Royal Holloway, University of London
Department of Economics

Essays on Female Labor Supply and Flexible Working Arrangements

A thesis submitted for the degree of
Doctor of Philosophy

Amairisa Kouki

January, 2019

Declaration of Authorship for Co-Authored Work

I Amairisa Kouki hereby confirm that the thesis I am presenting has been co-authored with Robert M. Sauer.

Within this partly co-authored work, I declare that:

The chapter *Flexible Working Arrangements and Women's Lifetime Outcomes* is entirely my own work.

The chapter *Working at Home and the Female Wage Penalty: Flexible Working Arrangements Can Be Costly* is co-authored. I downloaded the data from "National Longitudinal Surveys: A Program of the U.S. Bureau of Labor Statistics". I performed the analysis with Robert M. Sauer.

Acknowledgments

I would like to thank my advisers Robert Sauer, Ija Trapeznikova, and Ronni Pavan for their support, assistance and mentoring. I would like to express my gratitude to Robert Sauer, as this thesis would not have been possible without his guidance and continuous encouragement. I thank Daniel Hamermesh, Dan Anderberg, Arnaud Chevalier, Melanie Lührmann, Manolis Galenianos, Jesper Bagger and Juan Pablo Rud for insightful discussions, useful comments and suggestions. I thank my friends Georgia, Fanio, Sofia, Tina, Stefanos, Nadia, Spyros, Vaios, Michelle, Flo, Annika and all my classmates. All of you have inspired and motivated me making the PhD more tolerable. I also thank my "second family", Evi, Thodoris, Sissi and Giannis. Finally, I thank Dimitris, for his unconditional love, practical and emotional support throughout these years.

This thesis is dedicated to my beloved parents and brother.

I would not have come this far without them.

Abstract

Fertility and family responsibilities are key factors leading to career interruptions and earnings disadvantages for women. Flexible working arrangements, which afford employees the possibility of workplace alterations, could potentially curb the negative consequences. The two chapters of this thesis examine how workplace flexibility, as captured by the choice of work location (at home vs. on site), affects women's lifetime outcomes.

The first chapter quantifies the pecuniary and non-pecuniary returns associated with workplace flexibility for women. A dynamic model of joint marriage, fertility and employment decisions is formulated and estimated by the simulated method of moments (including indirect inference) using data from the NLSY79. Explicitly modelling women's lifetime choices in a unified framework addresses issues of endogeneity, selection and heterogeneity biases. The results from counterfactual experiments show the losses from a lack of work location flexibility. When there is less of a penalty for working at home, the proportion of women opting for flexibility, female labor force attachment, earnings and utility all increase in the long run. The pecuniary penalties from flexibility are relatively more important than the non-pecuniary penalties. When a subsidy or equivalent tax deduction is provided to women for working from home, lifetime earnings increase. The lifetime benefit from the subsidy is greater than the cost. The birth rate also increases.

The second chapter focuses on the pecuniary effects of workplace flexibility within an alternative methodological approach. Instrumental variables estimates of the impact of flexibility on earnings are presented using a temporary health shock to a child as an instrument for working at home. A temporary health shock to a child raises the opportunity cost of working on site, thereby increasing the demand for remote work in order to more flexibly care for the child. The penalties from working at home are substantially different from OLS and fixed-effect estimates, suggesting that there are significant biases due to unobserved omitted variables that change over time as well as possible reverse causality.

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1 Flexible Working Arrangements and Women's Lifetime Outcomes

Amairisa Kouki

Abstract

This paper quantifies the pecuniary and non-pecuniary returns to workplace flexibility for women. A dynamic model of joint marriage, fertility and employment decisions is formulated and estimated by the simulated method of moments (including indirect inference) using data from the NLSY79. The existing literature is extended by introducing a dimension of flexibility through the choice of work location (at home or on site). The results from counterfactual experiments illustrate that flexibility substantially affects women's lifetime outcomes. The pecuniary penalties from flexibility are relatively more important than the non-pecuniary penalties. When there is less of a penalty for working at home, the proportion of women opting for flexibility, female labor force attachment, earnings and utility all increase in the long run. Policies, such as subsidies that aim to encourage location flexibility, may be key to strengthening female labor force attachment along with fertility.

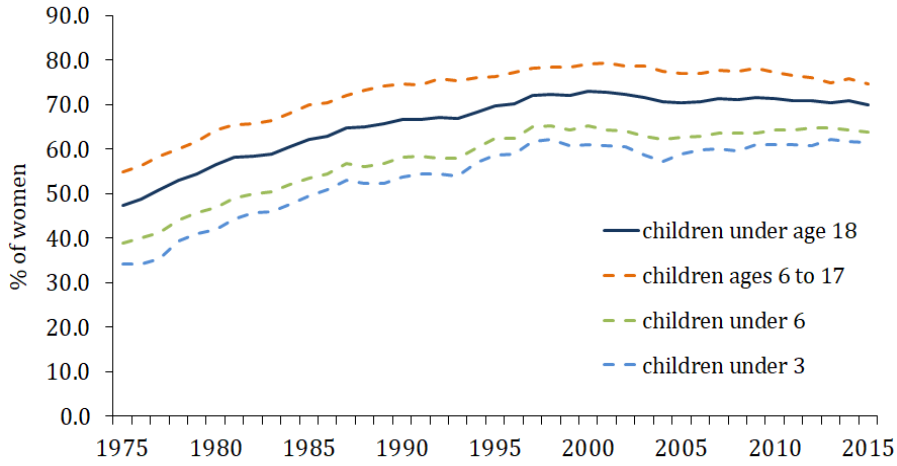
Keywords: *labor supply, work arrangements, fertility, childcare, dynamic programming, simulation*
JEL Classification: *C53, C61, J13, J22*

1.1 Introduction

Female labor supply behavior and its implications for other lifetime outcomes have been the subject of extensive research by economists and other social scientists. Data from the Current Population Survey (CPS) reveal that, among American mothers with children under 18, the labor force participation rate increased dramatically from 47% in 1975 to approximately 70% and has remained at this level over the last 20 years (Figure 1). In 2015, 75% of unmarried mothers with children under 18 were in the labor force compared to 67% of married mothers with children in the same age range. Fertility and family responsibilities are important factors leading to career interruptions and earnings disadvantages for women (Eckstein and Wolpin, 1989; Francesconi, 2002; Keane and Wolpin, 2010; Adda et al., 2017). Flexible working arrangements, which afford employees the

possibility of workplace alterations, could potentially ease these economically harmful effects (Goldin, 2014; Goldin and Katz, 2016). Investigating the extent to which workplace flexibility, as captured by the choice of work location, affects female labor supply is important for the analysis of current public policies and for creating new initiatives aimed at influencing female lifetime outcomes.

Figure 1.1: Labor Force Participation of Women by Age of Youngest Child, 1975-2015



Source: U.S. Bureau of Labor Statistics, CPS, 1975-2015, Annual Social and Economic Supplement
Included are people 16 years of age and older residing in any of the 50 states or the District of Columbia, who are not confined to institutions, such as nursing homes and prisons, and who are not on active duty in the Armed Forces. For more information see BLS report.

This issue is worth investigating for two additional reasons. First, previous literature that focuses on fertility-related career costs distinguishes between part-time and full-time employment but pays limited attention to other dimensions affecting women's employment choices over time, such as work location (Eckstein and Wolpin, 1989; Francesconi, 2002; Keane and Wolpin, 2010; Adda et al., 2017). Second, employment decisions are also affected by non-economic utility flows. There is no consensus about the nature of these flows when working from home. Working from home might be considered beneficial by employees, as it may offer higher autonomy and decrease work-family conflicts (Gajendran and Harrison, 2007). However, working remotely has been associated with negative feelings and fears of disapproval for taking advantage of flexible arrangements, and might also signal a reduced commitment to work (Allen et al., 2015).

Despite women's higher educational and vocational attainments, family-related responsibilities and tasks continue to be disproportionately allocated between

spouses.[1] One challenge is to accommodate conflicting family and workplace demands. Recognizing these difficulties, an increasing number of employers provide flexplace. One form of flexplace is working from home on an occasional, part-time or full-time basis.

According to the Decennial Census, the proportion of workers working from home at least three of five days per week was 3.3% in 2000 and has not grown much since 1980 (when 2.3% of employees worked at home at least 3 out of 5 days). The Survey of Income and Program Participation (SIPP) reports that there is an increase in the percent of work-at-home employees, from 7.5% in 2002 (8.0% and 7.1% for women and men, respectively) to approximately 9.5% in 2010 (9.5% and 9.4% for women and men, respectively).[2] The 2016 National Study of Employers presents an increasing trend in the percentage of employers allowing for some flexibility related to working at home. The number of employers who allow for occasionally working some regular paid hours at home increased from 34% in 2005 to 66% in 2016.[3]

The National Longitudinal Survey of Youth 1979 (NLSY79) provides detailed information about working from home. In 1988, the NLSY79 introduced a question concerning the number of hours per week usually worked at home. As shown in Table 1.1, women with some work-at-home experience had significantly higher average accumulated total years of experience, unconditionally and conditional on the number of children.

In this paper, new evidence about working from home and women's lifetime

[1] The percentage of women who reported doing housework on an average day remains relatively high, at 50% in 2015 and 54% in 2003, compared to the respective 22% and 19% for men (American Time Use Survey (ATUS), 2015). In households with children under 6, time spent providing physical care (such as bathing or feeding a child) averaged 1.2 hours in 2003 and 1.0 hour in 2015 for women and 24 minutes in 2003 and 25 minutes in 2015 for men. See Hersch (2009), among others, for evidence of the negative relation between housework and wages.

[2] In 2010, 19% of employees in management, business, and financial occupations and 13% of those in professional and related occupations reported working from home exclusively or for at least one full day a week and workers in other occupations were less likely to work from home. Employees aged 25 and over, married and highly educated, with a bachelor's degree or more, are more likely to work from home (SIPP). The estimates of work-at-home employees from the Decennial Survey and SIPP include self-employed workers and are not directly comparable because each survey queried workers about home-based activities differently.

[3] The increase is not so sharp in the case of allowing for working from home more regularly (31% in 2005 to 40% in 2016). The same study states that small employers (50 to 99 employees) are more likely than large employers (1,000 or more employees) to allow all or most employees to work some regular paid hours at home occasionally (9% of small employers and 1% large ones). However, small employers are less likely than large employers to allow all or most employees to work some regular paid hours at home on a regular basis (2% of small employers and 3% large ones). The main reasons cited by employers for providing workplace flexibility are retention of employees (39%), recruitment of employees (15%) and increase in productivity (9%). More altruistic reasons for such programs are associated with helping employees manage work and family life (21%), providing job satisfaction (12%) and improving morale (11%). The main obstacle to implementing workplace flexibility, cited by 28% of the employers, is cost. The second most frequently cited obstacle is the difficulty of supervising employees (14%), followed by job requirements and workload that do not allow for such programs (11%), potential loss of productivity and ensuring that work is done and satisfies the customer (both 10%), a lack of staff to implement such programs (9%) and potential abuse (8%).

Table 1.1: Labor Force Attachment

	With work-at-home experience	Std. dev.	Without work-at-home experience	Std. dev.
Total experience	16.20	6.44	14.12	6.80
Number of children				
0	17.48	6.41	16.67	6.74
1	16.02	5.85	14.08	5.95
2	15.79	6.36	13.68	6.69
+3	14.87	6.70	11.51	6.59

Source: NLSY79
Notes: Total experience is defined as total years of labor force participation.

outcomes is presented. To the best of my knowledge, this is the first paper to introduce work location as a separate choice within a dynamic structural model. Other approaches primarily focus on the interactions between fertility, part-time and full-time employment, ignoring the fact that employees consider both time and location when making labor supply decisions (Hotz and Miller, 1988; Eckstein and Wolpin, 1989; Francesconi, 2002; Keane and Wolpin, 2010; Adda et al., 2017). Including work location in addition to time within a unified model provides parameter estimates that help indicate the importance of workplace flexibility for women's lifetime outcomes.

The main goal of this paper is to quantify the pecuniary and non-pecuniary returns to workplace flexibility, as captured by working from home. I construct and estimate a dynamic discrete choice model of joint marriage, fertility and employment decisions made by women. In the model, women are forward-looking and make their decisions annually. Preferences are defined for consumption, marriage, hours (part-time or full-time employment) and location of work (at home or on site), and the number and age of children. Job offers partly depend on previous employment state, work hours and work location. An individual's skill endowment is modelled as an unobserved individual-specific time-invariant factor. The marriage decision is constrained by receipt of a marriage offer. If a woman is single, she may or may not receive a marriage offer, which she can accept or reject. One of the main trade-offs in the model arises from allowing for different forms of experience and child-care costs. Over their lifetimes, women endogenously accumulate human capital in the form of on-site and at-home work experience. Childcare costs depend on the employment state and age of the

youngest child.

The structural estimates of the dynamic decision model reveal that the pecuniary returns to workplace flexibility are negative and substantial. That is, an additional year of work-at-home experience decreases part-time wages by 3.5%, full-time at home wages by 1.1% and full-time on-site wages by 5.9%. At the same time, the model indicates positive selection into flexible working arrangements.

The estimated model is also used to perform counterfactual experiments. One experiment allows calculation of the earnings and welfare effects of an unavailability of remote working. Remote work elimination decreases lifetime earnings by 6.3% and lifetime utility by 1.5%. Another experiment measures the relative importance of the pecuniary and non-pecuniary penalties from working at home. The elimination of both the pecuniary and non-pecuniary penalties results in an increase in lifetime earnings and utility of 21.1% and 6.4%, respectively. 68.8% of the total increase in lifetime utility due to the elimination of the negative returns to flexibility can be attributed to the elimination of the pecuniary penalties. If a subsidy or an equivalent tax deduction that corresponds to a 35% decrease in childcare costs is provided to women for working from home, it would increase the proportion of those who opt for flexibility by 26.8%. Lifetime earnings and fertility increase by 3.4% and 4.3%, respectively.

The rest of the paper is organized as follows. Section 2 briefly reviews the related literature. Section 3 describes the data and provides empirical evidence about the relationship among different lifetime outcomes. Section 4 develops the model. Section 5 discusses the estimation method and identification. Section 6 presents the estimation results and model fit. Section 7 elaborates on the estimation results and discusses the counterfactual exercises. Section 8 summarizes and concludes.

1.2 Literature Review

The growth in remote working in recent years suggests that both employers and employees have recognized the benefits of workplace flexibility in reconciling work and family life. An extensive literature focuses on women's disproportionate

caregiving responsibilities and their implications for the family or motherhood gap, i.e., lower wages for mothers than childless women (Waldfogel, 1998), as well as for the gender pay gap (Bertrand et al., 2010; Goldin, 2014). However, the way workplace flexibility affects women's remuneration is under debate.[4]

Recent studies show how important labor market experience is for women's earnings disadvantages (Mincer and Polachek, 1974; Blau and Kahn, 2000; Adda et al., 2017). These studies are based upon the model of human capital depreciation and focus on the trade-offs between career and family. The presence of children and related career interruptions are associated with substantial earnings penalties due to lower skill accumulation. More family-friendly occupations such as physicians, veterinarians and pharmacists appear to decrease non-employment spells and aid in balancing work and family commitments by providing greater predictability of the career trajectory, substitutability across workers and temporal flexibility for meeting specific time demands (Goldin and Katz, 2008; Goldin, 2014; Goldin and Katz, 2016). However, many occupations do not provide opportunities for flexibility and impose large penalties for divergence from long-hour schedules and uninterrupted careers (Bertrand et al., 2010; Goldin and Katz, 2011).

Multiple studies approximate flexibility as the possibility of working fewer hours, and study the trade-off between part-time work and hourly wages using hedonic wage models (Moffitt, 1984; Altonji and Paxson, 1988; Blank, 2010). These models exclude the possibility that an employer offers both a higher wage and flexibility, which, under specific circumstances, may result in an increase in the firm's profit and a reduction in turnover. As a remedy to this restriction, more recent studies introduce frictions and estimate job search models without (Blau, 1991; Bloemen, 2008) or with bargaining (Flabbi and Moro, 2012) over wages and hours in an attempt to recover preferences about hours-related flexibility.

In addition to being able to decrease one's hours, Leber Herr and Wolfram (2012) use other firm-specific family friendliness rankings to provide evidence on the causal role of the absence of workplace flexibility in "pushing" Harvard graduates out of the labor force at motherhood. They also associate working in a

[4] See Allen et al. (2015) and Glass and Noonan (2016) for reviews of research on telecommuting.

flexible job before having children with a woman's labor supply five years later. Other studies focus on specific fringe benefits such as maternity leave and the advantages of their provision on the post-birth labor market outcomes of mothers in California, showing increases in usual weekly hours worked and increases in wages between 10% and 17% (Rossin-Slater et al., 2013).

Oettinger (2011) uses U.S. census data on the method of transportation used to get to work and provides evidence on the evolution of home-based employment in the U.S. from 1980 to 2000. He shows that the factors associated with the increase in the number of home-based workers and the decrease in their wage penalty are the increase in the employment share of women, who tend to value home-based arrangements more than men, and the decreasing employer costs of offering home-based work arrangements due to the expansion of technology. Black et al. (2014) uses U.S. census data on the total commuting times for the same decades and investigates the negative correlation between commuting times and married women's labor force participation rates. The probability of not being in the labor force increases the most with commuting times for married women with younger children.

Golden (2008) uses the 2001 May CPS Supplement on Work Schedules and Work at Home to show that there are disparities in access to location flexibility. Women, whites, those who are married, educated workers, and those in higher-skilled jobs have an increased likelihood of working from home. Rather than using cross-section datasets, Glass and Noonan (2016) consider telecommuting in a longitudinal gender and earnings analysis. They employ alternative fixed-effect models and provide evidence that work location does not significantly impact earnings in the first 40 hours per week. Overtime work appears to be remunerated more when performed on site.

This paper extends the existing literature in multiple ways. First, it constructs a dynamic discrete choice model that includes work location as a separate choice in addition to time devoted to the labour market. Explicitly modelling joint marriage, fertility and employment choices in a unified framework resolves several issues of endogeneity, most notably biases due to selection, unobserved

heterogeneity and simultaneity. Second, it uses a nationally representative sample from the NLSY79, takes advantage of the panel structure of the data, and exploits questions on hours worked on-site and hours worked at home. Third, unlike previous studies, both the pecuniary and non-pecuniary returns to flexible work arrangements are measured and their relative importance is examined. Fourth, this paper contributes to the literature on childcare and career interruptions through counterfactual policy experiments that alter the availability and the returns to workplace flexibility.

1.3 Data and Descriptive Statistics

Data

The data are taken from the National Longitudinal Survey of Youth 1979 (NLSY79). The NLSY79 is a large and nationally representative sample of American young men and women who were 14-22 years old when they were first surveyed in 1979. Data are available at an annual frequency until 1994, and biannually from 1994 onward. Following the same individuals, NLSY79 gathers event history data related to respondent's education, labor market experience, family background and life, wages and earnings.[5]

In 1988, the NLSY79 introduced various questions on the number of hours per week usually worked at home. Responses to these questions are used to estimate the model. The model treats work at home as a discrete choice. The respondents' answers to these questions allow for creating two types of accumulated experience: one for working exclusively on site and one for working at home.

In the analysis, a respondent is considered to have worked at home if she is a full-time employee who reported having worked at home for more than 30 hours during the year.[6] The rest of the variables used in the analysis are defined in Appendix B.

[5] The sample originally included 12,686 respondents and consists of a cross-sectional sample (6,111 total - 3,108 women and 3,003 men); a set of supplemental samples designed to oversample civilian Hispanic or Latino, black, and economically disadvantaged, nonblack/non-Hispanic youths (5,295); and a military sample designed to represent the population serving in the military as of September 30, 1978 (1,280). More information on NLSY79 can be found here.

[6] Few respondents in this sample report working part-time and at home (3.7% of the observations).

Basic Patterns for Work at Home

In this subsection, relationships between motherhood, work-at-home experience, labor force participation rates, hours worked and the hourly wages of women are displayed.[7] I first document changes in labor market outcomes around childbirth. For each mother, $t = 0$ is the year in which the first child is born, $t = -5, ... -1$ are the years prior to the birth and $t = 1, ..., 10$ are the years after the birth. Outcomes are measured relative to the year just before the birth of the first child ($t = -1$).

In Panel A of Figure 2, participation rates increase in a parallel manner for mothers with and without work-at-home experience until the year of birth of the first child. Obviously, women's participation rate is affected by childbirth. With work-at-home experience, mothers' participation rate reverts faster to the pre-birth level in the years following the first birth.

Panel B of Figure 2 shows the evolution of hours worked relative to the year prior to the first birth. The hours worked show a similar pattern to that of the participation rates. For mothers with work-at-home experience, the hours worked gradually return to the pre-birth levels. Panel C of Figure 2 plots the hourly wage evolution. For both mother groups, hourly wages decrease immediately and substantially after the birth.

Figure A.2 presents the effects of births on women's labor outcomes conditional on the number of children.[8] As the number of children increases, labor market outcomes tend to return faster to the pre-first-child levels for mothers with work-at-home experience.

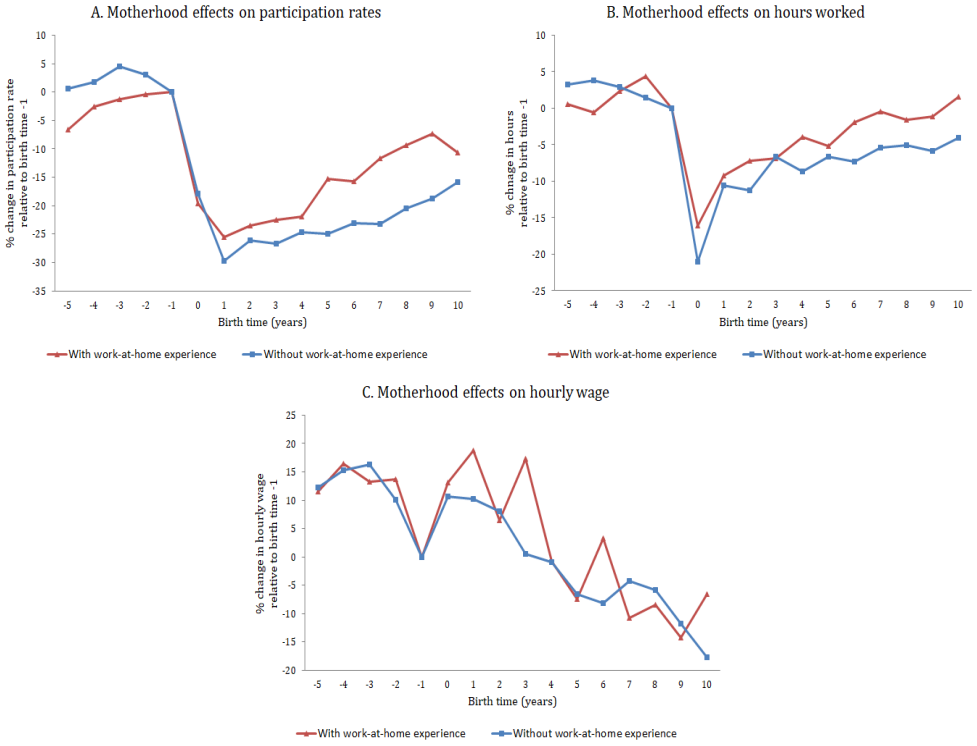
Table 1.2 presents the proportions of women with and without a preschool child reporting working at home and the relevant hours worked at home as a proportion of the total hours worked annually.[9] The top panel shows that the proportion of women and hours worked at home substantially increase with at least one preschool child. The bottom panel is conditional on different occupations. The proportions of women working at home increase in each

[7] See Figure A.1 for the different effects of parenthood on the labor outcomes of women and men.

[8] See Figure A.3 for the different effects of parenthood on the relevant women's and men's labor outcomes conditional on the number of children.

[9] See Table 1.A.2 for a finer classification of the 10 most and least frequent occupations working at home in this sample.

Figure 1.2: Motherhood and Labor Market Outcomes



Source: NLSY79

The figures show percentage changes in the participation rates, mean hours worked annually and hourly wages of white women, who had their first child when aged 15 - 42. Wages are deflated using CPI index. The base year is 2005.

category with the existence of a preschool child, while the proportion of hours either increases or changes slightly. Women tend not to work exclusively from home. Women in high-skilled occupations, i.e., professionals, technical workers and managers tend to work more at home in terms of proportions. Women in low-skilled occupations, i.e., services, tend to work more at home in terms of hours.

Table 1.2: Annual Hours Worked at Home

	Work at home %	% Mean hours at home %
Women with at least one preschool child	23.00	28.88
Women without preschool children	17.38	21.72

	Women with at least one preschool child		Women without preschool children	
	Work at home %	Mean hours at home %	Work at home %	Mean hours at home %
Professional, technical, managers	34.04	17.60	29.29	17.55
Sales and clerical	13.82	25.32	10.50	21.04
Service	30.71	74.76	12.97	49.10
Craftsmen	11.21	18.34	9.68	14.72
Operatives and non-farm labourers	3.42	47.75	3.13	27.05

Source: NLSY79
Notes: Individuals' reported hours after 1988 are used for the calculations. A preschool child is at most 6 years old. Women in full-time employment are included.

Descriptive Statistics

Table 1.3 presents summary statistics for the sample used in estimation. Women have on average 13.2 years of education, and their husbands have attained similar average levels of education. Table 1.A.1 presents evidence on positive assortative mating in education.[10] On average, women work more hours and receive relatively higher wages when working from home compared to working on site.

Table 1.3: Summary Statistics

	Mean	Std. Dev.
Age	37.61	5.91
Education		
Highest grade completed (hgc)	13.22	2.03
Less than high school	0.07	0.25
High school or at most some college	0.72	0.45
At least bachelor's degree	0.21	0.41
Employment		
Labor force participation in years	15.04	6.72
Mean annual hours in 000's		
Part-time	1.02	0.32
Full-time at home	2.40	0.53
Full-time on site	2.07	0.30
Mean annual wage in 000's (2005$)		
Part-time	12.90	11.69
Full-time at home	46.53	39.14
Full-time on site	31.93	19.25
Fertility and Marriage		
Birth rate	0.06	0.23
Marriage rate	0.74	0.44
Husband's annual wage in 000's (2005$)	56.38	54.89
Husband's highest grade completed	13.46	2.37
Number of observations	*28,294*	
Number of women	*1,712*	

Source: NLSY79
Notes: Calculations include individuals' responses after 1988.

The employment choice distribution by age range is displayed in Panel A of Table 1.4. The percentage of women who work full-time on site exclusively increases with age. Almost 11% of women in the sample work full-time at home.

[10] Positive assortative mating refers to a positive correlation in sorting between spouses. The correlation between married women's highest grade completed and their husbands' is 0.53. In general, married high-school graduates and above tend to have similar educational attainment as their spouses.

The percentage of women who choose the part-time and full-time at home option increases slightly for those aged 32 to 39. Women in this age ranges have, on average, the most children under age 18.

The choice distribution by the number of children is displayed in Panel B of Table 1.4 and reveals how fertility might affect women's employment choices. More than 60% of women work full-time on site when they have no children. On the contrary, more women move to non-employment and part-time as the number of children increases.

Table 1.4: Employment Choice Distributions

A. Employment Choice Distribution by Age Range

Age	Non-employed	Part-time	Full-time at home	Full-time on site	Number of observations
28-31	25.13	22.17	9.91	42.80	5,512
32-35	20.92	23.95	10.65	44.48	6,120
36-39	14.96	23.53	12.19	49.32	5,547
40-43	15.30	22.83	10.40	51.47	5,137
44-48	18.10	20.48	11.11	50.32	5,978

B. Employment Choice Distribution by Number of Children

Number of children	Non-employed	Part-time	Full-time at home	Full-time on site	Number of observations
0	10.61	15.55	12.90	60.94	8,448
1	16.99	22.47	10.93	49.61	4,967
2	21.19	25.17	10.64	43.00	9,017
+3	29.21	28.83	8.19	33.78	5,862
Total	*18.95*	*22.58*	*10.86*	*47.60*	*28,294*

Source: NLSY79
Notes: Calculations include individuals' responses after 1988. Women with at least one child less than 18 years old are included in the calculations of Panel B.

The one year employment transition matrix is shown in Panel A of Table 1.5. Each row presents the probability of remaining or moving to an employment state at *age+1* given the employment state at the current *age*. The probability of remaining at the same state in the following period, which captures persistence, is represented by the diagonal elements. For women in part-time employment, compared to those in full-time employment, persistence is lower, and the transition to non-employment is higher.

Panel B of Table 1.5 shows the annual employment transitions after a childbirth. Each row presents the probability of remaining or moving to an employment state the year after childbirth, given the employment state when the *childbirth* occurs. Compared to Panel A, non-employed women have a higher probability of remaining non-employed the year after the childbirth. Persistence is higher at non-employment and full-time states. Part-time employment becomes even more

transitional towards non-employment. Women who work full-time at home have the lowest transition rate to non-employment.

Table 1.5: Employment Transitions

A. Yearly Employment Transitions

	age+1			
age	Non-employed	Part-time	Full-time at home	Full-time on site
Non-employed	66.76	27.47	1.38	4.39
Part-time	12.68	58.65	4.82	23.84
Full-time at home	1.68	10.36	71.50	16.47
Full-time on site	1.33	10.62	3.90	84.15

B. Yearly Employment Transitions after Childbirth

	childbirth+1			
childbirth	Non-employed	Part-time	Full-time at home	Full-time on site
Non-employed	80.30	16.97	1.52	1.21
Part-time	27.58	49.86	5.01	17.55
Full-time at home	3.70	12.96	68.52	14.81
Full-time on site	5.44	10.89	3.44	80.23

Source: NLSY79
Notes: Calculations include individuals' responses after 1988.

Regression Analysis

In this section, reduced-form regressions are estimated in order to examine relationships between the state variables in the structural model and different lifetime outcomes. Linear probability models are estimated for the outcomes of working full-time at home, being married and giving birth. Columns (2), (4) and (6) in Table 1.6 report results for linear probability models with fixed effects. The estimates indicate that college-educated women are more likely to work from home, be married and give birth. The results also indicate that the number of children increases the probability of working at home, being married and giving birth.

Table 1.7 reports the results of wage regressions. The dependent variable is the log of annual wages. Columns (1) and (2) show positive and significant effects of education and experience on earnings. The effect of working at home on wages is also positive and precisely estimated. This is in sharp contrast with the estimates from the fixed-effect regressions in Column (3), where the effects of working at home on wages are negative and significant. These results are

Table 1.6: Linear Probability Models

	full-time at home		married		birth	
	OLS (1)	FE (2)	OLS (3)	FE (4)	OLS (5)	FE (6)
constant	-0.672**	-0.564**	0.405**	0.222	0.816**	0.969**
	(0.155)	(0.189)	(0.114)	(0.147)	(0.059)	(0.065)
$I(12 \leq hgc < 16)$	0.083**		0.115**		0.017**	
	(0.009)		(0.011)		(0.004)	
$I(hgc \geqslant 16)$	0.293**		0.191**		0.054**	
	(0.013)		(0.012)		(0.005)	
age	0.035**	0.034**	0.001	0.021**	-0.039**	-0.051**
	(0.008)	(0.010)	(0.006)	(0.008)	(0.003)	(0.003)
age sq./100	-0.044**	-0.040**	-0.005	-0.029**	0.042**	0.056**
	(0.011)	(0.014)	(0.008)	(0.010)	(0.004)	(0.004)
number of children	0.008	0.048*	0.273**	0.208**	0.045**	0.190**
	(0.009)	(0.026)	(0.006)	(0.024)	(0.002)	(0.008)
number of children sq.	-0.001	-0.014*	-0.049**	-0.044**	-0.007**	-0.038**
	(0.002)	(0.009)	(0.002)	(0.006)	(0.001)	(0.003)
married	0.014*	-0.003			0.025**	0.032**
	(0.008)	(0.012)			(0.002)	(0.004)
Number of women	1,451	1,451	1,712	1,712	1,712	1,712
Number of observations	10,027	10,027	28,294	28,294	28,294	28,294
ρ		0.4311		0.5861		0.1893
R^2	0.0626	0.0092	0.1053	0.0212	0.0645	0.0707

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. Columns (1) and (2) include women in full-time employment only.

suggestive of positive selection into jobs that offer locational flexibility.[11] They are in accordance with the negative and significant returns to work-at-home experience from the structural model specified below. The structural estimates yield even higher wage penalties from flexibility. The structural model also has the advantage of examining the effects of flexibility on a range of other lifetime outcomes such as marriage, fertility and labor supply, while taking into account forward looking behavior, unobserved heterogeneity and the simultaneity of these other decision dimensions.

Table 1.7: Wage Regressions

	OLS (1)	OLS (2)	FE (3)
constant	8.659**	8.998**	9.469**
	(0.032)	(0.034)	(0.042)
$I(12 \leq hgc < 16)$	0.197**	0.199**	
	(0.023)	(0.023)	
$I(hgc \geqslant 16)$	0.652**	0.631**	
	(0.028)	(0.027)	
experience	0.053**	0.040**	0.031**
	(0.002)	(0.002)	(0.003)
experience sq./100	-0.047**	-0.034**	-0.035**
	(0.003)	(0.003)	(0.004)
non-employment (t-1)		-0.557**	-0.314**
		(0.031)	(0.031)
part-time (t-1)		-0.359**	-0.108**
		(0.016)	(0.018)
full-time at home (t-1)		0.046*	-0.059**
		(0.025)	(0.025)
Number of women	1,634	1,634	1,634
Number of observations	14,488	14,488	14,488
ρ			0.552
R^2	0.228	0.270	0.058

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. Experience is defined as the accumulated number of hours worked annually in thousands. Full-time on site at *t-1* is the reference group.

[11] The results are robust to various alternative specifications including those controlling for employment state at t and when considering income from unemployment benefits or other public assistance when not employed. Returns to work-at-home experience, as captured by full-time at-home work at $t-1$, are negative and significant.

1.4 Model

Women are assumed to behave as if they were solving a discrete choice dynamic programming problem. The length of a period is a year, and a woman makes decisions at each age a between the ages of 25 and 55. At age 25, women differ in their completed education level, accumulated work experience, marital status, number of children, age of the youngest child and unobserved type. Choices are made about:

(1) *Employment*. The employment choice set K contains four mutually exclusive elements: non-employment (k=ne), part-time (k=part), full-time with work at home (k=home) and full-time exclusively on site (k=site). The employment choice variable is denoted by $d_a^k, k \in K$ and is defined as $d_a^k = 1$ if a woman chooses the employment state k at age a and $d_a^k = 0$ otherwise.

(2) *Marriage*. Marital status at each age a is denoted by m_a, where $m_a = 1$ if a woman is married and $m_a = 0$ otherwise. Individuals that cohabitate are considered as single.

(3) *Fertility*. The fertility choice at each age a is denoted by f_a, where $f_a = 1$, if a child is conceived at age a and $f_a = 0$ otherwise. Fecundity constraints are imposed by setting $f^a = 0$ for women older than 42. Additional fecundity constraints, such as the probability of miscarriage or abortion, are not incorporated. If a woman chooses to conceive at age a, live births occur with certainty. A woman can choose to conceive a child in any employment and marriage state. The possibility of multiple births is excluded.

At each age, if a woman has less than 4 children and is at a fecund age, she chooses among 16 mutually exclusive alternatives. If she has 4 children or is older than 42, she chooses among 8 mutually exclusive alternatives. In this model, education is assumed to be completed by age 25. Hence, it is incorporated as an exogenous factor.

The Structure

In each period, women receive utility from consumption, marriage, children, and leisure. The utility flow also depends on tastes and random shocks that vary over marriage and employment states. The model captures differences in the

behavior of women who are employed or non-employed, married or not married and with or without children. It accounts for multiple dynamic considerations: human capital accumulation through work experience from working on site and at home, marriage and children effects. When women decide on their employment state, they can foresee expected future payoffs. When they decide to have children, they can anticipate the expected increased costs of childcare as well as the benefits from having children. Utility from consumption interacts with each employment, marriage and fertility state. Disutility from work effort varies by the hours spent at work. All choices are made jointly and are discussed separately below.

Labor Supply. The employment choices available in each period depend partly on the previous period's employment status. When currently non-employed, a woman has a probability π_0 of receiving a job offer. When currently employed, one can always choose to continue in the same employment state. In general, job offers may be received for working part-time, full-time at home or full-time on site. Job offer probabilities are specified as a multinomial logit so that only one offer in each period can be received and job offer probabilities lie between zero and one.

More formally, the probability of receiving an offer in a paid employment state $k =$ *part-time, full-time at home, full-time* on site is:

$$\pi_k = \frac{exp(\rho_k)}{\sum_{i \in k} exp(\rho_i)}. \tag{1.1}$$

Women's wages in paid employment are defined over the hours and location of work. If in part-time employment, the log of a woman's wage is specified as:

$$w_a^{part} = exp(b_0^{part} + b_1^{part} x_a + b_2^{part} {x_a}^2 + b_3^{part} h_a + b_4^{part} {h_a}^2 + b_5^{part} \eta + \varepsilon_a^{part}) \tag{1.2}$$

If in full-time employment, the wage equations are:

$$w_a^{home} = exp(b_0^{full} + b_1^{full} x_a + b_2^{full} {x_a}^2 + b_3^{home} h_a + b_4^{home} {h_a}^2 + b_5^{home} \eta + \varepsilon_a^{full}) \tag{1.3}$$

$$w_a^{site} = exp(b_0^{full} + b_1^{full} x_a + b_2^{full} {x_a}^2 + b_3^{site} h_a + b_4^{site} {h_a}^2 + b_5^{site} \eta + \varepsilon_a^{full}) \tag{1.4}$$

where x_a is the accumulated experience from working on site and h_a is the accumulated experience from working at home. η is a time-invariant individual specific component that determines a woman's type. The random shocks to the wages in each period are ε_a^{part} and ε_a^{full} for part-time and full-time jobs, respectively.

The laws of motion for the on site and at home experience are:

$$x_{a+1} = x_a + d_a^{part} + 2(d_a^{home} + d_a^{site}) \tag{1.5}$$

$$h_{a+1} = h_a + d_a^{home} \tag{1.6}$$

where on-site experience is augmented each year by 1 or 2 units if the woman is engaged in paid part-time and full-time employment, respectively. At-home experience increases by 1 if the woman works at home.

Marriage. The decision to marry is constrained by the receipt of a marriage offer. If a woman is single, she receives a marriage proposal with probability π_m^a. Conditional on the receipt of a marriage offer, a woman decides about getting married based on the utility from marriage M and the husband's annual wages w_a^h, which will constitute a woman's non-labor income.

The direct utility value of marriage, if a woman receives and accepts a marriage offer or is already married, is:

$$M_a = exp(\varepsilon_a^m) \tag{1.7}$$

where ε_a^m is a transitory shock. Following others (Van Der Klaauw, 1996; Francesconi, 2002; Keane and Wolpin, 2010; Sauer, 2015) and relying on assortative mating, a husband's annual wages depend on the woman's time-invariant characteristics and age, as a proxy for his experience. Husband's wages are specified as follows:

$$w_a^h = exp(b_0^h + b_1^h \eta + b_2^h a + b_3^h a^2 + \varepsilon_a^h) \tag{1.8}$$

where ε_a^h is a transitory productivity shock.

If a woman decides to stay single, she may receive a new offer the following

year. Divorce may occur due to a sufficiently negative shock to the husband's earnings or direct utility from marriage.

Fertility. The direct utility flow related to children is:

$$N_a = b_1^f n_a + b_2^f n_a^2 \tag{1.9}$$

This specification allows for diminishing marginal utility in the number of children. The law of motion in the stock of children n_a is:

$$n_{a+1} = n_a + f_a \tag{1.10}$$

Budget constraint. The budget constraint determines a woman's consumption at each age. The budget constraint is specified as:

$$C_a^d = \begin{cases} (g d_a^{ne} + w_a^k d_a^k) - cc_k, & \text{if } m_a{=}0 \\ \\ \tau((g d_a^{ne} + w_a^k d_a^k + w_a^h) - cc_k), & \text{if } m_a{=}1 \end{cases} \tag{1.11}$$

where τ is an estimable parameter that indicates the share a married woman ($m_a = 1$) receives of total household net income $0 < \tau \leqslant 1$. There are no borrowing and saving decisions incorporated into the model. Income when non-employed is represented by g, which captures unemployment benefits or other types of public assistance.

The costs of children, cc_k, are shared between spouses when married. Childcare costs are differentiated by the age of the youngest child, the total amount of hours devoted to the labor market and work location. Childcare costs can affect work hours as well as the decision to work on site or at home. The childcare cost function for each employment state k at age a is:

$$cc_k = \begin{cases} p_k(b_1^c d_{1-6}^c + \alpha^c b_1^c d_{7-18}^c), & \text{if } f_a{=}0 \\ \\ p_k(b_0^c + b_1^c d_{1-6}^c + \alpha^c b_1^c d_{7-18}^c), & \text{if } f_a{=}1 \end{cases} \tag{1.12}$$

where b_1^c is the childcare cost which is different when the youngest child is less

than 7 years old (pre-school age). a^c captures this proportional difference in cost given the youngest child's age. b_0^c is a fixed cost incurred upon birth of a child. p_k is a factor which changes childcare costs depending on employment state. In particular, the maximum childcare costs are incurred when a woman works full-time and exclusively on site, i.e., $p_{site} = 1$ and $0 < p_k \leqslant 1$, $k = ne, part, home$ are estimable parameters.

Utility flow. $U_{a,d}$ is the current period utility flow associated with marriage, fertility and employment choices at each age. $U_{a,d}$ is linear in consumption $C_{a,d}$ and its other components are additively separable. Women observe all the pecuniary and non-pecuniary returns associated with each choice in each period. The specific functional utility form at age a for each feasible choice combination $d \in (m_a, f_a, d_a^k)$ is:

$$U_{a,d} = \mu_k C_{a,d} + M_a + N_a + F d_a^{home} \tag{1.13}$$

The marginal utility of consumption term captures the disutility of work effort and depends on the hours worked, also allowing leisure to be incorporated into the utility flow. The disutility of work effort is standardized such that $\mu_{ne} = 1$ and $0 < \mu_{full} < 1$. An additional restriction imposed is $\mu_{part} = 1$.[12] F captures the non-pecuniary returns to flexibility when working full-time at home.

Heterogeneity. The model corresponds to the lifetime choice problem of women who differ at the age of 25. According to the model, women at this age have already made choices related to their education. Prior education choices, in addition to other unobserved cognitive abilities and traits, can affect women's employment, marriage and fertility decisions throughout the lifecycle. The model accounts for unobserved heterogeneity by assuming that there are discrete types of women. Education partially determines a woman's unobserved type.

The probability that a woman is of type $\eta = 0, 1$ is π_η and depends on the woman's highest grade completed in the following logistic form:

$$\pi_\eta = \frac{exp(\gamma_0 + \gamma_1 I(12 \leq hgc < 16) + \gamma_2 I(hgc \geqslant 16))}{1 + exp(\gamma_0 + \gamma_1 I(12 \leq hgc < 16) + \gamma_2 I(hgc \geqslant 16))}. \tag{1.14}$$

[12] Setting μ_{part} to one is plausible given that estimates of $0 < \mu_{full} < \mu_{part} < 1$ in previous versions do not substantially deviate from one.

The logistic form ensures that probabilities remain between zero and one.

The Optimization Problem

Each woman is characterized by a vector of initial conditions Ω_0. The choices made at each age a, between 25 and 55 depend on marital, fertility and employment histories up to that point in time. These histories, along with the unobserved type η and the shocks at each age a, comprise the state space, which individuals take as given at the start of each period. The state space Ω_a contains marital status at the beginning of the period, the number of children, the age of the youngest child, the employment state at the beginning of the period, on-site accumulated experience, at-home accumulated experience, the woman's type, current period preference shocks for marriage and current period productivity shocks to wages and husband's income. Thus:

$$\Omega_a = (\Omega_0, m_{a-1}, n_a, age_a^c, d_{a-1}^k, x_a, h_a, \eta, \varepsilon_a^m, \varepsilon_a^h, \varepsilon_a^w) \tag{1.15}$$

The model is solved by backward recursion. A full numerical solution method is used. In each period, a woman chooses an optimal combination $d \in (m, f, d^k)$ that corresponds to the maximum alternative-specific value function, denoted as $V_a^d(\Omega_a)$. With U_a^d being the current utility, the alternative-specific value function for choice $d \in D$ that satisfies the Bellman equation is:

$$V_a^d(\Omega_a) = U_a^d(\Omega_a) + \delta(EmaxV_{a+1}^d(\Omega_{a+1})|\Omega_a) \tag{1.16}$$

where δ is the discount factor. At the start of each period, a women takes as given the number of children, the age of the youngest child, the accumulated on-site and at-home experience, employment and marital status at the end of the previous period and current period shocks to wages, husband's earnings and the utility of marriage. Conditional on being non-married, women may receive a marriage offer and decide on whether to get married or stay single. If they are in a marriage, they decide whether to stay married or not. For the fertility decision, if conception is chosen, the child is born with certainty the following year, updating the number of children and the age of the youngest child. Women choose an

employment state conditional on previous employment state and whether a job offer is received if non-employed.

1.5 Estimation Method

Simulated Method of Moments

The parameters of the model are estimated by the Simulated Method of Moments (SMM) (McFadden, 1989; Pakes and Pollard, 1989). Women's marriage, fertility and employment choices, wages, work experience, and their husband's earnings are simulated for any given vector of parameters. The simulated data are used to construct moments which are matched to the corresponding moments in the actual data. The SMM estimator is defined as the value of the vector of parameters of the model θ that minimizes the distance between the actual and simulated moments.

The objective function to be minimised with respect to θ is:

$$\hat{\theta} = \underset{\theta}{\operatorname{argmin}}(m_d - m_s(\theta))' W (m_d - m_s(\theta)) \tag{1.17}$$

where m_d is a vector of empirical moments calculated from the sample data and $m_s(\theta)$ is the corresponding vector of moments simulated by the model. W is the weighting matrix and is set to be the identity matrix.

Identification

Parameters to be identified appear in the woman's wage offer function, husband's earnings equation, the budget constraint and the utility flow. The choice of moments affects identification of the parameters of the model. A variety of unconditional and conditional moments, both static and dynamic, and estimates from various OLS regressions (indirect inference) are matched. Moments are computed for women between the ages of 28 and 48. A detailed list of the moments used in estimation is shown in Table 1.A.3.

The wage offer parameters are identified using moments related to unconditional actual accepted wages and accepted wages by age and employment status. Several specifications of OLS wage regressions are also used to identify the structural wage offer functions. Initially, wages are regressed on experience

by occupation. Then, wages, further to experience, are regressed on age, education, duration of uninterrupted employment and the number of children. Income when non-employed (g) is identified using actual data on unemployment benefits or other public assistance or welfare.[13] The parameters related to the unobserved type of woman are identified by computing the residual from the regression of wages on education, experience and employment status. This residual includes information about unobserved ability. The variance of this residual and actual wages by education are used as moments for the identification of the unobserved type parameters function.

Parameters of the husband's wage equation are identified using actual data on their wages. Assuming assortative mating, the coefficients from the OLS regression of husband's wage on wife's age and education help to identify the parameter of the woman's type in husband's wage function.

Actual moments related to marriage are used to identify the marriage offer and the marital shock. These moments include marriage rates by age, duration of marriage by age and marriage transition rates. Further to the actual moments, the variance of the residual from OLS regression of marriage duration on experience, age and the number of children help to identify the marital shock. The marriage rate along with the actual women and their husbands' wage moments help to identify the income sharing parameter (τ).

The probabilities of receiving a job offer are identified using data on employment status proportions by age and the transition rates among employment states. The marginal utility of consumption (μ_{full}) is identified by duration in each employment status by age in combination with actual wage moments.

Parameters for childcare costs by employment state and utility from children are identified using actual data on the number of children by age and employment status, proportions of those giving birth and proportions with children under six by age. OLS regressions of the number of children on age and employment spells are used to further help the identification of the parameters related with the utility from children.

[13] Information about total amount of unemployment compensation, AFDC, food stamps or SSI/other public assistance/welfare the respondent received each calendar year is available in NLSY79 and is used for the identification of g.

Identification of the non-pecuniary returns to working at home (F) indirectly relies on actual data. Women's choices cannot be explained exclusively by the variation in wages among different employment states. For example, if women with more children work from home less than expected based on wage differentials among employment states, this could suggest the existence of non-pecuniary utility from working at home.[14] The identification of non-pecuniary returns is realized by regressing a dummy equal to 1 if a woman works at home and 0 if she works on site on wage, education, age, number of children and marriage. The residual from this regression contains information about the unobserved factors that affect a woman's choice to work at home. The variance of the residual is computed and along with the coefficients from the regression are used for the identification of non-pecuniary returns to flexibility.[15]

1.6 Estimation Results

The structural decision model contains 43 estimable parameters. The point estimates and standard errors are reported in Table 1.8 and Table 1.9. In this section, the estimation results and the fit of the model are discussed.

Parameter Estimates

The estimates imply that wage offers increase with accumulated on-site experience. Each unit of accumulated on-site experience adds 2.1% and 1.2% to part-time and full-time wage offers, respectively. The quadratic in accumulated on-site experience reveals higher diminishing returns to part-time employment compared to full-time employment. The effect of accumulated at-home experience is negative and significant. Each additional unit of full-time at-home experience decreases part-time, full-time at-home and on-site wages by 3.5%, 1.1% and 5.9%, respectively. These wage penalties to working from home suggest a possible loss of productivity when working remotely. However, it may also reflect a compensating wage differential, according to which women are willing to bear a cost in terms of foregone earnings in order to obtain flexible work

[14] As mentioned above, the trend in the percentage of employers allowing for remote working is increasing and reaches levels that could justify the existence of non-pecuniary returns as an additional factor that could discourage employees to work more or less occasionally from home.

[15] Additionally, the fact that non-pecuniary returns only enter the utility flows of the full-time at home employment options allows for exclusionary restrictions to be applied.

arrangements (most recently Felfe (2012); Goldin (2014)).

The non-pecuniary returns to working from home are also negative and precisely estimated. Utility decreases in monetary equivalent terms by $8,355. A disutility from working at home might derive from negative feelings due to physical absence from the workplace and isolation due to remote working. A more detailed discussion of the non-pecuniary returns to flexibility follows in the next section.

Table 1.8: A. SMM Parameter Estimates

			Woman's wage					
	Marriage utility (1)	Children's utility (2)	Non-employment (3)	Part-time (4)	Full-time at home (5)	Full-time on site (6)	Husband's wage (7)	Non-pecuniary returns to flexibility (8)
Constant			8.0593	8.7370	9.7760		8.4340	-8,354.87
			(3.51946)	(0.18239)	(0.05858)		(0.02238)	(3,847.08)
a							0.0909	
							(0.00849)	
a^2							-0.0009	
							(0.00003)	
x_a				0.0213	0.0127			
				(0.00148)	(0.00494)			
x_a^2				-0.0005	-0.00002			
				(0.00001)	(0.00000)			
h_a				-0.0352	-0.0107	-0.0590		
				(0.00223)	(0.00208)	(0.00658)		
h_a^2				0.0005	0.0001	0.0002		
				(0.00025)	(0.00003)	(0.00001)		
η				0.1451	0.4917	0.2943	0.4517	
				(0.00770)	(0.08332)	(0.04450)	(0.06979)	
n_a		10,039.67						
		(11.53857)						
n_a^2		-773.33						
		(58.80841)						
$\sigma_{\varepsilon_{ne}}$			0.331300					
			(0.04974)					
σ_{ε_m}	11.7185							
	(0.22020)							
$\sigma_{\varepsilon_{wpart}}$				0.7933				
				(0.04114)				
$\sigma_{\varepsilon_{wfull}}$					0.4015			
					(0.01402)			
σ_{ε_h}							0.6895	
							(0.01189)	

Notes: Simulated moments are calculated based on 1,000 simulations. Asymptotic standard errors in parentheses.

When a woman is currently non-employed, the probability that she receives a job offer is 64.5%. A job offer for a part-time job arrives with a probability of 38.9%. To avoid identification issues, the probability that the full-time offer includes location flexibility is not estimated and is fixed at 17.8%.[16]

[16]Data for the frequency employers provide employees with telecommuting opportunities are available in the National Studies of Employers, held in 1998, 2005, 2008, 2012, 2014 and 2016. In these studies data are not directly comparable due to firm sizes restrictions. According to the Society for Human Resource Management (Research Report on employee Benefits) telecommuting benefits of any type (on an ad-hoc, part-time and full-time basis) have seen a threefold increase over the past two decades, from 20% in 1996 to 60% in 2016. These figures combined with the technological limitations in the late 1980s make me confident that a job offer rate for working at home at around 30% of the total full-time job offers consists a good approximation of the availability of telecommuting for the years under consideration. It is worth noting that there are no census or government produced data on the availability of telecommuting benefits provided by the employers.

In line with previous literature, the magnitude of μ_{full} indicates that consumption and leisure are substitutes (Keane and Wolpin, 2010; Sauer, 2015). Fewer hours of work imply less disutility from work effort and therefore a higher marginal utility of consumption. Because of this substitutability, the marginal utility of consumption when in the non-employment and part-time work states is greater than the marginal utility of consumption when engaged in full-time employment.

The estimates related to marriage are also consistent with previous findings. The sharing parameter indicates that a married women receives 43% of net household income. Sauer (2015) finds a sharing parameter of similar magnitude, namely 43.5%. The magnitude and sign of the woman's type coefficient in the husband's wage function is consistent with positive assortative mating and indicates that spouses' traits are complements. High-skilled women are married with high-skilled men.[17]. The estimates indicate that the husband's wages substantially affect a woman's employment state and marriage stability. For example, the higher the husband's earnings, the lower is a woman's incentive to be employed (non-labor income effect) or get divorced. The estimated marriage offer probability is approximately 8%.

Table 1.9: B. SMM Parameter Estimates

Marginal utility of consumption			Income sharing	Type probability		
				Constant	High school or at most some college	At least bachelor's degree
μ_0	μ_{part}	μ_{full}	τ	γ_0	γ_1	γ_2
1.0000	1.0000	0.8441	0.4306	-2.1520	1.1959	2.9010
		(0.21701)	(0.00003)	(0.00003)	(0.00001)	(0.00001)

Childcare costs						
	...if the youngest child is...					
Cost of childbirth	...less than 6	Additional cost ... more than 6	Non-employment	Part-time	Full-time at home	Full-time on-site
b_0^c	b_1^c	a_c	p_{ne}	p_{part}	p_{home}	p_{site}
30,515.80	18,160.42	1.4060	0.0478	0.1059	0.6356	1.0000
(7,285.51)	(1,903.99)	(0.00023)	(0.00001)	(0.00001)	(0.00005)	

Notes: Simulated moments based on 1,000 simulations. Asymptotic standard errors in parentheses.

The utility from children is quadratic in the number of children. The estimated annual childcare costs are differentiated by the age of the youngest child and

[17] In this model, skill is a function of education. Educational assortative mating is well documented in the literature (Becker, 1973; Mare, 1991; Pencavel, 1998)

mothers' employment status. When the child is less than 6 years old, these costs are $868 when a woman is non-employed and $1,923, $11,543 and $18,160 when she is employed part-time, full-time at home and on site, respectively.[18] The cost of childbirth amounts to $30,515, which is directly comparable with the disutility of pregnancy and child start-up costs estimated in Keane and Wolpin (2010) and Sauer (2015). Childcare costs increase by 40.6% when the youngest child is older than 7. Sauer (2015) uses a comparable specification for the childcare costs and finds that children between the ages 7 and 18 cost is 40.2% more than younger children.

There are two types of women, higher-skilled and lower-skilled. Type 1 women are higher-skilled and are more likely to be highly educated. They constitute 36.1% of the population. Higher-skilled women are also more likely to be married and have fewer children than lower-skilled women. Table 1.8 shows that Type 1 women enjoy a wage offer premium, which is differentiated among employment states. As noted below, this premium is rather important when considered in association with the negative returns to working at home.

Model Fit

Table 1.10 reports the aggregate actual and simulated employment choice distribution and actual and simulated accepted wages of women and their husbands.[19] The simulated choice distribution fits the actual distribution well. The model's fit to wages in different employment states is also quite good.

Table 1.11 displays the actual and simulated employment transition rates. The simulated data exhibits high persistence in each employment state in a similar manner as the actual data. The model overpredicts the persistence in part-time employment and underpredicts the transition from non-employment to part-time. Persistence in all of the other employment states is accurately reproduced. In both the actual and simulated data, transitions from part-time and full-time at home employment are mainly towards full-time on site employment. Transitions from part-time to non-employment are higher than those to full-time employment.

[18] The gross childcare fees for two children (ages 2 and 3) attending full-time care at a typical childcare center in the U.S. are estimated by the OECD to represent about 32% of average earnings in 2015(OECD - family database), which is estimated to be approximately $59.7K (OECD - average wages).

[19] See Table 1.A.4 for the actual and simulated choice distribution by age range.

Table 1.10: Actual and Simulated Employment Outcomes

Non-employed	Part-time	Full-time at home	Full-time on site
18.95	22.58	10.86	47.60
(18.79)	(22.58)	(10.90)	(47.73)

Woman's wage			
Part-time	Full-time at home	Full-time on site	Husband's wage
12.90	46.53	31.93	56.49
(13.72)	(47.66)	(32.72)	(56.36)

Source: NLSY79
Notes: Calculations include individuals' responses after 1988. Simulated moments are in parentheses. Simulated moments are calculated based on 1,000 simulations.

Table 1.11: Actual and Simulated Yearly Employment Transitions

	age+1			
age	Non-employed	Part-time	Full-time at home	Full-time on site
Non-employed	66.76	27.47	1.38	4.39
	(69.71)	(19.24)	(3.37)	(7.68)
Part-time	12.68	58.65	4.82	23.84
	(13.76)	(65.86)	(5.06)	(15.32)
Full-time at home	1.68	10.36	71.50	16.47
	(5.50)	(8.13)	(69.50)	(16.87)
Full-time on-site	1.33	10.62	3.90	84.15
	(3.25)	(5.45)	(4.28)	(87.02)

Source: NLSY79
Notes: Calculations include individuals' responses after 1988. Simulated moments are in parentheses. Simulated moments are calculated based on 1,000 simulations.

Table 1.12 displays the actual and simulated marriage transitions. The persistence in each marital status and the transitions between marital states produced by the simulated data match with the actual data relatively well. Notably, the model also reproduces the total marriage and birth rates. The simulated marriage and birth rates are 74.2% and 5.6%, respectively, and the corresponding figures from the actual data are 74.4% and 5.7%. The average years of labor force participation (15.48) is also close to the actual data (15.04).

Table 1.12: Actual and Simulated Yearly Marriage Transitions

	age+1	
age	non-married	married
non-married	92.00	8.00
	(92.66)	(7.34)
married	2.45	97.55
	(2.56)	(97.44)

Source: NLSY79
Notes: Calculations include individuals' responses after 1988. Simulated moments are in parentheses. Simulated moments are calculated based on 1,000 simulations.

1.7 Discussion

Negative Returns to Flexibility

According to the estimates, both the non-pecuniary and pecuniary returns to working at home are negative and significant. Economists have modelled and estimated stigma effects in the past in various contexts, such as the stigma associated with taking up welfare.[20] Scant attention has been given to possible stigmatization associated with workplace flexibility, which is amply documented in the psychological and sociological literature.[21] Thus, the negative non-pecuniary returns estimated here may derive from a flexibility stigma. Flexibility stigma is distinct from the actual control over time and location of work that is structurally part of many people's jobs (Freidson, 1973). It stems from negative feelings, perceptions and impressions due to physical absence from the workplace and subsequent reduced social participation and interaction with coworkers, along with fears that remote work might signal limited commitment to work and diver-

[20] See for example Moffitt (1983) and Keane and Wolpin (2010).
[21] See Allen et al. (2015) and Glass and Noonan (2016) for reviews of research on telecommuting and references to flexibility stigma and work from home.

gence from the ideal worker norm (Williams, 2000; Blair-Loy, 2006; Williams et al., 2013; Allen et al., 2015).

Including the possibility of a non-pecuniary effect of flexibility is crucial in this model for fitting the actual data. Without non-pecuniary returns in the model, the pecuniary penalties to flexibility (expressed through wage offers) would be overstated to such an extent that working at home would become an optimal choice for high-skilled women much later in their lives only when working remotely would become affordable. The data do not indicate this tendency. It is interesting to note that the model indicates positive selection on unobservables into working from home. Most women who choose flexible work are highly skilled.

Skills in this model are represented by an initial endowment correlated with higher educational attainment and is fixed over time (unobserved type). However, productivity evolves with experience. Lower skills and less accumulated experience is associated with lower wage offers. This implies that lower skilled women cannot afford the penalties from flexible working as can higher skilled women, especially when younger and early in their careers. Lower skilled women do better in utility terms by working part-time or remaining non-employed given their lower wage offers and the higher marginal utility of consumption in these employment states. As their on-site experience gradually increases, they do become more inclined to work full-time, but exclusively on site rather than at home because of the wage penalty.

To demonstrate the contribution of the model to the measurement of the wage penalty, Table 1.13 presents the results of a reduced-form wage regression using the simulated data. The results are directly comparable to those in Table 1.7 where self-selection and unobserved heterogeneity is not taken into account as in the model. The wage penalty in the simulated data is 12.2% as opposed to the wage benefit of 4.6% from the OLS regression. The positive and significant coefficient on unobserved type shows the large impact of unobserved heterogeneity on wages, which, if not accounted for, leads to the upward biased returns to flexibility revealed in OLS.

Table 1.13: Simulated Wage Regression

	log-wage
constant	9.361**
	(0.031)
experience	0.025**
	(0.002)
experience sq./100	-0.010**
	(0.003)
non-employment (t-1)	-0.956**
	(0.021)
part-time (t-1)	-0.591**
	(0.017)
full-time at home (t-1)	-0.122**
	(0.020)
η	0.339**
	(0.013)

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. Experience is the accumulated amount of hours worked annually. Simulated data based on 1,000 simulations. Number of observations is 21,000.

Counterfactual Experiments

In addition to correcting for selection and simultaneity biases that often arise in regression analysis, structural models facilitate the performance of counterfactual experiments. In this section, changes in specific parameters of the model, which correspond to counterfactual experiments, are implemented and the simulation results are compared to the baseline model. The first counterfactual experiment calculates the earnings and welfare losses from complete elimination of work-at-home availability. The second counterfactual exercise measures the relative importance of pecuniary and non-pecuniary penalties associated with working at home. The third counterfactual experiment examines the effects of a subsidy that is provided to women who work remotely.

Remote Work Elimination. The first experiment eliminates the possibility of working from home by setting the work-at-home job offer probability to zero. Table 1.14 displays the simulation results under this counterfactual experiment and compares the results to simulation outcomes in the baseline model. When

working at home is not possible, there is a 6.3% decrease in lifetime earnings, which is mainly due to increase in non-employment and part-time employment. Lifetime utility loss is 1.5% and lower relatively to lifetime earnings loss. The increase in non-employment and part-time employment combined with the increase in the marriage rate shows that women seek to greater consumption through non-labor income, balancing partly out their lifetime utility losses.

Table 1.14: Remote Work Elimination

	Baseline (1)	Elimination (2)
Full-time at home	10.90	-
Non-employed	18.79	19.86
Part-time	22.58	25.74
Full-time on-site	47.73	54.40
Married	74.20	75.97
Total fertility	5.60	5.62
Labor force participation	15.48	15.34
Husband's wage	56.36	56.76
Lifetime earnings	502,039	470,283
		-6.34
Lifetime utility	5,665	5,579
		-1.52

Notes: Simulated moments are calculated based on 1,000 simulations. Labor force participation is in years. Lifetime earnings and utility are the sums of wages and realized utility flows over people and years.

Relative Importance of Pecuniary and Non-pecuniary Penalties. The second counterfactual experiment aims to quantify the relative importance of the pecuniary and non-pecuniary penalties associated with working at home. Column (1) of Table 1.15 shows that when there are both non-pecuniary and pecuniary penalties, the baseline model predicts that the proportion of women choosing to work at home is 10.9%. The proportion of women working at home is made up of mostly high-skilled women, which implies that high-skilled women can most easily afford the negative pecuniary and non-pecuniary returns to flexibility.

Column (2) of Table 1.15 shows that eliminating both pecuniary and non-pecuniary penalties increases the proportion of women working at home to 26.7%. The proportion of high-skilled women in full-time at home employment decreases, as more low-skilled women choose this option when there are no costs to bear. The benefits from working at home arise from lower childcare costs, as well as

from the accumulation of more work experience. The simultaneous decrease in marriage rate implies that women have greater incentive to substitute away from leisure and seek consumption from labor. This substitution effect as well as the decrease in birth rate result in a lower increase in lifetime utility in percentage terms than lifetime earnings.

Table 1.15: Relative Importance of Pecuniary and Non-pecuniary Penalties from Remote Work

	Both pecuniary and non-pecuniary penalties (1)	No pecuniary nor non-pecuniary penalties (2)	Only non-pecuniary penalties (3)
Full-time at home	10.90	26.74	21.59
Non-employed	18.79	12.22	14.84
Part-time	22.58	19.53	20.12
Full-time on site	47.73	41.51	43.45
Married	74.20	67.22	67.60
Total fertility	5.60	5.41	5.41
Labor force participation	15.48	16.46	16.05
Husband's wage	56.36	56.22	56.22
Lifetime earnings	502,039	607,867	583,422
		21.08	*16.21*
Lifetime utility	5,665	6,028	5,913
		6.41	*4.38*
Proportion of high-skilled in full-time at home	73.86	50.22	54.18

Notes: Simulated moments are calculated based on 1,000 simulations. Labor force participation is in years. Lifetime earnings and utility are the sums of wages and realized utility flows over individuals and years.

Column (3) of Table 1.15 presents the case when only the non-pecuniary penalties are reintroduced into the model. The proportion of women choosing to work at home decreases from 26.74% to 21.59%, while the proportions in all the other employment states, including non-employment increase compared to those in Column (2). Low-skilled women keep opting for flexibility, as non-pecuniary penalties do not affect them as much. This result highlights the greater importance of pecuniary penalties from remote work compared to the non-pecuniary penalties.

Changes in lifetime utility and earnings show that there can be substantial benefits to individual welfare that derive from the elimination of negative pecuniary and non-pecuniary penalties from working at home. When the negative returns to flexibility are totally eliminated, lifetime utility increases from 5,665 to 6,028. The total utility benefit that is attributed to the elimination of both the pecuniary

and non-pecuniary penalties is 6.4%. Reintroducing only the non-pecuniary penalties results in a 2% decrease in lifetime utility. This means that 68.8% of the total increase in lifetime utility due to the elimination of the negative returns can be attributed to the elimination of the pecuniary penalties. Thus, the losses from flexibility to welfare are mainly driven by the pecuniary penalties. The total earnings benefit that is attributed to the elimination of both the pecuniary and non-pecuniary penalties is 21.1%.

Subsidies for Working at Home. After years of stability (1990 - 2005), the fertility rate in the U.S. is decreasing.[22] In many countries, fertility has been encouraged by subsidies or tax relief. There is extensive literature identifying the effects of such family policies on fertility and female employment.[23]

The U.S. Internal Revenue Service (IRS) offers a deduction of expenses for business use of the home to self-employed workers and employees. The latter must work at home for the convenience of their employer to qualify for the home office deduction.

Table 1.16 shows two scenarios, the baseline and one in which a subsidy or an equivalent tax deduction that corresponds to a 35% decrease in childcare costs is provided to women for business use of the home. After the introduction of the subsidy, the proportion of women working at home increases by 26.8%. At the same time, non-employment and the proportion of high-skilled women in full-time at home decrease. The proportions in the other employment states and the marriage rate remain relatively unaffected. Fertility also increases by 4.3%. The increase in lifetime earnings and utility highlight the effect a reduction in the childcare costs could have on the labor force attachment of lower-skilled women, who would otherwise be out of the labor market.

The 3.4% increase in mean lifetime earnings associated with the subsidy corresponds to a social benefit of $16,842 per woman. The social cost of the subsidy is $7,225 per woman. Thus, the lifetime benefit from the subsidy is greater than the cost in this model. Offering a financial subsidy or an equivalent tax reduction to encourage flexibility and fertility may require relatively less

[22] See OECD - fertility rates for the definition of the fertility rate and relative statistics.
[23] See Yamaguchi (2017) for a review of international evidence about parental leave and childcare policies.

investment than the potential economic and fertility gains.

Table 1.16: Subsidies for Working at Home

	Baseline (1)	Subsidy (2)
Full-time at home	10.90	13.82
		26.79
Non-employed	18.79	16.15
Part-time	22.58	22.86
Full-time on site	47.73	47.17
Married	74.20	74.10
Total fertility	5.60	5.84
		4.28
Labor force participation	15.48	15.88
Husband's wage	56.36	56.41
Lifetime earnings	502,039	518,881
		3.35
Lifetime utility	5,665	5,707
		0.74
Proportion of high-skilled in full-time at home	73.86	71.22

Program evaluation	
Social benefit	16,842
Social cost	7,225
Net social benefit	9,617

Notes: Simulated moments are calculated based on 1,000 simulations. Labor force participation is in years. Lifetime earnings and utility are the sums of wages and realized utility flows over people and years.

1.8 Conclusion

This paper formulates and estimates a dynamic discrete choice model of joint marriage, fertility and employment decisions which focuses on the phenomenon of working at home. The model is estimated using data from the NLSY79. Taking into account the fact that employees consider both time and location when making labor supply decisions, this paper quantifies both the pecuniary and non-pecuniary returns to workplace flexibility. The structural estimates reveal negative and significant pecuniary and non-pecuniary penalties to working at home. In particular, an additional year of work-at-home experience decreases part-time wages by 3.5%, full-time at-home wages by 1.1% and full-time on-site wages by 5.9%. The model also indicates positive selection into flexible working arrangements. Lower-skilled women cannot afford the penalties from flexible

working as can higher skilled women, especially when younger and early in their careers.

The estimated model is also used to perform several counterfactual experiments. One experiment allows the calculation of the earnings and welfare effects of an unavailability of remote working. Remote work elimination decreases lifetime earnings by 6.3% and lifetime utility by 1.5%. Another experiment measures the relative importance of the pecuniary and non-pecuniary penalties from working at home. The elimination of both the pecuniary and non-pecuniary penalties results in an increase in lifetime earnings and utility by 21.1% and 6.4%, respectively. 68.8% of the total increase in lifetime utility due to the elimination of the negative returns can be attributed to the elimination of the pecuniary penalties. Another experiment introduces a subsidy or equivalent tax deduction that corresponds to a 35% decrease in childcare costs to women working from home. Introduction of the subsidy increases the proportion of women who opt to work at home by 26.8%. Lifetime earnings and fertility increase by 3.4% and 4.3%, respectively.

The model could be expanded in several ways. For example, a task-based approach with a finer occupational choice (manual and cognitive occupations) could be introduced into the decision problem. In addition, incorporating the husband's occupational choices could result in better specification of the household budget constraint and female decision making related to remote work.

Appendix 1

Appendix 1.A

Table A.1: Assortative Mating in Education

	Husband's education		
Wife's education	Less than high school	High school or at most some college	At least bachelor's degree
Less than high school	36.14	57.31	6.55
High school or at most some college	9.94	72.17	17.89
At least bachelor's degree	0.97	32.78	66.25

Source: NLSY79
Notes: Calculations include individuals' responses after 1988.

Table A.2: Most and Least Frequent Work-at-Home Occupations

Most frequent	Proportion
Managers and administrators, n.e.c.	17.64
Child care workers	6.35
Primary school teachers	6.25
Managers and specialists in marketing, advertising, and public relations	4.04
Secretaries and stenographers	3.81
Office supervisors	3.39
Salespersons, n.e.c.	2.99
Financial managers	2.90
Computer systems analysts and computer scientists	2.41
Accountants and auditors	2.34

Least frequent	Proportion
Civil engineers	0.03
Electrical engineer	0.03
Chemists	0.03
Dental hygenists	0.03
Guides	0.03
Athletes, sports instructors and officials	0.07
Janitors	0.07
Police,detectives and private investigators	0.07
Vocational and educational counselors	0.07
Pharmacists	0.10

Source: NLSY79
Notes: The classification of occupations follows Autor and Dorn (2013).

Table A.3: Moments Used in the Estimations

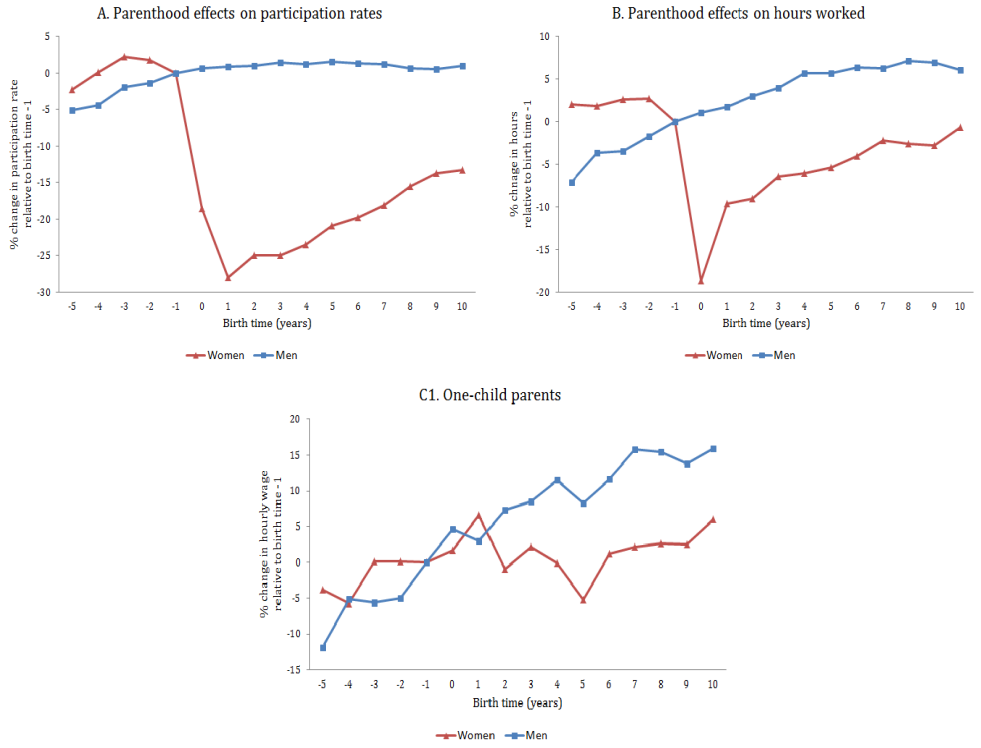
Employment state
Proportion in each employment state, by age
Transition rates among employment states
Work experience, by age
Labor force attachment, by age
Spells of employment, by occupation
Spells of non-employment
Wages
Average wage, by occupation and standard deviations
OLS regression of wage on experience by occupation
OLS regression of wage on experience, age, education, duration of uninterrupted employment, number of children
Variance of residual of wage on education, accumulated experience and employment status
OLS regression of working at home on wage, education, age, number of children and marital status
Variance of the residual of working at home
Fertility
Average number of children, by occupation and marital status
Proportion with children under six years old, by age
Proportion of childbirth, by age
OLS regression of the number of children on age and employment spells
Marriage
Proportion of married women, by age
Duration of marriage by age
Annual transition rates among marital states
Average husband's earnings, by age and standard deviation
OLS regression of husband's earnings on wife's age and education
OLS regression of the duration of marriage on experience, age and the number of children

Table A.4: Actual and Simulated Employment Choice Distribution

Age	Non-employed	Part-time	Full-time at home	Full-time on site
28-31	25.13	22.17	9.91	42.80
	(17.13)	(26.12)	(8.43)	(48.33)
32-35	20.92	23.95	10.65	44.48
	(18.42)	(25.88)	(8.00)	(47.70)
36-39	14.96	23.53	12.19	49.32
	(22.88)	(23.40)	(9.25)	(44.47)
40-43	15.30	22.83	10.40	51.47
	(23.15)	(22.20)	(11.03)	(43.62)
44-48	18.10	20.48	11.11	50.32
	(13.70)	(16.74)	(16.40)	(53.16)

Source: NLSY79
Notes: Calculations include individuals' responses after 1988. Simulated moments are calculated based on 1,000 simulations.

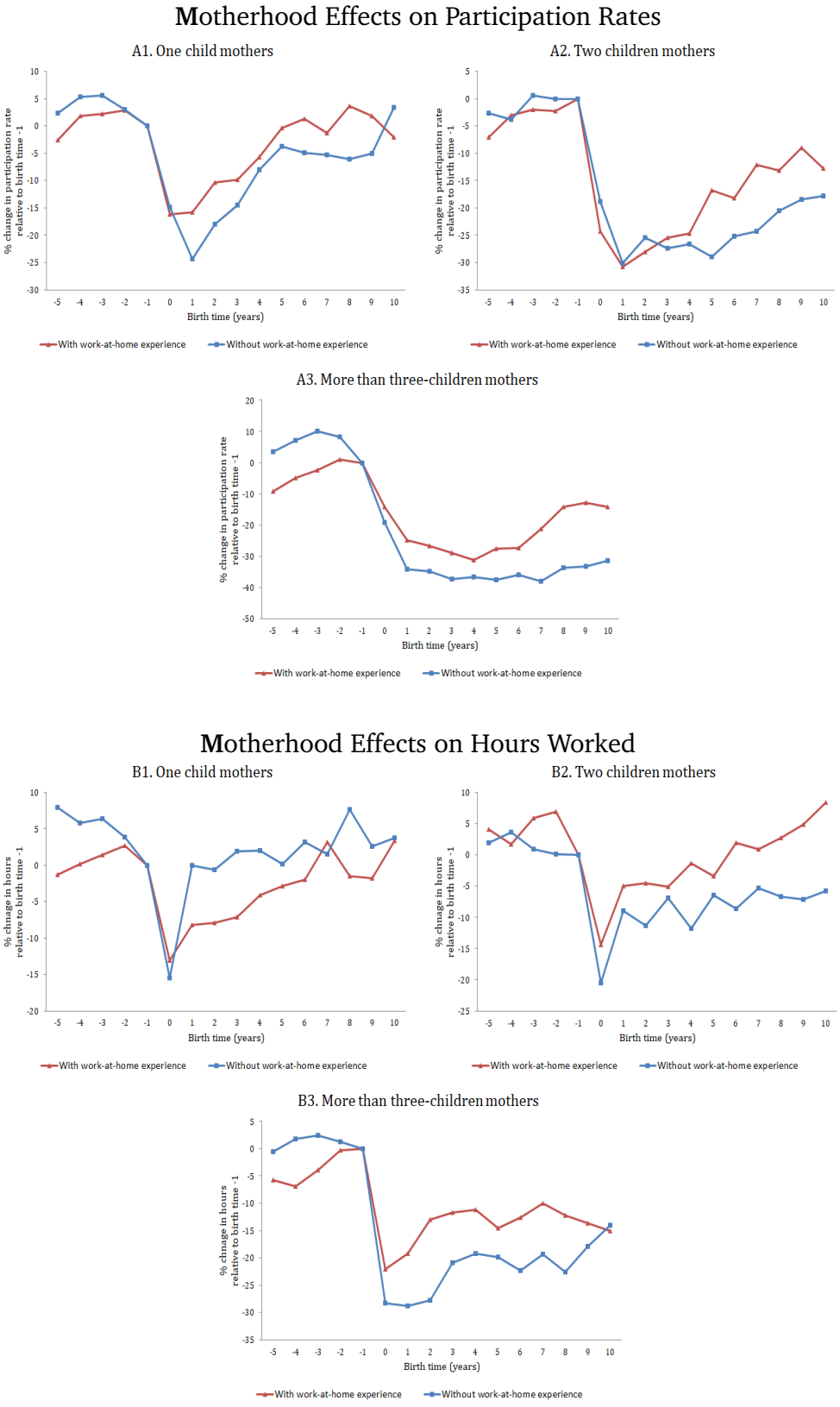
Figure A.1: Parenthood effects on labor market outcomes

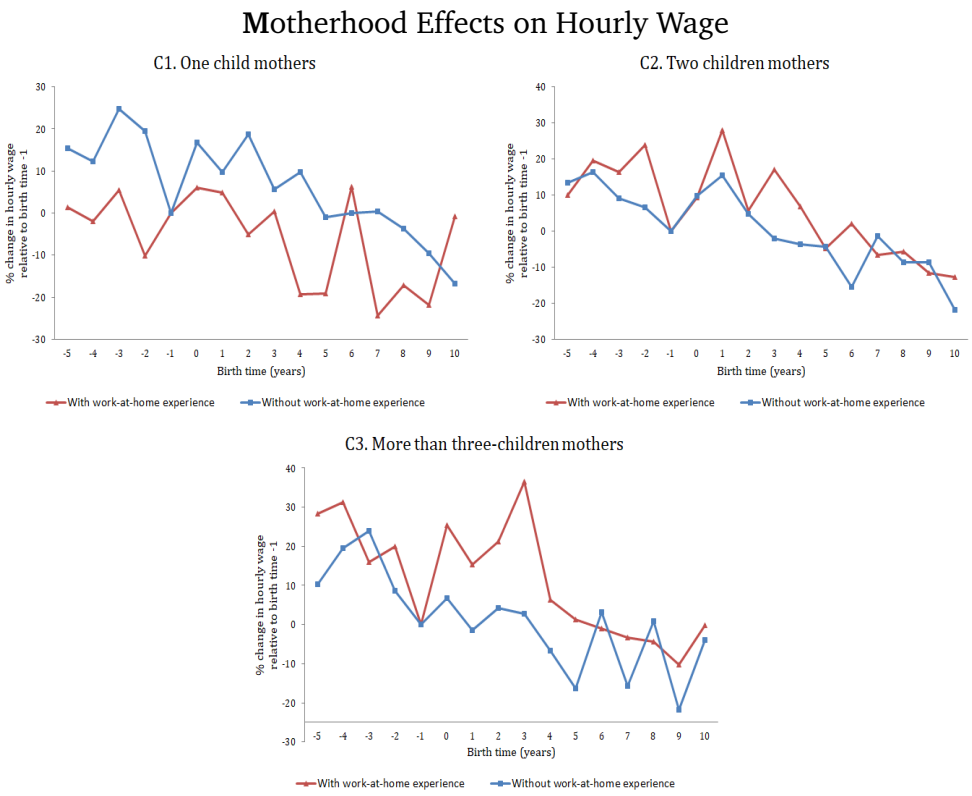


Source: NLSY79

The figures show percentage changes in the participation rates, mean hours worked annually and hourly wage of white parents, white women and men, who had their first child when aged 15 - 42. Wages are deflated using CPI index. The base year is 2005.

Figure A.2: Motherhood Effects Conditional on the Number of Children

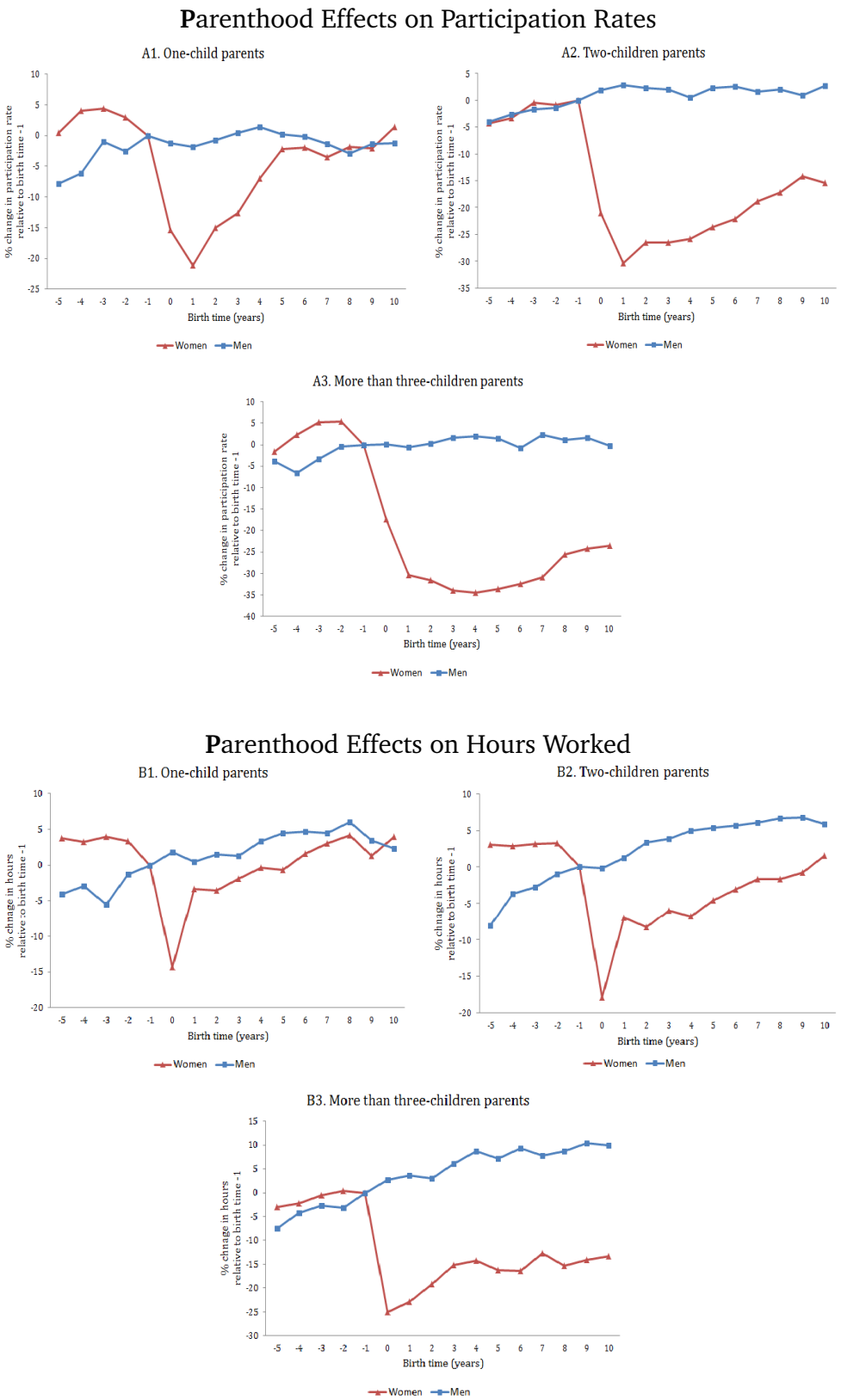


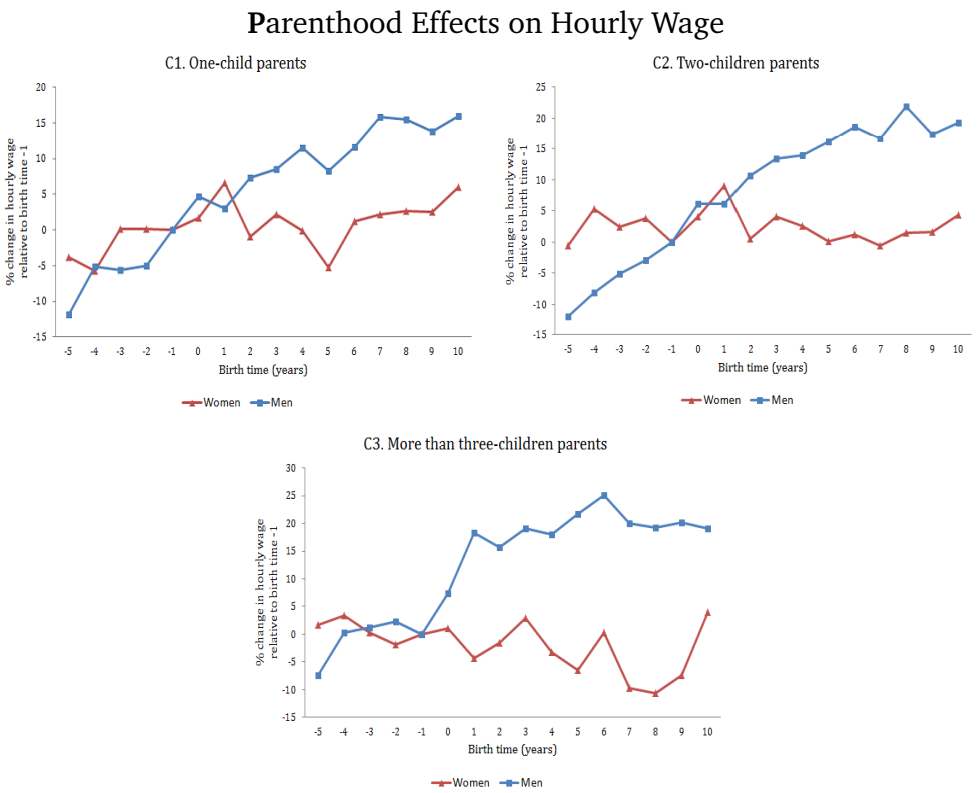


Source: NLSY79

The figures show percentage changes in the participation rates, mean hours worked annually and hourly wage of white mothers, who had their first child when aged 15 - 42, conditionally on the number of children. Wages are deflated using CPI index. The base year is 2005.

Figure A.3: Parenthood Effects Conditional on the Number of Children





Source: NLSY79

The figures show percentage changes in the participation rates, mean hours worked annually and hourly wage of parents, white women and men, who had their first child when aged 15 - 42, conditionally on the number of children. Wages are deflated using CPI index. The base year is 2005.

Appendix 1.B Sample Selection

This analysis is focused on white women from the NLSY79 cross-sectional sample.[24] Given that data for hours of work at home are available since 1988, this analysis starts from this year. Respondents with more than one year of data are included in the sample. Women with incomplete observations on their marital status, fertility history and schooling are excluded. Individuals with missing information about their occupation (missing census code) are excluded, too. Women with completed schooling at the age of 25 are included.[25] The analysis is based on a sample of 1,712 women. Table 1.B.1 shows how each restriction affects the sample size.

Table B.1: Sample Restrictions and Size

	Sample size
- Full NLSY79 Sample	6,283
- Having worked at least once more than 520 hours or worked at least 260 and less than 520 with more than 30 hours usually worked per week	5,919
- More than one year of data	5,381
- Consistent marriage, childbirth, schooling information and completed schooling at age 25	3,976
- White women	2,270
- White women from the cross-sectional sample	1,712

Data Construction

In the model, a year is a period. In the data, in accordance with the model, a year is defined as a calendar year from January 1st to December 31st. Details on data construction follow.

Education. A number of inconsistent school attendance and grade completion observations were reconstructed based on information about enrollment, highest degree received, highest grade completed, dates of diplomas and degrees. An individual is considered to have attended school during the year if she has reported completing one grade level during this year. High-school graduates are considered individuals with a high-school diploma or a general equivalency diploma (GED). Individuals are assigned into three education categories: less

[24] As evidenced by Keane and Wolpin (2010), race can be a source of preferences heterogeneity in marriage, fertility and employment decisions. Race is not taken into account in this analysis. Furthermore Golden (2008) presents evidence about significant disparities in the distribution of work-at-home opportunities among demographic groups. Future work could include and analyze the importance of racial differences in women's flexibility choices.

[25] Women who report a change in the highest grade attained after the age of 25 end up with a lower than high-school grade (44%), get a high-school diploma or GED (37%), obtain some college qualifications (18%) or at least a bachelor's degree (1%).

than high school, high school or at most some college and at least a bachelor's degree.

Work and Wages. Reported weekly employment histories are used to construct annual information on hours worked on site and at home, occupations, job transitions and wages. Each job corresponds to a particular employer and an individual holds up to five jobs in a year. As the job number depends on the actual survey round, I assign a specific number at each job that is constant across the survey years. In this way, a job/employer id is constructed, which allows linking the reported information with each specific job.

Hours worked is the accumulating hours worked on site (the job location outside of the home) and hours worked at home annually. Observations of individuals employed at least 10 hours per week are included. A woman is considered to be employed, either part-time in the period, if she reported working between 520 and 1,559 hours - or more than 260 and at most 520 annually and more than 30 hours weekly - or full-time if she reported working at least 1,560 hours annually. A woman is considered as non-employed if she was unemployed or out of the labor force or works for less than the lower limit of hours as described before. If a woman is non-employed, unemployment benefits or other public assistance or welfare are taken into account.

When a respondent reports more than one employers, either because she worked in more than one jobs or within that year one or more jobs have ended and others have begun, data on the main job is used. A main job is defined as the job in which the respondent worked the most hours. A working individual is assigned to one of the three occupational categories: part-time, full-time at home (when she reports a sufficient number of hours worked at home, i.e., more than 30 hours) and full-time on-site (when she works out of the home exclusively).

The hourly wage rate is used to construct women's annual wages. 0.1% of lower and higher hourly wage observations are considered as missing. Wages are deflated using CPI index. The base year is 2005.

Marriage and Family Background. The maximum number of marriages considered are three. The year in which each marriage began and ended is reported

in NLSY79. An individual is considered to be married in a year if she reports being married at the interview or a spouse exists. In this analysis, marriage and cohabitation are differentiated with each other. The question about spouse's wages, salary, or tips, before deductions for taxes or anything else is used to construct spouse's annual earnings. Similarly with women's wages, CPI index is used to convert husbands' earnings to 2005 dollars.

NLSY79 makes available information about members of the respondent's family through the household roster. Each member of the household is assigned a number that makes her identifiable in every survey year. I use this household enumeration to collate information about the age and highest grade completed on household members of interest (i.e., spouses).

Fertility. The maximum number of children considered is four. Based on the question about the year of birth of each child, a continuous fertility history is constructed.

2 Working at Home and the Female Wage Penalty: Flexible Working Arrangements Can Be Costly

Amairisa Kouki and Robert M. Sauer

Abstract

This paper evaluates the female wage penalty from workplace flexibility. Using longitudinal data on women and their children, the impact of flexibility on earnings is estimated in an IV framework. Our IV strategy exploits the exogenous variation in the propensity to work from home due to a temporary health shock to a child in the household. The estimates show that the female earnings' losses from remote working are substantial, negative and persistent. A subsidy or a tax reduction to mothers working at home could help offset the wage penalties from flexibility.

Keywords: *labor supply, work arrangements, fertility, health, instrumental variables*
JEL Classification: *C26, J13, J22, I19*

2.1 Introduction

Do women who choose flexible work arrangements, such as working from home rather than on site, pay for it indirectly through lower wages? Theoretically, flexibility in work location could hurt earnings as individuals may accept job offers with lower wages in return for the benefits of working from home. These benefits can include better coordination of time needed to care for children as well as reduced childcare and commuting costs. Lower earnings from locational flexibility can thus arise in a competitive labor market as a type of compensating wage differential. An alternative possibility is that working from home directly reduces an individual's productivity. Sociologists and psychologists have long highlighted the importance of social participation and interaction with co-workers as key factors for successful employment outcomes. In addition, a desire to work at home might signal to employers a limited commitment and devotion to the job which prevents or delays a move up the job ladder (Williams, 2000; Blair-Loy, 2006; Williams et al., 2013; Allen et al., 2015).

Despite the theoretical reasons why one might expect to observe earnings losses associated with work location flexibility, the empirical evidence for a wage penalty is sparse. Existing estimates mostly derive from data on select groups of individuals such as college educated women or women who work in occupations at the higher end of the earnings distribution. For example, Bertrand et al. (2010) focus on female MBA graduates who work in the financial and corporate sectors. They show that these women are more likely to choose to be in a job for family-related reasons post-birth than in the prebirth base period, and if these mothers choose a new job with the opportunity to work remotely, they suffer an earnings penalty of up to 20 percent. Glass and Noonan (2016) find that among full-time working women the first 40 hours per week worked at home are associated with either a positive or zero effect on earnings, while overtime hours worked at home yield lower earnings growth compared to overtime hours worked on site.

In this paper, we provide more comprehensive evidence and estimates of earnings losses due to flexibility in work location by using longitudinal data on a nationally-representative sample of working women. We also go beyond previous studies in this area by offering estimates of the female wage penalty in an instrumental variables (IV) framework. The source of exogenous variation in the propensity to work from home that we propose is a temporary adverse health event amongst one of the children in the household. Exogenous variation in the propensity to work at home helps correct for estimation biases due to unobserved omitted variables that change over time and possible reverse causality that have called into question the accuracy of previous estimates.

The two datasets that we utilize are the National Longitudinal Survey of Youth 1979 (NLSY79) and the NLSY79 Child and Young Adult Survey (CYA). The CYA is particularly useful because it contains assessments of the health of all biological children born to female respondents in the NLSY79 and allows us to construct the child health shock instrument. The economic logic of the instrument is that a temporary health shock to a child raises the opportunity cost of working on site, thereby increasing the demand for remote work in order to more flexibly attend to the needs of the child. The key identifying assumption is that after controlling

for standard determinants of earnings, the temporary health shock to the child does not affect the mother's earnings capacity beyond inducing her to work more at home for a limited period of time.

The main results of the study suggest that the female earnings loss associated with working from home is substantial both in magnitude and statistical significance. According to our preferred specifications, ordinary least squares (OLS) estimates indicate that working from home leads to a decrease in mean annual earnings of 9.9 percent. Fixed-effect estimates that take advantage of the longitudinal aspect of the data yield a stronger wage penalty of 13.1 percent. IV estimates that exploit the panel data and the exogenous source of variation to measure the earnings loss amongst women who are induced to work at home due to a temporary health shock of a child yield a much more serious wage penalty ranging from 73.3 percent without fixed effects to 79 percent with fixed-effects.

In addition to measuring the mean wage penalty in the population of working women and the local average treatment effect amongst working mothers, we closely examine heterogeneity in earnings losses. This facilitates speculation about the mechanisms that give rise to the wage penalties when working from home. We do not find evidence of heterogeneous effects. We also perform a number of robustness checks to justify the exogeneity of the instrument. A placebo type test shows that a child health shock does not affect mothers' earnings 2 years before it arises. However, the child health shock does have a persistent negative effect on earnings even 6 years after its occurrence. In a similar manner, flexibility wage penalty persists for working mothers 6 years after the child health incident.

We also discuss the policy implications of the results. In particular, a subsidy or tax reduction to mothers working at home, one that especially targets women at the lower end of the earnings distribution, could help offset the loss in earnings. Public discussions and policy proposals that often focus solely on increasing the supply of work-at-home opportunities tend to overlook the importance of the wage penalty associated with remote work.

The rest of the paper is structured as follows. Section 2 describes the data,

provides OLS and fixed-effects estimates of the wage penalty and discusses the child health instrument. Section 3 outlines the IV approach. Section 4 reports reduced-form and IV estimates of the wage penalty. Section 5 examines heterogeneity, speculates about the mechanisms underlying the penalty, performs robustness checks and discusses public policy implications. Section 6 summarizes and concludes.

2.2 Data

The NLSY79 is a large and nationally representative sample of American young men and women who were 14-22 years old when they were first surveyed in 1979. Data is available at an annual frequency until 1994. The survey became biannual from 1994 onward. The NLSY79 follows the same individuals over time, gathering event histories related to the respondent's labor market experience, education, family background, wages and earnings.[1]

Importantly for our purposes, the NLSY79 introduced questions on the number of hours per week usually worked at home starting in 1988. For this reason, our analysis starts from this year. The individuals in the estimation sample are employed females 24 to 55 years old between 1988 and 2012. After implementing standard sample exclusion restrictions, we obtain an estimation sample of 1,606 white women, either without children or with children under 18 years old, amounting to 17,397 women-year observations.[2]

The CYA surveys contain information on children born to female NLSY79 respondents. NLSY79 children are assessed and interviewed every two years since 1986. For consistency with the NLSY79, children are followed after 1988. Information about children's health is obtained by mothers during childhood. As children age they provide self-reported health information. We use various questions in the CYA to create the health history of NLSY79 female respondents' children. We take into account only temporary health conditions. The health

[1] The sample originally included 12,686 respondents. It contained a cross-section of 6,111 individuals of which 3,108 were women and 3,003 were men. There was also a set of supplemental samples designed to increase the representation of civilian Hispanics or Latinos, Blacks, the economically disadvantaged, non-Black/non-Hispanic youths (5,295 in total) and a military oversample designed to increase the representation of those serving in the military as of September 30, 1978 (1,280 in total). More information on NLSY79 can be found here.

[2] Only women who have finished their education are included in the sample. Women with incomplete observations on their marital status and fertility history, and with inconsistent schooling information, are excluded from the sample. Individuals with missing information about their occupation (missing census code) are also excluded. Fixed effects regressions require women with more than one year of employment attachment to be included in the sample.

problems considered are related to limiting health conditions, accidents and injuries requiring medical attention or hospitalization, emotional and behavioral problems, as well as utilization of specialized medical equipment and services. The number of children belonging to women included in the sample is 3,028.

In the analysis that follows, the hours worked variable is the sum of weekly hours worked on site (the job location outside of the home) and weekly hours worked at home to produce a total annual hours worked figure. Up to 2,080 hours of work each year are considered as regular-time hours. Hours beyond this amount are considered overtime hours. Glass and Noonan (2016) have similarly used the NLSY79 and the number of standard and overtime hours by location to measure telecommuting practices and flexibility in a fixed-effect analysis.

Respondents in the NLSY79 can report up to five employers. If more than one employer is reported, we consider the annual hours worked at the main job only. A woman is considered employed if she has reported working at least 10 hours per week.[3] The work-at-home variable is a dummy which is set equal to one for women who report having worked at home more than 30 hours annually. The majority of women in the sample do not work exclusively at home. However such cases are not excluded.[4] Work at home is our proxy for employer flexibility in work location. Wages are deflated using CPI index. The base year is 2005.

Table 2.1 displays the proportion of women in the sample who work at home by age and the distribution of the number of children under 18 by age. Pooling over all ages, the work-at-home rate is 16.4%. The proportion of women who work at home is fairly constant at around 18% until the age of 39. There is then a drop in the proportion that generally persists until age 55. As can be seen in Column (7), the drop in the proportion working at home coincides with a fall in the proportion of women with children under the age of 18. This is suggestive of a positive correlation between working at home and the presence of children in the household.

Table 2.2 shows differences in means by work location (at home vs. on site).

[3] If the sum of annual hours is less than 520 hours, the woman is considered employed if she worked more than 260 hours in total and reported more than 30 hours weekly.

[4] In our sample, 91.4% work at home less than 1,560 hours, and amongst these 78.2% work at home less than 520 hours. The mean hours worked at home (excluding zero hours) is 524.4.

Table 2.1: Proportion of Women Working at Home by Age and Distribution of Number of Children by Age

		Distribution of Number of Children under 18					
Age	Work at Home	0	1	2	>2	>0	*N*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
24	15.97	71.53	21.53	6.25	0.69	28.47	144
25	20.69	66.90	22.07	8.62	2.41	33.10	290
26	18.14	58.73	25.62	12.70	2.95	41.27	441
27	16.26	51.72	24.96	18.23	5.09	48.28	609
28	18.21	48.15	26.65	19.92	5.28	51.85	758
29	17.04	44.30	26.44	22.44	6.82	55.70	851
30	17.93	38.67	23.34	28.07	9.92	61.33	887
31	17.73	34.55	24.42	28.88	12.16	65.45	987
32	17.84	31.72	23.46	29.30	15.53	68.28	908
33	18.33	26.46	24.63	33.10	15.81	73.54	873
34	18.11	23.72	23.21	33.55	19.52	76.28	784
35	15.82	22.13	22.25	36.96	18.67	77.87	809
36	18.82	20.29	20.44	38.24	21.03	79.71	680
37	17.87	21.76	22.91	38.18	17.15	78.24	694
38	16.39	20.67	24.04	37.21	18.07	79.33	653
39	17.38	23.02	25.76	35.37	15.85	76.98	656
40	14.05	24.18	29.41	33.50	12.91	75.82	612
41	12.94	28.52	27.20	32.50	11.77	71.48	603
42	12.41	29.26	32.98	26.77	10.99	70.74	564
43	13.65	34.47	30.72	25.26	9.56	65.53	586
44	15.15	35.04	33.76	23.72	7.48	64.96	548
45	15.58	43.60	30.80	19.48	6.12	56.40	539
46	13.46	47.69	27.69	18.08	6.54	52.31	520
47	14.32	54.27	27.94	13.39	4.39	45.73	433
48	16.26	58.02	26.54	12.14	3.29	41.98	486
49	13.39	63.25	23.10	12.07	1.57	36.75	381
50	15.54	73.45	18.64	6.50	1.41	26.55	354
51	14.62	72.73	18.58	7.91	0.79	27.27	253
52	14.81	84.13	9.52	5.82	0.53	15.87	189
53	14.55	85.45	12.73	1.82	0.00	14.55	110
54	17.92	85.85	13.21	0.94	0.00	14.15	106
55	13.48	92.13	7.87	0.00	0.00	7.87	89
Total	16.41	38.78	25.05	25.54	10.63	61.22	17,397

Source: NLSY79
Notes: The figures in the number of children distribution are row percentages. *N* is the number of observations at each age.

Earnings correspond to the total income from wages from the main job earned by an employee in a calendar year. Earnings are deflated using the CPI index with a base year of 2005. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. The figures illustrate that women who work at home tend to be more highly educated, are more likely to be married and have larger families, work more regular and overtime hours, have higher earnings and are more likely to work in professional, technical or managerial roles. These raw correlations, which are obviously not conditional means, suggest a wage premium to working at home rather than a wage penalty.

Table 2.2: Differences in Means by Work Location (At Home vs. On Site)

	Full Sample (1)	Work at Home (2)	Work on Site (3)	Diff (2) - (3) (4)	
Age	37.059	36.458	37.177	-0.719	(0.152)
$HighestGradeCompleted(hgc) < 12$	0.060	0.019	0.068	-0.049	(0.003)
$12 \leq hgc < 16$	0.728	0.552	0.763	-0.211	(0.010)
$hgc \geqslant 16$	0.212	0.430	0.169	0.261	(0.010)
$Numberofchildren > 2$	0.106	0.128	0.102	0.025	(0.007)
Married	0.708	0.742	0.702	0.041	(0.009)
Professional, technical and managers	0.338	0.570	0.293	0.277	(0.010)
Sales and clerical	0.357	0.222	0.384	-0.162	(0.009)
Services, craftsmen, operatives and laborers	0.304	0.208	0.323	-0.116	(0.009)
Regular hours	1.691	1.757	1.678	0.079	(0.010)
Overtime	0.083	0.253	0.050	0.203	(0.008)
Log-earnings	9.942	10.112	9.909	0.203	(0.021)
N	1,606	859	1,567		
NT	17,397	2,854	14,543		

Source: NLSY79
Notes: The figures are averages in the pooled sample. N is the number of women. NT is the number of woman-year observations. Standard errors in parentheses.

OLS and Fixed-Effects Estimates

OLS and fixed-effects estimates of the impact of working at home on mean earnings are presented in Table 2.3. Column (1) does not contain any controls other than an indicator for working at home. This specification yields a precisely estimated wage premium to working at home of 20.3 percent. When other controls are added, including education, annual regular and overtime work hours, occupation, marital status and number of children, a precisely estimated wage penalty emerges. The OLS estimates in Column (2) imply that working at home is associated with a decrease in mean earnings of 9.9 percent. Column (3) reports fixed-effects estimates which explicitly use the longitudinal aspect of the data. Controlling for time-invariant unobserved individual characteristics as well as time-varying observed heterogeneity, a precisely estimated wage penalty of

13.1 percent is obtained.

Table 2.3: OLS and Fixed Effects Estimates of the Wage Penalty

	Earnings		
	OLS (1)	OLS (2)	FE (3)
Work at home	0.203**	-0.099**	-0.131**
	(0.036)	(0.026)	(0.020)
$I(12 \leq hgc < 16)$		0.166**	
		(0.032)	
$I(hgc \geqslant 16)$		0.478**	
		(0.041)	
Regular hours		1.731**	1.837**
		(0.071)	(0.054)
Regular hours sq.		-0.258**	-0.335**
		(0.026)	(0.019)
Overtime		0.555**	0.450**
		(0.059)	(0.044)
Overtime sq.		-0.200**	-0.141**
		(0.028)	(0.024)
Professional, technical and managers		0.374**	0.143**
		(0.022)	(0.016)
Sales and clerical		0.176**	0.053**
		(0.019)	(0.016)
Other regressors	No	Yes	Yes
R^2	0.008	0.563	0.514

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. The number of women is 1,606. The number of woman-year observations is 17,397. The dependent variable is the natural log of annual earnings in constant 2005 dollars. Work at home is an indicator for having worked at home for more than 30 hours during the survey year. *hgc* stands for the highest grade completed. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Other regressors include age, age squared, an indicator for more than two children under 18 and whether the woman is married.

The Child Health Instrument

The OLS and fixed-effects estimates of the earnings effects of working at home may suffer from biases due to unobserved omitted variables that change over time and reverse causality. These biases can potentially be reduced by introducing exogenous variation in the propensity to work at home. We define and exploit a

temporary health shock to a child as a source of credible exogenous variation.

Children's health problems have been used before as instruments in related contexts. For example, Powers (2001) uses 11 impairment categories to instrument the parental assessment of children's functional disability, assuming that the impairments are important determinants of the child care burden but do not directly interfere with parental labor supply. The study finds that the effect of child disability on maternal labor supply is insignificant for wives and negative and more severe for female household heads. The results are substantially different when no instrument is used.

Zan and Scharff (2018) uses a variety of chronic health conditions to instrument the financial and time health-related costs of children under 18 years old. They similarly assume that children's health problems affect their mothers' employment only through health-related financial and time caregiving burdens. Estimates that exploit the exogenous variation show that mothers are more likely to participate in the labor market with a higher monetary caregiving burden, and less likely to participate with a higher time caregiving demand. The effects of caregiving on mothers' employment are underestimated without instrumenting.

The economic logic of the instrument used in our case is that a temporary health shock to a child raises the opportunity cost of working on site, thereby increasing the demand for remote work in order to more flexibly care for the child. The key identifying assumption is that after controlling for a comprehensive set of standard determinants of earnings, including total hours worked and unobserved fixed-effects, the temporary health shock to the child does not affect mother's earnings beyond inducing her to work more at home for what might be a limited amount of time. The local average treatment effect that we estimate is limited to those who are induced to work at home due to a child's health becoming compromised. It is likely to be a lower-bound estimate. This is because we do not explicitly take into account women who are induced to leave the labour market completely, and who may experience more severe losses in human capital and earnings (Eckstein and Wolpin, 1989; Francesconi, 2002; Keane and Wolpin, 2010; Adda et al., 2017).

In constructing the child health instrument, we consider a broad range of health problems causing temporary activity limitations and participation restrictions, as well as injuries and accidents requiring medical attention or hospitalization. Mothers, and later children themselves, are asked in the survey whether the child has a condition that limits school attendance, work and play activities or requires special equipment. The type and duration of the condition is also specified. Mothers are also asked if children had an accident, injury, or illness requiring medical attention or hospitalization and when the three most recent injuries and accidents occurred. Responses to questions about serious behavioral issues, mental or emotional conditions are also used for the construction of the instrument.

The questions about the duration of limitations and the time of injuries or accidents in the CYA allow creation of a continuous child health history. This enables us to distinguish between a permanent and a temporary health problem of the child. A temporary health problem is defined as one which occurs for one year only. Limitations, accidents, injuries and mental conditions, as described above, with a duration of more than one year, or health issues that occur as a result of another disability, in the sense that they coexist with a permanent health condition, are not considered temporary and are not taken into account.

Table 2.4 presents the proportion of children with a temporary health problem at each child age less than or equal to 18. A maximum of four children per mother are considered. The overall prevalence of at least one child with a temporary health problem in the household is 12.3%.[5] Note that preschool children (less than 7 years of age) are more likely to experience a temporary health problem.[6]

In the regression analysis that follows, a temporary child health problem in

[5]Prevalence (or prevalence rate) is defined as the proportion of persons in a population who have a particular condition over a specified period of time. The prevalence rate of both the permanent and temporary health conditions in this dataset is 38.7%. Different reports use different data and criteria to define the level of limitation or disability. According to Bethell et al. (2011), who use data from the 2007 National Survey of Children's Health, in children younger than 17 , the prevalence of chronic conditions is 43% and reaches 49.9% for moderate or severe conditions (as rated by parent greater than mild). Data from Survey of Income and Program Participation (SIPP) show that the prevalence of non-severe and severe disability, as defined by the difficulty performing a specific set of functional and participatory activities, for children under 15 is 8.4% in 2010. Approximately 50% of children with disability were classified with severe disabilities (see Current Population Report). Child Trends use National Health Interview Survey data for 1998 - 2013 and a set of questions related to limitations in normal physical activities due to health conditions and impairments, difficulty seeing, difficulty hearing, diagnosed learning disabilities, or difficulty bathing or showering without assistance and find that the proportion of children aged 5 to 17, whose parent or other adult household member reported as having at least one limitation, remained relatively constant from 1998 to 2013, fluctuating between 17% and 20%.

[6]Evidence for the U.S. and other countries shows that children at preschool age spend more time at home, the leading location for accidents for young children (Pauline et al., 2007; Phelan et al., 2011).

Table 2.4: Proportion of Children with a Temporary Health Problem by Age

Child's Age	Health Problem	*N*
0	7.85	1,503
1	26.65	1,666
2	26.64	1,832
3	21.33	2,025
4	18.80	2,192
5	17.45	2,333
6	16.38	2,484
7	14.04	2,622
8	14.37	2,741
9	11.79	2,833
10	10.98	2,870
11	10.58	2,912
12	8.65	2,914
13	10.25	2,908
14	7.90	2,872
15	6.18	2,816
16	5.59	2,739
17	6.68	2,650
18	4.52	2,565
Total	12.27	47,477

Source: CYA
Notes: The health problem figures are proportions. N is the number of children observations at each age.

the family is represented by a dummy which equals one if at least one child is temporarily suffering, and zero otherwise. The proportion of mothers that have at least one child with a temporary health problem in the sample is 15.6%.

2.3 Instrumental Variables Approach

The child health instrument is exploited within the framework of a two-stage least squares model that estimates a linear relationship between the log of annual earnings of woman i at time t, $Y_{i,t}$, and working at home at time t, $F_{i,t}$,

$$Y_{i,t} = \alpha_i + \beta_1 F_{i,t} + \beta_2 X_{i,t} + u_{i,t}, \tag{2.1}$$

where α_i is an unobserved individual fixed-effect, $X_{i,t}$ is a vector of time-varying individual characteristics including age, age squared, regular hours, regular hours squared, overtime hours, overtime hours squared, the existence of more than two children in the household, marital status, and different occupational categories. $u_{i,t}$ is an individual-specific productivity shock in each year t.

The first stage equation in the two-stage least squares procedure is

$$F_{i,t} = \gamma_i + \delta_1 H_{i,t} + \delta_2 X_{i,t} + \upsilon_{i,t}, \tag{2.2}$$

where γ_i is an unobserved individual fixed-effect, $H_{i,t}$ is the child health instrument and $\upsilon_{i,t}$ is an individual-specific error term in each year t that may be correlated with $u_{i,t}$ in Equation (2.1).

As mentioned earlier, the key identifying assumption is that a child's compromised and temporary health condition increases the opportunity cost of working on site but does not directly influence earnings, after controlling for observable determinants of earnings and unobservable time-invariant characteristics. The IV estimates have a causal interpretation as long as the association between children's health and earnings is exclusively due to the association between children's health and the decision to work remotely. The main identification challenge arises from the possible impact of children's health on earnings through alternative channels such as the choice of working hours and occupation. We deal with this challenge by using flexible specifications for hours worked and including

indicators for different occupational categories as covariates. We also perform robustness and placebo tests which increase confidence in the validity of the instrument.

2.4 Estimation Results

Reduced Form Estimates

Table 2.5 presents reduced form estimates of the effect of a temporary child health problem. The same set of covariates are used as in the OLS and fixed effects estimations corresponding to Table 2.3. Columns (1) and (2) of Table 2.5 display, respectively, first-stage estimation results without and with fixed-effects. In both cases, the occurrence of a temporary health problem substantially increases the probability to work at home. The increase in the probability is 5.3 percent without fixed effects and 3.8 percent with fixed effects. These are large magnitudes considering that the the mean proportion that work at home in the sample is 16.4 percent. The $F-statistics$ of 29.50 and 18.94 in Columns (1) and (2), respectively, indicate that the instrument is relevant and strong.

In Columns (3) and (4) it is shown that there is a precisely estimated negative effect of a temporary child health problem on annual earnings. Mean annual earnings are lower by 3.9 percent without fixed effects and 3.0 percent with fixed effects amongst women with at least one child with a temporary health problem. The ratio of the coefficients corresponding to the temporary child health variable in Table 2.5 indicates that the IV estimates of the earnings effect of working at home will be negative and quite substantial in magnitude.

Instrumental Variable Estimates. Instrumental variables estimates of the effect of working at home on annual earnings are reported in Table 2.6. The same set of regressors described earlier for OLS and fixed-effects regressions in Table 2.3 are included. Working at home is instrumented by the temporary child health problem variable. The IV estimates of the wage penalty are precisely estimated and large in magnitude. In Column (1), without fixed effects, the wage penalty is 73.3 percent. In Column (2), with fixed effects included, the wage penalty increases to 79 percent. These IV estimates are more than 6 to 7 times the un-instrumented estimates shown in Columns (2) and (3) of Table 2.3. Our estimates

Table 2.5: Reduced Form Estimates

	Work at Home		Annual Earnings	
	OLS	FE	OLS	FE
	(1)	(2)	(3)	(4)
Health problem	0.053**	0.038**	-0.039**	-0.030**
	(0.010)	(0.009)	(0.015)	(0.012)
$I(12 \leq hgc < 16)$	0.055**		0.161**	
	(0.011)		(0.032)	
$I(hgc \geqslant 16)$	0.197**		0.458**	
	(0.019)		(0.041)	
Regular hours	0.108**	0.084**	1.720**	1.826**
	(0.040)	(0.037)	(0.071)	(0.054)
Regular hours sq.	-0.052**	-0.035**	-0.253**	-0.331**
	(0.015)	(0.013)	(0.026)	(0.019)
Overtime	0.761**	0.546**	0.479**	0.378**
	(0.043)	(0.040)	(0.059)	(0.044)
Overtime sq.	-0.223**	-0.145**	-0.178**	-0.122**
	(0.024)	(0.020)	(0.029)	(0.024)
Professional, technical	0.078**	0.019	0.366**	0.140**
and managers	(0.012)	(0.013)	(0.022)	(0.017)
Sales and clerical	-0.010	-0.054**	0.178**	0.060**
	(0.009)	(0.011)	(0.019)	(0.017)
Other regressors	Yes	Yes	Yes	Yes
$F-stat$	29.50 (0.000)	18.94 (0.000)	596.04 (0.000)	841.18 (0.000)
R^2	0.172	0.067	0.562	0.509

Source: NLSY79

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. The number of women is 1,606. The number of woman-year observations is 17,397. The dependent variable in Columns (1) and (2) is a dummy indicating having worked at home for more than 30 hours during the survey year. The dependent variable in Columns (3) and (4) is the natural log of annual earnings in constant 2005 dollars. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Other regressors include age, age squared, an indicator for more than two children in the household, and whether the woman is married. The $F-stat$ is for the test of excluded instruments ($P-values$ in parentheses).

are comparable but still higher in magnitude than those found in Bertrand et al. (2010). In this latter study, the wage penalty amongst female MBA graduates who choose a new job that provides the opportunity to work remotely is 20 percent but the wage penalty amongst these same women who choose a new job that provides flexible hours of work is much higher at 64 percent.

Table 2.6: IV Estimates of the Wage Penalty

	Annual Earnings	
	(1)	(2)
Work at Home	-0.733**	-0.790**
	(0.303)	(0.342)
$I(12 \leq hgc < 16)$	0.201**	
	(0.036)	
$I(hgc \geqslant 16)$	0.603**	
	(0.071)	
Regular hours	1.800**	1.892**
	(0.079)	(0.065)
Regular hours sq.	-0.291**	-0.359**
	(0.031)	(0.024)
Overtime	1.038**	0.809**
	(0.235)	(0.194)
Overtime sq.	-0.341**	-0.237**
	(0.073)	(0.057)
Professional, technical and managers	0.423**	0.155**
	(0.033)	(0.019)
Sales and clerical	0.171**	0.018
	(0.020)	(0.024)
Other regressors	Yes	Yes

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. The number of women is 1,606. The number of woman-year observations is 17,397. The dependent variable is the natural log of annual earnings in constant 2005 dollars. Work at Home is an indicator for having worked at home for more than 30 hours during the survey year. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Other regressors include age, age squared, an indicator for more than two children in the household, and whether the woman is married.

Note that the wage penalty estimates in Table 2.6 should be considered local average treatment effects. They reflect the effect on earnings amongst women

who are induced to work at home solely as a result of at least one child in the household developing a temporary health problem. This subpopulation of women, the compliers (Angrist et al., 1996), are those who would not have worked at home had the child not become ill. The seemingly large magnitude of the wage penalty is partially due to the estimates isolating the effect amongst this particular group of women, whose opportunity cost of working on site are the highest.

Table 2.7 presents additional IV results which test for heterogeneous treatment effects. In particular, we examine whether the effect of work at home on earnings depends on education, occupation, regular and overtime hours. Given the magnitude of the interaction terms coefficients, there are not significant interactions between working at home and education, occupation, regular and overtime hours. This means that there is not sufficient evidence of heterogeneous treatment effects.

2.5 Discussion

Robustness checks

As illustrated in Table 2.6, IV estimates indicate a substantial decrease in mean annual earnings when women choose to work from home. The first-stage estimates in Table 2.5 suggest that the instrument used to produce the wage penalty estimates is both relevant and strong. Evidence for the exogeneity condition holding as well is clearly more difficult when there is exact identification. Nonetheless, we do attempt to justify the exogeneity of the instrument by performing alternative first-stage regressions and a set of placebo tests.

The alternative first-stage regressions in Table 2.8, which include fixed effects, examine whether the child health shock triggers changes in the other observed determinants of earnings that we use as controls. The idea is that if the temporary child health problem is strongly correlated with many controls, then perhaps it is also correlated with omitted variables that are not captured by the individual fixed effects (i.e., omitted time-varying determinants of earnings). If the temporary child health shock was leading to widespread changes then the exogeneity of the instrument would perhaps be less plausible.

In the year a temporary health problem occurs the regular hours worked

Table 2.7: IV Estimates - Heterogeneous Treatment Effects

	Annual Earnings				
	Without Fixed Effects		With Fixed Effects		
	(1)	(2)	(3)	(4)	(5)
Work at Home	0.738	-0.484	-0.806	-2.343	-1.276*
	(3.610)	(0.364)	(0.655)	(1.431)	(0.712)
Work at Home*$I(12 \leq hgc < 16)$	-1.963				
	(3.608)				
Work at Home*$I(hgc \geqslant 16)$	-1.009				
	(3.643)				
Work at Home*Professional, technical and managers		-0.221	0.255		
		(0.577)	(0.862)		
Work at Home*Sales and clerical		3.393	4.778		
		(9.065)	(12.416)		
Work at Home*Regular Hours				1.404	
				(2.034)	
Work at Home*Overtime					7.593
					(8.050)
Other regressors	Yes	Yes	Yes	Yes	Yes

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. The number of women is 1,606. The number of woman-year observations is 17,397. The dependent variable is the natural log of annual earnings in constant 2005 dollars. Work at Home is an indicator for having worked at home for more than 30 hours during the survey year. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Other regressors include regular hours, regular hours squared, overtime hours, overtime hours squared, dummies for occupations, age, age squared, an indicator for more than two children in the household, and whether the woman is married.

decrease and the probabilities of having a sales or clerical job, being married and have more than two children increase. The overtime hours or the probability of working in a professional, technical or managerial role are not directly affected by the health problem. Given these results, we perform alternative placebo tests to justify the exogeneity of the instrument.

The results of placebo tests are presented in Table 2.9. We run reduced form estimations with fixed effects as in Table 2.8 but we falsely assign the temporary child health problem to be two years before it actually occurred. This is then repeated for two, four and six years after it actually occurred.[7] The results from Panel A of Table 2.9 indicate that there is no strong association between a health problem and earnings two years before the child actually falls sick. However, as shown in Panels B-D, the temporary health shock effect does seem to be persistent and is associated with lower mean earnings and fewer regular hours worked up to 6 years after its occurrence.

The results from IV regressions of similar placebo tests are presented in Ta-

[7]The CYA surveys are held biannually.

Table 2.8: Alternative First-Stage Regression Results

	Regular hours (1)	Overtime (2)	Professional, technical and managers (3)	Sales and clerical (4)	Married (5)	Number of children (6)
Health problem	-0.088**	-0.004	0.003	0.018**	0.049**	0.042**
	(0.012)	(0.005)	(0.008)	(0.009)	(0.009)	(0.008)
Regular hours		-0.374**	-0.064	0.001	0.040	0.046
		(0.019)	(0.040)	(0.043)	(0.040)	(0.033)
Regular hours sq.		0.174**	0.037**	0.007	-0.034**	-0.032**
		(0.008)	(0.014)	(0.015)	(0.015)	(0.012)
Overtime	0.897**		0.102**	-0.073**	-0.045	0.034*
	(0.033)		(0.032)	(0.027)	(0.033)	(0.019)
Overtime sq.	-0.299**		-0.038**	0.027*	0.002	-0.019*
	(0.019)		(0.018)	(0.014)	(0.015)	(0.010)
Professional, technical and managers	0.083**	0.021**		-0.641**	0.005	-0.004
	(0.015)	(0.011)		(0.014)	(0.012)	(0.009)
Sales and clerical	0.038**	-0.014*	-0.579**		-0.000	-0.019**
	(0.015)	(0.008)	(0.014)		(0.012)	(0.009)
Other regressors	Yes	Yes	Yes	Yes	Yes	Yes

Source: NLSY79

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. The number of women is 1,606. The number of woman-year observations is 17,397. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Number of children is an indicator for more than two children under 18. Other regressors include age, age squared, an indicator for more than two children in the household, and whether the woman is married.

Table 2.9: Reduced Form Regressions - Placebo Tests

	Annual earnings (1)	Regular hours (2)	Overtime (3)	Professional, technical and managers (4)	Sales and clerical (5)	Married (6)	Number of children (7)
A. 2 years before							
Health problem	0.001	-0.069**	-0.007	-0.013	-0.000	0.050**	0.017**
	(0.013)	(0.012)	(0.005)	(0.009)	(0.009)	(0.009)	(0.008)
B. 2 Years after							
Health problem	-0.038**	-0.080**	0.001	-0.006	-0.002	0.029**	0.045**
	(0.012)	(0.013)	(0.005)	(0.009)	(0.010)	(0.010)	(0.009)
C. 4 Years after							
Health problem	-0.028**	-0.118**	-0.003	-0.016	-0.021**	0.007	0.042**
	(0.013)	(0.014)	(0.006)	(0.010)	(0.010)	(0.009)	(0.010)
D. 6 Years after							
Health problem	-0.039**	-0.113**	-0.004	0.002	-0.008	-0.006	0.015
	(0.014)	(0.016)	(0.007)	(0.011)	(0.012)	(0.011)	(0.010)

Source: NLSY79

Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. Annual earnings is the natural log of annual earnings in constant 2005 dollars. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. The number of children is an indicator for more than two children in the household.

ble 2.10. The impact of flexibility on earnings is not significant before a health problem actually occurs, while flexibility wage penalty persists for working mothers 6 years after the child health incident.

Table 2.10: IV Estimates of the Wage Penalty - Placebo Tests

	Annual Earnings			
	2 years before (1)	*2 years after* (2)	*4 years after* (3)	*6 years after* (4)
Work at Home	0.059	-1.145**	-0.788*	-0.930**
	(0.605)	(0.438)	(0.414)	(0.397)
Regular hours	1.798**	1.876**	1.859**	1.877**
	(0.078)	(0.076)	(0.076)	(0.081)
Regular hours sq.	-0.321**	-0.358**	-0.352**	-0.358**
	(0.031)	(0.029)	(0.029)	(0.030)
Overtime	0.340	1.005**	0.821**	0.876**
	(0.329)	(0.244)	(0.232)	(0.208)
Overtime sq.	-0.107	-0.292**	-0.237**	-0.245**
	(0.090)	(0.069)	(0.064)	(0.056)
Professional, technical and managers	0.133**	0.149**	0.144**	0.153**
	(0.020)	(0.022)	(0.022)	(0.028)
Sales and clerical	0.061	-0.015	0.007	0.027
	(0.037)	(0.031)	(0.028)	(0.024)
Other regressors	Yes	Yes	Yes	Yes

Source: NLSY79
Notes: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$. Regular and overtime hours are the total hours worked by an employee on site and at home in a calendar year. Number of children is an indicator for more than two children under 18. Other regressors include age, age squared, an indicator for more than two children in the household, and whether the woman is married.

Policy Implications. Our estimates indicate that the penalty from working from home is high when flexibility is chosen as a response to increased caring responsibilities. This implies that some mothers may not find it worth it to work at all, even given the possibility to work at home. This would lead to less labour force participation due to caregiving and a loss in human capital accumulation, see for example, Eckstein and Wolpin (1989); Francesconi (2002); Keane and Wolpin (2010); Adda et al. (2017).

In the U.S., access to work-family benefits is rather limited compared to other developed countries. Indicatively, the U.S is the only OECD member to offer no statutory entitlement to paid maternity leave on a national basis.[8] In addition,

[8]For more details see OECD - Parental Leave Systems.

few employees have access to quality of life benefits, such as paid childcare (11%) and subsidized commuting (7%). Part-time workers and those at the lower end of the wage distribution are among the most deprived of such benefits.[9]

Leave policies are differentiated across employees, employers and states. Not all employees have access to paid sick leave benefits (70% of all civilian workers).[10] The federal Family and Medical Leave Act (FMLA) provides employees with a job-protected, unpaid leave. However, it only covers firms with more than 50 employees, while at the same time many employees, such as part-time or temporary workers, are excluded from being eligible for the benefits provided by the act.[11]

Considering the lack of uniform work-family support and the high cost of working from home, policy interventions could aim at encouraging flexibility by decreasing the associated wage penalties.[12] A childcare subsidy or a tax reduction to those working from home may potentially have such an effect by making remote working more worthwhile, especially for those at the lower end of the earnings distribution. Employers in turn could benefit by offering more flexibility, helping to retain employees.

2.6 Conclusion

This paper evaluates the wage penalties from workplace flexibility, as captured by working from home, using longitudinal data on a representative sample of working women. OLS estimates indicate that remote working decreases annual earnings by 9.9 percent. Fixed-effects estimates yield a stronger wage penalty of 13.1 percent. IV estimates that exploit the panel aspect of the data and the exogenous variation in the propensity to work at home due to a temporary child health shock yield a higher wage penalty of 79 percent.

The results from placebo tests show that a child health shock does not affect mothers' earnings 2 years before it arises. The child health shock though has

[9] According to 2016 National Compensation Survey - Quality of Life Benefits, 5% and 3% of part-time workers and 4% and 2% at the lowest quantile of the average wage distribution have access to paid childcare or subsidized commuting.

[10] According to Data on Access to Paid Sick Leave Benefits, in 2016, 83% of full-time workers, 33% of part-time workers and 29% of those at the lowest decile of hourly average rate distribution had access to paid sick leave. Very few workers have access to paid sick leave on an as needed basis (4% of civilian workers). 25% of those at the highest quantile of average rate distribution had access to paid sick leave as part of consolidated leave plan.

[11] For more information about paid and unpaid leave in the U.S., see Paid Parental Leave in the United States.

[12] According to 2016 National Study of Employers and Research Report on Employee Benefits more than 60% of employers offered telecommuting in 2016.

substantial, negative and persistent effects even 6 years after its occurrence. In a similar manner, flexibility wage penalty persists for working mothers 6 years after the child health incident.

Considering the wage penalties from remote working, a childcare subsidy or a tax reduction to mothers working from home may help to make flexibility more affordable, especially for those at the lower end of the earnings distribution. Employers could also benefit by offering more flexibility, helping to retain employees.

Human capital and earnings losses due to a possible inability to work on site, and hence a move into unemployment, are not taken into account in this framework. For this reason, the local average treatment effect is likely to be a lower-bound estimate. A dynamic structural model could allow selection issues to be addressed explicitly.

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