Does it Pay to Delay?

Understanding the Effect of First Birth Timing on Women's Wage Growth*

Jane Leber Herr†
University of California - Berkeley

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Abstract

In this paper I estimate the effect of the timing of a woman's first birth on her wage growth, and explore which economic factors drive this effect. Relying on fertility instruments to address the possible endogeneity of timing, I find that a one-year delay increases women's wage growth over the first 15 years after labor market entry by 3 percent, or up to 5 percent among the college educated. I find that the effect is not only stronger among the more educated, but also more permanent. In assessing the economic means of this return to delay, I find the largest effect through the influence of timing on labor supply, in terms of both hours worked and the length of the longest labor force exit. I similarly find an important effect through the influence of timing on the propensity to accumulate more schooling, and, for the high school educated, on the probability of remaining in the pre-birth job.

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[†] Department of Economics, University of California-Berkeley, 549 Evans Hall #3800, Berkeley, CA 94720-3880.

1 Introduction

The past decades have seen a dramatic increase in the female labor force participation rate, (Goldin, 1990 and 2007, Blau and Kahn, 2005), and with it a rise in women's earnings relative to men's (O'Neill and Polachek, 1993, Blau and Kahn, 2000).[1] This same period has also seen a striking increase in the median age at first birth (Chen and Morgan, 1991). Cross-sectional data show a strong correlation between age at motherhood and wages (Hofferth, 1984), suggesting a possible incentive for delay among a population of women spending more of their adult lives in the labor force.[2] Furthermore, as shown in Figure 1, when I compare across cohorts the median age at first birth (Wilmoth, 2005) with women's earnings relative to men's when the cohort reached age 40, there is a striking correlation in the timing of the two trends. The goal of this paper is therefore to understand how this shift in the timing of first birth may have causally contributed to the rise in women's wages.[3]

Figure 1: Age at First Birth Compared to the Female/Male Earnings Ratio

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[1] Mulligan and Rubinstein (2005) provide an interesting explanation for the pattern of wage convergence, based on the effect of the growth in wage inequality in shifting the composition of working women.

[2] The ability to delay has become possible in large part because of the changes in birth control during this period (Bailey, 2005 and Goldin and Katz, 2000).

[3] Current Population Survey, "Median Usual Weekly Earnings of Full-time Wage and Salary Workers in Current Dollars by Race, Hispanic or Latino Ethnicity, and Sex, 1979-2004 Annual Averages".

In contrast to the existing literature, which defines timing of first birth in terms of age, I pose this question in terms of a woman's career position at the time of her first child, a redefinition that allows me to link this assessment into the wage growth literature (Mincer, 1974). By limiting myself to women who have children after they begin working, I am also focusing on those for whom the arrival of a child creates a discontinuity in the opportunity cost of time.[4] Given my identification strategy – relying on fertility shocks as instruments (Miller, 2005) – I also must limit myself to those women who were married at conception.[5] Thus, in comparison to studies of teenage childbearing (Hotz *et al.*, 1997, Geronimus and Korenman, 1992), I am studying the effect of timing for those women who follow a more traditionally 'middle class' experience: women who finish school, begin working, marry, and have a baby.

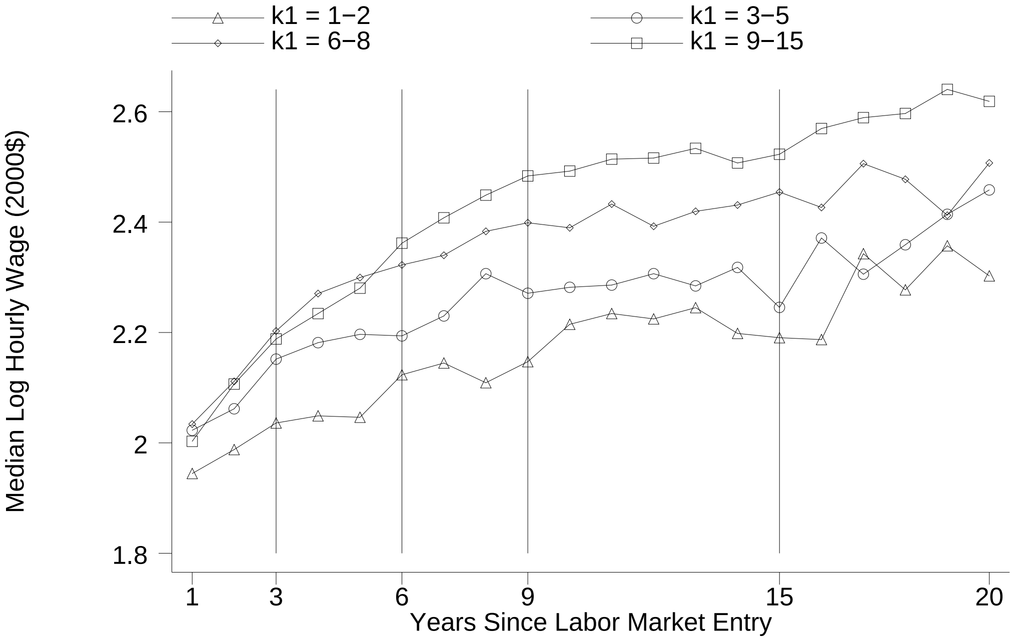

Figure 2: Wage Path by Timing of First Birth

Figure 2 shows the stark relationship between timing of first birth and the experience profile of wages for the subgroup of women in the National Longitudinal Survey of Youth (NLSY) who had their first child after they began working (categorized by the timing of

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[4] This is evident in their labor supply; see also Klerman and Leibowitz (1994) and Barrows (1999).

[5] Notice that this focus on married women may pick up a different average treatment effect simply because the presence of a partner itself may influence how timing affects wage growth.

their first birth, k_1).[6] Consider the wage path for the last three groups. For the first three years, their wages are almost identical. At that point, however, the growth rate stalls for those with their first birth between years 3 and 5. By comparison, the remaining two groups continue to move together, diverging only when the next group begins to have children. Thus we see a systematic pattern not only across wage levels, but also in the path of wages over time. Fitting a simple regression model of the overall growth in wages over the first 15 years after labor market entry, I find that a one-year delay of this transition into motherhood is associated with 3.5 percent greater wage growth, varying from 2.8 percent for the high school educated to 4.7 percent among college graduates.

The coincident timing of the slowing in wage growth and the transition into motherhood suggests that the timing of the first child has an important causal role in the wage path. Yet for most of these women, the arrival of this child is a planned event. In Section 2 I develop a simple model in which women choose their optimal timing by selecting the point where the benefit of one more year of delay is just equal to its cost. As I show below, if the marginal benefit is constant across women, then timing will vary only with the taste for early motherhood, and OLS will provide a consistent estimate of the return to delayed first birth. But if the benefit of delay varies, women with higher returns will systematically have children later, and the OLS estimate will be biased upwards.

To address this possible endogeneity, I follow Miller (2005) in relying on fertility shocks — the incidence of miscarriage and contraceptive failure — to introduce a random element into a woman's observed timing of first birth. I begin by exploring the validity of these instruments, comparing their incidence to the distribution of pre-determined characteristics, such as family background, AFQT scores, and stated tastes for early motherhood. I find that the results vary by the mother's marital status at conception: whereas among unmarried women there is evidence that the incidence of these factors is non-random, for married women they are valid instruments. Furthermore, when interacted with the age at which they occur,

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[6] If I include women who never had children and those who had their first before working, the wages of the former roughly follow those of women with first births in year 6 or later, and the wages of the latter match almost exactly those with their first birth in years 1 or 2.

they provide great statistical power in influencing the timing of a woman's first child.

Focusing on the subset of married mothers, when I use these fertility shocks to instrument for the timing of first birth, I find that the IV estimates are surprisingly similar to their OLS counterparts. Additionally, even though the precision of the estimates falls, the coefficient for the sample as a whole and that for the college educated remain strongly significantly different from zero.[7] Thus the first key result of this paper is that the relationship observed in Figure 2 reflects a causal effect of the timing of first birth on women's wage growth.

Given this result, I next consider *how* timing affects wages.[8] A complication when posing this question is that it lacks the obvious link between cause and assumed effect that exists for more common economic questions, such as the effect of a training program on employment rates. Yet to get at this question, I can consider how timing may affect various economic factors that theory suggests are important in explaining wage growth. I do this first by considering whether delay affects these economic factors. I then include each as additional controls in the wage equation, and estimate their relative importance based on the size of these first- and second-stage coefficients.[9]

In particular, I consider five possible channels through which delayed childbirth may influence wages, reflecting elements of either the human capital (Becker, 1962) or job search (Pissarides, 1976) models of wage growth: (1) total labor supply, (2) labor force exits, (3) additional schooling, (4) remaining in the pre-birth job, and (5) job mobility. (I also consider how much of the effect may arise through the influence of timing on family structure.) Overall, I find that these economic factors can explain only half of the return to delay, or 57 percent for those women who entered the labor force with a high school diploma, 85 percent for those with some college, and only 31 percent for those with at least a college degree.

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[7] The coefficient for the high school educated has a t-statistic of 1.5, almost significant at traditional levels.

[8] Although the existing literature on timing touches on this by comparing the return to delay with and without including various intermediate factors, such as labor supply, there has been little systematic study of the mechanism of this effect. (For another recent look at this question, see Buckles, 2007.)

[9] I begin Section 6 with a simple example to explain the math of this decomposition.

In estimating their relative importance, I find the strongest effect through the influence of timing on labor supply, both in terms of hours worked, and with respect to the longest labor force exit. For the high school and college educated, I find that the effect of the latter is almost twice as large as the former, suggesting the importance of delay on minimizing the length of time spent out of the labor force, and the subsequent depreciation of human capital. I also find a strong effect of timing through its influence on the propensity to get more schooling, and for the high school educated I find a strong effect through the increased probability of remaining in the pre-birth job.

Lastly I consider the permanence of these results. A limitation of using the NLSY is that I cannot observe these women through the end of their careers. If the overall effect is independent of timing, but evolves gradually, then by measuring the relationship at 15 years I may be observing a correlation that no longer holds by career end. To test this, I estimate the return at the 20th year, when the youngest children of most have entered school, and the largest costs of children may therefore have passed. I find that the result varies by education, with the return to delay falling by over 30 percent for high school women, compared to only 13 percent for the college educated. Thus, the effect of timing on wage growth appears more permanent among the more educated.

The remainder of this paper is structured as follows. In Section 2 I introduce a simple model of an optimizing woman's choice of the timing of her first child, and discuss how the literature addresses this inherent endogeneity problem. In Section 3 I then introduce my sample. In Section 4 I discuss my identification strategy, and the corresponding estimates of the return to delayed first birth. Given that these results suggest a causal relationship, in Section 5 I discuss the economic factors that may indirectly drive this effect, followed in Section 6 with estimates of the effect of timing on each, and their corresponding importance in the overall return to delay. In Section 7 I end with an assessment of the permanence of these effects, and in Section 8 I conclude.

2 Addressing the Endogeneity of Timing of First Birth

A problem facing any study of the effect of first birth timing on women's wages is that timing is non-random and thus potentially endogenous.[10] A particular concern is that if the return varies across the population, then observed timing will be correlated with a given woman's marginal benefit of delay. Below I begin by developing a simple model of the endogeneity problem associated with this question, and then discuss the approaches taken in the literature to address this and the other econometric complications inherent in estimating the return to the delay of first birth.

2.1 The Effect of Endogeneity on Estimates of the Return to Delay

To think through the implications of this potential relationship between observed timing and the marginal benefit of delay, consider the following simplified model of a woman's wage path:

$$\begin{aligned} w_t &= w_0 e^{g_1 t} && \forall\ t \leq k_1, \quad \text{and} \\ w_t &= w_0 e^{g_1 k_1} e^{g_2 (t-k_1)} && \forall\ t > k_1, \end{aligned} \tag{1}$$

with $g_1 > g_2$.[11] Thus for a given woman, wage growth from labor market entry to some point $t > k_1$ will be the linear function

$$d_i = log(w_{ti}) - log(w_{0i}) = (g_{1i} - g_{2i})k_{1i} + g_{2i}t. \tag{2}$$

(Although this reflects a very simplified model of women's wages, notice that we see almost such a piece-wise linear pattern in Figure 2.) When I calculate the return to delay in Section 4.2, I will be estimating Equation 2 using as my dependent variable wage growth from labor market entry until 15 years later, $d_{15i} = log(w_{15i}) - log(w_{0i})$.

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[10] Heckman and Walker (1990) use Swedish data to study the effect of current female wage rates on the hazard of movement from parity $j-1$ to parity j. They find large negative effects, strongest for the first birth. (See also Perry, 2003).

[11] For a structural approach to women's timing decisions, see, for instance, Happel *et al.* (1984) and Mullin and Wang (2002); the latter finds the same result, discussed below, that timing rises with the productivity loss from kids. (See Arroyo and Zhang, 1997, and Gustafsson, 2001, for reviews of this literature.) For broader models of women's fertility and labor supply decisions, see, for instance, Moffitt (1984), Rosenzweig and Schultz (1985), Hotz and Miller (1988), Newman (1988), Eckstein and Wolpin (1989), and more recently Altug and Miller (1998), Francesconi (2002), and Gayle and Miller (2003).

From Equation 2 we see that the benefit of delay is driven by the change in wage growth at k_1, $dg_i \equiv (g_{1i} - g_{2i})$. Suppose we then wish to measure the population mean return to delay, $\overline{dg}$. If I rearrange Equation 2,

$$d_i = \overline{dg}k_{1i} + \overline{g_2}t + (dg_i - \overline{dg})k_{1i} + (g_{2i} - \overline{g_2})t + \varepsilon_i, \tag{3}$$

we see that the least squares estimate of the mean return will be biased if k_{1i} is correlated with any of the last three terms.

To see that timing will be endogenous to the change in wage growth at first birth, suppose women choose their optimal timing, k^*_{1i}, to maximize the following utility function, $U = log(y) - c(k_1)$, where earnings are a function of timing, $y = g(k_1)$, and the cost of delay, $c(k_1)$, will vary across women with their taste for early motherhood. (See the math appendix for a discussion of including husbands in this optimization problem.) For a very simplified model of $g(k_1)$, I show in the math appendix that the linear approximation of the marginal benefit of delay, $g'(k_1)/g(k_1)$, has the form

$$MB(k_1) = (g_{1i} - g_{2i}) - m_{1i}k_{1i}, \tag{4}$$

where

$$m_{1i} = \frac{(g_{1i} - g_{2i})(g_{2i} - r)}{e^{(g_{2i}-r)T} - 1} > 0.$$

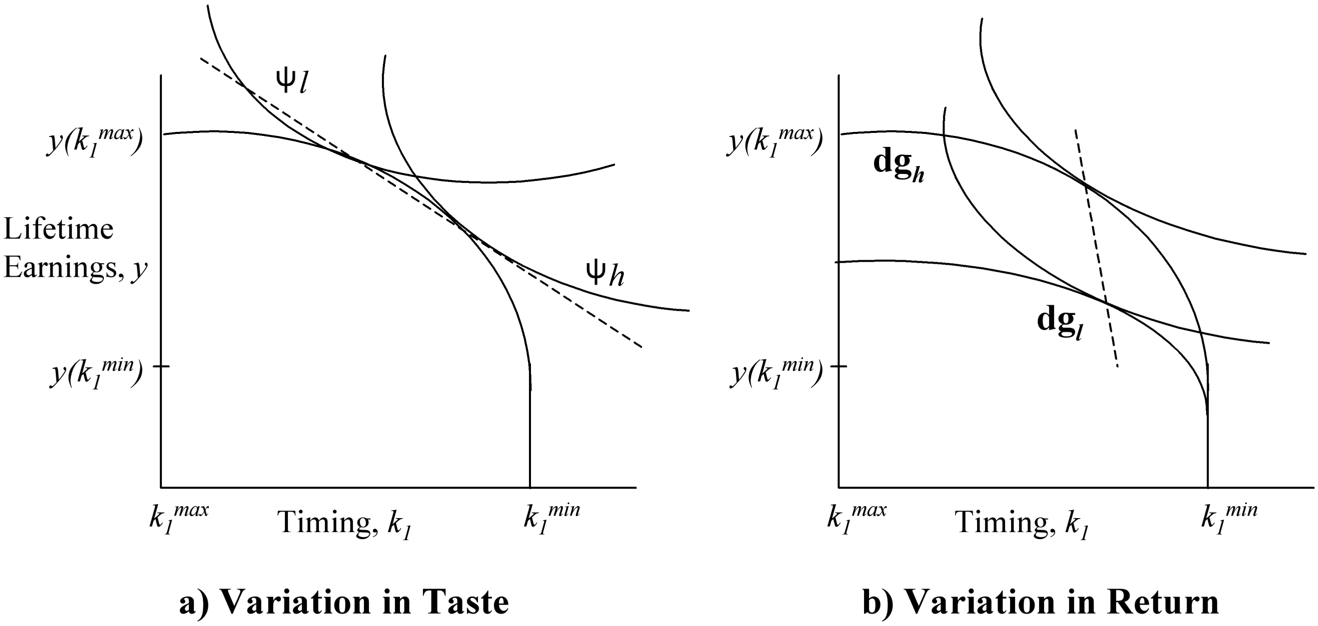
If we similarly assume a linear form of the marginal cost function,

$$MC(k_1) = c'(k_1) = \psi_i + m_2 k_{1i}, \quad m_2 > 0, \tag{5}$$

an optimizing woman will choose k^*_{1i} by setting the two equal:

$$k^*_{1i} = \frac{(g_{1i} - g_{2i}) - \psi_i}{m_{1i} + m_2}. \tag{6}$$

Thus it is clear from Equation 6 that k^*_{1i} will be increasing in $dg_i = (g_{1i} - g_{2i})$, and thus correlated with the third term in Equation 3, creating upward bias in the OLS estimate of $\overline{dg}$.[12,13]



a) Variation in Taste **b) Variation in Return**

Figure 3: Optimal Timing Given Variation in Taste vs. Return

Consider these results in light of Figure 3.[14] On the left-hand side there is no variation in the production function, $\overline{dg} = dg_i$ for all i, and women vary only in their taste for early motherhood. If this condition holds, then $(dg_i - \overline{dg}) = 0$ for all, and the OLS coefficient – reflected by the dashed line – will provide a valid estimate of the mean return to delay (the slope of the production function).[15] By comparison, on the right-hand side women vary only in their production function and not with respect to taste. In this case there is a strong positive bias, with the OLS coefficient overestimating the marginal benefit of delay for either the low- or high-return women.[16]

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[12] Although $(g_{1i} - g_{2i})$ appears in both the numerator and denominator of k_{1i}^*, for reasonable values of g_{2i}, r and T, the remainder of the expression for m_{1i} approaches 0, thus the term in the numerator dominates.

[13] It is unclear what bias may be created by the fourth term, $(g_{2i} - \overline{g_2})t$. If women in high-earning careers (reflected in both g_{1i} and g_{2i}) also face a greater drop in wage growth at k_1, then the correlation of g_{2i} and $(g_{1i} - g_{2i})$ will lead to even further upward bias in the OLS estimate, with the bias increasing in t.

[14] To plot timing as a "good", the x-axis runs from later (k_1^{max}) to earlier (k_1^{min}), first birth timing. See Buckles (2005) for an interesting discussion of the effect of loosening the fertility constraint (k_1^{max}) through infertility treatment.

[15] This assumes for the moment that $Corr(dg_i, g_{2i}) = 0$.

[16] Notice that on the left, women with early children are those with a high marginal cost of delay, and hence a high marginal benefit at k_1^*, whereas the opposite holds on the right.

2.2 Existing Methods for Addressing the Endogeneity of Timing

The literature on the return to delayed first birth has approached this endogeneity problem, as well as issues such as unobserved heterogeneity, in several ways.[17] Chandler *et al.* (1994) begin by providing simple OLS estimates of the relationship between age at first birth and wage level, finding that a one-year delay is associated with 2.1 percent greater wage growth among married women working full-time.[18] Drolet (2002) takes a similar approach using Canadian data, finding that among women born after 1960, those who delay have wages 13 and 4 percent higher than those with early and on-time first births, respectively.[19]

A second approach has been to use fixed effects to address unobserved heterogeneity. For instance, Taniguchi (1999) uses the NLS young women's cohort to calculate fixed-effect estimates of the size of the motherhood wage gap by age at first birth. In comparison to women with no kids, she finds that those with first births at age 28 or beyond face no wage penalty, compared to a 4 percent effect for those with their first birth between ages 20 and 27.[20] Similarly, Ammuedo-Dorantes and Kimmel (2005) use the NLSY to focus on the college educated, categorizing 'late' mothers as those who delay beyond age 30. Like Taniguchi, they find that late mothers have higher wages: 13 percent among the college educated and 7 percent among the sample as a whole.[21]

Ellwood *et al.* (2004) also use the NLSY to look at the pattern of mothers' wage trajectories before and after first birth, using AFQT scores to focus on 'high' versus 'low' skill women.[22] Just as I find in Figure 2, their results show a clear divergence of wages after

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[17] This literature has grown out of research on the "motherhood wage gap", the wage difference observed between women with and without kids. For US data see, for instance, Waldfogel (1998a), Anderson *et al.* (2002), and Simonsen and Skipper (2006); for an international comparison see Waldfogel (1998b), Harkness and Waldfogel (1999) and Joshi *et al.* (1999). (For a detailed discussion of the econometric problems inherent in estimating the effect of children on women's wages, see Neumark and Korenman, 1992.)

[18] In addition they try a two-stage least squares approach, relying on religious attendance and number of siblings for identification. The authors do not report these results, except to say that they are comparable.

[19] She defines an early or late first birth as those observed at least 2 years before or after predicted. Also, as in several studies that follow, because these results control for factors endogenous to timing (such as work experience), they do not reflect the *full* return to delay.

[20] See Ellwood *et al.* (2004) for a critique of using non-mothers as the relevant comparison group.

[21] The authors also instrument for the probability of being a late mother using family background characteristics, but by their admission this approach gives improbably large estimates of the return to delay.

[22] The authors discuss a search for valid instruments, rejecting those used here because of their possible

first birth. Using a fixed effects approach, the authors find that the wage gap broadens with time, from a 9 percent effect four years after first birth to a 22 percent difference after ten years (a larger 10 to 30 percent among the high skilled). Lastly, Miller (2005) combines the use of miscarriages (Hotz *et al.*, 1996, Hotz *et al.*, 1997) and other fertility shocks to estimate the effect of delay on women's earnings, labor supply, and wages. Again using the NLSY, she finds that a one-year delay leads to 10 percent higher earnings and 2.6 percent greater wage growth by age 34.

3 Data

As others have done before me, I use the NLSY to consider this question of the effect of first birth timing on women's wage growth. The data appendix provides a detailed discussion of how I define the variables introduced below and my sample selection criteria (exploring whether the latter provide a non-representative sample).[23] What follows is an overview of this information.

The NLSY began in 1979 with a sample of 6,283 14- to 22-year old women, who by 2004 had reached the age of 40 to 47. Of the sample observed until age 40 (approximately beyond the childbearing years), I focus on the 2,133 women who had their first child after they entered the labor market (72 percent of the weighted sample of mothers). Because my dependent variables measure wage growth from career start (t_1) to approximately 15 and 20 years later (Yr_{15} and Yr_{20}), I also limit myself to the women with observed data for all three measures.[24] These criteria provide a starting sample of 1,402 mothers, of whom 912, or 73 percent (weighted), were married when they conceived their first child. Figure 4 plots the distribution of first birth timing for this latter group.

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endogeneity and their low incidence (providing little statistical power). The first result matches my findings among those unmarried (they do not consider this by marital status), and as I show in Table 5, the power of these shocks rises dramatically when I interact them with the age at which they occurred.

[23] Because I require an observed post-birth wage approximately 15 years into a woman's career, later mothers have fewer years to return to work in time to be observed. I therefore capture a smaller, negatively selected, proportion of later mothers, which may bias my OLS results towards zero.

[24] I define Yr_{15} as any point between career years 13 and 17 for which I observe a wage, and Yr_{20} as any year between 18 and 22. I also exclude the 70 women who had their first birth after Yr_{15} so that I can compare the return at Yr_{15} and Yr_{20} for the same set of women.

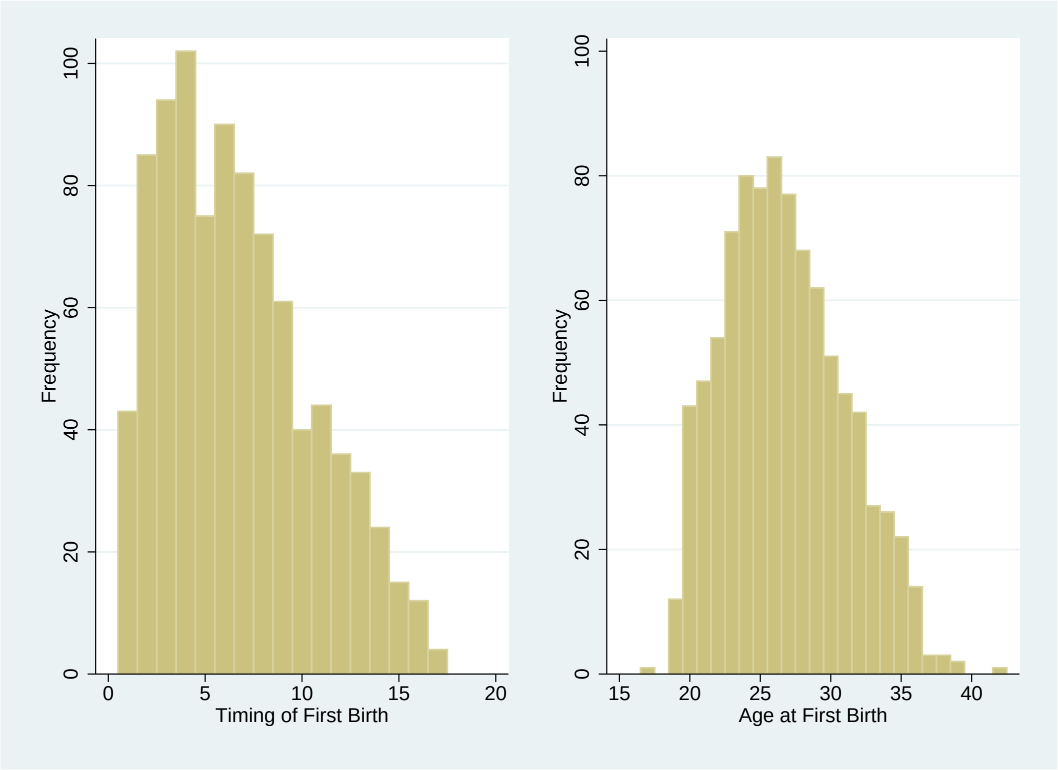

Figure 4: Distribution of Timing of First Birth

Tables 1 and 2 list summary statistics for this primary sample of 912 mothers, the former by timing of first birth and the latter by education at labor market entry. In each, the first panel lists the dependent variables and their components, the second lists the variables I explore as potential intermediaries in the effect of timing on wage growth, and the third lists background characteristics. (Since I estimate the effects separately by schooling level, I provide summary statistics by education as well as by timing.)

Table 1: **Summary Statistics by Timing of First Birth**

	All	**By Fertility Timing (k_1)**			
		$1-2$	$3-5$	$6-8$	$9-Yr_{15}$
Dependent Variable:					
Wage growth by Yr_{15}	0.41	0.23	0.31	0.40	0.60
Wage growth by Yr_{20}	0.50	0.33	0.44	0.47	0.66
Starting wage (2000$)	8.51	8.42	8.65	8.65	8.31
Yr_{15} wage (2000$)	13.97	11.04	12.78	13.95	16.59
Yr_{20} wage (2000$)	15.27	12.26	14.74	14.57	17.88
Wage Growth Intermediaries (by Yr_{15}):					
Total hours worked (x1000)	24.65	22.26	22.15	24.35	28.57
Labor force gap at k_1 (mos)[1]	11.6	11.7	17.0	12.6	5.1
Change in hours per week at k_1^2	4.3	2.2	5.4	5.1	3.5
Total labor force exits (excluding at k_1)[3]	1.7	2.1	1.8	1.6	1.4
Longest labor force exit (mos)[3]	19.7	24.4	27.5	19.2	10.0
Full-time schooling beyond t_1 (yrs)	0.23	0.08	0.20	0.23	0.33
Part-time schooling beyond t_1 (yrs)	0.42	0.22	0.30	0.43	0.62
Remain in pre-birth job at k_1	0.67	0.57	0.55	0.67	0.83
Total job changes (non-family)[3]	2.8	2.3	2.5	2.8	3.4
Worked in professional job at k_1	0.33	0.17	0.29	0.33	0.45
Ever changed jobs for family reasons[3]	0.07	0.13	0.05	0.09	0.05
Family Characteristics:					
Age at first birth	26.7	21.8	24.1	26.8	31.7
Husband's earnings at k_1 (2000$, x1000)	36.0	24.3	30.4	37.7	45.6
Total children (by last year observed)	2.15	2.51	2.38	2.05	1.84
Family structure at Yr_{15}:					
Total children	2.00	2.45	2.26	1.98	1.55
Age of youngest child	5.4	8.3	7.1	5.3	2.5
Married	0.83	0.73	0.75	0.84	0.93
Own age	35.4	35.5	35.5	35.2	35.5
Background:					
Race:					
White	0.70	0.63	0.67	0.72	0.73
Black	0.13	0.17	0.15	0.10	0.12
Hispanic	0.17	0.20	0.18	0.18	0.14
Mother's education (years)	11.3	10.8	11.1	11.1	11.8
Mother worked (when 14)	0.63	0.63	0.61	0.63	0.67
AFQT score (age-adjusted)	10.4	2.8	8.7	11.7	14.7

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Table 1 – Continued

	All	**By Fertility Timing (k_1)**			
		$1-2$	$3-5$	$6-8$	$9-Yr_{15}$
Highest grade expected (in 1979)	14.4	14.0	14.3	14.3	14.6
Total education at t_1 (years):	13.4	12.9	13.4	13.4	13.6
Less than 12 years	0.06	0.12	0.06	0.05	0.03
12 years	0.45	0.47	0.46	0.45	0.42
13-15 years	0.23	0.23	0.20	0.22	0.26
16+ years	0.26	0.18	0.27	0.27	0.29
Sample Size:	**912**	**128**	**271**	**244**	**269**
Percent of Total Sample:		14.0%	29.7%	26.8%	29.5%

NOTES:

1. Defined as total weeks with 0 reported work hours in the period flanking first birth. **2.** Change in weekly hours comparing the 52 weeks worked before k_1 and the 52 weeks after returning to work. **3.** I define any movement from one job to another with 4 or fewer weeks out of the labor force inbetween as a job change; all with a gap greater than 4 weeks are defined as a labor force exit.

In the first panel of Table 1 we see the same result evident in Figure 2: women with later first births have distinctly greater wage growth. In the second panel, we see that the pattern of labor force participation also varies systematically by timing. For instance, those with later children worked more over this 15-year stretch, and changed jobs more frequently. Thus if timing has a causal effect on wage growth, that effect may arise through its influence on these factors.

Table 2: **Summary Statistics by Education**

	Education at Labor Market Entry (t_1)			
	< 12 years	**12 years**	**13-15 years**	**16+ years**
Dependent Variable:				
Wage Growth to Yr_{15}	0.26	0.34	0.42	0.54
Wage Growth to Yr_{20}	0.40	0.45	0.53	0.58
Starting wage (2000$)	7.14	7.39	8.26	10.94
Yr_{15} wage (2000$)	9.48	11.13	13.51	20.19
Yr_{15} wage (2000$)	11.09	12.59	15.34	20.69
Wage Growth Intermediaries (by Yr_{15}):				
Total hours worked (x1000)	19.62	23.25	25.12	27.73
Labor force gap at k_1 (mos)[1]	18.9	14.9	9.4	6.3

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Table 2 – Continued

	Education at Labor Market Entry (t_1)			
	$<$ 12 years	**12 years**	**13-15 years**	**16+ years**
Change in hours per week at k_1^2	0.1	4.3	4.7	5.0
Total labor force exits (excluding at k_1)^3	3.0	1.9	1.4	1.2
Longest labor force exit (mos)^3	32.6	23.2	18.8	11.6
Full-time schooling beyond t_1 (yrs)	0.19	0.19	0.23	0.31
Part-time schooling beyond t_1 (yrs)	0.04	0.33	0.52	0.56
Remain in pre-birth job at k_1	0.55	0.57	0.73	0.81
Total job changes (non-family)^3	3.0	2.8	2.8	2.6
Worked in professional job at k_1	0.13	0.16	0.28	0.71
Ever changed jobs for family reasons^3	0.21	0.05	0.06	0.08
Family Characteristics:				
Age at first birth	23.1	25.3	27.4	29.4
Husband's earnings at k_1 (2000$, x1000)	22.0	29.2	37.3	49.5
Total children (by last year observed)	2.25	2.19	2.15	2.06
Family structure at Yr_{15}:				
Total children	1.98	2.01	2.00	2.00
Age of youngest child	6.2	5.4	5.1	5.6
Married	0.62	0.80	0.84	0.90
Own age	32.9	34.1	35.8	38.1
Background:				
Race:				
White	0.47	0.72	0.60	0.79
Black	0.06	0.12	0.20	0.12
Hispanic	0.47	0.16	0.21	0.10
Mother's education (years)	8.4	10.6	11.6	12.8
Mother worked (when 14)	0.57	0.61	0.68	0.66
AFQT score (age-adjusted)	-16.8	-0.5	12.7	32.6
Highest grade expected (in 1979)	12.2	13.2	15.1	16.1
Total education at t_1 (years):	9.9	12.0	13.8	16.2
Sample Size:	**53**	**410**	**208**	**241**
Percent of Total Sample:	5.8%	45.0%	22.8%	26.4%

NOTES: See notes to Table 1.

Next consider Table 3, which compares fertility outcomes to expectations for this sample of mothers. We see immediately that the majority of women poorly anticipated when they would have their first child.[25] Whether measured at labor market entry or 2 years

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[25] Quesnel-Vallee and Morgan (2003) discuss the correlation between fertility intentions and outcomes.

before first birth, only 40 percent correctly predicted the timing of their first child, the latter ranging from 30 to 50 percent by either timing or education. A third measure of the uncertainty of fertility timing is to consider the proportion of women who wanted to become pregnant when they conceived. Even among this sample of married women, 13 percent did not, with this proportion almost equal across education levels. These data therefore suggest that for many women there were unanticipated elements in the timing of their first child.

Table 3: **Fertility Expectations vs. Outcomes**

BY TIMING OF FIRST BIRTH, k_1

	All	**By Fertility Timing (k_1)**			
		$1-2$	$3-5$	$6-8$	$9-Yr_{15}$
Predicted timing of first birth	5.1	3.5	4.5	5.6	5.9
Observed timing of first birth	6.7	1.7	3.9	6.9	11.6
Correctly predicted k_1 (±1 yr)	0.40	0.57	0.65	0.45	0.06
Predicted timing 2 yrs before k_1	2.5	3.6	2.8	2.4	1.8
Correctly predicted 2 yrs before	0.39	0.26	0.32	0.45	0.48
First child not wanted then/ever:	0.13	0.21	0.19	0.09	0.06
Total children expected at t_1	2.38	2.43	2.40	2.37	2.35
Total children (by last observed)	2.15	2.51	2.38	2.05	1.84
Correctly predicted total	0.40	0.48	0.41	0.41	0.35
Sample Size:	**912**	**128**	**271**	**244**	**269**

BY EDUCATION AT LABOR MARKET ENTRY

	Education at Labor Market Entry (t_1)			
	< 12 years	**12 years**	**13-15 years**	**16+ years**
Predicted timing of first birth	4.7	5.4	5.1	4.9
Observed timing of first birth	5.3	6.6	7.0	6.9
Correctly predicted k_1 (±1 yr)	0.55	0.39	0.37	0.41
Predicted years 2 yrs before k_1	2.7	2.8	2.3	2.2
Correctly predicted 2 yrs before	0.31	0.35	0.41	0.47
First child not wanted then/ever:	0.13	0.16	0.10	0.10
Total children expected at t_1	2.27	2.30	2.56	2.39
Total children (by last observed)	2.25	2.19	2.15	2.06
Correctly predicted total	0.37	0.37	0.37	0.48
Sample Size:	**53**	**410**	**208**	**241**

Yet returning to the last panel of Table 1, a comparison of background characteristics shows that despite this uncertainty, women still vary systematically by the timing of their first child. For instance, those with later children have more educated mothers, are themselves more educated, and received higher scores on the AFQT.[26] These systematic differences

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[26] Surprisingly, this does not translate to starting wages, where the average is *lowest* for the latest group.

therefore suggest that a simple least squares estimate of the relationship between timing and wage growth may not reflect the causal effect of the former on the latter.

4 Identifying the Effect of First Birth Timing on Wage Growth

4.1 Using Fertility Shocks as Instruments for First Birth Timing

Because of the possible endogeneity of the timing of first birth, I follow Miller (2005) in estimating its effect on wage growth by relying on naturally-occurring fertility shocks as instruments.[27] Using the incidence of miscarriage and contraceptive failure, I can capture the effect of timing on wage growth using only that element of timing beyond a woman's control.

One must ask, however, whether these factors are truly random. Contraceptive failure may be correlated with the cost of an unintended pregnancy, and miscarriages may be misreported abortions. To test this, I explore in Table 4 the correlation between these factors and women's observable characteristics, such as family background, education and ability, and fertility preferences.[28] As this shows, for women married at conception, neither the incidence of miscarriage nor contraceptive failure is correlated with any of these background factors, even including religion and taste for early motherhood.[29] Remember that a strength of the NLSY is the richness of the information available. If the incidence of these fertility outcomes were *not* randomly distributed among these women, this should be evident by the comparisons shown here.

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[27] Miller also uses a third instrument, time to pregnancy, in her identification strategy. I exclude this factor because, although in theory a valid instrument, the NLSY data are not well suited to capture this information. (See Ellwood *et al.*, 2004, for a discussion of the econometric problem of using an instrument that algebraically reduces to age at first birth minus age at first unprotected intercourse, as an instrument for age at first birth.)

[28] For the married mothers I include only those miscarriages that occurred within marriage; a slightly higher 12.5 percent ever miscarry before their first birth. This exclusion has no effect on the results shown in Table 4.

[29] At the bottom of the first panel this result is supported by the test of joint significance of the full set of background characteristics in predicting these instruments. Excepting the last column, observable background factors have no power in predicting the incidence of these instruments among those who were married when they conceived their first child. (Because of its significance, I include the control for missing data in both the first- and second-stage of the IV specifications, although this has no effect on the coefficients.)

Table 4: **Correlations Between Fertility Instruments and Background Characteristics**

	Miscarriage Before First Birth	Miscarriage x Age at Miscarriage	Pregnant While Contracepting	Contraceptive Failure x Age At Pregnancy	Contraception Data Missing
MARRIED AT PREGNANCY LEADING TO FIRST BIRTH (N=912)					
Summary Statistics:					
Mean	10.4%	25.8	9.7%	25.6	7.0%
Median (25th - 75th percentile)		26.2 (21.6-28.9)		24.6 (21.9-28.4)	
Correlations with Background Characteristics:					
White	0.01	0.02	0.00	0.00	-0.03
Catholic	-0.03	-0.03	0.00	0.01	0.01
Mother's education	0.03	0.04	0.07	0.08	-0.04
Mother worked when 14	0.00	0.00	0.00	0.00	-0.07
AFQT score (age-adjusted)	0.03	0.05	0.04	0.05	-0.02
Highest grade expected (in 1979)	0.03	0.05	0.00	0.01	-0.02
Predicted timing of first birth (at t_1)	-0.02	0.01	0.00	0.01	-0.07
Education at labor market entry	0.05	0.08	0.01	0.03	-0.05
F-test of joint significance[1]:	0.73	0.79	0.64	0.52	0.11[2]
UNMARRIED AT PREGNANCY LEADING TO FIRST BIRTH (N=490)					
Summary Statistics:					
Mean	10.7%	21.8	22.8%	25.4	8.6%
Median (25th - 75th percentile)		20.8 (19.1-24.0)		24.5 (21.6-28.3)	
Correlations with Background Characteristics:					
White	0.02	0.01	0.04	0.03	0.05
Catholic	-0.05	-0.05	-0.05	-0.05	0.02
Mother's education	-0.06	-0.04	0.12	0.11	0.02
Mother worked when 14	-0.04	-0.01	0.04	0.03	-0.04
AFQT score (age-adjusted)	0.01	0.02	0.18	0.15	0.02
Highest grade expected (in 1979)	-0.02	-0.01	0.18	0.17	-0.02
Predicted timing of first birth (at t_1)	-0.07	-0.06	0.09	0.09	0.02
Education at labor market entry	-0.14	-0.12	0.20	0.22	0.02
F-test of joint significance[1]:	0.01**	0.03*	0.09$^+$	0.04*	0.24[2]

NOTES: (Significance: ** at 1 percent, * at 5 percent, $^+$ at 10 percent)

1. These reflect the p-values of the joint significance of a regression of each instrument on background characteristics, religion, AFQT, expected highest grade, education at t_1, fertility expectations, and controls for t_1 and local conditions at that time (region, SMSA status, and local unemployment rate).

2. This value reflects the joint significance of all controls when I exclude the dummy for missing AFQT score. Because the AFQT was given in 1981, and the first wave of fertility data was collected in 1982-83, there is a moderate correlation of missing values for these two. The significance when I include this control is 0.04 and 0.23 for these two groups, respectively.

The same result does not hold for the second group. Among those unmarried, background characteristics can significantly predict the incidence of both miscarriages and contraceptive failure. For instance, I now find strong correlations with education and ability, and with predicted timing of first birth.[30] Thus it is clear that these fertility shocks are only valid instruments among those women who were married when they conceived their first child.

Table 5: First-Stage Relationship of Timing of First Birth and Fertility Instruments

Y = **Timing of first birth (k_1)**	**All Instruments** coefficient (s.e.)	**Excluding Age Interactions** coefficient (s.e.)
Miscarriage before first birth	-11.47**	1.30**
	(1.94)	(0.37)
Age at miscarriage x Miscarriage	0.49**	-
	(0.07)	
Miscarriage data missing	2.36	2.47
	(1.64)	(1.74)
Became pregnant while contracepting	-15.62**	-0.43
	(2.04)	(0.40)
Age at pregnancy x Pregnant while contracepting	0.60**	-
	(0.08)	
Contraception data missing	-1.12*	-1.09*
	(0.45)	(0.47)
F-Statistic of joint significance:	**21.1****	**4.9****
Sample Size:	912	912

NOTES: $^+$ = significant at 10%; * = significant at 5%; ** = significant at 1%

I next consider the strength of this relationship by estimating the first-stage effect of these fertility instruments on timing of first birth, both with and without interacting with the age at which the shocks occurred. (A comparison of the two columns of Table 5 shows the importance of the age interactions.) Applying the coefficients in column 1 to the distribution of age at miscarriage and contraceptive failure reported at the top of Table 4, we see that at the median age for miscarriages, 26.2, these coefficients translate into a delay of 16 months, compared to 2.7 years at the 75th percentile, 28.9. Similarly, for contraceptive failure, at the median this reflects an acceleration of only 10 months, but at the 25th percentile an effect

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[30] The positive correlation between contraceptive failure and education likely stems from the propensity to contracept.

of 2.5 years.

4.2 OLS Versus IV Estimates of the Effect of k_1 on Wage Growth

Given this identification strategy, Table 6 compares the OLS and IV estimates of the effect of a one-year delay of first birth on women's wage growth from labor market entry to Yr_{15}.[31] The first two columns compare the OLS estimates for the full sample of mothers to those who were married at conception. We see that across education groups, the effect is larger for the latter: a one-year delay is associated with 3.5 percent greater wage growth overall, ranging from 2.8 percent for the high school educated to 4.7 percent for college graduates.[32]

Table 6: **IV vs. OLS Estimates of the Effect of First Birth Timing**

	All	**Married at Pregnancy**	
$Y_{15} = \log(Wage_{15}) - \log(Wage_{start})$	OLS coefficient (s.e.)	OLS coefficient (s.e.)	IV coefficient (s.e.)
Timing of First Birth (k_1)	0.027**	0.035**	0.029*
	(0.004)	(0.005)	(0.015)
Sargan statistic of overidentification (p-value):	-	-	0.36
By Education at Labor Market Entry:			
Exactly 12 years	0.021**	0.028**	0.033
	(0.006)	(0.007)	(0.022)
13 to 15 years	0.030**	0.038**	0.016
	(0.007)	(0.010)	(0.022)
16 or more years	0.039**	0.047**	0.048*
	(0.009)	(0.010)	(0.021)
Sargan statistic of overidentification (p-value):	-	-	0.17
Sample Size:	**1,402**	**912**	**912**

NOTES: ($^+$ = significant at 10%; * = significant at 5%; ** = significant at 1%)

Controls: background (race, religion, parents' education and occupation, and family situation at age 14), fertility expectations at t_1 (predicted timing of first birth, number of children expected, and a summary measure of gender/family attitudes, the last as reported in 1979), highest grade expected, age-adjusted AFQT score, education at t_1, early occupation, local characteristics at t_1 and Yr_{15}, and controls for the calendar and career year of Yr_{15}.

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[31] The results by education reflect the coefficients on k_1 interacted with education dummies.

[32] As a percentage of total wage growth over this 15 years, this reflects a surprisingly even 8.2, 9.0, and 8.7 percent by education level. For comparison, also using the NLSY, Miller (2005) finds a return of 3.7% (at age 34) and Buckles (2007) finds a return of 3.1% by 2004 (both via OLS). Because neither limits her sample to those married at conception, these are a better comparison for the full-sample results listed in Table 6.

Notice that these results reflect the OLS coefficients on k_1 when I control for a full set of background variables (listed at the foot of Table 6). Yet if I run these specifications uncontrolled, the estimated coefficients are largely unchanged. This holds, despite the fact that these controls include measures, such as education and AFQT score, likely to be correlated with unobserved motivation. The fact that their inclusion leaves unaffected the measured relationship between timing and wage growth is a suggestion of a true causal effect.[33]

For those married at pregnancy, the third column of Table 6 reports the estimated return to delay when I instrument for timing using the fertility shocks discussed above. Surprisingly, the coefficients are very resilient. Whereas the possible endogeneity of timing suggests that the OLS coefficients would be biased upwards, for the high school and college educated I find instead that the IV estimates are *larger* (although not significantly so). Furthermore, the power of my instruments provides sufficient precision that I can reject that the relationship is equal to zero. Instead, I find that the overall return to a one-year delay is 2.9 percent greater wage growth, with 3.3 percent for the high school educated and 4.8 percent for college graduates.[34]

Consider this result in light of the pattern of wage growth evident in Figure 2. Looking closely at the wages for the last three groups, we can see that their pre- and post-birth growth rates (g_1 and g_2) are almost equal. The rate of growth before first birth is almost a single straight line, and the wage trajectories afterwards are almost parallel. (To test the former, if I regress wage growth through year 5 on timing of first birth using only those with $k_1 > 5$, I find absolutely no relationship between wage growth thus far and the subsequent timing of the first child.[35]) Thus if, as discussed in Section 2, g_{1i} and g_{2i} are equal across women, then, as predicted, least squares will provide a consistent estimate of the mean marginal benefit of delay.

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[33] This robustness of the OLS coefficients also suggests that the slight negative sample selection discussed in the data appendix does not influence the estimated return to delay.

[34] When I separately instrument using just the miscarriage or contraception shocks, the former gives an IV coefficient of 0.023 (s.e.=0.021) and the latter 0.034 (0.020). In light of Figure 3, it is unsurprising that the estimate is larger when calculated for those with a contraceptive failure, since this moves observed timing to an earlier (steeper) stretch of the production function.

[35] Via OLS, I get a coefficient on k_1 of 0.0003 (s.e.=0.005), and via IV, 0.001 (0.017).

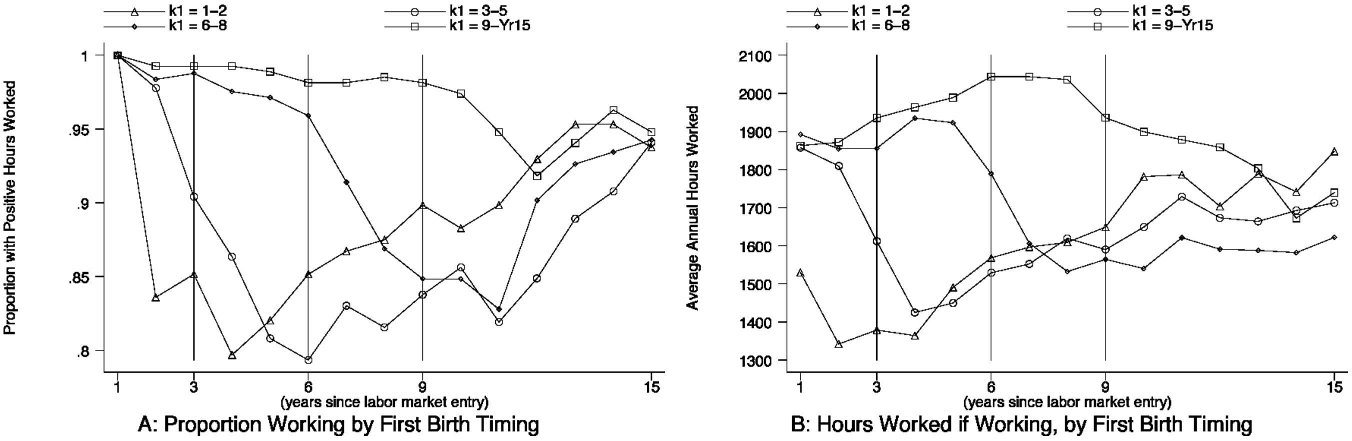
5 Understanding the Mechanism of the Effect of Timing

Now that I have established a causal link between timing of first birth and women's wage growth, in the next two sections I consider *how* the effect arises. To begin, I discuss the economic intermediates that may drive the effect of timing on wage growth, separately considering those factors that speak to the human capital and job search theories of wage growth. In Section 6 I then estimate the relative importance of each.

5.1 Human Capital Theory of Wage Growth

Total Labor Supply

The first element I consider is labor supply, and by assumption human capital (Becker, 1962, Ben Porath, 1967).[36] Figure 5 plots the proportion of women with positive hours worked per year, and average hours worked for those working, for the first 15 years after labor market entry. As we can see from the figure on the right, until k_1 the vast majority of these mothers are permanent members of the labor force. Thus my definition of timing reflects a measure of work experience accrued before the transition into motherhood.



A: Proportion Working by First Birth Timing

B: Hours Worked if Working, by First Birth Timing

Figure 5: Labor Supply Pattern at First Birth Timing

At the arrival of the first child, however, labor supply drops: 15 to 20 percent exit the labor force and the remainder decrease their hours by 300-400 per year. Thus a mechanism

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[36] Using the human capital model, Mincer and Polachek (1974) argue that because of specialization within the household, women's wages will lag men's because their anticipated time off for children gives them a smaller incentive to invest in human capital. For discussion see, for instance, Sandell and Shapiro (1978), Corcoran *et al.* (1983), Gronau (1988), Blau and Ferber (1991), and Sicilian and Grossberg (2001).

by which timing may affect wages is through this intermediate effect on labor supply: later mothers simply have more full-time, high-intensity work years before they transition into parenthood.[37]

Labor Force Exits

I next consider two elements that are central to labor supply, but may themselves have secondary effects on a woman's wage path: the number of times she exits the labor force, and the length of these absences.[38] The first may affect wages through the loss in specific human capital associated with each exit (Becker, 1962), and the second through the depreciation of general human capital during time out of the labor force (Mincer and Ofek, 1982).[39]

Consider especially total exits. Erosa *et al.* (2002) develop a model of the gender wage gap focusing on differences in turnover rates, where patterns of human capital accumulation and job-to-job transitions are gender neutral, but the underlying utility function varies because women derive utility from time at home with children.[40] This model shows that a given exit has a long-term effect on wage growth not only because women give up their current stock of specific human capital, but also because both job destruction and the arrival rate of new opportunities are correlated with human capital, providing an additional means by which past exits harm future wage growth. Thus if a delay of first birth has a direct effect on either total exits or their length, these factors may in part explain the effect of timing on wage growth.

Education

Notice that using labor supply as a measure of human capital assumes either a (costless)

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[37] I cannot test two related theories: (1) whether women adjust their effort after children (Becker, 1985; see Hersch and Stratton, 1997, for evidence on the effect of housework on the wages of married women); or (2) whether mothers decrease their availability for overtime (as evident by the variance of weekly hours).

[38] I distinguish between those job-to-job transitions that have 4 or fewer weeks off inbetween (defined as a 'job change'), and those with a gap of greater than 4 weeks (a 'labor force exit'). Notice that the latter does not capture time off in which a woman returns to an existing job.

[39] For a discussion of the effect of work interruptions on women's wages see, for instance, Corcoran and Duncan (1979), Jacobsen and Levin (1995), Albrecth *et al.* (1999) and Baum (2002).

[40] Bowlus (1997) similarly uses a search model, with wages a function of quit rates, to study the gender wage gap. Gronau (1988) also observes that women's quit rates are more sensitive to demographic changes; Blau and Kahn (1981) similarly find quit rates higher among women.

learning-by-doing interpretation of human capital accumulation (Rosen, 1972), or identical patterns of (costly) investment in on-the-job training across the population.[41] Yet we cannot observe the investment level associated with a given year of work, and therefore cannot consider whether a delay of first birth may affect way growth through its influence on investment.[42] We can, however, observe the choice to accumulate more human capital through additional schooling. I therefore consider whether a delay of first birth influences the level of education accrued over this 15-year stretch, and whether that, in turn, explains part of the effect of k_1 on wage growth.

Remaining in the Pre-Birth Job

A final factor is whether a woman leaves her pre-birth job, and thus loses the associated specific human capital at what may be an especially critical point in her career.[43] All else equal, a delay of first birth will increase a mother's tenure by k_1, increasing both the opportunity cost of leaving her pre-birth job, and the probability of maternity leave coverage.[44] I therefore explore whether fertility delay increases the probability that a woman remains at her pre-birth job, and whether this factor is important in explaining the effect of timing on wage growth.

5.2 Job Search Theory

Job Changes (for non-family reasons)

In contrast to human capital theory, job shopping models theorize that wage growth arises from movement across jobs towards better productivity matches, rather than through increases in productivity within a job (Jovanovic, 1979, Topel and Ward, 1992). If the arrival

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[41] See, for instance, Killingsworth (1982) and Heckman *et al.* (2002) for a comparison of these models.

[42] Among those who remain working, there is no obvious reason why women should lower their investment level at k_1, unless there is a limitation placed on the proportion of their time that can be spent on investment (such as if employers control access to investment and systematically bar mothers from it). For this reason women may not have complete control over their total investment, or its timing. For a discussion of differences in on-the-job training and its return by gender, see, for instance, Duncan and Hoffman (1979) and Barron *et al.* (1993). Lynch (1991) looks specifically at the effect of on-the-job training on mobility among women.

[43] See Klerman and Leibowitz (1999) for more evidence on patterns of job continuity at first birth, and Waldfogel (1999) and Waldfogel *et al.* (2001) for evidence of the effect of maternity leave policies on this continuity.

[44] Much of the literature on the motherhood wage gap focuses on the effect of maternity leave policies on mothers' wages.

of a baby discontinuously increases the transaction costs of job search, a delay of first birth may increase wage growth by allowing women to achieve higher quality matches before they transition into motherhood.

Job Changes (for family reasons)

Yet it is possible that among mothers job changes are movements towards jobs with *lower* wages, reflecting a compensating differential for family-friendly aspects of the job.[45] If a delay of first birth increases the opportunity cost of such a job change, either through increasing human capital or the quality of the match, this may explain part of the effect of timing on wage growth.

6 Estimating the Importance of the Economic Intermediaries

The following section explores the relative importance of each of these economic factors in driving the effect of first birth timing on women's wage growth. I also explore how much may be explained purely by the effect of timing on family structure, such as total kids by Yr_{15} and the age of the youngest. I begin by looking at the first-stage effect of k_1 on each of these factors. Because my results above find no evidence of bias in the OLS estimates, I now rely on least squares, although using IV as a check. I then estimate each factor's relative importance by including all potential intermediaries as additional controls in the original specification of the wage equation.

To describe my method of calculating the percent explained by each factor, consider the following simplified case. Notice that in Section 4.2 I estimate a model of the form:

$$d = \alpha + \beta X + \theta k_1 + \varepsilon. \tag{7}$$

Suppose we believe, however, that k_1 has no *direct* effect on wage growth, d, but instead the relationship captured in θ reflects an indirect effect through two mechanism variables, m_1

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[45] See Sicherman (1996) for evidence on patterns of quit rates by gender and reason; both Keith and McWilliams (1995) and Albrecht *et al.* (1999) consider the different effect of leaves and quits by reason.

and m_2. Thus the true causal model would be

$$d = \alpha' + \beta' X + \lambda_1 m_1 + \lambda_2 m_2 + \varepsilon'. \tag{8}$$

Given the first-stage effect of k_1 on each mechanism variable:

$$m_i = \alpha_i + \beta_i X + \delta_i k_1 + \zeta_i, \tag{9}$$

for $i = \{1, 2\}$, if I plug Equation 9 into Equation 8,

$$d = \alpha + \beta X + \lambda_1 \Big(\alpha_1 + \beta_1 X + \delta_1 k_1 + \zeta_1\Big) + \lambda_2 \Big(\alpha_2 + \beta_2 X + \delta_2 k_1 + \zeta_2\Big) + \varepsilon, \tag{10}$$

we see by rearranging the coefficients on k_1 that $\theta = \lambda_1 \delta_1 + \lambda_2 \delta_2$.[46] Since Equation 7 provides θ, Equation 9 provides δ_i, and Equation 10 provides λ_i, I can calculate the relative importance of each mechanism by the following means:

$$p_i \equiv \frac{\lambda_i \delta_i}{\theta} = \frac{\lambda_i \delta_i}{(\lambda_1 \delta_1 + \lambda_2 \delta_2)}.$$

Thus the importance of each factor in driving the effect of timing on wage growth depends on both the strength of the first-stage effect of timing on the given variable, δ_i, and the variable's second-stage effect on wage growth, λ_i.[47]

6.1 Measuring the Effect of k_1 on Potential Intermediate Factors

Labor Supply

I start by considering whether a delay of first birth affects a woman's total labor supply accumulated over this 15-year stretch. The first line of Table 7 shows a clear relationship: a one-year delay is associated with 600 to 700 more hours worked.[48] Yet the magnitude of

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[46] In Equation 8 $\alpha' = \alpha + \lambda_1 \alpha_1 + \lambda_2 \alpha_2$, $\beta' = \beta + \lambda_1 \beta_1 + \lambda_2 \beta_2$, and $\varepsilon' = \varepsilon + \lambda_1 \zeta_1 + \lambda_2 \zeta_2$.

[47] Notice that although I have shown above that the OLS estimate of θ is unbiased, and I can compare the OLS- and IV-estimates of the coefficients in Equation 9, I have no instruments for the mechanism variables themselves, so my estimates of λ_i may be biased.

[48] When calculated by IV these results are slightly weaker, although in no cases significantly different.

these first-stage effects is fairly small, reflecting only 2 to 3 percent of total hours worked over the first 15 years, or approximately 40 percent of an average pre-birth year.[49] Thus although we saw in Figure 5 that the arrival of a first child creates a clear discontinuity in labor supply, the magnitude of the effect is not overwhelming.

Table 7: Effect of k_1 on Wage Growth Intermediaries

	All	**High School**	**Some College**	**College+**
	coefficient	coefficient	coefficient	coefficient
	(s.e.)	(s.e.)	(s.e.)	(s.e.)
Dependent Variable:	[% change]	[% change]	[% change]	[% change]
General Human Capital:				
Labor Supply by Yr_{15}:				
Total hours worked (x1000)	0.702**	0.739**	0.592**	0.707**
	(0.071)	(0.100)	(0.130)	(0.133)
	[2.8%]	[3.2%]	[2.4%]	[2.5%]
Labor force exits	-0.044*	-0.067**	-0.005	-0.039
(excluding at k_1)	(0.018)	(0.025)	(0.033)	(0.033)
	[-2.6%]	[-3.5%]	[-0.4%]	[-3.2%]
Longest labor force exit (mos)	-2.020**	-2.438**	-1.884**	-1.375**
	(0.247)	(0.347)	(0.450)	(0.460)
	[-10.3%]	[-10.5%]	[-10.0%]	[-11.9%]
Schooling Between t_1 and Yr_{15}:				
Full-time schooling (yrs)	0.014*	0.012	0.018^{+}	0.019^{+}
	(0.006)	(0.008)	(0.011)	(0.011)
	[6.1%]	[6.3%]	[7.8%]	[6.1%]
Part-time schooling (yrs)	0.037**	0.033*	0.033^{+}	0.063**
	(0.011)	(0.015)	(0.020)	(0.020)
	[8.8%]	[10.0%]	[6.3%]	[11.3%]
Specific Human Capital:				
Remain in pre-birth job at k_1	0.031**	0.034**	0.037**	0.017^{+}
	(0.005)	(0.006)	(0.008)	(0.009)
	[4.6%]	[6.0%]	[5.1%]	[2.1%]
Job Search:				
Total job changes	0.084**	0.033	0.122*	0.124*
	(0.026)	(0.036)	(0.047)	(0.048)
	[3.0%]	[1.2%]	[4.4%]	[4.8%]

Continued on Next Page…

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[49] Angrist and Evans (1998) find a 10 percent effect, but this reflects a third child.

Table 7 – Continued

Dependent Variable:	**All** coefficient (s.e.) [% change]	**High School** coefficient (s.e.) [% change]	**Some College** coefficient (s.e.) [% change]	**College+** coefficient (s.e.) [% change]
Worked in professional job at k_1	0.018**	0.021**	0.020**	0.010
	(0.004)	(0.005)	(0.007)	(0.007)
	[5.5%]	[13.1%]	[7.1%]	[1.4%]
Compensating Differential:				
Ever changed jobs for family reasons	-0.0051^+	-0.0013	-0.0113*	-0.0047
	(0.0026)	(0.0037)	(0.0048)	(0.0049)
	[-7.3%]	[-2.6%]	[-18.8%]	[-5.9%]
Sample Size:	**912**	**410**	**208**	**241**

NOTES: ($^+$ = significant at 10%; * = significant at 5%; ** = significant at 1%)

These coefficients reflect the OLS-estimated effect of first birth timing on the listed dependent variable, holding constant the original set of controls listed at the bottom of Table 6. (Because of the decomposition method used here, I treat the indicator variables as continuous.) The reported percentage reflects the effect of a one-year delay on the given intermediary, as a proportion of the mean value observed for this sample (shown in Table 2).

I can also consider whether timing influences the *change* in labor supply at first birth, or if the effect measured above is purely through the existence of an additional pre-birth year. Measuring the effect of k_1 on time off at first birth and the change in weekly hours upon return, I find that a one-year delay is associated with a 10 to 15 percent decrease in the former and a smaller 4 to 5 percent decrease in the latter.[50] Not surprisingly, these effects are strongly correlated with whether a woman remains in her pre-birth job.[51] Yet within each subgroup there is no additional effect of timing on either element.[52] Overall, Figure 6 shows the relatively equal change in hours worked by women of varying timing of first birth.[53]

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[50] The former decreases by 0.8 to 1.4 months and the latter by 0.2 hours, each significant at 10 percent. (When estimated by IV these effects only remain significant among women with some college.)

[51] See Altonji and Paxson (1992) for a discussion of constraints in hours choice and its effect on married women's job decisions.

[52] This relationship is driven not only because those who return to their original job go back to work more quickly, but also because those who were covered by paid leave were recorded as "at work" by the NLSY; see Klerman and Leibowitz (1994) for the distinction between employment and work for new mothers. (Because of this, when I separately consider the effect of k_1 on time off I exclude those with no gap, since this reflects missing data.) By comparison, the effect of timing on total hours worked holds within both subgroups.

[53] This figure shows the change in hours for all women, including those who stop working.

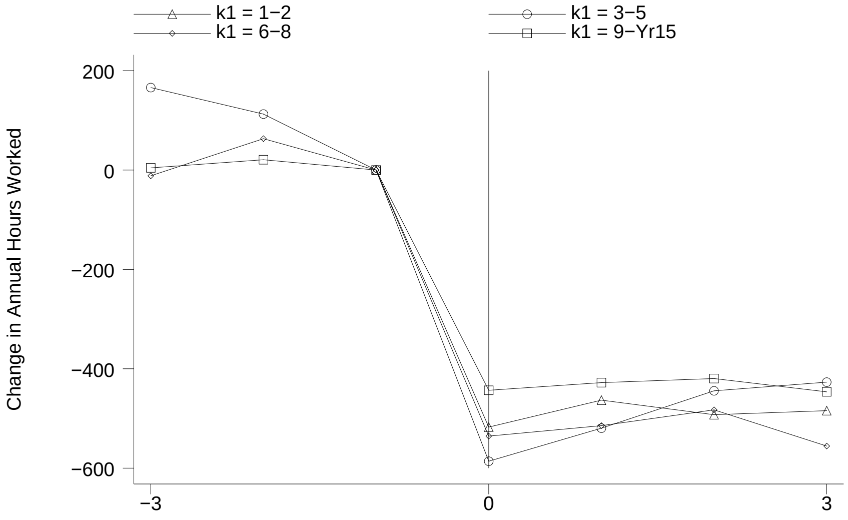

Figure 6: Change in Average Hours Worked per Year at First Birth

Labor Force Exits

Because hours worked do not capture the intermittency of a woman's labor force presence, I next consider whether delay affects the pattern of labor supply accumulation.[54] I begin by considering the first-stage effect of k_1 on total labor force exits, and then consider the effect on the length of the longest exit.[55] As we see in Table 7, a one-year delay is associated with a 3 percent drop in total exits (most clearly significant for the high school educated), and a larger 10 percent decrease in the length of the longest (almost equal across groups).[56]

Education

I next consider the intermediate effect of first birth timing on additional education accumulated between t_1 and Yr_{15}. As we see in Table 7, a one-year delay leads to a 6 and 9 percent increase in full- and part-time schooling, respectively. (By IV I still find a statistically significant relationship between education and timing for those with more schooling, despite the loss in precision.)

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[54] Light and Ureta (1995) similarly distinguish between cumulative work experience and its pattern of accumulation.

[55] For the former I exclude any exit at k_1 because I want to separately assess the importance of whether a woman stays in her pre-birth job, but for the latter I include any such exit in calculating the longest.

[56] By IV I find a much stronger effect of delay on total exits for the high school educated, with an exogenous one-year delay decreasing the total number of exits by almost 10 percent.

Remaining in the Pre-Birth Job

I next explore the effect of timing on remaining in the pre-birth job. Table 7 shows that a one-year delay increases this probability by 5 percent overall. I find, however, that the effect is more than twice as large among those with less than a college degree than for the college graduates. As shown in Table 2, the proportion of the latter who stay in their pre-birth job is very high to begin with.

Job Changes for Non-Family Reasons

Next I consider whether a delay of first birth leads to greater wage growth through its effect on job-to-job transitions. I begin by estimating the first-stage effect of k_1 on total job changes made for non-family reasons, thus not distinguishing by their timing.[57] Next, since Figure 7 shows that the proportion of women working in professional occupations increases over time, I also consider this idea in terms of whether a woman reached a professional job before she had her first child.[58]

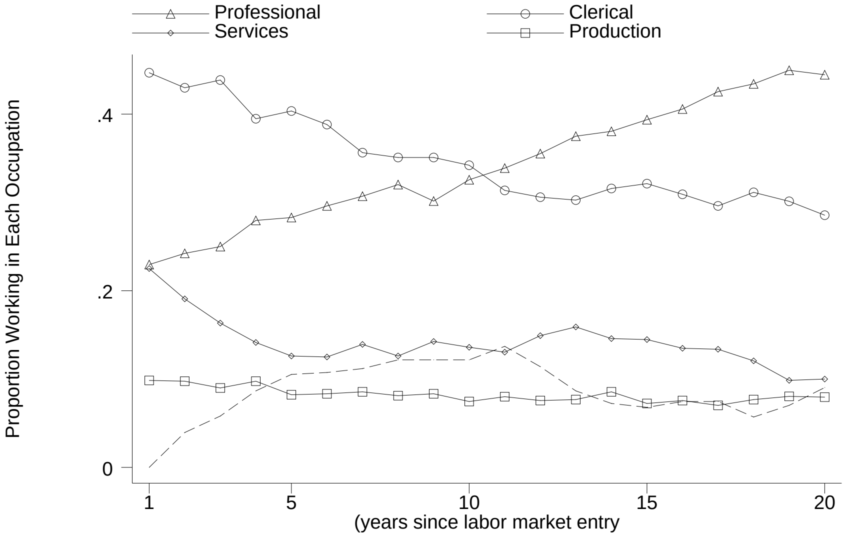

Figure 7: Occupational Mix Over Time

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[57] When considering the careers of men, Topel and Ward (1992) focus on early-career job changes because it is at this stage that clear increases in job match quality remain available. Yet because of the greater intermittency of women's careers, even later-timed changes may reflect a significant increase in job match quality, leading me to consider total changes rather than their timing. (For evidence on mobility patterns and their returns by gender, see for instance Viscusi, 1980, Keith and McWilliams, 1997 and 1999, Light and Ureta, 1990 and 1992, and Royalty, 1998.)

[58] The dashed line in Figure 7 reflects the proportion of women out of the labor market each year.

In Table 7 I show that a one-year delay of first birth leads to a 3 percent increase in job changes, with the effect increasing in education.[59] I also find that delay increases the probability that a woman reached a professional job by the time of her first child, although the effect is now strongest among those with less education.

Job Changes for Family Reasons

As a last step, I assess whether a delay of first birth translates into fewer shifts towards lower-wage jobs that provide a compensating differential in terms of family-friendly amenities. For every job exit, the NLSY collects data on the reason for the departure, including whether the woman left for family reasons. I find very few job changes on this basis: only 3 percent compared to a much larger 22 percent of all labor force exits. Thus the data show that when these mothers make a job shift for family reasons, they tend to move out of the market entirely. I therefore consider this factor in terms of whether a delay of first birth decreased the probability of *ever* observing a job change for family reasons. The last line of Table 7 shows a small negative effect of delay on this probability, driven by women with some college education.

6.2 Comparing the Relative Importance of These Factors

Given the first-stage results of the effect of k_1 on the economic intermediates discussed above, I now assess their relative importance. I first estimate Equation 8 to calculate the second-stage coefficients of each mechanism on wage growth, λ_i. I then combine these coefficients with the estimates of δ_i and θ listed above to calculate the relative importance of each mechanism variable, p_i, in explaining the effect of timing on wage growth.

In particular, the first lines of Table 8 report the initial coefficients on k_1, θ, and the coefficient when all of the mechanism variables are included. As we see from the second line, either I lack some of the relevant mechanisms, or k_1 has a direct effect on wage growth. The factors considered here combine to explain only 53 percent of the effect of timing for

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[59] By IV the effect is only clearly significant for those with some college education, with an estimated effect twice as large as that seen here.

Table 8: **Relative Importance of the Economic Channels**

Y = log($Wage_{15}$) - log($Wage_{start}$)	**All** coefficient (s.e.) [% explained]	**High School** coefficient (s.e.) [% explained]	**Some College** coefficient (s.e.) [% explained]	**College+** coefficient (s.e.) [% explained]
Coefficient on k_1:				
Initially:	0.0348**	0.0276**	0.0384**	0.0472**
Fully controlled:	0.0163**	0.0119	0.0056	0.0325**
Percent Explained:	**53.2%**	**56.9%**	**85.4%**	**31.1%**
Total hours worked	0.0136	-0.0123	0.0531	0.0416
	(0.0128)	(0.0202)	(0.0364)	(0.0278)
	[17.2%]	[8.4%]	[37.6%]	[10.1%]
Labor force exits	-0.0053	-0.0099	-0.0344	-0.0744
	(0.0259)	(0.0402)	(0.0605)	(0.0640)
	[1.3%]	[3.9%]	[4.2%]	[2.5%]
Length of longest exit	-0.0063**	-0.0044	-0.0051	-0.0137*
	(0.0023)	(0.0032)	(0.0046)	(0.0065)
	[18.3%]	[24.5%]	[2.7%]	[17.3%]
Full-time schooling	0.0990**	0.0761	0.1554*	0.0822
	(0.0306)	(0.0511)	(0.0644)	(0.0532)
Part-time schooling	0.0405*	0.0248	0.0699*	0.0216
	(0.0161)	(0.0254)	(0.0303)	(0.0307)
Additional Education	[8.3%]	[6.3%]	[13.3%]	[6.2%]
Remain in pre-birth job at k_1	0.0547	0.1581*	0.0487	-0.1973^{+}
	(0.0454)	(0.0655)	(0.0982)	(0.1063)
	[4.9%]	[19.5%]	[4.7%]	[-7.1%]
Job changes (non-family)	0.0099	-0.0242	0.0483	0.0668^{+}
	(0.0171)	(0.0275)	(0.0327)	(0.0348)
Professional job at k_1	0.0199	-0.0197	0.1250	-0.0089
	(0.0466)	(0.0723)	(0.0860)	(0.0815)
Job Mobility	[1.9%]	[-3.6%]	[11.9%]	[2.1%]
Ever changed jobs (for family)	-0.0769	-0.1093	-0.2343	-0.0607
	(0.0667)	(0.1184)	(0.1497)	(0.1285)
	[1.1%]	[0.5%]	[6.9%]	[0.6%]
Sample Size:	**912**	**410**	**208**	**241**

NOTES: ($^{+}$ = significant at 10%; * = significant at 5%; ** = significant at 1%)

These results reflect the OLS-estimated coefficient on the given mechanism variable in the regression of wage growth on timing and all of the economic intermediaries included here. The percentage listed in brackets reflects the proportion of the effect of timing on women's wage growth that is driven by the intermediate effect of k_1 on the given variable.

the sample overall, 57 percent for high school educated women, 85 percent for those with some college education, and only 31 percent for college graduates. The next lines show the coefficients on the given mechanism variables, λ_i, and the corresponding estimates of the relative importance of each factor, $p_i = \lambda_i \delta_i / \theta$.[60]

As we see in Table 8, the relatively small first-stage effect of k_1 on labor supply translates into a large effect on wage growth. For the sample as a whole, the indirect effect of timing on labor supply explains 17 percent of its effect on wage growth, ranging from 10 percent for the high school and college educated, to almost 40 percent for those with some college. Yet total hours worked is not the most important factor. I instead find that the effect of timing on reducing the length of the longest labor force exit, and thus protecting human capital from depreciation during time off, explains a larger part of the effect: 18 percent overall, 17 percent for the college educated, and 25 percent for the high school graduates.

Another important factor is the effect of timing on the propensity to get additional schooling, which explains 8 percent of the return to delay for the sample overall, and as much as 13 percent for those women who enter the labor force with some college education. I also find that the effect of timing on the propensity to stay in the pre-birth job has a strong effect on wage growth for high school educated women.[61]

Lastly, for women with some college, for whom I am able to explain the greatest proportion of the total effect, I also find the importance of timing on job mobility, especially through the probability of reaching a professional job before becoming a mother. Similarly, for this group alone I see the importance of timing on decreasing the propensity to switch jobs for family reasons.

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[60] Although I do not show the coefficients here, to allow for nonlinearities I include in this estimation a quadratic term in total hours worked, total labor force exits, the length of the longest exit, and total job changes. Because my results may be especially sensitive to transitory elements that hold at Yr_{15}, I also include a control for full-time status that year.

[61] Despite also seeing a strong first-stage effect on other labor force exits, I find that this has little additional effect on the wages of high school educated women.

6.3 Considering the Effect of Timing Through Family Structure

Finally, I consider how much of the return to a delay of first birth may arise simply through its effect on family structure. In Table 9 I begin by estimating the first-stage effect of k_1 on four factors: total children and the age of the youngest at Yr_{15}, the probability that the mother is married at that point, and her husband's income the year their first child was born. The first element addresses the fact that the estimated return to delay may simply pick up a smaller wage penalty associated with fewer children. Yet the second and third may have a negative transitory effect on her wage at Yr_{15}, and thus *lower* the estimated return to delay.[62] Similarly, if a delay increases her husband's earnings by the time their first child is born, this may decrease a mother's subsequent labor supply, leading to lower overall wage growth.

As a caveat before I discuss these results, I should stress that OLS may not provide valid estimates of the causal link between timing and these family variables. Although my results above suggest that observed timing is not endogenous to economic factors, it will be correlated with taste for early motherhood, and thus likely with taste for children overall. This suggests, for instance, that women who delay also systematically want fewer children, creating a downward biased estimate of the causal effect of the one on the other. Yet because the fertility instruments may be invalid because of a *direct* effect on these dependent variables, I rely on OLS to provide an estimate of the magnitude of the importance of these family factors.

The top panel of Table 9 shows a clear relationship between the timing of first birth and all of these family variables. For instance, a one-year delay is associated with 5 percent fewer children.[63] I also find that delay leads to a lower age of the youngest child in Yr_{15}, a

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[62] Because my instruments are only defined for those who are married at conception, by construction women with later births will be more likely to remain married at Yr_{15}.

[63] Kohler *et al.* (2001) find a similar result for Danish women, where delay lowers fertility by 3 percent. I consider how much of this effect is permanent by comparing this result to the effect of k_1 on total children by the last year these women are observed (when the median age is 43). I find some 'catch up' in the subsequent years, although least among the college educated, who were on average already 38.1 at Yr_{15}.

Table 9: **Measuring the Importance of Family Structure**

	All	**High School**	**Some College**	**College+**
	coefficient	coefficient	coefficient	coefficient
	(s.e.)	(s.e.)	(s.e.)	(s.e.)
Dependent Variable:	[% change]	[% change]	[% change]	[% change]
Children:				
Total children by Yr_{15}	-0.098**	-0.112**	-0.103**	-0.068**
	(0.008)	(0.011)	(0.014)	(0.014)
	[-4.9%]	[-5.6%]	[-5.2%]	[-3.4%]
Total children by last year observed	-0.072**	-0.080**	-0.073**	-0.055**
	(0.008)	(0.012)	(0.015)	(0.016)
	[-3.3%]	[-3.7%]	[-3.4%]	[-2.7%]
Age of youngest child[1] at Yr_{15} (yrs)	-0.662**	-0.603**	-0.626**	-0.766**
	(0.038)	(0.054)	(0.068)	(0.063)
	[-12.2%]	[-10.9%]	[-12.1%]	[-14.3%]
Marital Status:				
Probability married at Yr_{15}	0.022**	0.030**	0.013*	0.015*
	(0.004)	(0.005)	(0.007)	(0.007)
	[2.7%]	[3.8%]	[1.5%]	[1.7%]
Husband's income at k_1 (2000$, x1000)	1.649**	1.515**	1.719*	1.796*
	(0.384)	(0.541)	(0.700)	(0.717)
	[4.6%]	[5.2%]	[4.6%]	[3.6%]
Initial coefficient on k_1:	0.0348**	0.0276**	0.0384**	0.0472**
Including Family Factors:	0.0333**	0.0374**	0.0220^{+}	0.0332*
Percent explained	[-4.3%]	[-27.5%]	[42.7%]	[29.7%]
Sample Size:	**912**	**410**	**208**	**241**

NOTES: + = significant at 10%; * = significant at 5%; ** = significant at 1%

1. Defined only if more than one child by Yr_{15}.

higher probability of being married at that point, and an increase in the husband's earnings at k_1.

As shown in the last lines of Table 9, when I include all of these factors as controls in the regression of timing on wage growth, I find that for women with at least some college education these factors may combine to explain as much as 30 to 40 percent of the effect of timing on wage growth. Yet for women with a high school degree, these factors instead dampen the return to delay, such that when controlled for, the estimated effect of a one-year delay rises by almost 30 percent.

7 Is the Effect of Timing on Wage Growth Permanent?

A last consideration in gauging the effect of first birth timing on women's wage growth is its permanence. A limitation of using the NLSY to measure the return to delay is that I cannot observe these women through the end of their careers. If the effect of the arrival of children is independent of the timing of the first, I may still measure an effect at 15 years if I am observing these women at different stages of this transition. Given this sample I can, however, assess whether the effect diminishes over the next 5 years. With their youngest children now in school, by Yr_{20} the majority of the cost of children may have passed.[64]

Table 10: **Comparison of the Return to Delay at Yr_{15} to Yr_{20}**

	By 15th Year		By 20th Year	
Y_t = log($Wage_t$) - log($Wage_{start}$), t = 15 or 20	OLS coefficient (s.e.)	IV coefficient (s.e.)	OLS coefficient (s.e.)	IV coefficient (s.e.)
Timing of First Birth (k_1)	0.035**	0.029*	0.025**	0.004
	(0.005)	(0.015)	(0.005)	(0.015)
By Education at Labor Market Entry[1]:				
Exactly 12 years	0.028**	0.033	0.019*	-0.007
	(0.007)	(0.022)	(0.007)	(0.022)
13 to 15 years	0.038**	0.016	0.029**	0.012
	(0.010)	(0.022)	(0.010)	(0.024)
16 or more years	0.047**	0.048*	0.041**	0.047*
	(0.010)	(0.021)	(0.010)	(0.022)
Sample Size:	912	912	912	912

NOTES: $^{+}$ = significant at 10%; * = significant at 5%; ** = significant at 1%

Table 10 compares the OLS- and IV-estimated returns to a one-year delay of first birth at Yr_{15} and Yr_{20}. The OLS coefficients show that the return for the sample as a whole falls by almost 30 percent and is decreasing in education.[65] For the high school educated the return falls by 32 percent, versus 13 percent for the college graduates.[66] Thus although the return to the delay of first birth falls with time, it is more permanent among the more educated.

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[64] Even among the latest mothers, $k_1 \geq 9$, the average age of the youngest child is 7.3 in Yr_{20}, compared to 2.5 in Yr_{15}.

[65] Drolet (2002) and Chandler *et al.* (1994) also find that the return to delay erodes with time.

[66] By comparison, the IV-estimated coefficients now show no evidence of a return to delay, except among the college educated, although I cannot reject that the IV and OLS estimates are equivalent.

8 Conclusion

The results discussed above show that the cross-sectional relationship observed between timing of first birth and wages reflects a true causal effect. As evident in Figure 2, women's wage growth stalls at first birth, providing a return to delayed motherhood. For women who have their first child after they enter the labor force, a one-year delay leads to 3 percent greater wage growth over the first 15 years worked, or as much as 5 percent among the college educated. By comparing this return to that 5 years later, I also find that the effect is not only strongest, but also most permanent, among women with more education.

Yet given the calculations shown in Section 2, a comparison of the IV and OLS coefficients suggests that the distribution of timing observed across women must arise primarily from variation in taste for early motherhood. As we see by close inspection of Figure 2, both the pre- and post-birth growth rates — and thus the change in wage growth at k_1 — are surprisingly similar across women with varying timing of first birth.

The second goal of this paper was to establish the economic means by which this return to delay arises. I find the strongest effects through labor supply, both in terms of the influence of timing on hours worked, and its effect on time spent out of the labor force. I similarly find a strong effect through the influence of timing on additional education, and for the high school educated on the propensity to stay in the pre-birth job.

With these results in mind, consider again the pattern evident in Figure 1, which plotted the striking correlation between the change in age at first birth and the male/female earnings ratio for the cohorts of women born between 1940 and 1964. Over this 25-year stretch we see that the median age at first birth rose by 4 years. Supposing that the results estimated here reflect the return to delay across all of these cohorts, such a shift in the timing of motherhood could have caused as much as a 12 percent increase in women's wages.[67] Comparing this to the 25 percent increase in the male/female earnings ratio over

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[67] It is possible that the return to delay evolved over time for these cohorts; notice that I am estimating the return among women born in only the last 8 years of this 25-year stretch.

this same period, this suggests that the dramatic shift in the timing of motherhood evident during this time period may have been one of the most important factors in explaining the rise in women's relative earnings.

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Data Appendix

This analysis of the effect of first birth timing on womens wage growth relies on the sample of women from the National Longitudinal Survey of Youth (NLSY). The survey began in 1979 with a sample of 6,283 14- to 22-year old women, who by 2004 reached the age of 40 to 47. Given my focus on childbearing, I limit my analysis to those women I observe till the year they turn 40, when most who will have children have had at least their first.[68] This limits me to 4,130 women, or 68 percent of the original sample (82 percent of the weighted sample).[69] The largest groups lost are the military and supplemental white/poor samples, who were dropped from the NLSY in 1984 and 1991, respectively. Exclusive of these women, this age criterion drops 13 percent (14 percent weighted) of the original sample. Of these 4,130 women, 3,467, or 84 percent (82 percent weighted) have children by their last year observed, when the median woman turned 43.[70]

As noted in the introduction, rather than considering timing of first birth with respect to age, I instead define it as a function of the year a woman entered the labor market. To determine the latter, I first establish the year in which she completed continuous schooling, based on annual attendance data, and retrospective data asked in 1979. (In some cases I allow gaps in her education before her graduation year, as long as upon her return she completed more years of schooling at a sufficiently fast pace.[71]). Starting from June of that year, I then search forward for the first twelve-month period in which she worked at least 1000 hours.[72] I define that year — the second calendar year in that 12-month stretch — as

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[68] Among the sample of mothers observed in the last survey year, 2004, 99.2 percent had their first child by age 39.

[69] My focus in building this sample was to determine a woman's first year in the labor market. Some women were dropped in this process, especially those for whom I had to rely on retrospective data on their last year of school attendance and their labor supply in 1975 through 1977. Those dropped either had missing labor force or last-attendance information, or they left school before 1974, leaving me unable to distinguish their first year in the labor force. (A few were also dropped because I could not distinguish when their first child was born, or because they were still in school when they fell out of the NLSY.) After all the variable designation, I am left with a sample of 6,048, and the 4,130 (82 percent weighted) are the subset that I observe till the year they turn 40.

[70] For 6.2 percent of the women observed through their 40th year, their last year observed is before 2004.

[71] In particular, I allow a one-year gap before returning to school if after returning her reported education level increased. (Many respondents reported school attendance without their completed education level increasing thereafter.) I also allow up to a two-year gap before returning, if upon return she stayed in school for at least two years, completed at least two years of schooling in that timeframe, and completed it at a rate of at least 0.65 school years per calendar year (e.g., finishing 2 school years in 3 years but not 4). These criteria are used only for women completing years of schooling beyond high school. Broadly speaking, this approach assumes, for example, that even up to two years of work experience in the type of job one could hold without a college degree, will not build strongly into the wage level received in the job first taken after finishing college. Lastly, I allow up to a 4-year gap (but no longer), if during that time she never worked more than 1000 hours per years and when she returned to school she completed at least one-year of full-time or 2 years of part-time schooling.

[72] When trying to determine the last year of schooling versus the first year of working, in some cases of part-time (post-high school) education, I count her as already in the labor force if she was simultaneously

t_1, her first year in the labor market.[73] Using this 1000-hour criteria, 119 women of all those observed till 40 never entered the labor force.

Given this definition of a womans first year in the labor force, I define her timing of first birth, k_1, with respect to this year. For example, women with their first birth the same year they began working have $k_1 = 1$, whereas those with their first birth three years later have $k_1 = 4$.[74] As noted in the introduction, I focus this analysis on those women who had their first child after they began working, $k_1 > 0$. This step limits me to 62 percent (71 percent weighted) of all NLSY mothers observed till age 40, or 2,133 women. (I maintain a larger 84 percent, 88 percent weighted, of those who were married when they became pregnant with their first child.)

My next data restriction arises from the definition of my dependent variable, wage growth from labor market entry till 15 or 20 years later.[75] In particular, I define a woman's starting wage as her wage in her first year, t_1, or her second year if first year wage is missing. For her 15th and 20th years (denoted Yr_{15} and Yr_{20}), I allow a broader range, using any wage for career years 13 through 17 for the 15th, and 18 through 22 for the 20th (beginning as close to 15 and 20 as possible).[76] Given these definitions I include in this analysis only those women with observed starting, 15th and 20th year wages. This gives me a sample of 1,472 women, or 69 percent (66 percent weighted) of the 2,133 women above. Furthermore, because I want to estimate the effect of first birth timing by the 15th year and whether it has diminished by the 20th, I include only those women who have their first child by Yr_{15}. This excludes an additional 70 women, leaving me with a starting sample of 1,402 mothers.

Lastly, as discussed in Section 4.1, my identification strategy relies on the exogeneity of miscarriages and contraceptive failures, which I find only hold among women who were

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working at a rate of 1000 hours or more per year.

[73] Because of my definition of timing, notice that those with their first birth in their third year will include, for instance, a mixture of 21-year old high school graduates and 25-year old college graduates.

[74] For women with their first birth in the same calendar year that they began working, I take care to include only those who began working *before* the baby arrived. The remainder are coded as $k_1 = 0$.

[75] At each interview women are asked for their wage at their current job, and their ending wage for any other jobs worked since the last interview. The latter can therefore provide wages for earlier calendar years, which fills in some data for off-interview years or years where the respondent was missing from the survey. Furthermore there are often multiple wages for a given year, corresponding to wages for different jobs worked. As a starting point I begin with the wage for the current job, and if not working, for the job that corresponded with a time closest to the middle of the calendar year (based on the date the job ended). In some cases of implausible wages I use an alternative listed wage for that given year if it appears more reasonable, or correct values that appear to be typos in terms of the decimal point. In some cases where neither gives me a reasonable alternative I simply exclude the reported value. I also exclude any wages below \$2 per hour and those greater than \$200, both in year 2000 dollars, with the upper bound lower for earlier survey years. (Wages are converted to year 2000 dollars using the Consumer Price Index for all urban consumers.)

[76] For the majority of these women, the 15th and 20th years fall at or after 1994, when the survey became biennial. Although the survey does capture some data for the off-years, I pick a wage from an even (survey) year, if possible.

married when they became pregnant with their first child. The majority of my analysis therefore focuses exclusively on the 65 percent (73 percent weighted) of these 1,402 women for whom this criterion holds. Thus the final sample size for the majority of my analysis is 912 women, all of whom I observe till at least their 40th year, had their first child after they began working, have observed starting, Yr_{15} and Yr_{20} wages, and were married when they conceived their first child. Table 1 lists summary statistics for this sample of women overall and by timing of first birth; Appendix Table A-1 gives these same values for the larger sample of 1,402 mothers.[77]

Table A-1: **Summary Statistics by k_1 (All with $k_1 > t_1$)**

	All	**By Fertility Timing (k_1)**			
		$1-2$	$3-5$	$6-8$	$9-Yr_{15}$
Dependent Variable:					
Wage Growth to Yr_{15}	0.37	0.27	0.29	0.38	0.55
Wage Growth to Yr_{20}	0.47	0.39	0.42	0.46	0.61
Starting wage (2000$)	8.25	7.87	8.35	8.46	8.24
Yr_{15} wage (2000$)	13.01	10.85	11.96	13.32	15.65
Yr_{20} wage (2000$)	14.27	12.21	13.67	14.19	16.68
Marital Status at Pregnancy with First Child:					
Married	0.65	0.45	0.64	0.72	0.75
Marry father, but at pregnancy:					
Living together	0.08	0.07	0.07	0.09	0.08
Not yet living together	0.09	0.22	0.10	0.04	0.03
Unmarried & did not marry partner	0.18	0.26	0.19	0.15	0.15
Wage Growth Intermediaries (by Yr_{15}):					
Total hours worked (x1000)	24.25	22.14	21.94	24.69	28.22
Labor force gap at k_1 (mos)[1]	12.2	11.8	17.7	12.3	5.8
Change in hours per week at k_1^2	3.7	1.6	4.5	4.6	3.4
Total labor force exits (excluding at k_1)[3]	1.9	2.4	2.0	1.8	1.6
Length of longest labor force exit (mos)[3]	21.6	27.2	28.5	19.3	11.1
Full-time schooling after t_1 (yrs)	0.23	0.17	0.19	0.23	0.32
Part-time schooling after t_1 (yrs)	0.43	0.26	0.33	0.45	0.65
Remain in pre-birth job at k_1	0.62	0.53	0.51	0.66	0.80
Total job changes (non-family)[3]	2.8	2.4	2.5	2.9	3.4
Worked in professional job at k_1	0.28	0.14	0.24	0.30	0.41
Ever changed jobs for family reasons[3]	0.07	0.09	0.06	0.09	0.06

Continued on Next Page…

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[77] I add as a last panel the summary statistics for fertility expectations versus outcomes included in Table 3.

Table A-1 – Continued

	All	**By Fertility Timing (k_1)**			
		$1-2$	$3-5$	$6-8$	$9-Yr_{15}$
Family Characteristics:					
Age at first birth	26.0	21.3	23.7	26.7	31.5
Husband's earnings at k_1 ($2000, x1000)	27.4	16.8	23.1	30.8	37.7
Family characteristics at Yr_{15}:					
Own age	35.2	35.0	35.1	35.1	35.4
Married	0.69	0.61	0.66	0.71	0.78
Age of youngest child	5.9	8.3	7.3	5.5	2.7
Total children	1.99	2.44	2.18	1.94	1.48
Background:					
Race:					
White	0.59	0.45	0.58	0.64	0.66
Black	0.22	0.33	0.21	0.17	0.20
Hispanic	0.19	0.22	0.20	0.19	0.14
Mother's education (years)	11.1	10.6	10.9	11.0	11.7
Mother worked (when 14)	0.63	0.63	0.61	0.62	0.67
AFQT score (age-adjusted)	4.77	-3.19	3.73	7.22	9.95
Highest grade expected (in 1979)	14.2	13.9	14.1	14.2	14.6
Total education at t_1 (years):	13.0	12.6	12.9	13.1	13.4
Less than 12 years	0.09	0.11	0.10	0.09	0.04
12 years	0.49	0.56	0.52	0.45	0.44
13-15 years	0.23	0.22	0.19	0.24	0.28
16+ years	0.19	0.11	0.19	0.22	0.24
Fertility Expectations vs. Outcomes:					
Predicted timing of first birth	5.2	4.2	4.7	5.5	5.9
Observed timing of first birth (k_1)	6.1	1.6	3.9	7.0	11.6
Correctly predicted k_1 (± 1 yr)	0.37	0.39	0.61	0.43	0.06
Predicted timing 2 years before k_1	2.9	4.3	3.2	2.6	2.1
Correctly predicted 2 yrs before	0.35	0.22	0.27	0.41	0.47
First child not wanted then/ever:	0.26	0.40	0.33	0.18	0.17
Total children expected at t_1	2.37	2.37	2.43	2.33	2.34
Total children (by last year observed)	2.13	2.53	2.28	2.02	1.75
Correctly predicted total children	0.37	0.43	0.38	0.37	0.34
Sample Size:	**1,402**	**282**	**422**	**340**	**358**
Percent of Total Sample:		20.1%	30.1%	24.3%	25.5%

NOTES: See notes to Table 1

Because all of these data restrictions lower my sample size appreciably from the original set of 3,467 mothers observed until age 40, Appendix Table A-2 explores whether these restrictions create a biased sample. As a starting point for this comparison, however, I begin with the group who had children after they began working, and who were married when they became pregnant with their first child.[78] Given how I frame this question, and my identification strategy, it is clear that my estimates can only reflect the average causal effect of a one-year delay of first birth for this subgroup of mothers.

Among these women the criteria now limiting my sample is the requirement of an observed wage at labor market entry and at Yr_{15} and Yr_{20}. These restrictions may give me a selected sample if the availability of these data is associated with the timing of first birth. For example, later mothers have relatively fewer years available to return to work in sufficient time for me to observe a wage at Yr_{15}. If those who return quickly are a positively selected group, this may drive the OLS-estimated correlation observed between timing and wage growth. Yet if the opposite holds — for instance, if wives of lower earnings husbands return to work more quickly — then this may instead bias the estimate towards zero.

Appendix Table A-2 explores these two possibilities. The top panel begins by listing the sample size of the full set of mothers who had their first birth after labor entry, who I observe till age 40, and who were married when they conceived their first child. Of these, it then lists the percentage included in my sample — those with observed wage data for all three time points. Among the sample as a whole 65 percent of these women are included, ranging from 76 percent of those in the earliest timing group to 60 percent in the latest. Thus the wage criteria act more strongly on the latest mothers.

The next panel explores which of the wage data are missing among those excluded from my sample, and whether the missing data arise from being out of the labor force entirely in the given time period.[79] For instance, first we see that I lack starting wages for 23 to 33 percent of these women, mostly for those who entered the labor market before 1978, the earliest year for which I have wage data.[80] We next see that a larger 33 to 49 percent are excluded because I lack a Yr_{15} wage. Among the earliest mothers slightly more than half of this reflects women who did not work at all from years 13 to 17 (the years used as Yr_{15}), while the other half worked but I simply lack any wage data. By contrast, for the latest mothers a larger percentage are missing a Yr_{15} wage, and now fully two-thirds of this was driven by women out of the labor market. The last lines explore the reason behind missing Yr_{20} wage data, which now includes women who fell out of the sample before their 18th year

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[78] In addition, I include only those who had their first child by their 17th year, the last year used for Yr_{15}.

[79] The percentages add to more than 1 since women may be missing more than one of the three wages.

[80] Although the survey collected retrospective labor force information, the wage data begins in 1979, the first survey year. (A small subset of responses cover jobs in 1978.)

in the labor market, the first year used for this measure.[81] Whereas overall I lose a larger percentage of late mothers because of missing Yr_{15} wage data, the same does not hold for Yr_{20}. Yet I still find that a larger percentage of late mothers lack Yr_{20} wage data because they were out of the labor market. Thus because the reason women are missing from the sample varies by timing, these results raise the possibility that the *type* of women excluded from the sample also varies systematically by the timing of their first birth.

The last two panels explore this possibility. The first compares means, between those included and excluded from the sample, of the elements that more immediately factor into a woman's inclusion — the timing of her first child, how many years I observe her beyond that point, and how much time she took off at first birth. As we see, especially strongly in the last group, those included have earlier first births, are observed for longer after that point, and take off less time. Yet notice that even among the latest group of mothers, those excluded are observed for an average of more than 10 years beyond first birth.

The next panel compares background characteristics of those included in the sample to those excluded. As we can see from the first column there are clear differences in factors such as parents' education and own education and starting wage, with those women included in my sample *negatively* selected. By timing we see that these factors are driven primarily by the penultimate group, where a larger set of characteristics are statistically different.

These results combine to show that my sample is somewhat negatively selected, more strongly so among later mothers, who in turn are also less likely to be captured in my sample. This raises the possibility that any OLS estimates of the effect of first birth timing on wage growth may provide a downward biased estimate of the true return to delay.

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[81] Only 2 women observed till age 40 fall out of the sample before their 13th year, the first used for Yr_{15}.

Table A-2: **Comparing those Included to those Excluded from the Sample**

		All						**Timing of First Birth (k_1)**							
					$1-2$			$3-5$			$6-8$			$9-Yr_{15}$	
Sample Size:															
- observed till age 40															
- first birth after t_1		1,399			168			415			369			447	
- married at pregnancy															
Of these, those with observed starting, Yr_{15}, and Yr_{20} wages		912			128			271			244			269	
Percent Included:		65.2%			76.2%			65.3%			66.1%			60.2%	
Among starting sample, reason excluded:															
Missing starting wage:															
Began working before 1978		0.23			0.28			0.27			0.21			0.20	
Missing starting wage (if $t_1 \geq 1978$)		0.04			0.03			0.06			0.05			0.03	
Missing Yr_{15} wage:															
Did not work (post-k_1) years 13-17		0.32			0.18			0.33			0.35			0.33	
Missing post-k_1 $Wage_{15}$ (if worked yrs 13-17)		0.12			0.15			0.07			0.10			0.16	
Missing Yr_{20} wage:															
Left sample before 18th year		0.14			0.28			0.14			0.18			0.10	
Did not work years 18-22		0.35			0.28			0.31			0.35			0.38	
Missing Yr_{20} wage (if worked yrs 18-22)		0.19			0.17			0.19			0.19			0.18	
	In		**Out**	**In**		**Out**	**In**		**Out**	**In**		**Out**	**In**		**Out**
Characteristics Driving Inclusion:															
Timing of first birth (k_1)	6.7	**	7.6	1.7		1.6	3.9		3.9	6.9		7.0	11.6	**	12.4
Years observed beyond k_1	16.5	**	15.2	21.6		21.1	19.3		19.2	16.2	+	15.5	11.6	**	10.5
Labor market gap at k_1 (mos)	11.6	**	25.3	11.7	+	19.7	17.0	**	28.6	12.6	**	23.6	5.1	**	25.0
Background Characteristics:															
Father's education	11.5	**	12.2	10.4		10.0	11.3	+	12.1	11.4	+	12.2	12.1	+	12.8
Mother's education	11.3	**	11.9	10.8		11.2	11.1	*	11.8	11.1	*	12.0	11.8		12.0
AFQT score (age-adjusted)	10.4		12.0	2.8		2.8	8.7		11.2	11.7		12.8	14.7		14.2
Highest grade expected (in 1979)	14.4		14.5	14.0		14.0	14.3		14.2	14.3	*	14.9	14.6		14.6
Education at t_1	13.4		13.6	12.9		13.1	13.4		13.4	13.4	*	14.0	13.6		13.6
Starting wage ($2000)	8.54	**	9.59	8.51		8.43	8.59	*	9.61	8.76	**	10.20	8.30	**	9.40
Predicted k_1 (at t_1)	5.1		5.0	3.5		2.9	4.5		4.2	5.6	*	5.0	5.9		5.9
Predicted number of children (at t_1)	2.4		2.5	2.4		2.6	2.4		2.6	2.4		2.5	2.4		2.4
Sample Size:	912		487	128		40	271		144	244		125	269		178
		1,399			**168**			**415**			**369**			**447**	

NOTES: $^+$ = significant at 10%; * = significant at 5%; ** = significant at 1%

Math Appendix

A Solving for the Marginal Benefit of Delay, $MB(k_{1i})$

Given the assumed path of wages in Equation 1, to solve for the marginal benefit of delay we must start by solving for the production function of earnings, $y = g(k_1)$. First, let me make the simplifying assumption that labor supply is not only independent of timing, but also constant throughout the lifecycle: $h_t = 1$ for all t. In this case the net present value of lifetime earnings, $g(k_1) = \int_T w_t h_t e^{-rt} dt$, will be equal to:

$$\begin{aligned}
&\int_0^{k_1} w_0 e^{g_1 t} e^{-rt} dt + \int_{k_1}^{T} w_0 e^{g_1 k_1} e^{g_2 (t-k_1)} e^{-rt} dt \\
&= \int_0^{k_1} w_0 e^{(g_1 - r)t} dt + \int_{k_1}^{T} w_0 e^{(g_1 - g_2)k_1} e^{(g_2 - r)t} dt, \\
&= \int_0^{k_1} w_0 e^{(g_1 - r)t} dt + \int_{0}^{T-k_1} w_0 e^{(g_1 - r)k_1} e^{(g_2 - r)s} ds,
\end{aligned}$$

which solves to

$$g(k_1) = \frac{w_0(g_2 - g_1)}{(g_1 - r)(g_2 - r)} e^{(g_1 - r)k_1} + \frac{w_0}{(g_2 - r)} e^{(g_2 - r)T} e^{(g_1 - g_2)k_1} - \frac{w_0}{(g_1 - r)}. \tag{A-1}$$

Given this production function in Equation A-1, the marginal benefit of delay will equal $g'(k_1)/g(k_1)$. Taking the linear approximation of this expression, this solves to

$$MB(k_{1i}) = (g_{1i} - g_{2i}) - k_{1i}\Big(\frac{(g_{1i} - g_{2i})(g_{2i} - r)}{e^{(g_{2i} - r)T} - 1}\Big).$$

Thus for each woman the marginal benefit of delay has an intercept term equal to the change in her wage growth rate at first birth, $dg_i = (g_{1i} - g_{2i})$, and the return is decreasing in k_1 (regardless of the relative size of g_{2i} and r, the coefficient on the second term is positive).

If I instead allow labor supply to vary over time because of children, the expression becomes more complicated. Supposing we take the simplest version of this, where h_t varies by the existence and age of kids, but not by the timing of the first:

$$\begin{aligned}
&h_t = 1 &&\text{for } t < k_1 \text{ and } t > k_1 + \Delta, \quad \text{and} \\
&h_t = (1 - \delta) &&\text{for } t \in \{k_1, k_1 + \Delta\}.
\end{aligned} \tag{A-2}$$

Thus I am assuming that women work full-time up to first birth, at which point they reduce their hours by a factor δ. They then work at this reduced level for Δ years, after which they return to full-time status.

Assuming the same structure of the wage path as above, the production function of earnings is now

$$\int_0^{k_1} w_0 e^{g_1 t} e^{-rt} dt + \int_{k_1}^{k_1+\Delta} (1-\delta) w_0 e^{g_1 k_1} e^{g_2 (t-k_1)} e^{-rt} dt + \int_{k_1+\Delta}^{T} w_0 e^{g_1 k_1} e^{g_2(t-k_1)} e^{-rt} dt,$$

$$= \int_0^{k_1} w_0 e^{(g_1-r)t} dt + \int_{k_1}^{k_1+\Delta} (1-\delta) w_0 e^{(g_1-g_2)k_1} e^{(g_2-r)t} dt + \int_{k_1+\Delta}^{T} w_0 e^{(g_1-g_2)k_1} e^{(g_2-r)t} dt,$$

$$= \int_0^{k_1} w_0 e^{(g_1-r)t} dt + \int_0^{\Delta} (1-\delta) w_0 e^{(g_1-r)k_1} e^{(g_2-r)s} ds + \int_0^{T-(k_1+\Delta)} w_0 e^{(g_1-r)k_1} e^{(g_2-r)\Delta} e^{(g_2-r)s} ds,$$

which solves to

$$\Big[\frac{w_0}{(g_1-r)} - \frac{w_0}{(g_2-r)}\Big(\delta(e^{(g_2-r)\Delta}-1)+1\Big)\Big] e^{(g_1-r)k_1} + \frac{w_0}{(g_2-r)} e^{(g_2-r)T} e^{(g_1-g_2)k_1} - \frac{w_0}{(g_1-r)}.$$

(As expected, this expression reduces to Equation A-1 if $\delta = \Delta = 0$.) Without calculating the full linearization of the corresponding marginal benefit function, I can show that the intercept term in $MB(k_1)$ is again a (more complicated) function of $(g_{1i} - g_{2i})$:

$$= \frac{(g_{1i}-g_{2i})\Big(e^{(g_{2i}-r)T}-1\Big) - \delta(g_{1i}-r)\Big(e^{(g_{2i}-r)\Delta}-1\Big)}{\Big(e^{(g_{2i}-r)T}-1\Big) - \delta\Big(e^{(g_{2i}-r)\Delta}-1\Big)}.$$

B Including Husbands in the Model of Optimal Timing

Notice that the optimization problem outlined in Section 2 ignores husbands. In truth we might want to consider this in a household perspective, where utility is a function of household income, and household taste for early parenthood (although I will assume that the latter is defined by the woman's preferences). Considering this in light of Figure 3, if we assume that husbands' earnings are unaffected by k_1, then the production function would simply shift upwards by the value y_h, reflecting the husband's lifetime earnings.

The question is whether y_{hi} will vary systematically with either dg_i, the change in the wife's wage growth at k_1, or ψ_i, the taste for early motherhood. Consider the first. If dg_i is positively correlated with g_{1i}, meaning women in higher earning careers experience a larger drop in wage growth at k_1, then assortive mating suggests that women with a larger benefit of delay will marry men with higher lifetime earnings. The positive income effect associated with the latter would thus in part offset the incentive to delay, lowering k_1^*.

To think through the effect of such a relationship on the OLS estimate of the mean return to delay, $\overline{dg}$, looking at the picture on the right of Figure 3, the level difference in the two production functions would increase (higher earning women marrying higher earning men). As noted, this would induce higher return women to have earlier children, and the OLS bias would become larger – the dashed line would become steeper. (If instead $Corr(dg_i, g_{1i}) = 0$ we would see no change in the OLS estimate. But if the correlation were instead *negative* – higher return women marry lower earning men – the bias would become smaller.)

Consider this now in terms of variation in the taste for early motherhood, ψ_i. Suppose women with greater taste for early children actively search for men with higher earnings. In this case we would see in the figure on the left that women with larger ψ_i would also have systematically higher production functions, with the associated positive income effect pushing births even earlier. If this were the case, the OLS estimate would now be biased towards zero – the dashed line would become flatter than the production function faced by any given woman. If, however, women with taste for early motherhood are forced to 'settle' for lower quality men in order to marry soon enough to have children early, the negative correlation between ψ_i and y_{hi} would instead bias the OLS estimate upwards.