The Impact of Childbearing on the Gender Income Gap：Summary

By Yucong Li*

Undergraduate Honors Thesis

University of Colorado, Department of Economics

Advised by:

Richard Mansfield, PhD, Department of Economics

Defense Committee:

Richard Mansfield, PhD, Department of Economics

Brian Cadena, PhD, Department of Economics

David S. Brown, PhD, Department of Political Science

Defense Date: April 5, 2022

Abstract

In this paper, I will establish a model to explore the impact of fertility on income in the United States and explore the differences between men and women in this impact. I will also examine how childbirth affects the gender income gap, and whether the gender income gap changes with the age of the child. If the gender income gap changes with age, how does it change? What does marriage mean for women and men with children? I select NLSY79 data to analyze and establish regression models. I hope that through this research, I can better explore the status of women in the family and workplace, and discover the influence of child rearing on women and men, so as to help us to dig into the root cause of gender income gap. The results show that having children influences on the incomes of both men and women. The overall penalty for women having children is much greater than for men, and having children will lead to a wider gender gap. According to the regression results, married men earn more when they have children, while married women earn less when they have children. I also found that having children had a greater impact on married women because they were more likely to stop working. The gender gap widens after having children but then stabilizes. The gender income gap is widest between the child ages of three and five, and then gets smaller, but the gender income gap doesn't disappear as children get older.

Keywords: yearly income, Gender, Gender income gap, child penalty

Introduction

According to the “American Association of University Women and the Women's Policy Institute, the gender income gap for working women of all ages is about 82 percent”(Dugas, 2012). In other words, women are experiencing unequal pay results even when the same amount of effort and time as their male colleagues. Today, as we pay more attention to women's career development, women today enjoy more work opportunities and participation than ever before. Because differences in opportunities and resources are getting smaller, the pay gap is decreasing. Although women are catching up or even surpassing men in fields such as education, the income gap still exists (Dugas, 2012). Since women are the subject of reproductive rights, they may be punished for low income after having children. Therefore, childbirth may be the main cause of the gender pay gap.

For one thing, only women are biologically able to have children, so the time cost of a woman's reproductive behavior and the psychological changes that come with it can be an obstacle to women returning to the workforce. More time women spend having babies, the more emotionally costly to return to work and rely on day care. “The more children women have, the lower their post-natal wages”(Gorman, 2011). Second, influenced by motherhood myths and social roles, many women may be willing to spend time with children because they tend to spend more time than men on pregnancy and childbirth. As a result, they may choose to spend more time with their children than with colleagues, clients, or partners. Third, women are more likely to be discriminating against at work. In other words, some jobs are inherently sexist against women. For example, the owners are assuming that mothers will be less productive than fathers without evidence. Plus, some employers think women are less stable than men because they need to take a

break from work to have children. Previous studies have shown that after men have children, their income will increase, while women's income will decrease (Michelle, et al., 2014). This suggests that fertility affects the income of both men and women in varying degrees.

The paper is intended to answer the question: How does the impact of childbearing on earnings differ between men and women? How much of the gender income gap can be explained by childbearing? Based on the previous question, I also raised a corresponding research question: Does the gender income gap change as children get older? In this paper, I will use NLSY1997 panel data to analyze the impact of childbearing on male and female annual income and the impact on gender income gap. I will also explore how the gender income gap changes as children age. I will select observations from 1997 to 2019 among all men and women over the age of 22 for the analysis of the impact of childbirth on income and how it differs between men and women. In addition, I also quantified the effect of having children on gender earnings differentials.

I used difference-in-difference as my methodology, or to be more accurate, event study. In my paper, we wanted to trace the effects of fertility over multiple periods, and our event was fertility. There are basically two differences. There's a difference between men and women, and there's a difference between before and after having children.

In addition, the age of the child may affect the size of the punishment because there may be differences in the degree to which children of different ages need parental care. Parents' income may vary when the child is very young (under 2 years old), when the child enters nursery school, or a formal school, or graduates from college. Does having a child have a permanent effect? Is marital status likely to affect the size of the punishment? Why do we consider that punishment might depend on marital status depending on the age of the child? What do we consider to be the effect of having children on men? What are the different experiences that women have that lead

them to react differently to childbirth? How many of them are obliged to work by our husbands? Under which circumstances are we more likely to make these choices? I choose NLSY79 data for analysis and establish a regression model to answer the above questions. After controlling for the observers' educational background, their region, their age, marital status and so on, I calculate the differences between men and women before they had children and men and women after they had children. In addition, I consider the impact of childbearing on male and female earnings for married and unmarried respondents separately. Finally, I conclude by considering the influence of children's age on yearly income and gender income gap.

Literature Review

With the gradual improvement of people's awareness of gender equality and women's status, women began to choose to give up a stable life and engage in high-paying jobs. However, they must also assume the role of family caregiver. Therefore, more and more scholars began to pay attention to and analyze the impact of motherhood penalty on gender income gap. In each of these papers, each found that mothers with similar human capital characteristics earned significantly lower wages than childless people in any country. In other words, the child penalty is not only an important phenomenon, but also a cause of the gender wage gap (Angelov, et al., 2016; Juhn, et al., 2017; Kleven et al., 2019; Cukrowska-Torzewska, et al., 2016; Meurs et al., 2010). In addition, other scholars have found that “men's earnings increase after they have children, while women's earnings decrease. Low-income women bear a huge motherhood penalty, and the fatherhood bonus for low-income men does not help to offset that fact. All other things being equal, fatherhood boosts a man's earnings by more than 6 percent. At the very top of the female income distribution,

the fertility penalty is almost non-existent. However, at the bottom of the wage distribution, low-income women bear significant and costly fertility penalties "(Michelle, et al., 2014).

After concluding that child penalty was one of the causes of the gender wage gap, several papers went further, which is an extension of my paper. Cukrowska-torzewska and Lovasz(2016) studied "the size of the wage gap due to gender and parenthood, and the impact of family differences on the gender wage gap." They concluded that the father's wage premium had the most significant effect on the "gender wage gap", particularly in Poland. The motherhood punishment is also important, while gender differences play only a small role in childless individuals." Johansson, Angelov, and Lindahl(2016) explored the relationship between Swedish women's income and wage paths and their partners before and after the birth of their first child, using an event study and quantile regression method. That is, they looked at changes within families over time and found that the less educated a woman was compared to her spouse, the greater the impact of gender differences. Authors Meurs, Pailhe, and Ponthieux(2010) emphasize that in France, the cost of time for women to leave the labor market and devote themselves to childbearing and child care may be the main reason for the gender wage gap, as this period weakens women's professional experience. As a result, women's wages have fallen. Take into account these papers, I found that changes in the market for women in the 2000s reinforced the impact of childbearing on women's earnings compared to the 1990s.

The papers I worked on were closely related to Juhn's and McCue's papers and to Andresen's and Nix's papers. In Juhn and McCue's paper, the authors (2017) examine "the evolution of the gender gap in relation to marriage and parental status by comparing the same period of birth between 1936 and 1985" with family specialization and division of labor and using models to examine whether marriage is present, while the gap is narrowed as a model for

specialization prediction. The results showed that despite generous benefits, working women still spent more time with their children than men with similar human capital characteristics. Similarly, Kleven et al. (2019) conclude that the motherhood penalty is not primarily driven by public policy. Meanwhile, Michelle, et al. (2014) investigated whether and how the transition from childlessness to fatherhood affected male wages using data from 1979 to 2006 from the National Longitudinal Survey of Youth 1979 (NLSY79). Other things being equal, fatherhood boosts a man's earnings by more than 6 percent. Men's earnings increase after they have children, while women's earnings decline. "This is very close to the results of my research. In my paper sample, I will make NLSY1997 data set based on the papers of Michelle's, Juhn's and McCue's. My contribution is that these all deal with almost the same issues and are tracked in almost the same way. In addition to using panel data to explore and analyze the impact of childbirth on male and female annual income and the impact of the gender wage gap, I will also explore how gender income gap changes with the age of children.

I also used a model and compared the estimated income dynamics with motherhood penalty to determine the effect of childbearing on earnings between men and women and the effect of motherhood penalty on gender wage differentials. In a paper just published, Andresen and Nix(2016) used a similar model to explore differences in the influence of heterosexuality, adoption, and same-sex couples on motherhood penalty. Their results complement the conclusions of my paper. In other words, motherhood penalty is mostly for heterosexual couples. However, my contribution is that I also take into account additional factors such as education, region, age, etc. At the same time, I use the usual differences in differences or event studies as a research method. I'm going to use this method to find out if motherhood penalty changes over time.

Finally, it is not hard to find that a very limited number of papers have examined the extent to which the gender income gap in the US can be explained by fertility and explored whether motherhood penalty has changed over time (Angelov, 2016). For example, Johnson paper, Aganov, Lindahl (2016) "Data from Swedish administrative registers track the use of parents' income and wages in the Labor market for their professional lives, from the first years of childbearing to about 15 years after birth of their first child." I will use different datasets and methods and U.S. data for empirical analysis.

Data

To study the impact of childbearing on income in the United States, how it differs between men and women, and the impact of childbearing on gender income gap. I used data from the Bureau of Labor Statistics' 1979 National Longitudinal Survey of Youth (NLSY1997).

The NLSY97 data sample includes a nationally representative sample of people living in the United States at the time of the first survey in 1997 (" NLSY97 ", 2021). The 8,984 participants were born between 1980 and 1984. The participants were interviewed annually from 1997 to 2011 and every two years thereafter. After data screening, I chose to use the variables in NLSY1997 for data collation and analysis. These data are personal data.

I chose this as a data source because it can track the same woman or man over time. If I wanted to test how the age of the child might affect the size of the punishment, the data set would provide us with the observation and analysis of the income of children of the same woman at different ages. In this case, especially those age profiles, when comparing younger children with older children, I can basically compare the same group of women with the same group of men.

They looked at people from the same group, so I basically do not have to worry too much about group effects. In addition, this data source can observe the interviewees' early work experience so well that I can control their income before they have children. This data source is like a long-term census, and I can get good long-term data to examine how their income changes with the age of their children.

However, this data source also has some defects. For example, its sample is not very large, so it is difficult for me to obtain an accurate estimate because some people will choose to stop responding to the survey. I also encounter natural wear and tear. While no one would deliberately make the sample smaller, I might be concerned that the people whose incomes lost the majority might be those who did not have time to respond to the survey. If all the people who were most negatively affected were dropped from the sample because they did not respond the survey, my estimate would be biased.

Table 1.1 summarizes the eight main variables that I filtered and sorted using NLSY97. They are respectively yearly income, employed, had child, female, married, education categories, region, and parental age. I will select men and women over the age of 22 from NLSY97 datasets and analyze them from 1997 to 2019.

The main reason for the low number of yearly income observations is that many observers claim not to know their yearly income when they fill in the survey. Moreover, all dollar amounts used are adjusted for inflation between 1997 and 2019 using 2020 dollars. For instance, I used the current consumer price index to try to figure out what $160.5 in 1997 would buy in 2020. Because that same $160.50 loss of income 20 years ago meant a lot more to a person than $160.50 now. I also chose to construct parental ages from the data set. I subtracted their birth year from current year to get their age. When dealing with employers, I chose to build with yearly income data.

Everyone who answers the question is employed (yearly income>=0). I chose to add the observation of the skip question into the unemployed people because I think they skipped the question largely because they were not working. Therefore, we can discover that the average income of the observer is $18,501. Employed, had child, female, and married are dummy variables, so we use 0 and 1 to encode. Forty-eight percent of the observers were women, and about 39 percent had children. About 16 percent were married. The highest level of education among the observers was rated on a scale of 8 on a scale of 0-7 : 0 None; 1 GED (General Educational Development); 2 High school diploma (Regular 12 year program); 3 Associate/Junior college (AA); 4 Bachelor's degree (BA, BS); 5 Master's degree (MA, MS); 6 PhD;7 Professional degree (DDS, JD, MD). Region we are divided into 1Northest, 2 North, 3South, and 4West. The current age range of the participants ranged from 13 to 39 years old, with a mean age of 26 years.

Table 1.1 All the observers

stats	Number of observations	mean	maximum	minimum	standard deviation	standard error of mean (sd/sqrt(n))	coefficient of variation (sd/mean)
yearly income	121008	18500.54	249068.9	0	26675.59	76.68441	1.441882
employed	165928	.7775722	1	0	.4158782	.001021	.534842
Had child	206632	.3956212	1	0	.4889849	.0010757	1.235993
female	206632	.4880899	1	0	.4998593	.0010996	1.024113
married	165145	.1626207	1	0	.3690204	.0009081	2.269209
age	206632	25.98965	39	13	6.778735	.0149125	.2608244

Education categories	Number of observations	Percent %
0 None	37,145	17.98
1 GED	13,294	6.43
2 High school diploma	134,113	64.90
3Associate/Junior college	7,498	3.63
4 Bachelor's degree	14,145	6.85
5 Master's degree	368	0.18
6 PhD	46	0.02
7 Professional degree	23	0.01

Region	Number of observations	Percent %
1Northeast	22,309	16.27
2 North Central	29,708	21.67
3 South	54,254	39.57
4 West	30,836	22.49

Highest education level: 0 None; 1 GED(General Educational Development); 2 High school diploma (Regular 12 year program); 3 Associate/Junior college (AA); 4 Bachelor's degree (BA, BS); 5 Master's degree (MA, MS); 6 PhD;7 Professional degree (DDS, JD, MD)
Region:1Northeast (CT, ME, MA, NH, NJ, NY, PA, RI, VT);2 North Central (IL, IN, IA, KS, MI, MN, MO, NE, OH, ND, SD, WI);3 South (AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN ,TX, VA, WV);4 West (AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY)

Table1.2 summarizes the profile of variables when all observers are female and they all have children. I obviously found a decrease in the number of observations, the average income of women with children was about $17,930 compared to the average income of all observers. I find a large proportion of women who have children but are not in a state of marriage. The average age of women with children has also risen.

Table 1.2 All the observers were female and had children

stats	Number of observations	mean	maximum	minimum	standard deviation	standard error of mean (sd/sqrt(n))	coefficient of variation (sd/mean)
yearly income	23850	17929.28	249068.9	0	23348	151.1839	1.302227
employed	38960	.7954312	1	0	.4033913	.0020437	.5071354
married	42258	.2604714	1	0	.438897	.0021351	1.685011
age	45809	29.42917	39	13	5.462524	.0255222	.1856159

Education categories	Number of observations	Percent%	**Region**	Number of observations	Percent%
0 None	9,213	20.11	1Northeast	3,741	13.71
1 GED	3,425	7.48	2 North Central	5,481	20.08
2 High school diploma	28,812	62.90	3 South	12,434	45.56
3Associate/Junior college	1,759	3.84	4 West	5,634	20.64
4 Bachelor's degree	2,524	5.51			
5 Master's degree	60	0.13			
6 PhD	0	0			
7 Professional degree	16	0.03			

Highest education level: 0 None; 1 GED(General Educational Development); 2 High school diploma (Regular 12 year program); 3 Associate/Junior college (AA); 4 Bachelor's degree (BA, BS); 5 Master's degree (MA, MS); 6 PhD;7 Professional degree (DDS, JD, MD)

Region:1Northeast (CT, ME, MA, NH, NJ, NY, PA, RI, VT);2 North Central (IL, IN, IA, KS, MI, MN, MO, NE, OH, ND, SD, WI);3 South (AL, AR, DE, DC, FL, GA, KY, LA, MD, MS, NC, OK, SC, TN ,TX, VA, WV);4 West (AK, AZ, CA, CO, HI, ID, MT, NV, NM, OR, UT, WA, WY)

Methodology

In the first Place, this is the simplest formula.

$$\mathbf{y_{it} = \beta_0 + \beta_1 * 1(t > year\ of\ first\ birth_i) + \beta_2 * 1\ (t > year\ of\ first\ birth_i, \ell gender_i = F) + \beta_3 1(gender_i = female)} \quad \textbf{.....(1)}$$

I have three basic independent variables, which are whether the respondent have children $\mathbf{1(t > year\ of\ first\ birth_i)}$, whether I both have children and the respondent is female $\mathbf{1\ (t > year\ of\ first\ birth_i, \ell gender_i = F)}$, and whether the respondent is female $\mathbf{1(gender_i = female)}$. Among the independent variables, 1 represents an indicator, t represents the current year, and i represents individual. I encode all three variables with 1 and 0. The second independent variable needs to meet two conditions. First, it needs to have children and be female. It's equal to 1 if both conditions are met, and the third independent variable is female, which is equal to 1 if the person is female. The calculation is done by these three independent variables. I will use the coefficient of had child plus the coefficient of had child*female to calculate the overall penalty from having a child for women. In addition, I use the coefficient of had child to determine the overall penalty from having a child for men. I used the coefficient of had child*female to calculate the excess penalty from having a child for women. I will also use the coefficient of on female to get the result of gender income gap for women vs. men without children. Finally, I will use the

coefficient of female plus the coefficient of had child*female to calculate gender income gap for women vs. men with children.

$$\mathbf{y_{it} = \beta_0 + \beta_1 * 1(t > year\ of\ first\ birth_i) + \beta_2 * 1\ (t > year\ of\ first\ birth_i,\ gender_i = female) + \beta_3 * 1(gender_i = female)\ + \beta_4 age_{it} + \beta_5 age_{it}^2 + \beta_6 * 1(married_{it} = married) + \sum_{R=1}^{4} \beta_7^{Re} * 1\ (Region_{it} = R)\ + \sum_{e=1}^{5} \beta_8^{edu} * 1\ (educ_{it} = e)\ \ldots\ldots (2)}$$

In methodology (2), the dependent variable changes with the change we wish to observe. There are three different dependent variables and three different regression equations. The first dependent variable y is yearly individual income, which is measured in year 2020 dollars. The second dependent variable, y, is employed, which captures an individual's employment status. The third dependent variable, y, represents wage, which captures the rate at which people are paid per hour.

This simple model predicts the overall penalty for having children for men and women, the change in earnings. It also shows the gender income gap between childless women and childless men, and the gender income gap between women with children and men with children. I limited my sample to all men and women over 22 and assumed that having children was independent of any other factors that might affect wages. We are aware that in addition to the costs of motherhood, we can not ignore the fact that women themselves can be discriminated against on the basis of gender, which contributes to the gender income gap.

In addition, I will introduce five sets of additional variables to control the output of the results. They were the observers' educational background $\sum_{e=1}^{7} \beta_8^{edu} * 1\ (educ_{it} = e)$, the region they lived in $\sum_{R=1}^{4} \beta_7^{Re} * 1\ (Region_{it} = R)$, their age $\beta_4 age_{it}$, the square of their age $\beta_5 age_{it}^2$ and their marital status $\beta_6 * 1(married_{it} = married)$. The educational

background here is divided into seven levels: Not Received Any Education(0), General Educational Development (1), I have High School diploma (2), I have Associate/Junior College (3). Bachelor's Degree (4), Master's Degree (5), PhD (6) and Professional Degree (7). The region is divided into four areas: 1Northeast; 2 North Central; 3 South; 4 West.

Control Region:

For some areas, we should also control it because maybe some areas have higher birth rates than others. For example, if the people surveyed were in religious areas of the country, they were more likely to view born-again children. But they also have a culture that discourages women from working. In an area where women are discouraged from working, fewer will have children. So, when we compare people who have children with people who don't, we see the causality of having children and the difficulty of dealing with children. However, at the same time, jobs in these fields are generally unpopular. In those areas, they encourage part-time or non-working, so it's the regional effects that really drive the results. Nonetheless, since the relationship between place and fertility is determined by cultural differences, it might be biased.

In addition, different regions have different incomes. Incomes in the south are likely to be lower than in the west and northeast. If the potential earnings of having children are related to employment decisions, it is only because of where they live, not because of the actual child decision itself. In this case, I may be overestimating or underestimating the penalty for having a child, and the coefficient won't be as negative as it should be.

Control Age:

I need to control for age variables because women with children tend to be older than women without children. In other words, there are plenty of women who choose to have children before 30 years old, and some who choose to have children before 20 years old. Nevertheless,

earnings generally increase over time as they gain more work experience. If we don't control for age, we might underestimate the punishment of having children, because we're comparing people with children to people without children, but people with children are generally older than people without children. Overall, the income gap between younger and older generations is partly due to having children and partly to gain extra experience, gaining more wisdom or getting a promotion at work. I can say that it is difficult for them to earn a good income when they have children, but it may be better when they have children because of their age and experience. Therefore, there's a missing variable bias that might make I underestimate how hard it is to have a baby.

Control Education:

Higher education increases their earning potential. If they have a good income option, this may make women less willing to have children. However, if they don't earn much, the opportunity cost of not working and having children is not significant in terms of lost earnings. I need to control education, because the difference in income between people with and without children is partly caused by the difference in their average level of education, because education itself has an impact on income.

Control Marry Status:

If women are not married, they find it harder to quit their jobs when they have children. In addition, men marrying helps them increase their income. Gender role specialization makes men more productive. Male breadwinners should be given more money to meet the economic needs of family life, or employers wrongly assume that married men are more productive workers. Therefore, marital status may also affect the punishment of having children.

However, in Table 3 I will examine the effect of childbearing on the earnings of both men and women when marriage is a condition. Because I think the impact of having a child is very different for married and unmarried people.

To sum up, people who have kids may make less money for other reasons like they're less educated, they're married to someone else to help them increase their income, or they may live in a lower income area, etc. Moreover, adding the square of age can more accurately simulate the effect of age because it may have a non-linear relationship with the dependent variables. Marital status will be coded using 0 and 1.

When t is greater than the year of first birth and the individual is female, I obtain the expected value of y is $\boldsymbol{\beta_0 + \beta_1 + \beta_2}$+$\boldsymbol{\beta_3}$. When t is greater than the year of first birth and the individual is male, I get the expected value of y is $\boldsymbol{\beta_0 + \beta_1}$. When t is less than or equal to the year of first birth and the individual is female, I obtain the expected value of y is $\boldsymbol{\beta_0 + \beta_3}$. When t is less than or equal to the year of the first birth, and the individual is male, I get the expected value of y is $\boldsymbol{\beta_0}$.

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t > \textbf{year of first birth}, \textbf{female})] = \boldsymbol{\beta_0 + \beta_1 + \beta_2}+\boldsymbol{\beta_3} \text{.....(a)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t > \textbf{year of first birth}, \textbf{male})] = \boldsymbol{\beta_0 + \beta_1} \text{.....(b)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t \leq \textbf{year of first birth}, \textbf{female})] = \boldsymbol{\beta_0 + \beta_3} \text{..... (c)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t \leq \textbf{year of first birth}, \textbf{male})] = \boldsymbol{\beta_0} \text{.....(d)}$$

First, I can calculate a woman's overall punishment for having a child (a)-(c)= $\boldsymbol{\beta_1 + \beta_2}$. Overall punishment for male children (b) - (d) =$\boldsymbol{\beta_1}$. Women than men to have a child with children excessive punishment for (a) - (c) - ((b) - (d)) =$\boldsymbol{\beta_2}$. In other words, I believe that the penalty for women to have additional children is higher than the penalty for men to have children. The gender

income gap between childless women and childless men is (c) -(d) =$\boldsymbol{\beta_3}$. The gender income gap between women with children and men with children is (a)-(b)= $\boldsymbol{\beta_2}$+$\boldsymbol{\beta_3}$.

During the analysis, I guessed that there were a number of factors that might affect the results of our analysis, such as the educational background of the observers, the area they lived in, their age, marital status and so on. Therefore, I will conduct further analysis by controlling for these variables that may influence the results. I chose to control for five variables, age, age squared, region indicators, indicators for respondents' highest level of education, and marital status. By controlling for these variables, I can more accurately analyze the influence of having a child on income. In this formula, y_{it} which will change depending on what I study, it will be represented as yearly income, employment status and hourly wage rate.

In Table3, I will investigate the effect of childbearing on male and female earnings when marriage is a condition. Perhaps the effects of having children are very different for married and unmarried women.

Employment is also a useful additional consequence. I will limit the sample of employment to explore whether the impact of having children on income exceeds the impact of an individual's continued employment. Perhaps the main effect of having children on a mother's earnings comes from her quitting her job. Because when they don't have a job, the probability of earning zero increases. I will consider replacing total income with an employment indicator as a result, and then replacing total income with wages and making the sample of employed equal to 1. The idea is that mothers may opt out of the work force, or they may be fired because they are not productive. As a result, it's hard to discern specific causes. And if they just work fewer hours or they don't get promoted, then their earnings should show up on their annual income, even if they're employed. If it is primarily hours worked and not actual hourly wages, then it should be shown to employees

each year, not wages. That's how we can break down the original results to better understand where punishment comes from.

$$\mathbf{y_{it}} = \boldsymbol{\beta_0} + \sum_{g=1}^{4} \mathbf{1}(\boldsymbol{child\ age\ group_{it}} = \mathbf{g}) * \boldsymbol{\beta_j^M} + \sum_{j=1}^{4} \mathbf{1}(\boldsymbol{child\ age\ group_{it}} = \mathbf{j}) * \mathbf{1}(\mathbf{gender}_i = \mathbf{F}) * \boldsymbol{\beta_R^w} +) + \boldsymbol{\beta_3} 1(\boldsymbol{gender_i} = \mathbf{female}) + \boldsymbol{\beta_4} \mathbf{age}_{it} + \boldsymbol{\beta_5 age_{it}^2} + \boldsymbol{\beta_6} * \mathbf{1}(\mathbf{married}_{it} = \mathbf{married}) + \sum_{\mathbf{R}=1}^{4} \boldsymbol{\beta}_7^{\mathbf{Re}} * \mathbf{1}\ (\boldsymbol{Region_{it}} = \mathbf{R})\ + \sum_{\mathbf{e}=0}^{7} \boldsymbol{\beta}_7^{\mathbf{edu}} * \mathbf{1}\ (\mathbf{educ}_{it} = \mathbf{e})\ \text{.....(3)}$$

This is our final methodology(3), where y is income, I is individual, T is year and g and j are the age group of the child. I used the age group of the child as the independent variable. The impact of having a child on a woman's earnings changes from year to year over a child's lifetime. I am going to subtract the first year of the child's birth from the current year to get the child's age.

The impact of the child on the mother's income may depend on the age of the child because I suspect that it may be easier to find day care after the child is two or three years old. Or I could argue that public education is free from the age of six so that mothers of children can devote more time to work. Besides, perhaps children can take care of themselves by the time they reach their teens, freeing up time to work for their parents. Therefore, I divided the age of children into four groups for analysis. The children were in groups of 1 to 2 years old, 3 to 5 years old, 6 to 11 years old and 12 years old and older. I will define child age = 0 as actually part of the age range of the first age category (the child has been born but is not yet 1 year old). The maximum age limit for children is 18.

For example, I assume that when the child's age is 1 and the individual is female, I get the expected value of y as $\boldsymbol{\beta_0} + \boldsymbol{\beta_1^M} + \boldsymbol{\beta_1^w} + \boldsymbol{\beta_3}$. That is, the expectation when the child is 1 year old and the parent of the child is female. I also assume that the expected value of y is $\boldsymbol{\beta_0} + \boldsymbol{\beta_1^M}$ when t year of first birth=1 and the individual is male. When the respondents were female and had no

children, I get that the expected value of y is $\boldsymbol{\beta_0 + \beta_3}$. When t year of first birth=0, and the individual is male, I get that the expected value of y is $\boldsymbol{\beta_0}$.

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t - \textbf{year of first birth} = \mathbf{1}, \textbf{female})] = \boldsymbol{\beta_0 + \beta_1^M + \beta_1^w + \beta_3} \text{..(e)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t - \textbf{year of first birth} = \mathbf{1}, \textbf{male})] = \boldsymbol{\beta_0 + \beta_1^M} \text{.....(f)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t - \textbf{year of first birth} = \mathbf{0}, \textbf{female}] = \boldsymbol{\beta_0 + \beta_3} \text{..... (g)}$$

$$E[\mathbf{y_{it}} \mid \mathbf{1}(t - \textbf{year of first birth} = \mathbf{0}, \textbf{male})] = \boldsymbol{\beta_0} \text{.....(h)}$$

I can calculate that when a child is 1 years old, the total effect of female's annual income is (e)-(g)= $\boldsymbol{\beta_1^M + \beta_1^w}$, and the total effect of female's annual income is (f)-(h)= $\boldsymbol{\beta_1^M}$. At the age of 1, the gender income gap between males and females is (e)-(f)= $\boldsymbol{\beta_1^w + \beta_3}$. When they don't have children, the gender income gap between men and women is (g)-(h)= $\boldsymbol{\beta_3}$. This is the basic gender income gap. At the end, I added controls for past earnings to eliminate the possibility of reverse causality.

Result

Table 2: Regression
sample: 1997 cohort, all men and women above age 22

	(1) Simple regression	(2) Augmented regression	(3) employed	(4) yearly income if employed=1	(5) wage if employed=1
Had_child	5,403.524 (17.04)**	1,633.591 (5.29)**	-0.008 (2.83)**	2,070.944 (6.18)**	-0.741 (1.18)
Female	-1,989.334 (6.14)**	-4,656.303 (15.59)**	0.012 (4.09)**	-5,720.242 (18.13)**	-3.187 (5.41)**
Had child*female	-14,561.932 (32.22)**	-12,647.048 (30.52)**	-0.090 (23.83)**	-10,550.534 (23.34)**	-2.201 (2.61)**
married		9,805.533 (41.65)**	-0.029 (11.83)**	8,754.679 (34.26)**	3.677 (7.69)**
_cons	31,219.288 (148.19)**	-93,502.523 (18.62)**	0.249 (6.33)**	-102,102.973 (18.48)**	13.904 (1.35)
Analysis					
Overall penalty from having a child for women	-9,158.41	-11,013.46	-0.10	-8,479.59	-2.94
Overall penalty from having a child for men	5,403.524	1,633.591	-0.008	2,070.944	-0.741
Excess penalty from having a child for women	-14,561.932	-12,647.048	-0.090	-10,550.534	-2.201
Gender income gap for women vs. men without children	-1,989.334	-4,656.303	0.012	-5,720.242	-3.187

Gender income gap for women vs. men with children	-16,551.27	-17,303.35	-0.08	-16,270.78	-5.39
controls					
Highest education dummies		✓	✓	✓	✓
Region dummies		✓	✓	✓	✓
Age		✓	✓	✓	✓
Age^2		✓	✓	✓	✓
Number of observation(N)	70,539	69,730	114,275	55,798	50,785
R^2	0.04	0.21	0.08	0.21	0.01

* p<0.05; ** p<0.01

The regressions in Table 2 included men and women over 22 years of age and selected years from 1997 to 2019.

The Simple regression in Table 2 shows the results of regression equation (1). And what I can find is that, without controlling for any variables, I can infer a woman's experience of giving birth.

The variables Had_child, female, and had child*female can be used to predict annual income (dependent variables). Had_child is encoded as 0 and 1 (Had_child =0, Had_not_child=1). When Had_Child =0, that is, the family has no children, 5,404 *0=0. It doesn't change expected revenue. Had_Child = 1, 5,404*1=5,404. This shows that having one child increases a man's expected annual earnings by $5,404.

When women have children, two things happen during the return process. The Had_child variable will run from 0 to 1, and the Had child *female variable will run from 0 to 1. The female variables do not change because they're already female. Now, the expected change in revenue is $9,158. Overall, women earned $9,158 less when they had their first child.

All told, without controlling for any variables, the overall penalty for a woman having a child was $9,158, while a man's earnings went up by $5,404 with no penalty. The additional penalty for women having children is $14,562. In real life, there has always been a gap between men's and women's earnings. Statistically, the earnings gap between childless women and childless men is $-1,990. Without any controls, the income gap might seem small, but the gender income gap between men and women predates children. I can still see that the gender income gap between women with children and men with children is $-16,551. The gender income gap is even wider among those with children. Statistically, the overall penalty for women having children is much greater than for men, and having children is likely to lead to a wider gender gap between men and women.

However, for the first Simple Regression, these conclusions may be not correct if there are other variables that are correlated with both the female and child indicators as well as the income outcome. In the process of analysis, I will find that many factors may affect the results of our analysis, such as the educational background of observers, their area, and their age. Those who have children may earn less for other reasons such as they are less educated, they are married to someone else to help increase their income, or they may live in a lower income area, etc. Therefore, I will conduct further analysis by controlling for these variables that may influence the results. I chose to control for four variables: age, region, the respondents' highest level of education, and marital status.

The Augmented regression (2) in Table 2 shows the results of methodology(2). In this regression we control for variables. I can conclude that after controlling for the variables, the total penalty for a woman to have a child is approximately $11,013, which is an increase from the total penalty without the control variables. The overall penalty for women having children has become more pronounced. After controlling for variables, a man's income increased by $1,634 after having children. Income increases less than it would have if there were no control variables. According to the analysis, women's income is more strongly affected by having children. In addition, I can conclude that the gender income gap between childless women and childless men becomes larger after controlling for variables. The income gap is the gender income gap itself. According to regression, I can conclude that the gender income gap between women with children and men with children is $17,303. Obviously, by controlling for variables, I confirm that the gender income gap between men and women increases after having children, and the value is -$17,303. I can also find that marriage can increase the amount of income each year.

In the first two regressions in table 2, I guessed that women earned less, in part because they probably didn't go out to work, so many of them could have net incomes of zero. If they don't work, they have no income, so their lack of income will also be part of this coefficient. It is actually a combination of low-wage and low-probability jobs. In this case, I used the third and fourth regressions to help us understand how much of the reduction in women's earnings was due to their low probability of employment, and how much was due to their employment but low wages.

I use codes 0 and 1(umemployed =0, employed=1) to change the y variable to whether or not we are employed. When Had_child = 1, -0.008 *1=-0.008. This means that men with children are on average 0.8 percent less likely to be employed. Also, when women have children, two things happen during the regression process. The Had_child variable will run from 0 to 1, and the

Had_child*female variable will run from 0 to 1. The female variables don't change because they're already female. As a result, women are on average 10 percent less likely to be in employment when they have their first child, while men are on average 0.8 percent less likely to be in employment. This means that women's employment opportunities after having children are more affected than men's. In addition, among childless men and women, women were 1 percent more likely to work than men. Women with children are 8 percent less likely to work than men with children. Whether people have a job or not, having children affects both men and women, and has a big impact on women's employment rates.

I now perform a regression analysis on a sample of employed people (Table 2 (4)). I wanted to find out what happened to the income of people who got jobs this year by going back and looking at them. I thought the big effect on earnings might be because women stop working, so I can clearly see that among those who are employed, they show a smaller effect on earnings than I would expect. I am concerned that people with children may differ from people without children in other characteristics that affect income, and therefore there may be an omitted variable bias. Therefore, I control for a couple of characteristics that I know have a big impact on income. Therefore, the desire to have children with these characteristics is not as predictive of their earning power. Thereby, this is a better estimate of the causal effect of having kids on everybody's income.

When I analyzed only the sample of working women, the number of observations dropped to $55,798. All the people in the sample were employed. I have different results now. Having one child increases a man's expected annual earnings by $2,0701. This indicates that there were also men who did not work after having children, so their annual income was larger than the previous regression value. Similarly, when women have children, two things happen during the regression process. The Had_child variable will run from 0 to 1 and the had_child_female variable will run

from 0 to 1. The female variables don't change because they're already female. As a result, working women earn $8,480 less when they have their first child. In contrast, I can find that some women who stopped working during childbirth are still included in the return, and I think there is also a very small percentage of men who stopped working after they had their first child because their previous earnings increased by $1,634. Now, when they both have jobs, they earn $2,071 more. The difference could be the result of men quitting their jobs. But essentially, women should be more likely than men to quit over the birth of their first child. However, this statistical reality is not that obvious, so my guess is that when some women stop working and don't have any income, they are excluded because these women don't report their income. I still see that childless working women earn an average of $5,720 less per year than childless working men. This shows the true level of the gender income gap. When both men and women have jobs, I find a gender income gap of $16,271 between women with children and men with children. By surveying employed workers, I can find more clearly that having children has a significant impact on the gender income gap between employed workers.

Now, there may still be some bias in the ignored variables, but much less than before. There are two other possible reasons for the decline. They may have to take a job that pays less, or they may have to work fewer hours. Even if I eliminate the employment effect the zeros income effect, I need to think about whether there are additional effects even if they require someone to still have an income? Regression (5) in Table 2 considers only the impact of having children on the wage rate and not working hours. Wages are the money a person receives for his work. That is, it will be paid for the hours worked. Income is the total amount of money a person receives. It may include salaries, gifts, interest, bonuses, and dividends. It also adds up the wages for all hours worked, so that hours worked is an important determinant of total income. I found a significant

decrease in hourly wage rates for women when they have children. The gender wage gap also widens significantly after having children. It's also easy to see their effect on annual earnings, the motherhood penalty on wages is big enough to explain the entire motherhood penalty on income, and it looks like hours also fell more for women than men.

Table 3: Regression Coefficients
sample: 1997 cohort, all men and women above age 22

	(1) yearly income if married=0	(2) yearly income if married=1	(3) employed if married=0	(4) employed if married=1
Had_child	-2,784.895 (8.25)**	3,937.611 (5.70)**	-0.025 (8.78)**	0.008 (1.11)
Female	-2,964.674 (9.95)**	-10,680.707 (13.37)**	0.015 (4.96)**	-0.030 (3.42)**
had child*female	-5,433.966 (11.87)**	-17,065.480 (18.14)**	-0.047 (11.58)**	-0.187 (18.00)**
_cons	-121,457.037 (22.11)**	-60,836.996 (5.57)**	0.048 (1.17)	0.673 (5.57)**
Control				
Highest education dummies	✓	✓	✓	✓
Region dummies	✓	✓	✓	✓
Age	✓	✓	✓	✓
Age^2	✓	✓	✓	✓
Number of observation(N)	47,204	22,526	91,749	22,526
R^2	0.15	0.24	0.09	0.10

* $p<0.05$; ** $p<0.01$

In Table3, I will investigate the effect of childbearing on male and female earnings when marriage is a condition. Perhaps the effects of having children are very different for married and unmarried women. At the same time, conditions for marriage may affect the gender income gap. I guess because if a woman gets married and has kids, she won't have to cut back as much on spending if she chooses not to work, since her husband is still working. However, if a woman is single and has children, then she may not have the option of not working, because then all she has is government benefits. So for married women, the impact of having children may be smaller. According to the statistics, married men's earnings increase after having children, while married women's earnings decrease even more after having children. I can see evidence that having children has a greater impact on married women because they are more likely to stop working.

According to regression (1) and (2) of table3, I can also see that the gender income gap between unmarried women with children and unmarried men with children is $-8,399; The gender income gap between unmarried women and men without children is $2,965; The gender income gap between married women with children and married men with children is $-13,128; The gender income gap between married women without children and married men without children is $-10,681.

As a result, having children widens the gender income gap, whether married or not. But having children widens the gender income gap more for married women than for unmarried women. In addition, marriage also widens the gender income gap, regardless of whether or not they have children. As a result, the gender income gap is widest between married men and women with children.

In regression (3) and (4) of Table 3, the employment rate of women with children who do not choose marriage decreases by 7.2%, while that of women with children decreases by 17.9%, thus confirming that marriage is more likely to make women with children stop working. Similarly, the employment rate of men with children decreases before marriage but increases after marriage. This suggests that men with children are more likely to work to support their families after marriage.

Table 4: Regression Estimates by yearly income
sample: 1997 cohort, all men and women above age 22
outcome: income

Yearly income	(1) Simple regression	(2) Augmented regression
female	-4,683.189 (12.36)**	-7,955.667 (7.82)**
child_age_1to2	8,148.166 (5.26)**	9,453.648 (4.25)**
child_age_1to2_female	-11,982.133 (14.44)**	-6,703.108 (5.43)**
child_age_3to5	7,897.975 (5.60)**	11,512.312 (5.68)**
child_age_3to5_female	-13,585.007 (19.49)**	-8,650.068 (7.46)**
child_age_6to11	2,793.021 (2.24)*	10,407.751 (5.98)**
child_age_6to11_female	-11,755.058 (19.19)**	-7,164.341 (6.42)**
child_age_12over	-3,111.781 (2.62)**	8,231.728 (5.51)**
child_age_12over_female	-11,317.178 (12.64)**	-6,921.301 (5.42)**

income_before had_child		0.512 (58.11)**
married	9,203.848 (34.31)**	6,764.286 (23.05)**
age	3,621.551 (8.63)**	-1,816.366 (3.58)**
age_firstbirth	-89.650 (1.59)	-221.911 (2.66)**
_cons	-58,355.621 (9.80)**	22,813.240 (3.09)**
contorl		
Highest education dummies	✓	✓
Region dummies	✓	✓
Age^2	✓	✓
Number of observation(N)	54,679	35,459
R^2	0.22	0.32

* p<0.05; ** p<0.01

In Table 4, I want to show that perhaps the impact of having children on women's earnings varies from year to year in a child's life. Maybe The impact on income is particularly bad when the children are very young. Maybe when their kids get older, their income will get better or in fact, they'll continue to get lower wages. I will analyze the impact of children's age on annual income and gender income gap.

First, the overall impact of a child on a woman's annual income increases as the child ages. By the time a child is 1 to 2 years old, the overall impact of a woman's annual income is $-3,834.

By the time a child is 3 to 5 years old, the overall impact of a woman's annual income is $5,687. By the time a child is 12 years old or older, the overall impact of a woman's annual income is $14,429. In addition, the annual income gap between men and women widens after they have children. In regression (2) of Table 4, I control for education, region, age at birth, marital status, and income in the two years before the child's birth. In considering the effect of a child's age, I controlled for earnings in the first two years of life to deal with the fact that women who have children probably earn less anyway because they have lower opportunity costs. I added controls for past earnings to eliminate the possibility of reverse causality. When I did, I found that the punishment of motherhood might be a little bit more, but it's still big. So, it seems that the first causality is not driving most of our results. It does seem that having children has a causal effect on parents' income. Controlling for past earnings after taking into account the effect of child age, I found a gender income gap of approximately $-7,956 for men and women who had not had children. But if they have children, there is not only a gender difference, there is an additional difference. If they are between the ages of 6 and 11, the gender income gap between men and women is about $-15,120. I can calculate that the gender gap gets bigger after they have kids but then it stabilizes. The gender income gap is widest between the ages of three and five, and then gets smaller. The gender income gap doesn't disappear as children get older. It's not as big as when a child is 3 to 5 years old, but it's still there and it's not small.

Discussion and Conclusion

This paper analyzes the impact of childbearing on income and how this impact differs between men and women by using the data of all men and women over the age of 22 in NLSY97. In addition, I also quantified the effect of having children on gender earnings differentials.

I analyzed the control variables step by step to find the most accurate results. In the process of analysis, I found many factors that might affect our analysis results, such as the observer's educational background, their area of residence, their age, marital status and so on. Therefore, I conducted further analysis by controlling for these variables that might influence the results. I also suspect that women earn less partly because they may not go out to work, so many observations may have net incomes of zero. If they don't work, they have no income, so their lack of income will also be part of this coefficient. I identified a small percentage of men and women who don't work and earn nothing. In addition, I used current data on all men and women being employed to analyze and exclude those who stopped working because they had children so that even for those still working (by reducing hours or hourly wages), there would be no impact on earnings. Then I found out that people with children might have to take a lower-paying job, or they might have to work fewer hours. Through my analysis, I think that when women have children, they may be reducing their working hours. I also examined the impact of childbearing on men's and women's earnings when marriage was a condition. Meanwhile, based on the above conclusions, I also draw the influence of children's age on yearly income and gender income gap.

The results show that having children affects both men and women, whether they are employed or not, and has a big impact on women's employment rates. When control variables are included, the overall penalty for women to have children is much greater than that for men, and

the gender gap for women to have children is also larger, with a value of approximately -17,303.35 dollars. When they have their first child, women are on average 10 percent less likely to be in employment, while men are on average 0.8 percent less likely to be in employment. This means that women's employment opportunities after having children are more affected than men's. In addition, among childless men and women, women were 1 percent more likely to work than men. Women with children are 8 percent less likely to work than men with children.

Women should be more likely than men to quit over the birth of their first child. According to the statistics, married men's earnings increase after having children, while married women's earnings decrease even more after having children. I can see evidence that having children has a greater impact on married women because they are more likely to stop working. Whether married or not, having children widens the gender income gap. In addition, marriage also widens the gender income gap, regardless of whether or not they have children. As a result, the gender income gap is widest between married men and women with children.

The impact of having a child on a woman's earnings varies from year to year in a child's life. The overall impact of one child on a woman's annual income increases as the child ages. In addition, the annual income gap between men and women widens after they have children. Controlling for past earnings after taking into account the effect of children's age, I found a gender income gap of approximately $-7,956 for men and women without children. This is the value of the basic gender wage gap. I can calculate that the gender gap gets bigger after they have kids but then it stabilizes. The gender income gap is widest between the ages of three and five, and then gets smaller. The gender income gap doesn't disappear as their children get older. It is not as big as when a child is 3 to 5 years old, but it's still there and it's not small. In the future, I will hope to add NLSY79 data set for further analysis. That is to say, I will be able to use women in the NLSY79

cohort and NLSY97 cohort to study the changes in the motherhood penalty in different cohorts. In addition, I think it will be interesting to see whether the impact of a graduate student's second child is different from the impact of having a first child. Based on that, I can also study the impact of a fourth child and a fifth child because I think having more children has a bigger impact on motherhood. At the same time, I could explore whether the more educated a woman is, the bigger or smaller she makes the motherhood penalty. Whether the size of a motherhood penalty depends on the age at which a woman has her first child and so on.

There are some limitations to my research. First, a small proportion of men and women are non-earners recorded in the data, so I can also infer that there are some non-earners who are not recorded in the data. In addition, there may still be some bias in the ignored variables that I don't control. For example, I don't control the observer's class. Different occupations will affect income. A good career for women means they will have a better income. Having good income options tends to make them less likely to have children. Part of the income gap between people with and without children is due to what they do, so I don't control for what people do, which skews the results. In the end, the number of yearly income observers in the data is relatively small, because some observers choose not to know, which may cause deviations in the results.

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