothers earning between the 15th and 50th quantile wages show 4–5% lower hourly wages than nonmothers even in 2015–2019. On the other hand, mothers in the upper quantiles earn higher wages than nonmothers. Consistent with the uneven evolution of the MWG, mothers' wage distribution dramatically widens in the 2000s compared to the previous period and that of nonmothers, especially at the top of the wage distribution. In the period when the motherhood wage premium was prevalent among high-wage mothers and the MWG was frozen among low-wage mothers, maternal wage inequality also noticeably increased⁸.

I also estimated the distribution of the MWG by the number of children. The results are presented in Fig. 3. Since I include interaction terms of motherhood status and a dummy for the number of children in one regression, all three graphs in Fig. 3 are comparable. As expected, the greater the number of children is, the greater the wage differential, but the wage gap of mothers with two or more children is largely reduced over time. The wage gap between mothers with three or more children and

⁶ These estimates are significant at the 95% confidence level.

⁷ The MWG distribution derived from only full-time workers is presented in Online Appendix Fig. A2. The absolute magnitudes estimated from the full-time workers are 1–2 percentage points smaller than the entire sample results, but the overall trend in the MWG is the same as the results from all workers.

⁸ To check whether the heterogeneous evolution of the MWG occurs with an increase in wage inequality among mothers, I estimate how much the dispersion of the mothers' wage distribution changes in the 1990s and 2000s. The estimated inequality measure is based on the RIF following Fortin et al. (2011). The method and results are provided in Online Appendix B.

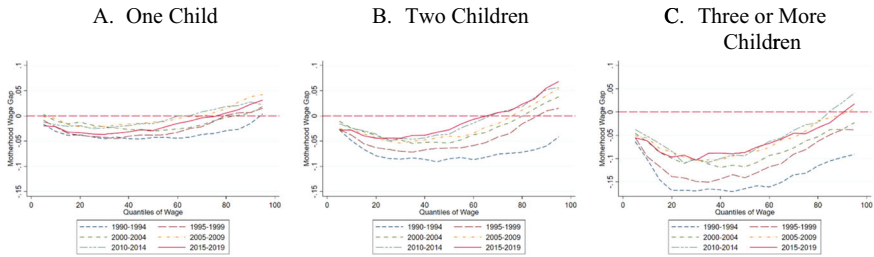


Fig. 3 Distribution of the motherhood wage gap by number of children. Notes: Figures show the distribution of the motherhood wage gaps by the number of children. The regression includes age, age squared, race, education, marital status, and year fixed effects. Three graphs are estimated from one regression that includes three interactions of motherhood and the number of children dummies (one child, two children, and three or more children)

nonmothers decreases by 6–11 percentage points above the 10th wage quantile during the analysis period, and the wage gap of mothers with two children is reduced by 3–12 percentage points during the period.

Two-child mothers experienced a 1–5 percentage point worse MWG than only-child mothers at all wage quantiles in the early 1990s. The wage gap between mothers with two children and nonmothers largely decreases by 8–12 percentage points at or above the 60th wage quantile between 1990–1994 and 2015–2019. This leads to a narrow MWG and a greater motherhood premium for two-child mothers compared to one-child mothers at or above the 60th quantile in 2015–2019. This large change is interesting in that the negative relationship between women’s wage and family size, long believed in the fields of economics and sociology, is no longer true for high-wage women.

Last, I separate the analysis by race to determine whether there have been different trends by race (Fig. 4). A total of 81.6% of the entire sample were white women, 10.7% were black, and 7.8% were other races, including 5.3% Asians. I estimate the MWG distribution among black women and compare the results from those among white women⁹. I pooled the data over ten years instead of 5 years, 1990–1999, 2000–2009, 2010–2019, due to the relatively small sample size of black women. Note that the MWG estimated from the white female sample is the wage gap between white childless women and white mothers and that derived from the black female sample represents the wage gap among black women by the presence of children.

First, the trends for white women are similar to the overall trends because the share of white women is large. In the 1990s, the MWG among white women was larger than that among black women. This may be caused by a generally lower wage rate for black women than for whites. The MWG among black women converges relatively evenly across the wage distribution between the 1990s and the 2000s, but there is no such evolution in the 2010s. In the 2010s, the motherhood wage gaps among black women were still smaller than those among white women below the median, but this was reversed above the 55th quantile.

⁹ The proportions of Asians (5.3% of the sample) and other races (2.5%) are too small to analyze.

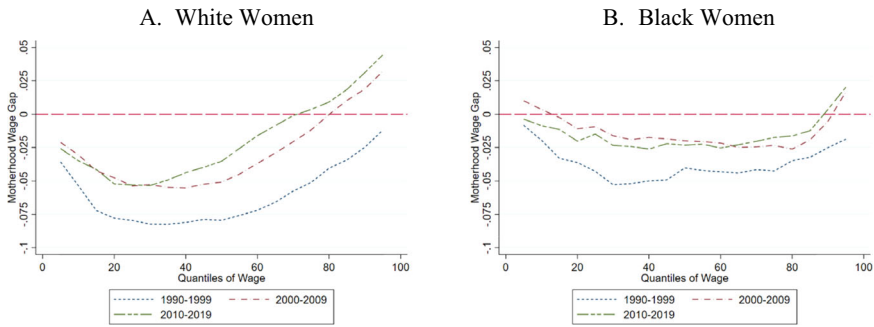


Fig. 4 Distribution of the motherhood wage gap by races. Notes: Figures show the motherhood wage gap distributions among white women and black women. The regression sample pools the data for 10 years from 1990 through 2019. The regression includes age, age squared, Hispanic indicator, education, marital status, and year fixed effects

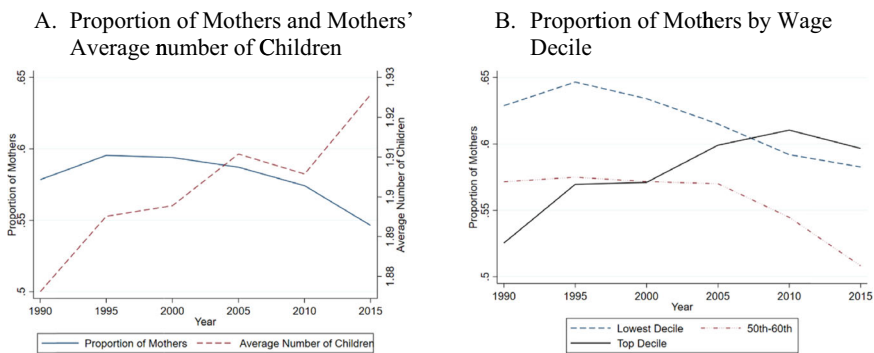


Fig. 5 Trends in the proportion of mothers and average number of children. Notes: The proportion of mothers is defined among all employed women. The average number of children is defined among mothers. Panel **A** presents trends derived from the entire sample, and Panel **B** presents the trends by women’s wage decile. The sample is divided into ten equal subsamples according to wage level regardless of the presence of children

3.3 Discussion

Since the estimated MWG is not a causal relationship between motherhood and female wages, a convergent MWG implies both decreasing the career cost of childrearing in terms of women’s wages and narrowing the unobserved differential between mothers and nonmothers, such as career attachment.

First, if working mothers’ time cost for childrearing has been sufficiently reduced, this would provide an incentive to increase the family size of working women. Figure 5 presents trends in the proportion of mothers. The average proportion of mothers among all working women has decreased since the late 1990s, and this decreasing trend comes from low- and middle-wage women. The ratio of mothers among women in the top wage decile has continued to increase since 1990. The proportion of mothers in the top wage decile becomes higher than the proportion in the bottom- and middle-wage groups in the 2010s, while it is the lowest in the 1990s. Contrary to the decreasing proportion of

mothers, I find that the mothers' average number of children tends to increase. Between 1990–1994 and 2015–2019, the average number of children increased from 1.88 children to 1.93 children. It tends to increase at all wage levels during the period, but the growth is more pronounced among high-wage mothers than among mothers with low wages.

Taken together, both the proportion of mothers and maternal family size tend to increase for women in the top wage decile. This finding supports the possibility that the career cost of childbirth may be reduced for high-wage women. In classical economic models, women's wages are considered the opportunity cost of childbirth, and a high-wage woman is considered to have a high opportunity cost of childbirth (e.g., Heckman and Walker, 1990). This is because women are likely to stop their careers and reduce their working hours after giving birth. However, high-wage mothers have reduced the time cost of childrearing without losing their high wages over time.

Second, the reduced MWG observed at all wage levels implies that the negative selection into motherhood—women with low workability are more likely to give birth—has decreased. As women's desire for their career and the value of paid work in the labor market increase over time, women who expect a large wage reduction after birth may avoid or postpone their first birth. The fact that women's education level has risen regardless of wage level supports this view. An interesting fact regarding the selection issue is that the motherhood premium—positive selection into motherhood—emerges in the 2010s at the upper quantiles of the female wage distribution. Positive selection into motherhood for high-wage women implies that highly skilled women who can avoid a wage reduction even after giving birth are likely to be mothers. This positive selection comes from mothers who postpone their first child until their 30s, nearly all of whom are married, and mothers who work for long hours. I continue to discuss the details of these sources of positive selection in Section 4.

4 Sources of heterogeneous trends in the MWG

In this section, I discuss several underlying factors that may have driven the heterogeneous evolution of the MWG. I check whether changes in first-birth timing, work hours, marriage benefits, employment rate, nonmothers' wage level, and occupation are related to the MWG trend. Among the six potential sources, I find that the first three are closely associated with the heterogeneous MWG trend. I discuss the results for these three relevant factors in the paper and present the other factors in Online Appendix C.

Potential sources and hypotheses	Result
<i>H1. First birth timing:</i> On average, women tend to delay their first birth. The procrastination would be more pronounced among high-wage women than low-wage women, which would be associated with a sharp increase in the maternal relative wages at the upper quantiles.	Supported
<i>H2. Work hours:</i> High-wage mothers' working hours would have increased during the period, and the increased work hours would accelerate the convergence of the MWG among high-wage earners.	Supported
	Supported

Table continued

<i>H3. Marital status:</i> There would be the heterogeneous marriage trends by wage level, consistent with the MWG trends.	
<i>H4. Employment rates:</i> Changes in women's employment rate would affect the estimated MWG and its observed trends because only working women are included in the regression.	Not supported
<i>H5. Nonmothers' wages:</i> Nonmothers' wage level might decrease, especially at the upper quantiles of the female wage distribution, leading to improved maternal relative wages.	Not supported
<i>H6. Occupations:</i> There would exist different trends in occupation shares by the presence of children, which could influence changes in the MWG.	Not supported

4.1 Changes in first birth timing

Delays in first births are among the critical factors in increasing maternal wages. The benefit of delaying motherhood is large for high-wage women because they have a higher opportunity cost associated with childbirth, especially in the early stages of their careers, than do low-skilled women. For example, Miller (2011) shows that exogenous delay in motherhood increases women's hourly wages and that the delay benefit is the largest for college-educated women and those in professional and managerial occupations. I calculate the average age at first birth by wage level from 1990–1994 through 2015–2019. As expected, high-wage women have their first child later than low-wage women, and women's average ages at first birth tend to increase in all wage groups. An interesting stylized fact is that the age at first birth increases the most in the highest wage decile. The average age at first birth increases by 1.61–1.75 years above the 70th percentile¹⁰ and by less than one year below the 30th percentile¹¹.

To identify the trends more clearly, I calculate the proportion of mothers whose first birth is at or after 30 years old (hereinafter late-birth mothers). One striking feature is that the percentage of late-birth mothers increases by more than 17.4 percentage points at the top decile (from 37.0% to 54.3%), and more than 50% of mothers in the top decile have their first child after 30 years of age in 2015–2019. Meanwhile, it increases by 5.8 percentage points in the lowest wage decile (from 10.5% to 16.3%) and by 12.3 percentage points in the middle-wage group (from 15.4% to 27.6%).

To ascertain how different the MWG is according to the first birth timing, I estimate the MWG of early-birth mothers and late-birth mothers separately by including interactions of motherhood status and first-birth timing.

$$\ln(\text{wage})_q = \beta_{q0} + \beta_{q1}(m * \text{early}) + \beta_{q2}(m * \text{late}) + \beta_{q3}X + \delta_y + \varepsilon \quad (2)$$

X includes age, age squared, education, marital status, and race. δ_y is year fixed effects. Note that the comparison group is nonmothers, and the quantiles of wages are comparable between β_{q1} and β_{q2} .

¹⁰ From 26.4–28.3 years old in 1990–1994 to 28.1–30 years old in 2015–2019.

¹¹ 24.5–24.8 years old in 1990–1994 to 25.3–25.6 years old in 2015–2019. The graphs are provided in Online Appendix Fig. 3.

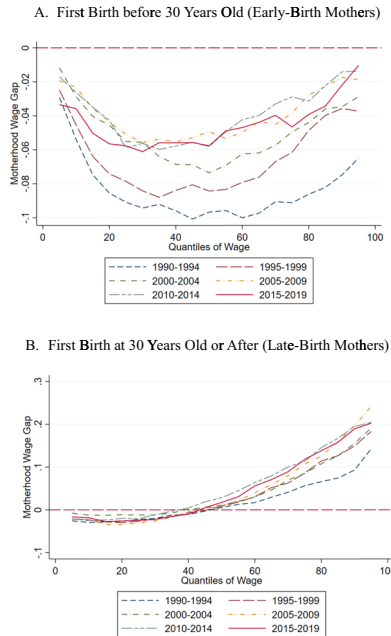


Fig. 6 Motherhood wage gap by maternal ages at first birth. Notes: Motherhood wage gaps are estimated by including interactions of first-birth timing (before or after 30 years of age) and motherhood dummies. The other covariates are age, age squared, race, education, marital status, and year fixed effects

Figure 6A shows the wage gap between early-birth mothers and nonmothers, and Fig. 6B shows the wage gap between late-birth mothers and nonmothers across the wage distribution. Early-birth mothers receive much lower hourly wages than nonmothers at all wage quantiles in the early 1990s. For example, early-birth mothers receive almost 10% lower wages than nonmothers at the middle of the wage distribution in 1990–1994. The wage gap converges over time, but the wages of early-birth mothers are still 3–6% lower than those of nonmothers below the 90th wage quantile, even in 2015–2019. As in the overall sample results, there exists a large convergence in the MWG at the upper quantiles in the mid-1990s. The MWG at the middle of the wage distribution substantially converges toward zero until the mid-2000s, but the wage gap has been almost unchanged since the mid-2000s.

Late-birth mothers above the median receive similar or higher hourly wages than nonmothers, even in the early 1990s. The motherhood premium for late-birth mothers greatly increases by 6–10 percentage points between 1990–1994 and 2015–2019 at or above the 75th quantile. Late-birth mothers earn approximately 20% higher wages than nonmothers at or above the 90th quantile in 2015–2019. The results show that the motherhood wage premium observed in the entire sample is derived from late-birth mothers, not early-birth mothers. Given that the proportion of late-birth mothers greatly increases in the high-wage group, a large motherhood premium among late-birth mothers in the upper wage quantiles explains the emergence of the motherhood premium and its increasing trend in the entire sample.

The motherhood premium among late-birth mothers means that late-birth mothers are a positively selected group in terms of wages¹². Positive selection among late-birth and high-wage mothers exists even in the early 1990s, and selection increases over time. During this period, high-wage women may be looking for both a successful career and a family. The positive selection of late-birth mothers earning high wages implies that women who can avoid a wage reduction after childbirth start a family, and delaying motherhood is advantageous to avoid a motherhood penalty, as Miller (2011) and Caucutt et al. (2002) found. A large increase in late-birth mothers among high-wage women indicates that high-wage women can avoid the motherhood penalty more easily by delaying first births than they could have in the past. In the next section, I demonstrate that the increased possibility of working long hours for late-birth mothers—possibly due to the intervention of third parties—helps maintain high wages while raising their children.

4.2 Changes in work hours

One of the primary reasons for the motherhood penalty, as explained by human capital theory, is the reduced human capital investment and work experience of mothers due to short work hours. In the same vein, mothers seek a flexible working schedule even with lower hourly wages. Goldin (2014) describes the reason for the gender wage gap in high-earnings occupations as the gender gap in the likelihood of working long hours and the wage premium of long work hours. She notes that motherhood is an important reason why women are less likely to work long hours. In this section, I explore changes in mothers' work hours and the likelihood of working long hours according to women's wage level and check whether these are associated with the heterogeneous MWG trend and the emergence of the motherhood premium.

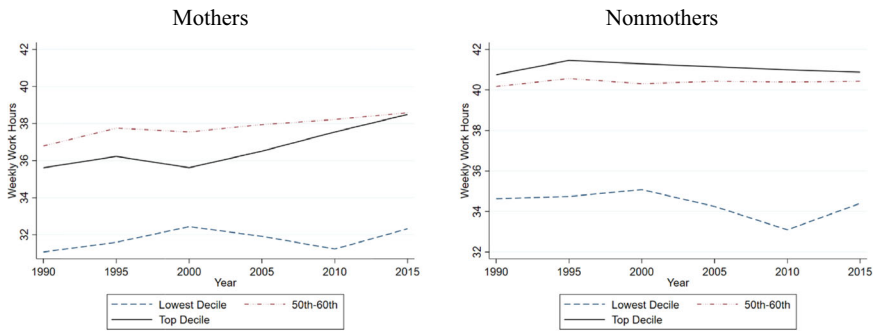
Mothers' work hours have increased since 1990. According to Fig. 7, mothers' work hours increase the most in the top wage decile. Mothers in the top wage decile increase their work hours by 2.9 h a week between 1990–1994 and 2015–2019, while nonmothers in the same wage decile present almost no change. An interesting feature regarding women's work hours is that the proportions of both mothers and nonmothers who work 50 or more hours a week increase in 1995–1999 at the top wage decile¹³. The proportion of mothers working long hours continues to increase even after 2000 at the top decile, while it decreases after 2005 for nonmothers. The proportion of mothers working long hours increases by 57% (from 7.9% to 12.4%) and that of nonmothers slightly decreases (from 15.7% to 15.4%) at the top wage decile in 2015–2019 compared to the early 1990s.

An increase in the proportion of mothers who work long hours is more prominent for late-birth mothers than for early-birth mothers (Fig. 7B). In 2015–2019, there was almost no difference in the proportion of “overworking” women between

¹² Late-birth and high-wage mothers, similar to nonmothers, are very likely to have high career commitment. This assertion is supported by the fact that the proportion of highly educated women among late-birth mothers is similar to that for nonmothers, and the proportion of highly educated women is even higher for late-birth mothers than for nonmothers in the top wage decile. The proportion of women who have at least a four-year college education by wage decile is presented in Online Appendix Fig. A4.

¹³ Working 50 h is the criterion for indicating long work hours or “overwork” used in the previous literature (e.g., Cha & Weeden, 2014; Cortés & Pan, 2019; Weeden et al., 2016).

A. Usual Hours Worked per Week



B. At Least 50 Hours Worked per Week

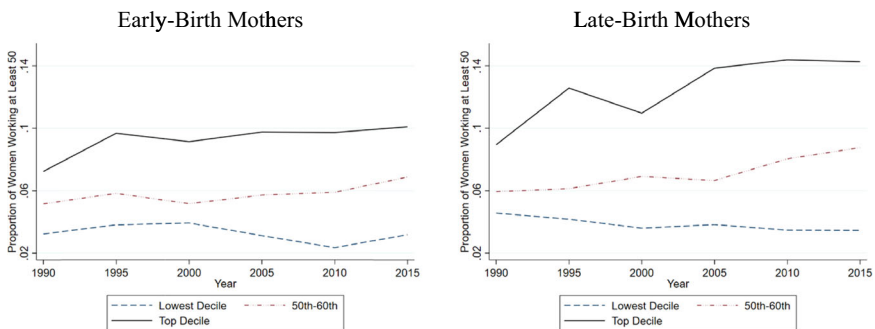


Fig. 7 Changes in weekly work hours by wage decile. Notes: Figures show women’s weekly work hours and the proportion of mothers working at least 50 h a week by wage decile. The sample is divided into ten equal subsamples according to wage level regardless of the presence of children, and mothers and nonmothers in the same wage group are comparable

nonmothers and late-birth mothers. An increase in mothers who work 50 or more hours a week may be related to a large increase in the relative wages of high-skilled mothers because mothers may have jobs whose requirements cannot be met with a shorter labor time. For example, a lawyer in charge of a large case is required to work more and receive greater hourly wages than a lawyer who provides counsel in lower-stakes cases.

To see whether long work hours are related to hourly wage rates, I ran a naïve regression of log hourly wages on an indicator of long work hours (50 h a week) including age, age squared, education, race, and marital status as additional controls. It describes how women’s wage compensation for long work hours changes over time across the female wage distribution. Estimating the effect of long work hours on wage rates is not obvious because women with long work hours, who represent less than 10% of the entire sample, would be positively selected, and the estimates are very likely to be upward biased. Therefore, the results indicate the evolution of the relative wages of “overworking” women and present whether changes in wage premiums for working long hours are more striking at the top of the wage distribution than at the bottom.

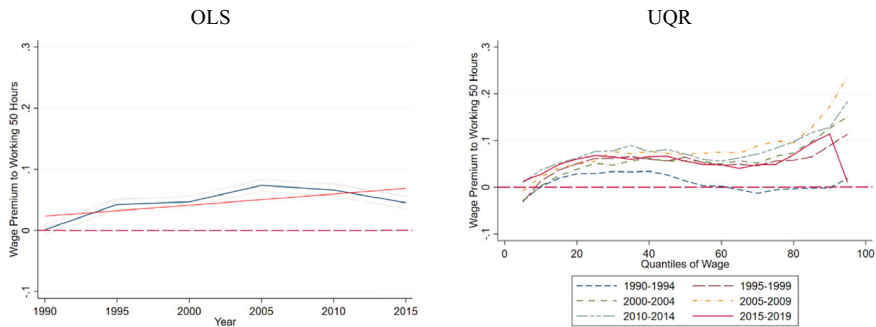


Fig. 8 Relationship between long work hours and hourly wages. Notes: Figures show the relationship between working 50 or more hours a week and the hourly wages of female workers. Covariates are an indicator of working at least 50 h a week, age, age squared, race, education, marital status, and year fixed effects. The dotted lines with the OLS estimates are the 95% confidence intervals

According to the OLS estimates (Fig. 8), there is no significant wage premium to work long hours in 1990–1994, but women working long hours receive 4.5–7.4% higher wages after 2000. The UQR results also show that there is no significant wage gap between women working long hours and those working less than 50 h a week above the median in the early 1990s, but the wage premium for long work hours increases from the mid-1990s. The premium for long work hours above the median increases by 5–10 percentage points between 1990–1994 and 1995–1999. The wage premium for long work hours continues to increase until 2010–2014. Especially at or above the 80th quantile, it increased by 10–16 percentage points between 1990–1994 and 2010–2014. The wage premium for long work hours rises by less than 5 percentage points at or below the 30th quantile and less than 6 percentage points at or below the 60th quantile during the same period¹⁴.

Wages of women working long hours noticeably increase at the top in the late 1990s when the MWG sharply declines at the upper quantiles. Additionally, the proportion of mothers who work long hours increases during the period, especially among late-birth mothers. Since the ratio of women who work long hours is still higher for nonmothers than for mothers, the increased ratio of mothers working long hours and the increased value of long work hours are not obvious reasons for the emergence of the motherhood premium. However, the increased ratio of mothers working more than 50 h a week at the top wage decile can be a reason for the rapidly convergent MWG at the top of the wage distribution. According to Goldin (2014), childbirth and childrearing restrict the female labor supply—both work time and labor force participation—and the reduced female labor supply is a major reason for the gender wage gap in high-wage occupations, which impose high value on long hours of work. However, late-birth mothers with high wages seem to largely complete Goldin’s “Grand Gender Convergence” by raising the likelihood of working long hours.

¹⁴ Since this wage premium may be driven by nonmothers, I separately run the same regression by motherhood status. The result show very similar trends and magnitudes to the results from the entire sample, meaning that the trend in the wage premium for long work hours is not driven by a certain group of women (Online Appendix Fig. A5).

4.3 Marital status

Pal and Waldfogel (2016) noted that an increase in husbands' participation in housework decreases the amount of time mothers spend on housework, thereby increasing mothers' working hours and reducing a motherhood penalty. If there exists a marriage premium for working mothers, this can be associated with maternal relative wages.

I find that the marriage rate is greatly reduced for low-wage women compared to high-wage women. Married women refer to women who are currently living with husbands in this section. The marriage rate of low-wage mothers, below the 30th wage percentile, dramatically decreases during the period by 15.6–20.2 percentage points (from 70–75.9% to 54.1–58.3%), while the marriage rate of high-wage mothers, above the 80th wage percentile, increases by slightly more than 1 percentage point (higher than 80% all years). A more than 15 percentage points decrease in the marriage rate among low-wage mothers is a remarkable change compared to high-wage mothers and low-wage nonmothers¹⁵. A large decrease in the maternal marriage rate means that the proportion of single mothers—mothers who do not currently live with husbands for any reason—largely increases among low-wage mothers.

Isen and Stevenson (2010) explain that a changing trend in marriage reveals that gains from “consumption complementarity¹⁶” are becoming more important and gains from “production complementarity¹⁷” are less important in terms of marriage benefits. A large decrease in the marriage rate for low-skilled women supports the reduced “production complementarity”. Increased “consumption complementarity” implies that marriage becomes more attractive to women with more disposable income, inducing positive selection into marriage.

I estimate the MWG of married mothers and single mothers separately by including the interactions of motherhood status and the presence of a husband in the baseline specification. Comparison of the MWG between married mothers and single mothers will provide evidence regarding whether husbands' role in housework affects the trend in the MWG and whether there exists a positive selection into marriage for high-wage women. Figure 9A shows the wage gap between married mothers and nonmothers. The MWG of married mothers is almost identical to the MWG of the entire sample in the early 1990s, but the MWG of married women converges toward zero much faster than the MWG of the entire sample. The motherhood premium at the upper quantiles also increases faster than that of the entire sample. The motherhood premium¹⁸ first appears in the late 1990s at the 95th quantile for married mothers, and it spreads over the wage distribution. Married mothers earn significantly higher wages than nonmothers at or above the 70th

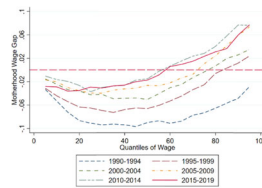
¹⁵ The marriage rate of nonmothers decreases by 3–11.6 percentage points at all wage levels during the period. It decreases by 6.7–11.6 percentage points below the median and 3.0–6.9 percentage points above the median between 1990–1994 and 2015–2019. The findings are presented in Online Appendix Fig. A6.

¹⁶ A married couple can share public goods. For example, a couple can reduce housing costs and enjoy higher utility by consuming leisure time together and by having children.

¹⁷ A married couple can achieve higher productivities in both housework and paid work in the labor market than single people can by specializing in housework and paid work.

¹⁸ Significant at the 95% confidence level.

A. Motherhood Wage Gap of Mothers Living with a Husband



B. Motherhood Wage Gap of Single Mothers

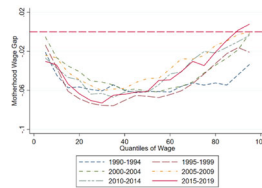


Fig. 9 Motherhood wage gap by the presence of a husband. Notes: Panel **A** shows the wage gap between married mothers and nonmothers, and Panel **B** shows the gap between single mothers and nonmothers. Married mothers indicate mothers who currently live with a husband, and single mothers indicate mothers who are not currently living with a husband for any reason. The motherhood wage gaps are estimated by including interactions of marital status and motherhood dummies. The other covariates are age, age squared, race, education, marital status, and year fixed effects

quantile in 2015–2019. This result implies that there exists a positive selection among married mothers with high wages, which leads to a motherhood premium.

Meanwhile, single mothers except for mothers in the 90th and 95th quantiles earn significantly¹⁹ lower wages than nonmothers even until 2015–2019. According to Fig. 9B, there is no motherhood premium for single mothers, which indicates that the motherhood premium in the entire sample comes from married mothers, not single mothers. The MWG of single mothers shows a U-shape over the wage distribution. Notably, the MWG of single mothers does not change much compared to that of married mothers. The large MWG of single mothers that does not diminish over time and the quickly converging MWG of married mothers are consistent with the argument that the spousal role in housework contributes to reducing the MWG. Increased market services for housework, including child care, may also have played an important role in improving the MWG, especially for married mothers with greater likelihood of having a high family income than single mothers. Last, the different trends in the MWG by marital status and a large increase in the single mothers at the lower wage quantiles can explain the limited convergence of the MWG for low-wage mothers.

5 Concluding remarks

In this paper, I examined recent trends in the MWG across the female wage distribution and explored plausible drivers of the heterogeneous evolution of the MWG. I found that the large decrease in the MWG observed on average is a high-quantile

¹⁹ Significant at the 95% confidence level.

phenomenon; the MWG has been reversed among high-wage earners (motherhood premium); and heterogeneous changes in first-birth timing, work hours, and marriage are major drivers of the heterogeneously changing MWG. The MWG has dramatically declined over the past several decades, and there is almost no unexplained wage gap between mothers and nonmothers, on average. However, the large convergence of the MWG, which is mainly driven by high-wage mothers, implies that wage inequality among mothers has increased, even though the average wage gap between mothers and nonmothers has decreased.

This paper highlights several social and academic issues hidden behind this large convergence of the MWG. First, the motherhood premium among high-wage earners implies that their birth trend has changed. Generally, low-skilled women tend to have low opportunity costs of childbirth and large family sizes (e.g., Heckman & Walker, 1990), and mothers have been thought to be negatively selected in terms of wages. However, the trend changes at the high end of the female wage distribution, leading to positive selection into motherhood. The traditional economics mechanism presenting a negative relationship between women's wages and fertility needs to be more sophisticated because it is no longer true for high-wage women.

Second, high-wage mothers have been breaking the "overwork" barrier by delaying their first births. In the paper titled "A Grand Gender Convergence: Its Last Chapter", Goldin (2014) noted that the gender wage gap due to differences in human capital has almost disappeared, and the last chapter of the gender wage gap is women's high demand for time flexibility due to childrearing and wage compensation for long work hours in the labor market. However, Goldin's last chapter may be complete for high-wage women. High-wage women increasingly delay their first-birth timing, and late-birth mothers have broken their "overwork" barrier. Time restriction due to children is no longer an obvious cause of the gender wage gap for women who earn very high wages, even though it has been until the 1990s.

This paper stimulates several follow-up studies. First, in addition to women's first-birth timing, marriage, and work hours, there may be other mechanisms that can explain the heterogeneous MWG trends across the wage distribution. Second, there are some empirical research topics that can be examined with the proposed mechanisms in this paper. This paper broadly explores the plausible sources of heterogeneous MWG and its trend, but it is limited in that it does not investigate how important each force is or the causal effects of these forces. Last, heterogeneous MWG depending on women's wages can be considered in research on women's fertility decisions. Childless women would have different expectations for their future wages after giving birth depending on their labor market outcomes, and these heterogeneous expectations could affect their fertility decisions.

Acknowledgements I am very grateful to Elizabeth T. Powers for her invaluable guidance and support. I would like to thank Mark Borgschulte, Rebecca Thornton and Eliza Forsythe for all of their great comments and guidance. I also appreciate the useful comments and suggestions by seminar participants at the University of Illinois at Urbana-Champaign. All errors are mine.

Compliance with ethical standards

Conflict of interest The author declares no competing interests.

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