Essays on Health, Family, and Work Choices

Joelle Abramowitz

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Reading Committee:

Judith Thornton, Chair
Anirban Basu
Seik Kim

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Introduction

This dissertation investigates how changes in policies, technology, and lifestyles affect individual's decisions about their health, well-being, and life choices. The dissertation primarily focuses on two questions within this topic: i) the effects of greater affordability of assisted reproductive technology (ART) on women's marriage and fertility timing decisions and ii) the effects of time spent working on individual's obesity and health status and the mechanisms contributing to these effects.

In two chapters, I examine whether greater affordability of ART has impacted women's fertility and marriage choices. ART consists of medical technologies that help women and couples with fertility problems conceive a child using such methods as in-vitro fertilization (IVF). Since the percentage of women facing infertility increases greatly with age, by making it affordable for women to delay family formation and then use ART to start families later if they face infertility, greater affordability of ART could induce women to delay marriage and childbearing. To formally identify channels through which greater affordability of ART might impact women's decisions about timing of family, I develop theoretical models of greater affordability of ART and women's allocation of time on work and family investment over the life course. To test the implications of the models, I utilize empirical strategies exploiting variation in the mandated insurance coverage of ART across U.S. states and over time. In the first chapter, I use linear probability models and the 1977-2010 Current Population Survey to examine the likelihood that women of different ages with and without mandated insurance coverage of ART have ever been married in order to compute marriage rates between age groups, the differences in the likelihoods of having ever been married between one age group and the next. Results show that greater access to ART is associated with marital delay for white (but not for black) women. In the second chapter, to estimate a more precise analysis and examine channels for the effects on marriage, I perform survival and competing risks analyses using the 1986-2009 Panel Study of Income Dynamics to examine the effects of the mandates on the hazards of transitioning to first marriage and first birth for single and childless women, respectively. The findings of this research suggest that the mandates are associated with delayed marriage and childbearing at younger ages and speeded transition to marriage and motherhood after age 30, but only for college graduate women, consistent with the theoretical framework's prediction that women with steeper wage trajectories should be more influenced by the mandates to delay family formation. For the full sample of women, the mandates appear to be associated with speeded transition to marriage after age 25 and motherhood within marriage after age 30, but not with delay at younger ages. This research builds on the literature examining changes in women's marriage and fertility timing and on the literature investigating the effects of ART insurance mandates. This research is valuable for understanding the impacts of technology and policy as well as the factors impacting women's marriage and fertility timing.

In the third chapter, I investigate mechanisms for the positive relationship between time spent working and Body Mass Index (BMI). BMI might increase and health status might decline with more hours spent working since as leisure time declines, the opportunity cost of time rises, and it becomes more costly to undertake health-producing activities and receive medical care.

Additionally, more time spent working would increase the incidence of detrimental effects of the workplace such as job-related stress, which would have a negative effect on health. This chapter uses the 2006, 2007, and 2008 American Time Use Surveys (ATUS) linked with Eating and Health module data to identify channels through which time spent working could affect BMI. While other datasets provide information on individuals' market work time, the ATUS also provides insight into individuals' non-market work activities. Linked with the Eating and Health module, it permits inference to be drawn about individuals' time use in a variety of activities as well as measures relating to eating and health, including BMI. Making use of this data, in this chapter I first replicate the results of other papers by estimating the effect of working time on BMI and find that increased working time is associated with a positive and significant effect on own BMI for both men and women. Then, to investigate the channels through which working time may impact BMI, I next estimate a series of equations to determine whether a variety of potential mediators significantly change the estimated effect of time spent working on own BMI. A number of the tested channels appear to mediate the effect of hours worked on BMI with strong significant effects found for exercise, active time, and screen time, and marginally significant effects found for secondary eating and food preparation. No significant effects were found for primary eating, secondary drinking, grocery shopping, purchasing prepared food, sleeping, housework, commuting, or own medical care. These results suggest the main channels through which working hours could be related to BMI are related to physical activity. These findings suggest plausible mechanisms for the association between time spent working and obesity.

This work contributes to the literature by using time use data to examine the effect of time spent working on BMI as well as by modeling the channels through which time use affects weight and health outcomes. While previous work has explored the effect of working time on BMI, this paper considers the effect of working time on various measures of time use to get a fuller picture of how work time affects lifestyle choices that affect weight and health. This is valuable because recent research has found that there is a growing disparity in working hours between Americans and those in other industrialized countries, and the full consequences of increasing working hours are not explored in the literature and can have significant implications for labor and tax policy. Further, to prescribe effective policy interventions, it is necessary to know the channels through which any effects are arising. This work contributes to the literature by investigating the potential eating, health investment, and physical activity channels driving the positive relationship between working time and BMI to obtain a fuller picture of how work time affects lifestyle choices that affect weight and health. This is valuable because as Americans transition to more sedentary jobs, the full consequences of increased work hours in those jobs are not explored in the literature and can have significant implications for labor and tax policy. Accordingly, the paper provides insights useful for designing effective policy interventions aiming to reduce obesity prevalence.

This research has examined questions related to individuals' health and life choices with relevant policy implications. Recent decades have seen significant changes in the roles of and opportunities for women and associated changes in lifestyle and the family, and this dissertation explores the effects of these changes. The findings of this research suggest that women have responded to lower prices of infertility treatment with higher educated women delaying marriage and child bearing, and it could be the case that these invest more time when younger in education and work. In addition, the research suggests that increased time spent working may be associated with an increase in BMI driven by allocating less time to physical activity. These results suggest that changes in technology and lifestyle over recent decades have had real effects on individuals' life choices and health.

Chapter 1: Turning Back the Ticking Clock: The Effect of Increased Affordability of Assisted Reproductive Technology on Women's Marriage Timing

Introduction

The past several decades have seen far-reaching changes in the lives of women. Women have married and started families later or have forgone marriage and motherhood altogether. The number of women in college and professional schools has greatly increased as has the number of women pursuing careers. Over the same period, significant developments in conceptive and contraceptive technologies have provided women more control over their fertility. Several papers have addressed the question of whether contraceptive technology has influenced women's choices beyond the scope of their fertility. This paper examines the connection between affordability of assisted reproductive technology (ART) and female marriage timing.

Goldin and Katz (2002) and Bailey (2006) examine whether the availability of the contraceptive technology of the birth control pill impacted women's life choices both within and beyond the scope of fertility. Goldin and Katz (2002) show that greater access to the pill was associated with being less likely to marry before age 23, more likely to be employed in professional occupations, more likely to never marry, and less likely to be divorced. Bailey (2006) associates early legal access to the pill with a reduced likelihood of a first birth before age 22, an increased number of women in the paid labor force, and an increase in their number of annual hours worked. These papers suggest that the availability of a fertility technology can impact women's choices, not just about their childbearing, but their marriage, education, and other life decisions as well.

While the above papers examined the effects of the diffusion of a contraceptive technology, this paper builds on this literature by investigating the effects of a development in the technology of conception: ART. ART consists of medical technologies that help women and couples with fertility problems conceive a child using such methods as in-vitro fertilization (IVF). This paper investigates whether greater affordability of ART has affected women's decisions about when to start families by examining effects on their timing of marriage. Since the percentage of women facing infertility increases greatly with age, by making it affordable for women to delay family formation and then use ART to start families later if they face infertility, greater affordability of ART could induce women to delay marriage in order to invest in education and a career or search longer for a spouse.

However, identifying whether advances in the availability and affordability of reproductive technology have in fact affected women's life choices is not straightforward. Over the same period when these technologies became available, women achieved greater educational and career opportunities, and it is these developments that have in turn increased the demand for delayed fertility and driven developments in the field of reproductive technology. Since the advances in women's education, career, and reproductive technology were co-determined, an analysis must be careful to identify the effects of each of these forces separately. In their analysis of the effects of availability of the birth control pill, Goldin and Katz (2002) and Bailey (2006) exploit cross-state variation in the age of majority and hence legal access to the birth control pill. To identify the effects of ART separately from other forces affecting women's marriage decisions, this paper exploits exogenous state variation in mandated insurance coverage of ART.

Beginning in 1977 and continuing through 2001, 15 states mandated insurance coverage for ART in some form which facilitated the use of ART by many women for whom it would have otherwise been too costly. The systematic variation in insurance coverage of ART by state and over time provides a strategy for identifying effects of a fall in the price of these technologies. It appears that the mandates have indeed been effectual in promoting the use of ART: several papers find effects of the ART insurance mandates on the use of infertility treatment (Jain, Harlow, and Hornstein, 2002; Bitler and Schmidt, 2006; Bundorf, Henne, and Baker, 2007; Bitler and Schmidt, 2012) and others find effects of the mandates on birth outcomes (Buckles, 2005; Bundorf, Henne, and Baker (2007); Schmidt, 2007; Bitler, 2008; Ohinata, 2011; Buckles, 2012; Hamilton and McManus, 2012). Given that the mandates appear to be effective in making ART accessible for many women, this paper uses the variation in the mandated insurance coverage of ART to examine whether greater affordability of ART is associated with changes in women's timing of marriage.

While the aforementioned papers examine the effects of the ART insurance mandates on the use of infertility treatment and birth outcomes, few papers examine whether greater affordability of ART has had impacts beyond only the users of ART and the scope of fertility. This paper adds to the literature by considering the effects of the mandates on all women through their expectations about their future fertility options regardless of whether they will ever actually use ART and examines whether advancements in ART are associated with changes in women's timing of marriage.

This paper uses variation in the mandated insurance coverage of ART to develop several empirical specifications to examine whether greater affordability of ART is associated with changes in women's marriage timing. The empirical analysis estimates the likelihood that women of different ages with and without mandated insurance coverage of ART have ever been married in order to compute marriage rates between age groups, the differences in the likelihoods of having ever been married between one age group and the next. By examining marriage rates between age groups, the analysis can be used to determine whether greater affordability of ART is associated with changes in women's marriage timing.

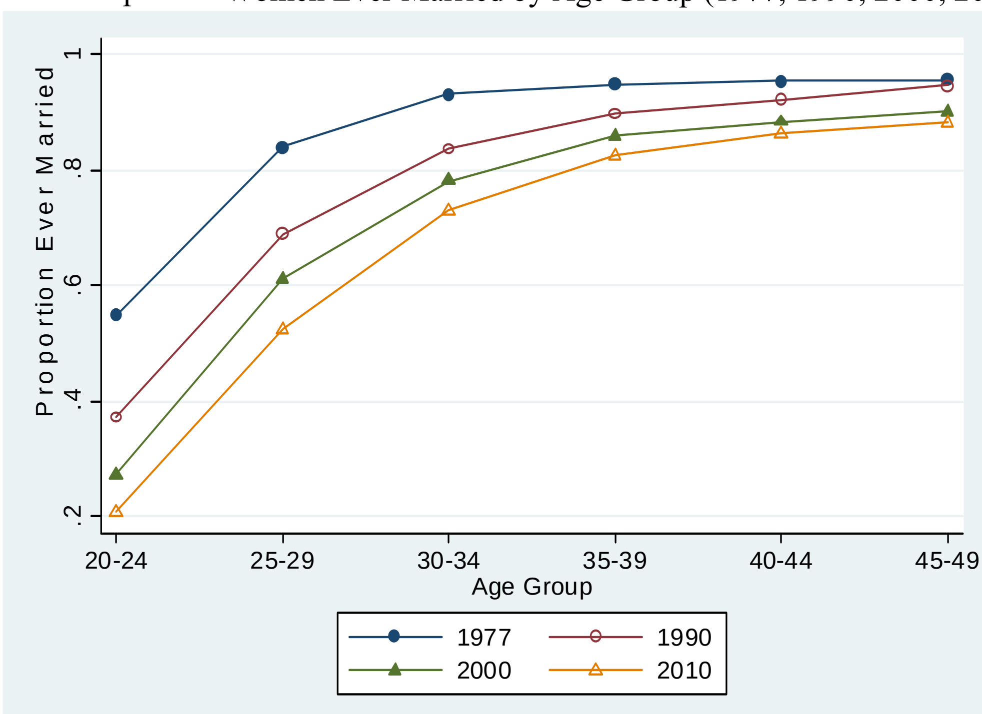
The results of the empirical analysis suggest that the mandates are associated with a pattern of marriage delay. Across all ages, the mandates appear to be associated with a lower likelihood of ever marrying: significant negative effects of the mandates on the probability of ever having married are found for women ages 20-49 for the full sample and for whites. However, it appears that the effects of the mandates vary greatly for women of different ages and are consistent with a pattern of marriage delay: estimating the effects of the mandates by age group suggests that for white women, the mandates are associated with a significantly lower probability of marrying over the 20-24, 25-29, and 30-34 age ranges and a significantly higher probability of marrying over the 30-34 and 35-39 age ranges. None of the mandate estimates were significant for blacks.

The rest of the paper is organized as follows. The next sections provide some background on women's age at first marriage as well as infertility and the ART insurance mandates. The following section develops a theoretical framework for understanding how ART might affect women's marriage timing decisions. The next sections outline the empirical specifications, present the data used in the analysis, and show results of the analysis. The last section concludes.

Changes in Marriage

Over the past several decades, there have been considerable changes in women's propensity to marry and timing of marriage. As shown in Figure 1, over 1977 to 2010, at all ages, the proportion of women ever married has decreased. While the likelihood to ever marry has also decreased, the likelihood of marrying at younger ages has fallen dramatically: in 1977, over 50 percent of women ages 20-24 had married, but by 2010, the proportion fell to little more than 20 percent. There has been extensive discussion in the economics and social sciences literature about the drivers and consequences of this change in marriage behavior.

Figure 1: Proportion Women Ever Married by Age Group (1977, 1990, 2000, 2010)[1]



From an economic perspective, understanding individuals' decisions about whether and when to marry is valuable since marriage can affect their work, family, and other life decisions and because it is useful to think of the marriage market itself as analogous to the labor market. While the institutional theory of marriage (Goode 1982; Modell 1985; Thornton 1989) would suggest

[1] Source: Integrated Public Use Microdata Series, Current Population Survey March Supplements, 1977, 1990, 2000, 2010 from King et al. (2010).

that marriage behavior might not be influenced by changes in the costs and benefits of marriage, using the framework pioneered by Becker (1973, 1974, 1981), it would be expected that decisions about marriage should respond to changes in the costs and benefits of marriage. This paper will examine whether changes in the affordability of ART have affected women's likelihood of marrying at different ages. However, over the same period that ART became more available and affordable, changes in many other factors have been found to contribute to changes in women's marriage timing as well.

One of the most important changes in the lives of women has been significantly expanded opportunities in the labor market. Goldin (2006) identifies increased opportunities in the workplace and education as well as developments in household production technology as key factors in women's changing economic roles over the last century and associates women's greater labor market opportunities and a later age at first marriage for women pursuing higher education beginning in the 1970s. Blau, Kahn, and Waldfogel (2000) also find that women's decisions to marry were responsive to their own labor market opportunities as well as men's. Using 1970, 1980, and 1990 Census data they find that women delay marriage when their own opportunities in the labor market improve or when men's opportunities in the labor market worsen. This suggests that greater labor market opportunities are increasingly driving women's decisions about family timing.

In addition to changes in the economic roles of women, changes in general economic conditions have been found to contribute to women's marital delay as well. Wage inequality has increased greatly over recent decades, and if women search longer for a spouse when there is higher male wage inequality, this could be an important factor contributing to delayed marriage. Loughran (2002) and Gould and Paserman (2003) examine the connection between increasing male wage inequality and declining female marriage rates within cities and establish a causal connection between the former and the latter.

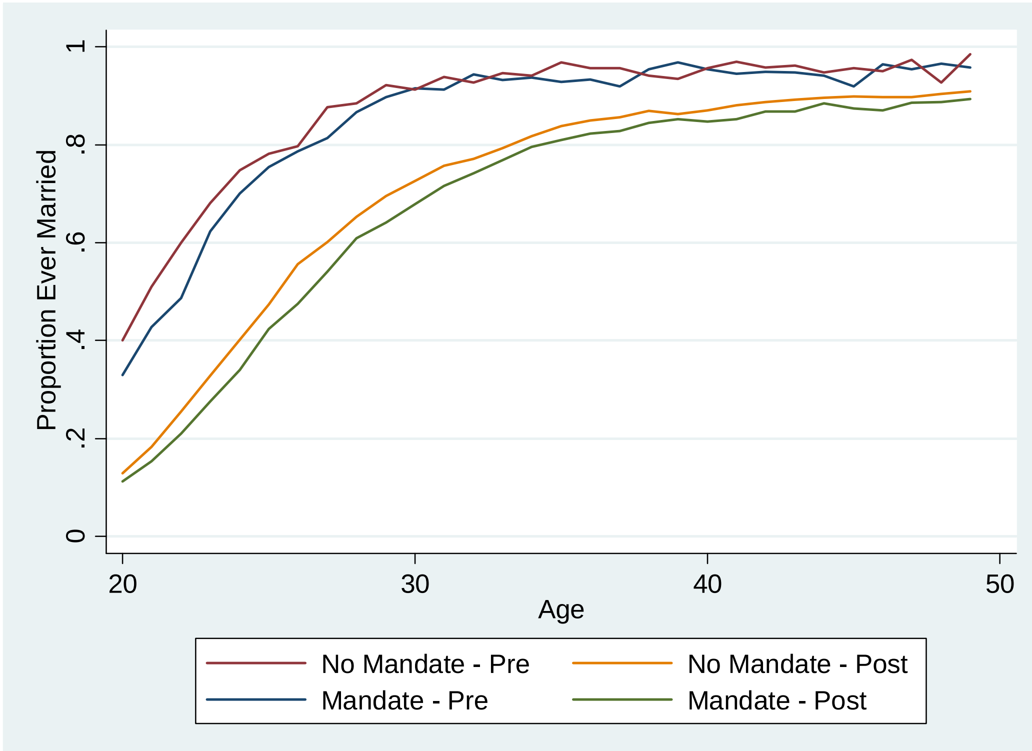
Over the same period, changes in social constructs related to marriage have also had the potential to impact women's family timing. Prevalent attitudes have become more tolerant of pre-marital sex, cohabitation, and out-of-wedlock childbearing and reduced the social cost of remaining unmarried. Consistent with these changes, Bumpass, Sweet, and Cherlin (1991) find that individuals are increasingly opting for cohabitation rather than marriage.

At the same time, there have been significant legal and technological developments related to birth timing. Changes in abortion laws made abortion much more widely available, and concurrently, a number of developments in the technology of conception and contraception afforded women more control over their birth timing. Akerlof, Yellen, and Katz (1996) discuss how the legalization of abortion and the increased availability of contraception for unmarried women led to a decline in shotgun marriages. Myers (2012) examines the effects of state policies related to access to oral contraception and to abortion on young women's probabilities of entering into marriage and parenthood at a young age and finds a significant negative effect of abortion but no significant effect of oral contraception, while Goldin and Katz (2002) provide evidence that the availability of oral contraception has caused women to delay marriage and Bailey (2006) shows that early legal access to oral contraceptives is associated with women's delay of childbearing and greater labor force participation.

There have been many explanations for the increase in delay of marriage and family of recent decades. This paper continues to examine the propensity of women to delay marriage and childbearing and considers the role of the affordability of ART in this regard. It appears that women take ART into consideration in their expectations about their future fertility: in a survey of high-achieving women, 85 percent responded that they believed that with fertility treatments, most women can get pregnant into their early 40's (Hewlett, 2002). Since the proportion of women facing infertility increases greatly with age, by making it affordable for women to delay family formation and then use ART to start families later if they face infertility, greater affordability of ART could induce women to delay marriage and childbearing. Further, the social, legal, and economic changes discussed above that make marriage delay less costly can only be effective if women believe they can delay their birth timing as well: in this way, greater affordability of ART may have facilitated the phenomena described above. By identifying systematic variation in the price of ART, it may be possible to estimate the effect of this technology separate from these co-determined factors.

This paper considers ART as a driver of changes in women's marriage timing using variation in the mandated insurance coverage of ART across U.S. states and over time. As can be seen in Figure 2, in the pre-mandate period, differences in marriage rates were evident at younger ages, but converged for women in their mid 20s and older. In the post-mandate period, differences in marriage rates increased for women from their late teens through their early 30s and only then began to converge for women at older ages. These differential trends in the proportion ever married at each age before and after mandate implementation suggests that the mandates could be associated with delayed marriage, but it is necessary to further examine this question controling for other factors that could be influencing marriage rates across states and over time.

Figure 2: Proportion Ever Married by Mandate Status Pre- and Post-Treatment[2]



There have been many explanations for the increase in marriage delay of recent decades. This paper continues to examine the propensity of women to delay marriage and considers access to infertility treatment in this regard. Further, the social, legal, and economic changes discussed above that make marriage delay less costly can only be effective if women believe they can delay their birth timing as well: in this way, ART may have facilitated the phenomena described above. By identifying systematic variation in the availability of ART, the analysis can investigate the effect of ART separate from these co-determined factors.

Background on Infertility, ART, and Insurance Mandates

Infertility is defined as the inability to conceive after a year of unprotected intercourse. Infertility treatments in general are defined as medical technologies that help women and couples with fertility problems conceive a child and can include a wide range of services from counseling and fertility testing to surgical procedures. The definition of ART used by the Centers for Disease Control and Prevention (CDC) includes all infertility treatments in which both eggs and sperm are handled. Over 2006-2010, 11.9 percent of women 15-44 years of age had ever received any infertility services, and 1.2 percent had undergone artificial insemination procedures (Centers for Disease Control and Prevention, National Center for Health Statistics, 2012). While women can face infertility at any age, the incidence of infertility increases with

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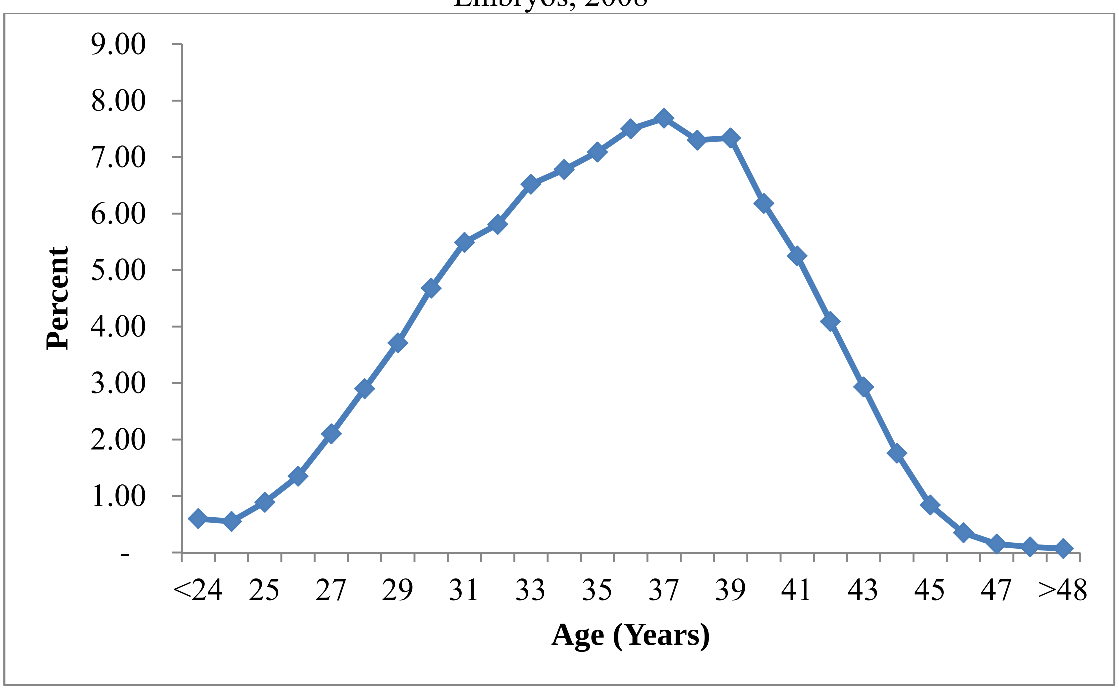
[2] Source: Integrated Public Use Microdata Series, Current Population Survey March Supplements, 1977, 1990, 2000, 2010 from King et al. (2010).

age. According to Leridon (2004), naturally, 75 percent of women starting to try to conceive at age 30 will have a conception resulting in a live birth within one year, while the percentage falls to 66 percent for women at age 35 and 44 percent for women at age 40. Thus, while only women facing infertility are likely to use infertility services and these women tend to be at older childbearing ages, a younger woman may anticipate using infertility services if she has a medical history that might encourage their use or if she plans on delaying marriage to older ages when she is more likely to face impaired fecundity and infertility.

One of the most well-known ART procedures is in-vitro fertilization (IVF), whereby an egg is taken from the woman's ovaries, fertilized, and then placed in her uterus. The first successful IVF procedure in the United States was performed in 1981, and since that time, ART procedures have become much more effective and widely-used. Other related ART procedures include gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT), but these procedures are much less commonly used as compared to IVF. By 2008, the CDC estimated that ART accounted for slightly more than 1 percent of all U.S. births. In 2008, 71.2 percent of women who had ART cycles using fresh nondonor eggs or embryos had no previous births (Centers for Disease Control and Prevention et al., 2010). Figure 3 shows the age distribution of the users of ART using nondonor eggs or embryos.[3] As can be seen in the figure, while some women use ART with their own eggs or embryos during their 20s, the majority are at least in their 30s, and nearly all women are younger than 45.

Figure 3: Age Distribution of Women Who Had ART Cycles Using Fresh Nondonor Eggs or Embryos, 2008[4]



[3] Age-specific data are only available for procedures using nondonor eggs or embryos. Procedures using nondonor eggs or embryos account for the majority of ART cycles, 70.7 percent in 2008 (Centers for Disease Control and Prevention et al., 2010).

[4] Centers for Disease Control and Prevention et al (2010), p. 28.

While the development of infertility treatments has benefitted many women, it must be noted that many women are unable to use these treatments due to their high prices. Hormone therapy can cost between a few hundred and a few thousand dollars, and a single cycle of IVF can cost around $10,000 (Bitler and Schmidt, 2012). Given that less than one-third of ART cycles using nondonor eggs or embryos result in live births (Centers for Disease Control and Prevention et al., 2010), it may take multiple cycles of ART to be successful, and the costs of procedures and medications can quickly become prohibitive.[5]

It would be ideal to examine how the introduction and availability of ART has affected women's expectations and choices about marriage at different ages. However, the introduction of ART was gradual and endogenously driven. Given the inability to identify the effects of the introduction of the technology separately from other forces, this paper uses an alternative and potentially exogenous source of variation affecting the use of ART: price.

While the prices of infertility treatment on their own do not vary in a systematic way, insurance coverage of ART does vary systematically by state. ART is generally not covered by insurance unless firms are required by a state mandate to their employees with insurance plans that cover it. In total, 15 states currently mandate insurance coverage for ART in some form. There could be some concern that states with mandates are fundamentally different from those that do not have mandates. It should be noted that the list of mandate states includes a very heterogeneous group of states geographically, politically, and otherwise. Anecdotal evidence suggests that states' adoption of the mandates often comes about due to idiosyncratic factors unrelated to their residents' considerations about delaying marriage and childbearing. The introduction of the ART insurance mandates was part of a greater trend in the implementation of insurance mandates in the United States between the 1970s and 1990s. Lobbying in favor of the mandates has generally been at the national level and has been led by RESOLVE, an organization promoting reproductive health and equal access to infertility treatment. The argument for the mandates is that infertility is a life-altering disease and that individuals should be able to insure against infertility like they would other such conditions. It appears that a primary factor determining whether a state implemented any particular mandate, including ART insurance mandates, was the state's view toward mandates generally, rather than its residents' demand for the particular benefits mandated to be covered. This anecdotal evidence suggests that interests in delaying marriage and childbearing did not drive state's adoption of the mandates. To test for endogeneity of the implementation of the mandates, in this analysis, a lead of the mandate variable interacted with age group was tested in the full empirical specifications, and it was not found to be significant.[6]

The states mandating insurance coverage of ART are Arkansas, California, Connecticut, Hawaii, Illinois, Louisiana, Maryland, Massachusetts, Montana, New Jersey, New York, Ohio, Rhode Island, Texas, and West Virginia. The enactment of the mandates began as early as 1977 in West Virginia and continued until as recently as 2001 in Louisiana and New Jersey. The

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[5] Success rates are similar for ART cycles using fresh or frozen nondonor eggs or frozen donor eggs; success rates for ART cycles using frozen donor eggs are higher, but still, only less than one-half of ART cycles using frozen donor eggs result in live births.

[6] This follows Bitler and Schmidt (2012).

mandates vary in whether they require that infertility treatment be covered if coverage is offered, known as a "mandate to cover" or only that a plan that includes infertility treatment be offered to firms offering insurance, known as a "mandate to offer." In addition, some of the mandates only apply to health maintenance organizations (HMOs) and some specifically mention that IVF be covered or be excluded from coverage. It is important to note that the mandates do not affect all residents of a state as the Employee Retirement Income Security Act of 1974 (ERISA) designates that state insurance mandates only affect individuals insured through firms that purchase insurance from an outside provider. However, larger firms that self-insure have increasingly provided the mandated coverage (Acs et al., 1996; Jensen and Morrissey, 1999). For example, according to King and Meyer (1997), half of all workers in Illinois were affected by the Illinois mandate in 1993. While it might be a concern that benefits are similar in firms in states that mandate relative to firms in states that do not mandate, Bitler and Schmidt (2012) note that this is not usually the case for infertility treatment, which is rarely covered in the absence of mandates.

Table 1 provides a list of the states with mandates currently in place as well as the date the mandates were enacted and relevant details. It is important to note that while the mandates cover only 15 states, they affect a relatively large share of births in the United States. States with mandates comprised over 47 percent of births in the United States in 2008.[7]

Table 1: States with Mandated Infertility Insurance[8]

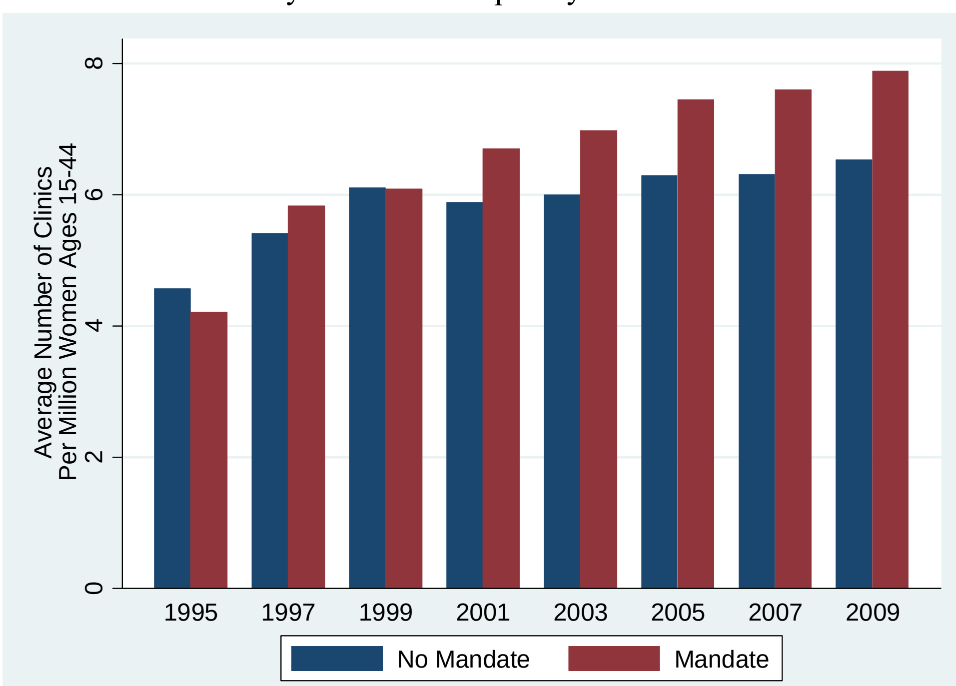
State	Year Law Enacted	Mandate to Cover	Mandate to Offer	IVF Coverage	IVF Only
Arkansas	1987	X			X
California	1989		X		
Connecticut	1989	X		X	
Hawaii	1987	X			X
Illinois	1991	X		X	
Louisiana	2001	X			
Maryland	1985	X			X
Massachusetts	1987	X		X	
Montana	1987	X			
New Jersey	2001	X		X	
New York	1990	X			
Ohio	1990	X			
Rhode Island	1989	X		X	
Texas	1987		X		X
West Virginia	1977	X			

[7] Centers for Disease Control and Prevention, National Center for Health Statistics, VitalStats.
[8] Source: American Society for Reproductive Medicine (2011), RESOLVE (2011), Bitler and Schmidt (2012). Connecticut changed its mandate from a mandate to offer in its 1989 law to a mandate to cover in its 2005 law. According to RESOLVE (2011) and as in Bitler and Schmidt (2012), Louisiana is considered to have implemented a mandate to cover beginning in 2001. According to the American Society for Reproductive Medicine (2011) and as in Bitler and Schmidt (2012), West Virginia is considered to have implemented a mandate to cover beginning in 1977. As in Bitler and Schmidt (2012), New York is considered to have implemented a mandate to cover beginning in 1990.

Effects of the Mandates

This paper explores whether greater affordability of ART has impacted women's timing of marriage and childbearing using ART insurance mandates as a source of plausibly exogenous variation in the price of ART. To use this variation as an identification strategy, it is necessary to establish whether the mandates have actually resulted in increased use of infertility treatments. This could come about directly, by reducing the price of infertility treatment, or indirectly, by inducing a greater supply of fertility services and greater awareness of the availability of these services. In this way, while the direct effects of a fall in price might only affect users of ART covered by the insurance mandates, the indirect effects of the mandates of greater supply and knowledge of ART could also impact younger women through their expectations about their future fertility options regardless of whether they will ever actually use ART. Considering these indirect channels, Figure 6 shows the average number of fertility clinics per million women ages 15-44 over the 1995-2007 period during and after the implementation of the mandates. At the beginning of the period, it appears that the average per capita number of fertility clinics is quite similar between states with mandates and those without. Over time, the average per capita number of fertility clinics increases more quickly in states with mandates than in those without, which could indicate that the mandates are associated with an increase in supply of ART accompanying their effect on lowering the price of ART to consumers.

Figure 4: Number of Fertility Clinics Per Capita by State's Mandate Status 1995-2009[9]



[9] Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Reproductive Health (2012).

Regardless of whether effects of the ART insurance mandates would come about through direct or indirect channels, extensive work in the economics literature finds effects of the ART insurance mandates on the utilization of ART and outcomes of treatment. Bundorf, Henne, and Baker (2007) find that use of infertility treatments is significantly greater in states adopting comprehensive mandates and that mandated coverage was associated with a relatively large increase in the probability of a multiple birth. Buckles (2012) also finds that strong mandate-to-cover laws are associated with an increase in multiple birth rates for married women, white women, and for women with a college degree. Hamilton and McManus (2012) find that comprehensive mandates result in large increases in access to treatment as well as significantly less aggressive treatment.[10] Bitler and Schmidt (2012) examine whether the mandates affect ART utilization for older, highly-educated women, and find that they have a large and significant effect for this subgroup. All of these papers suggest that the mandates are indeed associated with increased utilization of ART and that this increased utilization is associated with differential birth outcomes.

The economics literature has also begun to investigate if there are significant effects of the mandates on larger populations of women, not just the users of ART. The previous literature has focused on examining women at older childbearing ages because they are more likely to be infertile and demand treatment and because they tend to be privately insured at high rates. Several papers find that the mandates are associated with changes in birth rates. Schmidt (2007) uses Vital Statistics Detail Natality Data and Census population counts and finds that the mandates increase first birth rates for women over 35. Buckles (2005) uses Vital Statistics Detail Natality Data to show that mandates that cover IVF are associated with a higher age at first birth. Bitler (2008) finds that the mandates are associated with an increase in the probability of being a twin for children born to older mothers, an increase in the twin delivery rate for older women, as well as negative effects on health-related characteristics for samples of twins and, to a lesser extent, singletons. Only a few papers have considered the effects of the mandates on outcomes not related to births. Cohen and Chen (2011) find that the mandates are associated with increased adoption rates and Appleton and Pollak (2011) put these adoption results in context. Buckles (2005) finds that mandating insurance coverage increases labor force participation for women under 35 and decreases participation for women over 35 while increasing their wages. Lahey (2011) finds that for older women of childbearing age, the mandates do not appear to affect wages, but are associated with a decrease in total labor input.

This paper expands on this literature by considering the effects of increased affordability of ART on women's marriage timing. While most of the aforementioned papers focus primarily on examining the effects of the mandates on the users of ART, this paper considers the effects of the mandates on all women through their expectations of their future fertility regardless of whether they will ever actually use ART. In addition, this paper adds to the existing literature by

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[10] In contrast to Bundorf, Henne, and Baker (2007) and Buckles (2012), Hamilton and McManus (2012) find that the mandates are actually associated with a decrease in the percentage of pregnancies with three or more fetuses. Their contradictory results with respect to the impact of the mandates on aggressiveness of treatment and multiple births could be due to alternative samples and econometric techniques accounting for changes in the population using ART versus changes in procedures and outcomes for the population that would have received treatment without the mandates.

examining the effects of the mandates on marriage outcomes rather than fertility or labor market outcomes. To identify the potential effects of the mandates, the paper next develops a theoretical framework for understanding how greater affordability of ART could affect women's marriage timing.

Theoretical Framework

Lowering the price of ART through insurance mandates provides for greater access to ART, making it available for many women. To develop a framework for understanding how greater affordability of ART could affect women's decisions about marriage, this section presents a theoretical model building on the one presented in Goldin and Katz (2002) for identifying how the diffusion of the birth control pill could have affected professional career investments and the timing of marriage by young women.

I consider a three-period model with no discounting where there are an equal number of men and women. For simplicity, I assume that it is only possible to have children within marriage and marriage and childbearing take place in the same period. To a marriage, each man brings H_i, a husband contribution; F_i, a father contribution; and Y_i, an income contribution; and each woman brings W_j, a wife contribution; and M_j, a mother contribution. If a woman invests in a career in the first and second periods, for each period of investment she also brings α_j, a career return treated as a household public good. The distributions of H, F, Y, W, M, and α are known by all participants, and each individual's attributes are perfectly observable. Assume that F_i and M_j only contribute to the payoff of the marriage if it results in children, determined by the woman's probability of pregnancy, π. π is assumed to be the same for all women, and is initially π_0 in the first and second periods, but declines between the second and third periods by $\Delta\pi$. I assume that a marriage can only produce biological children.

As in Goldin and Katz, I assume that a woman's career investment in the first period is only possible if she delays marriage to the second period, which reduces utility by λ, the "impatience factor" for each partner, representing the utility lost from abstinence as well as from foregone home production. Goldin and Katz showed how all women with $\alpha_j > \lambda$ would invest in careers and delay marriage until the second period, while all others would marry in the first period. They then showed how the availability of the pill could reduce λ and shift down the cutoff point in the α distribution, leading more women to delay marriage and pursue careers.

I further assume that a woman's career investment in the second period is only possible if she delays considering marriage to the third period. For simplicity, I assume the payoff to continued career investment is again α_j and utility is again reduced by λ, but now, I also assume that utility is further reduced by $\Delta\pi*(F_i+M_i)$, the "ticking clock factor" for each partner, representing the utility lost from being less likely to have children as a result of a lower probability of pregnancy.

The payoff to a marriage between a man i and a woman j is determined by each partner's contributions as well as the probability they have children and start a family. If a man and woman marry in the first period, the payoff is: $\pi_0*(F_i+M_i)+H_i+Y_i+W_j$.

If the woman invests in a career in the first period and marriage is delayed until the second period, the payoff of the marriage is: $\pi_0*(F_i+M_i)+H_i+Y_i+W_j+\alpha_j-\lambda$.

If the woman invests in a career in the first period and continues to invest in a career in the second period so that marriage is delayed until the third period, the payoff of the marriage is: $(\pi_0 - \Delta\pi)*(F_i+M_i)+H_i+Y_i+W_j+2\alpha_j-2\lambda$.

As in Goldin and Katz, if $\alpha_j < \lambda$, the woman considers marriage in the first period, and if $\alpha_j > \lambda$, the woman invests in a career in the first period and does not consider marrying in the first period. If $\lambda < \alpha_j < \lambda + \Delta\pi*(F_i+M_i)$, the woman considers marrying in the second period and she does not continue to invest in her career. If $\alpha_j > \lambda + \Delta\pi*(F_i+M_i)$, then the woman further delays considering marrying until the third period and continues to invest in a career in the second period.

Unlike Goldin and Katz, I do not assume that all individuals marry. This model assumes that individuals choose when to consider marrying, and then a man and woman will choose to marry if the payoff to the marriage to each of them is greater than their respective payoffs from being single. As a result, women with $\alpha_j < \lambda$ and men who marry them may be single and/or marry in the second and third periods

Greater affordability of ART affects the model in three ways. First, it reduces $\Delta\pi$, say from $\Delta\pi_0$ to $\Delta\pi_{ART}$, and as with the birth control pill for the first period, shifts down the cutoff point in the α distribution for careers, this time for the second period. Second, as Goldin and Katz point out, as more women delay marriage, the marriage market for older women becomes thicker. It follows that if women prefer to have children within marriage and if children are a key reason for women to marry, then the framework predicts that patterns in the timing of first birth should be similar to those in the timing of marriage. Finally, it raises the value of marrying in the third period by $(\Delta\pi_{ART} - \Delta\pi_0)*(F_i+M_i)$ for any women who have not yet married, either because of delay related to career investment or because of opting out of marriage in the first and second periods.

The testable implications of the framework are then that greater access to ART could result in career-focused women delaying marriage and all women being more likely to marry at older ages. The empirical analysis will examine whether greater access to ART through ART state insurance mandates has resulted in delay of marriage, evidenced by a lower likelihood of marrying at younger ages and a higher likelihood of marrying at older ages; or in an increase in older marriage, evidenced by no difference in the likelihood of marrying at younger ages, but with a higher likelihood of marrying at older ages. The theoretical framework implies that factors that affect the payoff from marriage, the utility of being single, and the probability of pregnancy, like race, education, and age, should be controlled for in the empirical model.

By assumption, the model treats marriage and childbearing as a joint decision such that it is only possible to have children within marriage and marriage and childbearing take place in the same period. However, if women pursue childbearing outside of marriage or if women do not marry and have children in the same period, the framework would still predict effects of the mandates on women's timing of childbearing, but would predict lesser effects on women's timing of marriage. Given the increasing incidence of cohabitation and out-of-wedlock motherhood, the model would predict a lesser impact of the mandates on marriage.

The paper will proceed by outlining empirical strategy and data used to examine testable implications of the theoretical framework.

Empirical Specification

A baseline linear probability model is estimated first and then a more highly specified linear probability model is estimated. In all specifications, the data is weighted to be population-representative, and all specifications are first estimated for the entire sample and then separately for whites and blacks. A woman is considered to be living in a mandate state if there was a mandate enacted in the state by the time the woman was 30 years old or younger since it is around this age that she might be making marriage decisions considering fertility.[11,12] Since the introduction of the mandates could concurrently affect the marriage decisions of women, in this analysis, a mandate is allowed to affect marriage rates in the year it is enacted.[13]

Baseline Specification

The baseline across-ages specification estimates a linear probability model estimation as follows:

$$\begin{aligned} y_{iajt} = \beta_0 + \beta_1 Mandate_{ajt} + \beta_2 State_j + \beta_3 CPSYear_t + \beta_4 AgeGroup_a \\ + \beta_5 Race_i + \beta_6 Edu_i + \beta_7 Z_{jt} + \varepsilon_{iajt} \end{aligned} \quad (1)$$

where y_{iajt} is a dummy variable equal to 1 if woman i of age group a living in state j during time t has ever been married and 0 otherwise.[14] This specification exploits variation across states (mandate versus non-mandate) and over time (pre-mandate versus post-mandate). The coefficient on the mandate term (β_1) captures the associated difference in the probability of ever having married for a woman who lived in a state that had a mandate when she was 30 or younger relative to not having the mandate holding other characteristics constant and is the coefficient of interest in this specification representing the effects of the mandates on the probability of ever having married. Vectors of parameters are included to control for state fixed effects (β_2), year

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[11] To identify whether the woman is living in a state with a mandate her current state of residence is used since that is what is available in the data. There could be the concern that women wanting to delay marriage might move to mandate states. Over the 1981-2010 period, the average rate of migration across states was only 3 percent per year, and in most years over the period, mandate states had lower rates of in-migration than non-mandate states.

[12] If all women with mandates enacted in their states at the time of the survey were considered to be living in a mandate state, the impact of the mandate would be understated, since the treated population would include, for example, women who were 49 years old when the mandate was enacted, for whom the likelihood of the mandate having an effect on their marriage behavior would be quite limited. Accordingly, the cutoff of 30 years old or younger seemed most appropriate. Results of the full specification are additionally estimated using cutoffs of 25 years old or younger and 20 years old or younger and are presented as a robustness check.

[13] Alternative specifications in which the mandate is allowed to affect marriage rates only with a two-year lag were also estimated and yielded similar results.

[14] Linear probability models are used in all regressions rather than probit models for ease of computation of interaction effects. Results using cohort analysis yield similar results. This is consistent with the literature: Goldin and Katz (2002) and Blau, Kahn, and Waldfogel (2000) include specifications using linear probability models to model the probability of marriage and Bitler and Schmidt (2012) include specifications using linear probability models to model the probability of ART outcomes.

fixed effects (β_3), and age group fixed effects (β_4).[15] Vectors of race (β_5) and education controls (β_6) are included to account for differences in marriage rates among race and education groups. The Z vector (β_7) controls for labor market and marriage market conditions at the state level.[16,17] The error term is represented by ε.[18]

The results of this specification are somewhat limited since they mask variation in the effect of the mandate for women of different ages. However, they are useful in establishing a baseline effect of the mandate on the probability that women have ever been married.

Full Specification

Given that the baseline specification masks variation in the effects of the mandates on women of different age groups and does not control for age group-year-specific and age group-state-specific factors, a more highly specified model is estimated next that allows for differential effects of the mandates by age group and includes age group-year and age group-state interaction effects. This model allows for differential effects of the mandates by age group and provides for the computation of the probability of marrying between age groups. The full estimation follows the specification:

$$\begin{aligned} y_{iajt} = \beta_0 &+ \beta_1 Mandate_{ajt} + \beta_2\left(AgeGroup_a \times Mandate_{ajt}\right) \\ &+ \beta_3 State_j + \beta_4 CPSYear_t + \beta_5 AgeGroup_a \\ &+ \beta_6 (AgeGroup_a \times CPSYear_t) \\ &+ \beta_7 (AgeGroup_a \times State_t) + \beta_8 Race_i + \beta_9 Edu_i + \beta_{10} Z_{jt} \\ &+ \varepsilon_{iajt} \end{aligned} \tag{2}$$

The full specification includes the same dependent and explanatory variables as in the baseline specification with the addition of vectors of controls for age group-year fixed effects (β_6) and age group-state fixed effects (β_7)[19] and a vector of age group-mandate interaction terms (β_2) that

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[15] The paper considers six five-year age groups: 20-24, 25-29, 30-34, 35-39, 40-44, and 45-49. The 20-24 age group is omitted.

[16] Specifications including a variable representing the years since the mandate was enacted were considered but the results indicated that the mandates did not have a differential effect over time; therefore, the dummy variable approach presented here was used.

[17] To proxy for marriage market conditions, the state sex ratio is included. To proxy for labor market conditions, the state unemployment rate, labor force participation rate, log mean hourly wage, and log 10th percentile hourly wage for males and females are included. Controls are consistent with those used in Gould and Paserman (2003) to model the probability of marriage and those used in Schmidt (2007) to model the impact of the mandates on first birth rates.

[18] As per Betrand et al (2004), in all regressions, White robust standard errors clustered by state are used to control for serial correlation among the outcomes and the policy changes of interest.

[19] Alternative specifications estimated with linear and quadratic state time trends and age group time trends yielded quantitatively similar results.

capture the associated difference in the probability of ever having married for a woman in a given age group who lives in a state that had a mandate when she was 30 or younger relative to a woman in the 20-24 age group who lives in a state with a mandate holding other characteristics constant. The effects of the mandates on the proportion married of each age group, referred to as the marriage level effects, are found by summing the associated mandate term and age-group mandate interaction term. Investigating the marriage level effects is useful in understanding the impact on the mandates on the stock effect of the mandates, the likelihood of women to be married by a certain age. However, since the paper is primarily interested in understanding the flow effect of the mandates, the likelihood of women to marry for any given age group rather than the proportion married, the analysis estimates the effects of interest, the effects of the mandates on marriage rates between age groups, by computing the difference in the proportion ever married between age groups, which is the difference between the age group-mandate interaction terms for adjacent age groups. These marriage rate effects will be presented as the main results, and the marriage level effects will be presented subsequently.

Data

Since the changes in the affordability of ART may affect the marriage decisions of all single women, this analysis uses the 1977-2010 March samples of the Current Population Survey (CPS) from the Integrated Public Use Microdata Series (IPUMS) for women ages 20-49. The data represent annual repeated cross sections. The benefit to using CPS data is that it is available over the full duration of mandate implementation and that it is collected on a yearly basis. In contrast, Census data is collected only once every 10 years and CPS Merged Outgoing Rotation Groups data is available beginning only in 1979.

Ideally, the empirical analysis would exploit data on the age at which a woman married. However, this data is available in the CPS only through 1997, which does not cover the full period of mandate implementation. The data that is available for the full period of mandate implementation is the age and marital status of each of the surveyed women in each cross-section.

Given this data, the analysis estimates flows into marriage based on differences in the stock of married women between age cohorts. There are several drawbacks to estimating flows in this way. On the one hand, this methodology used in state-year fixed effects design could result in overestimating the magnitude of the effects. On the other hand, this methodology could underestimate the magnitude of the effects given that the dependent variable is a binary indicator of ever having married and thus a change in the stock of women who have ever married may be small even if there is a large effect on the number of women who marry in a given year. Considering these two opposing effects, the magnitude of the estimates of the analysis could be biased either upward or downward. Despite these possible limitations, the analysis provides an important contribution to the literature since investigates the extent to which ART insurance mandates affect marriage rates and uses an identification strategy that can control for unobservable differences across states in marriage rates.

Descriptive statistics for the sample can be found in Table 2. They are presented for the first and last years of the sample by whether the state ever enacted a mandate in the sample period. In general, an aging, greater educational attainment, and greater racial diversity of the population are apparent over time. There are differences in the education, racial composition, and urban status of the mandate and non-mandate states, and as such, these factors are controlled for in the empirical analysis. For both groups, there is evidence of increasing delay of marriage over the sample period, with the effect appearing to be stronger for the mandate states.

Table 2: Descriptive Statistics[20]

	1977		2010	
	Non-Mandate	Mandate	Non-Mandate	Mandate
Mean Age	32.69	32.80	34.72	34.65
	(0.07)	(0.07)	(0.07)	(0.07)
Mean Education (Years)	12.24***	12.33	13.61***	13.53
	(0.02)	(0.02)	(0.02)	(0.02)
Percent White	0.87***	0.86	0.79***	0.76
	(0.00)	(0.00)	(0.00)	(0.00)
Percent Black	0.12	0.12	0.15***	0.14
	(0.00)	(0.00)	(0.00)	(0.00)
Percent Other Race	0.01***	0.03	0.06***	0.11
	(0.00)	(0.00)	(0.00)	(0.00)
Percent Rural	0.45***	0.20	0.20***	0.09
	(0.00)	(0.00)	(0.00)	(0.00)
Percent Single, Never Married Age 20-24	0.42***	0.49	0.78**	0.81
	(0.01)	(0.01)	(0.01)	(0.01)
Percent Single, Never Married Age 25-29	0.15***	0.18	0.45***	0.51
	(0.01)	(0.01)	(0.01)	(0.01)
Percent Single, Never Married Age 30-34	0.07	0.07	0.25***	0.29
	(0.01)	(0.01)	(0.01)	(0.01)
Percent Single, Never Married Age 35-39	0.05	0.06	0.17	0.19
	(0.00)	(0.01)	(0.01)	(0.01)
Percent Single, Never Married Age 40-44	0.04*	0.05	0.14	0.14
	(0.00)	(0.01)	(0.01)	(0.01)
Percent Single, Never Married Age 45-49	0.04	0.05	0.11***	0.14
	(0.00)	(0.01)	(0.01)	(0.01)

Results

The coefficient estimates represent the difference in the probability of a woman ever having married. The coefficient estimates for the baseline specification are presented in Table 3. In

[20] Descriptive statistics are calculated using CPS population-representative weights. Standard deviations are in parentheses. The sample includes all women ages 20-49 from the 1977-2010 IPUMS CPS.

general, the results show that the probability of a woman ever having married increases with age. Non-white women (blacks, to a larger degree, and others, to a lesser degree) have a lower probability of ever having married relative to white women. More education is associated with a lower probability of ever having married, and living in a rural area is associated with a higher probability of ever having married relative to living in urban or suburban areas. With regard to marriage market conditions, the state sex ratio does appear to affect the probability of ever having married: the higher the ratio of men to women, the higher the probability of ever having married; interestingly, examining the effect separately by race, it appears to only be significant for blacks, but not for whites. With regard to labor market conditions, many of the controls do not appear to affect the probability of ever having married, but this is not surprising given state-wide variation in these factors. In general, better labor market conditions for men appear to be associated with a higher probability of ever having married, while the effects of labor market conditions for women appear to be mixed: an increase in the top 10th percentile of their hourly wage is associated with a higher likelihood of marriage while an increase in the female labor force participation rate appears to be associated with a lower likelihood of marriage.

Table 3: Baseline Specification Coefficient Estimates

	All	White	Black
Mandate (at age 30)	-0.0232***	-0.0266***	-0.0041
	(0.0048)	(0.0057)	(0.0071)
Age 25-29	0.320***	0.330***	0.255***
	(0.0057)	(0.0072)	(0.0052)
Age 30-34	0.471***	0.475***	0.420***
	(0.0088)	(0.0106)	(0.0074)
Age 34-39	0.536***	0.531***	0.535***
	(0.0104)	(0.0121)	(0.0067)
Age 40-44	0.564***	0.552***	0.606***
	(0.0107)	(0.0123)	(0.0055)
Age 45-49	0.576***	0.561***	0.647***
	(0.0109)	(0.0125)	(0.0065)
High School	0.0118**	0.00341	0.0602***
	(0.0051)	(0.0049)	(0.0041)
Some College	-0.0407***	-0.0609***	0.0848***
	(0.0076)	(0.0062)	(0.0068)
College	-0.0566***	-0.0805***	0.0872***
	(0.0084)	(0.0073)	(0.0085)
More than College	-0.0732***	-0.0990***	0.0922***
	(0.0087)	(0.0082)	(0.0097)
Rural	0.0413***	0.0456***	0.01
	(0.0034)	(0.0030)	(0.0087)
Race (Black)	-0.196***		
	(0.0060)		
Race (Other)	-0.0111		
	(0.0066)		
State Sex Ratio (Men to Women)	0.0164***	-0.000766	0.0206***
	(0.0029)	(0.0059)	(0.0040)
State Log Weighted Median Hourly Wage for Men	-0.000584	0.0161	0.0631**
	(0.0134)	(0.0156)	(0.0240)
State Log Weighted Top 10th Percentile Hourly Wage for Men	-0.00583	-0.00963	-0.0241
	(0.0140)	(0.0109)	(0.0450)
State Weighted Labor Force Participation Rate for Men	0.121***	0.0759**	0.231**
	(0.0370)	(0.0339)	(0.0996)
State Weighted Unemployment Rate for Men	-0.0416	-0.0548	0.141
	(0.0410)	(0.0376)	(0.1070)
State Log Weighted Median Hourly Wage for Women	0.000481	-0.00827	-0.00672
	(0.0137)	(0.0144)	(0.0345)
State Log Weighted Top 10th Percentile Hourly Wage for Women	0.0324**	0.0311*	0.0234
	(0.0158)	(0.0158)	(0.0354)
State Weighted Labor Force Participation Rate for Women	-0.0680*	-0.0687*	-0.0141
	(0.0358)	(0.0387)	(0.1130)
State Weighted Unemployment Rate for Women	0.0594	0.0543	-0.00191
	(0.0499)	(0.0433)	(0.1560)
Constant	0.188	0.214	-0.378
	(0.1610)	(0.1750)	(0.4570)
Observations	1,287,116	1,069,412	142,805
R-squared	0.27	0.26	0.23

As seen in Table 3, in the baseline across-ages specification, significant negative effects of the mandates on the probability of ever having married are found for the full sample and for whites. The results imply that the mandates are associated with a decrease in a woman's probability of ever having married of between two and three percentage points. These results could indicate that women are less likely to marry at all ages: that women delay marriage at younger ages, but then do not marry at older ages. From this specification, it is not possible to determine whether this is the pattern of marriage timing associated with the mandates. Therefore, the analysis estimates the full specification next to identify if there are differential effects of the mandates by age group. No significant effect of the mandates was found for blacks in the baseline specification; since the effects of the mandates generally do not appear to be significant for blacks, results of further specifications will only be presented for whites.

While the baseline results suggest that the mandates are associated with a lower probability of ever having married, to ascertain whether this effect is consistent for women of different ages, the full specification estimates the effects of the mandates separately for each age group. In this case, to find the effects of interest, the coefficient estimates themselves are not sufficient. The mandate-age group interactions coefficient estimates on their own do not reflect the true effects of the mandates on each age group as they only reflect the differential effect of the mandates on a particular age group in comparison to the omitted age group. To find the effects of the mandates on marriage rates, considered as the difference in the probability of ever having married between two age groups, the coefficients on adjacent mandate-age interaction terms are differenced. These effects – the effects of the mandates on the probability of marrying between each age group – are presented in Table 4.

The mandate marriage rate effects for the full specification, which includes age group-state and age group-year interaction controls, show an interesting pattern for the full and white samples: it appears that the mandates are associated with women having a significantly lower probability of marrying between the 20-24, 25-29, and 30-34 age ranges, but then having a significantly higher probability of marrying over the 30-34 and 35-39 age ranges. This is consistent with a pattern of marriage delay. These results suggest that the likelihood of marrying associated with the mandates is six percent lower (-0.019/0.330) over the 20-24 to 25-29 age groups, 11 percent lower (-0.017/0.146) over the 25-29 to 30-34 age groups, and 22 percent higher (0.011/0.052) over the 30-34 to 35-39 age groups. Interestingly, the mandates are also associated with women having a marginally significantly lower probability of marrying over between the 40-44 and 45-49 age ranges. Results estimated when excluding the age group-state and age group-year fixed effects suggest that the mandates have the effect of increasing marriage rates between most age groups, while the full specification results suggest a pattern of marriage delay, with younger age groups less likely to marry and older age groups more likely to marry. Since the full specification controls for state and year effects by age group, the results with the age group-interacted fixed effects may be attributing changes in age-group marriage rates by state and over time to the mandates. Therefore, the full specification is the preferred specification of this analysis, and it will be used for subsequent analyses.

Table 4: Mandate Marriage Rate Effects for Whites

	Full Specification	Full Specification Excluding Age Group-State and Age Group-Year Controls
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0191*	0.0127
	(0.0104)	(0.0103)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0167**	0.0358***
	(0.0067)	(0.0091)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0114**	0.0277***
	(0.0044)	(0.0061)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0034	0.0125***
	(0.0067)	(0.0039)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0073*	-0.0049
	(0.0037)	(0.0033)

Given that the theoretical framework predicts and other analyses (Bitler and Schmidt 2006, Bitler and Schmidt 2012) have found differential effects of the mandates by education level, the full specification estimated with education group interactions is presented next. Then to determine whether the mandates are affecting men's marriage timing, the full specification is estimated for men. Next, to put the marriage rate effects in context, the marriage level effects for each of the full, education level, and men's specifications are then presented.

Results by Education Level

In order to examine whether the mandates affected various education groups differently, the full specification was estimated for white women with interactions of the mandate, age group, and mandate-age group terms separately for women with some college education or less and those with college degrees or more education. The mandate marriage rate effects results are presented in Table 5.

Table 5: Full Specification for Whites by Education Level Mandate Marriage Rate Effects

Some College or Less	
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0128
	(0.0082)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.022***
	(0.0067)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0084*
	(0.0042)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0041
	(0.0067)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0044
	(0.0045)
College Graduate or More	
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0432**
	(0.0171)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.006
	(0.0124)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0161*
	(0.0081)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0069
	(0.0069)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0189**
	(0.0078)

The mandate marriage rate effects estimated with separate controls by education level yield interesting results. The results for both groups exhibit patterns of marriage delay associated with the mandates with women being less likely to marry over the 20-24, 25-29, and 30-34 age ranges and more likely to marry over the 30-34, 35-39, and 40-44 age ranges. However, the effects appear to be greater in magnitude for women with greater educational attainment. For white women with at least a college degree, the likelihood of marrying over the 20-24 to 25-29 age groups is 13 percent lower (-0.043/0.333) and the likelihood of marrying over the 30-34 to 35-39 age groups is 23 percent higher (0.016/0.071) /for women living in states with mandates as compared to those living in states that do not have mandates. This is consistent with the theoretical framework that predicts a greater incentive for delay for women with more education.

Results for Men

Since any changes affecting women's marriage decisions have the potential to affect men's marriage decisions as well, the full specification was also estimated for white men aged 20-59. Here, the coefficient estimates represent the difference in the probability of a man being single and never married. As in the analysis for women, a man is considered to be living in a mandate state if there was a mandate enacted in the state by the time he was 30 years old or younger. Table 6 presents the marriage rate effects results for men.

Table 6: Full Specification Mandate Effects for White Men

Age 20-24 to 25-29: Age 25-29 X Mandate	-0.014
	(0.0125)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0205*
	(0.0113)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	-0.0016
	(0.0107)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	-0.0031
	(0.0067)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	0.0216**
	(0.0091)
Age 45-49 to 50-54: Age 50-54 X Mandate - Age 45-49 X Mandate	0.0086
	(0.0091)
Age 50-54 to 55-59: Age 55-59 X Mandate - Age 50-54 X Mandate	0.0094
	(0.0070)

The effects of the mandates on white men follow a similar pattern to those for women, but with a lag. It appears that for men the mandates are associated with lower probabilities of marrying over the 20-24, 25-29, 30-34, and 40-44 age ranges, significantly so between the 25-29 and 30-34 age ranges, but a significantly higher probability of marrying between the 40-44 and 45-49 age ranges and higher probabilities of marrying over the 25-49, 50-54, and 55-59 age ranges, though they are not significant. This is consistent with the pattern of marriage delay seen earlier for women, but lagged by five to ten years. One explanation for this could be that these men would have married the women who delayed marriage and so the result is that they too will delay marriage. Another explanation could be that the increased availability and affordability of ART makes older women more marriageable relative to younger women, so men are finding it less costly to delay marriage. It could also be the case that men are responding to greater availability of ART for their own infertility issues. However, given the nature of the mandates, it seems unlikely that men's decisions in response to the mandates would be driving the marriage timing decisions.

Marriage Level Effects

The marriage rate effects presented above reflect the effects of the mandates on the likelihood of women to marry across age groups. It can also be valuable to understand the effects of the mandates on the proportion of women married at each age group, the marriage level effects. The marriage level effects for each age group are obtained by summing the associated mandate term and age-group mandate interaction term. The marriage level effects results for whites for the full specification and by education level are presented in Table 7.

Table 7: Mandate Level Effects

	Full Specification	By Education Level
Full Specification/Some College or Less		
Age 20-24: Mandate	0.0132	0.0092
	(0.0104)	(0.0107)
Age 25-29: Age 25-29 X Mandate + Mandate	-0.0059	-0.0036
	(0.0067)	(0.0077)
Age 30-34: Age 30-34 X Mandate + Mandate	-0.0226***	-0.0256***
	(0.0054)	(0.0061)
Age 35-39: Age 35-39 X Mandate + Mandate	-0.0112**	-0.0172***
	(0.0046)	(0.0053)
Age 40-44: Age 40-44 X Mandate + Mandate	-0.0079	-0.0131**
	(0.0065)	(0.0050)
Age 45-49: Age 45-49 X Mandate + Mandate	-0.0152**	-0.0175**
	(0.0060)	(0.0069)
College Graduate or More		
Age 20-24: Mandate		0.0396***
		(0.0142)
Age 25-29: Age 25-29 X Mandate + Mandate		-0.0036
		(0.0096)
Age 30-34: Age 30-34 X Mandate + Mandate		-0.0096
		(0.0102)
Age 35-39: Age 35-39 X Mandate + Mandate		0.0065
		(0.0059)
Age 40-44: Age 40-44 X Mandate + Mandate		0.0133*
		(0.0078)
Age 45-49: Age 45-49 X Mandate + Mandate		-0.0056
		(0.0042)

The marriage level effects of the full specification suggest that the mandates are associated with women having significantly lower probabilities of ever having married at the 30-34, 35-39, and 45-49 age ranges. Together with the marriage rate effects presented earlier, this indicates that while the mandates might be associated with women delaying marriage, it still appears that fewer women ever marry by the 45-49 age group. Analyzing these results by education level reveals that these effects only persist for women with some college education or less; for women with college degrees or more education, the mandates appear to have minimal effects of the proportion ever married by the 45-49 age group.

Robustness

To consider the robustness of the analysis, alternative estimations are performed. These estimations investigate heterogeneity of the mandates, consider alternate samples, and examine as the treatment group in the analysis women at different ages of mandate implementation.

Heterogeneity of Mandates

In the empirical analysis, all states with mandates related to ART were treated the same. To understand whether different degrees of the mandates are associated with different outcomes of women's marriage rates, the full specification was estimated with separate controls for states with "strong" mandates, those having both mandate-to-cover laws and IVF coverage, and for states with "weak" mandates, those having either mandate-to-offer laws, exclusions of IVF coverage, or both. In addition, the full specification was estimated with separate controls for states with mandate-to-cover laws and mandate-to-offer laws and with separate controls for IVF coverage and no IVF coverage. Table 8 presents these marriage rate effects results.

Table 8: Full Specification for Whites Mandate Effects by Mandate Coverage

	Strong/ Weak	Cover/ Offer	IVF/ No IVF
More Coverage			
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0246**	-0.0259**	-0.007
	(0.0119)	(0.0105)	(0.0150)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0202**	-0.0088	-0.0196***
	(0.0089)	(0.0072)	(0.0067)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0225***	0.0144**	0.0152*
	(0.0077)	(0.0056)	(0.0076)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0205***	0.0116	0.0107
	(0.0073)	(0.0073)	(0.0088)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0129*	-0.0065	-0.0094*
	(0.0065)	(0.0050)	(0.0056)
Less Coverage			
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0167	-0.009	-0.0292***
	(0.0141)	(0.0204)	(0.0100)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0154*	-0.0286***	-0.0143
	(0.0087)	(0.0059)	(0.0109)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0065	0.0073	0.0082**
	(0.0040)	(0.0048)	(0.0037)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	-0.0032	-0.0062*	-0.0031
	(0.0055)	(0.0037)	(0.0066)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0052	-0.0064*	-0.0066
	(0.0035)	(0.0038)	(0.0041)

The results show that "strong" mandates are associated with a lower probability of marrying over the 20-24, 25-29, and 30-34 age ranges and a higher probability of marrying over the 30-34, 35-39, and 40-44 age ranges. It appears that "weak" mandates are also associated with a lower probability of marrying at younger ages, but they do not appear to be associated with a higher probability of marrying at older ages. This is consistent with the expectation that stronger mandates should have stronger effects on women's behavior. This pattern appears to be consistent for the cover/offer analysis. Interestingly, comparing mandate states with IVF coverage and those without revealed little difference in marriage patterns.

Alternate Samples

In the empirical analysis, all states were included in each specification estimated. To examine whether differences in the evolution of marriage attitudes between mandate and non-mandate states is what drives the results, the full specification was estimated separately for a sample including only states that would ever pass mandates, only states that would ever pass mandates and neighboring states, and only states that did not pass mandates with a placebo for mandate status. Table 9 presents these marriage rate effects results.

Table 9: Full Specification for Whites for Alternate Samples

	Mandate States Only	Mandate States and Neighboring States	Non-Mandate States with Placebo Mandate
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.002	-0.0226**	0.017
	(0.0125)	(0.0103)	(0.0142)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0393***	-0.0194**	0.0104
	(0.0118)	(0.0072)	(0.0105)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0123**	0.008	-0.0011
	(0.0046)	(0.0048)	(0.0068)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0143	0.0049	0.0012
	(0.0117)	(0.0075)	(0.0075)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0112	-0.0047	-0.0049
	(0.0073)	(0.0038)	(0.0062)

The results show that for the samples of only mandate states and mandate states and neighboring states, the mandates are associated with a lower probability of marrying over the 20-24, 25-29, and 30-34 age ranges and a higher probability of marrying over the 30-34, 35-39, and 40-44 age ranges. No significant results were found for the placebo mandate for the non-mandate states.

Age at Mandate Implementation

The structure of the CPS makes identifying the effects of the mandates on marriage rates difficult since only a woman's marital status at the time of the survey is reported, not her age at first marriage. To perform the analysis, in all of the estimated specifications, a woman was considered to be living in a mandate state if there was a mandate enacted in the state by the time the woman was 30 years old or younger since it is around this age that she might be making marriage decisions considering fertility. If all women with mandates enacted in their states at the time of the survey were considered to be living in a mandate state, the estimated impact of the mandate would be less precise, since the treated population would include, for example, women who were 49 years old when the mandate was enacted. For such a woman, the likelihood of the mandate having an effect on her marriage timing would be limited. On the other hand, if a lower cutoff age was used, women who may be affected by the mandates may be included in the control rather the treatment group. Accordingly, the cutoff of 30 years old or younger seemed most appropriate. As a robustness check, the full specification was re-estimated both with a woman considered to be living in a mandate state if there was a mandate enacted in the state by the time the woman was 25 years old or younger and 20 years old or younger. Table 8 presents these mandate marriage rate effects results.

Table 10: Full Specification for Whites Mandate Effects – By Age by Mandate Passage

	Mandate by Age 30	Mandate by Age 25	Mandate by Age 20
Age 20-24 to 25-29: Age 25-29 X Mandate	-0.0191*	-0.0443***	-0.0075
	(0.0104)	(0.01466)	(0.01454)
Age 25-29 to 30-34: Age 30-34 X Mandate - Age 25-29 X Mandate	-0.0167**	0.0099	-0.0012
	(0.0067)	(0.01153)	(0.01318)
Age 30-34 to 35-39: Age 35-39 X Mandate - Age 30-34 X Mandate	0.0114**	0.0098	0.0224***
	(0.0044)	(0.00655)	(0.00799)
Age 35-39 to 40-44: Age 40-44 X Mandate - Age 35-39 X Mandate	0.0034	-0.0014	0.0179
	(0.0067)	(0.00516)	(0.01155)
Age 40-44 to 45-49: Age 45-49 X Mandate - Age 40-44 X Mandate	-0.0073*	0.0179*	0.0221**
	(0.0037)	(0.01031)	(0.01014)

The results show that while the estimates from the specification in which 30 years old is used as the cutoff appear to be the most indicative of the mandates being associated with an effect of marriage delay, all of the specifications suggest a lower probability of marrying at younger ages and a greater probability of marrying at older ages. However, the estimation considering the mandate for only women 20 years old and younger at its implementation does not find a significant delay effect, only a significant increase in the probability of marrying at older ages. This can be thought of as a conservative estimate. To better understand these results, analysis using more precise data would be valuable.

Conclusion

This paper examined the connection between greater affordability of ART and women's marriage timing. The paper developed a theoretical framework to understand how greater affordability of ART would affect women's marriage timing. The model predicted that greater affordability of ART could induce delayed marriage, especially for women pursuing careers. The paper used variation in the mandated insurance coverage of ART across U.S. states and over time to develop several empirical specifications to examine whether women are changing their marriage timing in response to greater access to ART. The results of the empirical analysis were consistent with the predictions of the theoretical framework. While significant negative effects of the mandates on the probability of ever being married were found for the full sample and for whites for women ages 20-49, examining the marriage rates of women of different age groups shows that the mandates are associated with a significantly lower probability of marrying at younger ages and a significantly higher probability of marrying at older ages. This is consistent with the theoretical framework where, with greater access to ART, women who want to pursue educational and career opportunities delay marriage.

The results estimated with separate controls by education level show that the pattern of delay is apparent for women of all education levels, but appears to be stronger in magnitude for women with greater educational attainment. An interesting result is that the mandates appear to have also had an effect on men, with men being less likely to marry at younger ages and then more likely to marry at older ages, similar to the pattern for women, but delayed by five to ten years. Several explanations could be consistent with these results; future work using more detailed data would be valuable in understanding the channels producing these results.

The marriage level effects results suggest that for the full sample of white women, while the mandates might be associated with delayed marriage, it still appears that fewer women ever marry by the 45-49 age group, but further analysis by education level reveals that this is only the case for women with some college education or less. For men, the mandates do not appear to be associated with a difference in the proportion ever married by the 45-49 age group.

Robustness checks confirm that more comprehensive mandates are associated with stronger effects on women's marriage behavior than less comprehensive mandates. The effects of the mandates of women's delay of marriage are robust to restricting the sample in various ways, and no significant results were found when estimating the specification with a placebo mandate for the non-mandate states. Estimates using different age cutoffs for inclusion in the treatment group are consistent with the pattern of delay, but appear to be strongest when a cutoff of age 30 is used.

The results of the analysis are useful from a policy perspective. While the mandates and greater availability of ART generally may have been intended to provide a means for women and couples with fertility problems to have a child, they may have had further reaching consequences. Greater availability of ART may have allowed women to delay marriage to pursue education and careers, allowing them greater lifetime opportunities. However, an unintended consequence may be that women then choose to delay marriage and childbirth, resulting in them being more likely to face fertility problems and pursue ART procedures, which as this paper highlighted, are very costly relative to natural childbirths.

A drawback to the use of the mandates as an identification strategy is that while all women may be able to benefit by the lower cost of ART due to the mandates, some women may have more knowledge of the mandates and their effects on the price of ART than others. For instance, a 35-year-old woman who is concerned about her fertility options may have reason to obtain greater knowledge of her fertility options and their prices than a 25-year-old woman. On the other hand, if the diffusion of information is relatively widespread, the information gap between groups of women may be small. In addition, since the mandates can only affect the price of ART through insurance markets, such an identification strategy may not capture the effect of lower prices and availability of ART on a larger scale. However, this would tend to bias the results toward zero, so the effects of the mandates found to be significant should be valid.

Overall, the paper makes several main contributions. First, the paper provides a theoretical framework for understanding the effect of greater affordability of ART on women's marriage timing. Second, the results increase our understanding of the factors that determine women's marriage timing. Third, the paper identifies a new consequence of ART mandates – delayed marriage – and reveals that the mandates affect both younger women through their expectations about their future fertility in addition to older women regardless of whether they will ever actually use ART.

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Chapter 2: Assisted Reproductive Technology and Women's Marriage and Birth Timing: Duration and Competing Risks Analyses

Introduction

This paper uses variation in the mandated insurance coverage of assisted reproductive technology (ART) to examine whether the price of ART is associated with changes in women's marriage and birth timing. The past several decades have seen far-reaching changes in the lives of women. Women have married and started families later or have forgone marriage and motherhood altogether. The number of women in college and professional schools has greatly increased as has the number of women pursuing careers. Over the same period, significant developments in conceptive and contraceptive technologies have provided women more control over their fertility. Several papers have addressed the question of whether contraceptive technology has influenced women's choices beyond the scope of their fertility. This paper examines the connection between the affordability of the conceptive technologies of ART and women's timing of marriage and childbearing.

ART consists of medical technologies that help women and couples with fertility problems conceive a child using such methods as in-vitro fertilization (IVF). Several papers examine how the mandates have affected the use of infertility treatment (Jain, Harlow, and Hornstein 2002; Bitler and Schmidt 2006; Bundorf, Henne, and Baker 2007; Bitler and Schmidt 2012) and others examine the effects of the mandates on birth outcomes (Schmidt 2007; Bitler 2008, Buckles 2012). Few papers examine whether greater ART availability has affected more than only birth outcomes including adoption (Cohen and Chen 2011) and women's labor force participation and wages (Buckles 2006; Lahey 2011). Abramowitz (2012) examines whether greater availability of ART was associated with differences in women's marriage timing and found that it was: women with increased access to ART through state-level insurance mandates were less likely to marry at younger ages and more likely to marry at older ages, indicating a pattern of marriage delay.

The outcome of interest of this paper is primarily marriage. The findings of Abramowitz (2012) elicit many further questions: are the mandates influencing women to delay marriage, childbearing, or both? Are the mandates associated with women "opting in" or "opting out" of marriage? Do mandates have differential effects on childbearing within or out of wedlock? This paper builds on Abramowitz (2012) by examining more closely how greater affordability of ART could affect women's timing of first marriage and first birth.

To formally identify channels through which the price of ART might impact women's decisions about timing of starting a family, the paper develops a theoretical framework. The framework models the effect of greater affordability of ART on women's allocation of time on work and family investment when young and old to derive implications for effects on women's marriage and birth timing. The implications of the model suggest that there is a tradeoff between pursuing a family when younger, by giving up a steeper wage trajectory, and pursuing a family when older, which requires the use of ART at a price. A fall in the price of ART induces more women along the wage trajectory distribution to use ART and shift from pursuing family when younger to pursuing family when older.

The paper proceeds by testing the implications of the theoretical framework to investigate whether greater affordability of ART has affected women's timing of marriage and childbearing. To identify the effects of greater affordability of ART separately from other forces affecting women's marriage and birth timing decisions, this paper exploits plausibly exogenous state variation in the mandated insurance coverage of ART.

Abramowitz (2012) investigates whether greater ART availability affects the proportion of the population married by mandate coverage status. This paper uses panel data to follow individuals and examine their likelihood of marriage and first birth at different ages in light of whether they were covered by a mandate prior to marrying or giving birth. To investigate whether greater affordability of ART is associated with changes in women's timing of first marriage and first birth, the paper uses the 1968-2009 Panel Study of Income Dynamics (PSID) to perform duration and competing risks analyses. The findings suggest that the mandates are associated with delayed marriage and childbearing at younger ages and speeded transition to marriage and childbearing after age 30, but only for college graduate women, consistent with the theoretical framework's prediction that women with steeper wage trajectories should be more influenced by the mandates to delay family formation. For the full sample of women, the mandates appear to be associated with speeded transition to marriage after age 25 and motherhood within marriage after age 30, but not with delay at younger ages.

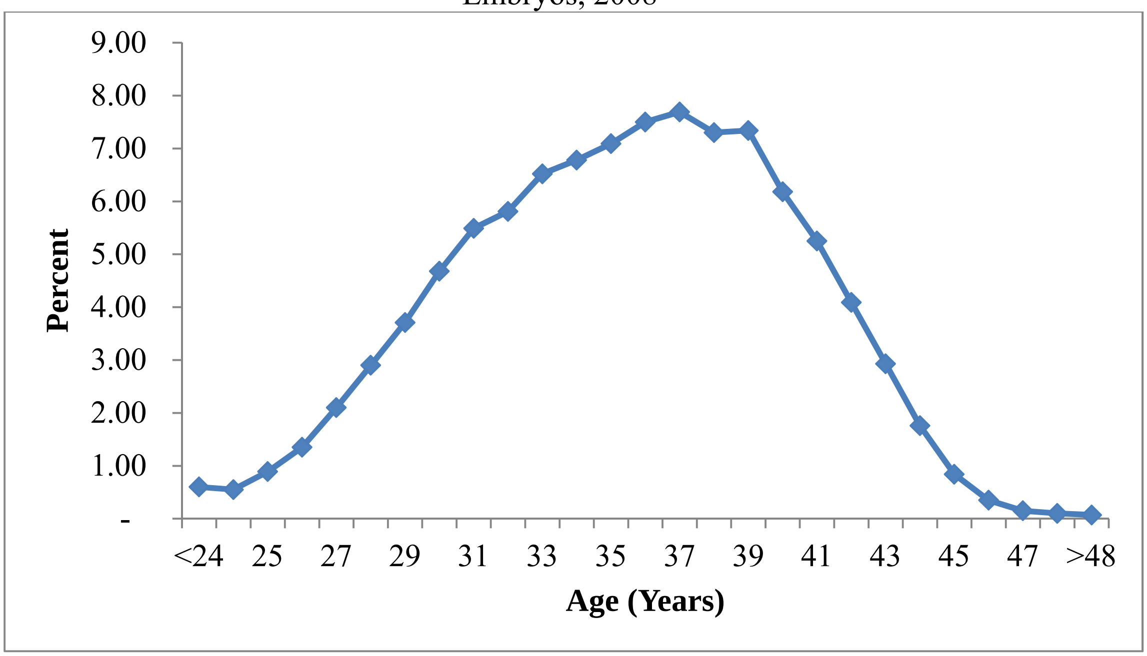
The rest of the paper is organized as follows. The next section provides background on infertility, ART, and the insurance mandates. The section that follows discusses whether the ART insurance mandates have affected utilization of ART and reviews the literature investigating the effects of the mandates. The next section develops a theoretical framework for understanding how ART might affect women's marriage and birth timing decisions. The following sections outline the empirical specifications, present the data used in the analysis, and show results of the analysis. The last section concludes.

Background on Infertility, ART, and Insurance Mandates

Infertility is defined as the inability to conceive after a year of unprotected intercourse. Infertility treatments in general are defined as medical technologies that help women and couples with fertility problems conceive a child and can include a wide range of services from counseling and fertility testing to surgical procedures. The definition of ART used by the Centers for Disease Control and Prevention (CDC) includes all infertility treatments in which both eggs and sperm are handled. Over 2006-2010, 11.9 percent of women 15-44 years of age had ever received any infertility services, and 1.2 percent had undergone artificial insemination procedures (Centers for Disease Control and Prevention, National Center for Health Statistics, 2012). While women can face infertility at any age, the incidence of infertility increases with age. According to Leridon (2004), naturally, 75 percent of women starting to try to conceive at age 30 will have a conception resulting in a live birth within one year, while the percentage falls to 66 percent for women at age 35 and 44 percent for women at age 40. Thus, while only women facing infertility are likely to use infertility services and these women tend to be at older childbearing ages, a younger woman may anticipate using infertility services if she has a medical history that might encourage their use or if she plans on delaying marriage to older ages when she is more likely to face impaired fecundity and infertility.

One of the most well-known ART procedures is in-vitro fertilization (IVF), whereby an egg is taken from the woman's ovaries, fertilized, and then placed in her uterus. The first successful IVF procedure in the United States was performed in 1981, and since that time, ART procedures have become much more effective and widely-used. Other related ART procedures include gamete intrafallopian transfer (GIFT) and zygote intrafallopian transfer (ZIFT), but these procedures are much less commonly used as compared to IVF. By 2008, the CDC estimated that ART accounted for slightly more than 1 percent of all U.S. births. In 2008, 71.2 percent of women who had ART cycles using fresh nondonor eggs or embryos had no previous births (Centers for Disease Control and Prevention et al., 2010). Figure 5 shows the age distribution of the users of ART using nondonor eggs or embryos.[21] As can be seen in the figure, while some women use ART with their own eggs or embryos during their 20s, the majority are at least in their 30s, and nearly all women are younger than 45.

Figure 5: Age Distribution of Women Who Had ART Cycles Using Fresh Nondonor Eggs or Embryos, 2008[22]



While the development of infertility treatments has benefitted many women, it must be noted that many women are unable to use these treatments due to their high prices. Hormone therapy can cost between a few hundred and a few thousand dollars, and a single cycle of IVF can cost around $10,000 (Bitler and Schmidt, 2012). Given that less than one-third of ART cycles using

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[21] Age-specific data are only available for procedures using nondonor eggs or embryos. Procedures using nondonor eggs or embryos account for the majority of ART cycles, 70.7 percent in 2008 (Centers for Disease Control and Prevention et al., 2010).

[22] Centers for Disease Control and Prevention et al (2010), p. 28.

nondonor eggs or embryos result in live births (Centers for Disease Control and Prevention et al., 2010), it may take multiple cycles of ART to be successful, and the costs of procedures and medications can quickly become prohibitive.[23]

It would be ideal to examine how the introduction and availability of ART has affected women's expectations and choices about marriage at different ages. However, the introduction of ART was gradual and endogenously driven. Given the inability to identify the effects of the introduction of the technology separately from other forces, this paper uses an alternative and potentially exogenous source of variation affecting the use of ART: price.

While the prices of infertility treatment on their own do not vary in a systematic way, insurance coverage of ART does vary systematically by state. ART is generally not covered by insurance unless firms are required by a state mandate to their employees with insurance plans that cover it. In total, 15 states currently mandate insurance coverage for ART in some form. There could be some concern that states with mandates are fundamentally different from those that do not have mandates. It should be noted that the list of mandate states includes a very heterogeneous group of states geographically, politically, and otherwise. Anecdotal evidence suggests that states' adoption of the mandates often comes about due to idiosyncratic factors unrelated to their residents' considerations about delaying marriage and childbearing. The introduction of the ART insurance mandates was part of a greater trend in the implementation of insurance mandates in the United States between the 1970s and 1990s. Lobbying in favor of the mandates has generally been at the national level and has been led by RESOLVE, an organization promoting reproductive health and equal access to infertility treatment. The argument for the mandates is that infertility is a life-altering disease and that individuals should be able to insure against infertility like they would other such conditions. It appears that a primary factor determining whether a state implemented any particular mandate, including ART insurance mandates, was the state's view toward mandates generally, rather than its residents' demand for the particular benefits mandated to be covered. This anecdotal evidence suggests that interests in delaying marriage and childbearing did not drive state's adoption of the mandates. To test for endogeneity of the implementation of the mandates, in this analysis, a lead of the mandate variable interacted with age group was tested in the full empirical specifications, and it was not found to be significant.[24]

The states mandating insurance coverage of ART are Arkansas, California, Connecticut, Hawaii, Illinois, Louisiana, Maryland, Massachusetts, Montana, New Jersey, New York, Ohio, Rhode Island, Texas, and West Virginia. The enactment of the mandates began as early as 1977 in West Virginia and continued until as recently as 2001 in Louisiana and New Jersey. The mandates vary in whether they require that infertility treatment be covered if coverage is offered, known as a "mandate to cover" or only that a plan that includes infertility treatment be offered to firms offering insurance, known as a "mandate to offer." In addition, some of the mandates only apply to health maintenance organizations (HMOs) and some specifically mention that IVF be

[23] Success rates are similar for ART cycles using fresh or frozen nondonor eggs or frozen donor eggs; success rates for ART cycles using frozen donor eggs are higher, but still, only less than one-half of ART cycles using frozen donor eggs result in live births.

[24] This follows Bitler and Schmidt (2012).

covered or be excluded from coverage. It is important to note that the mandates do not affect all residents of a state as the Employee Retirement Income Security Act of 1974 (ERISA) designates that state insurance mandates only affect individuals insured through firms that purchase insurance from an outside provider. However, larger firms that self-insure have increasingly provided the mandated coverage (Acs et al., 1996; Jensen and Morrissey, 1999). For example, according to King and Meyer (1997), half of all workers in Illinois were affected by the Illinois mandate in 1993. While it might be a concern that benefits are similar in firms in states that mandate relative to firms in states that do not mandate, Bitler and Schmidt (2012) note that this is not usually the case for infertility treatment, which is rarely covered in the absence of mandates.

Table 11 provides a list of the states with mandates currently in place as well as the date the mandates were enacted and relevant details. It is important to note that while the mandates cover only 15 states, they affect a relatively large share of births in the United States. States with mandates comprised over 47 percent of births in the United States in 2008.[25]

Table 11: States with Mandated Infertility Insurance[26]

State	Year Law Enacted	Mandate to Cover	Mandate to Offer	IVF Coverage	IVF Only
Arkansas	1987	X			X
California	1989		X		
Connecticut	1989	X		X	
Hawaii	1987	X			X
Illinois	1991	X		X	
Louisiana	2001	X			
Maryland	1985	X			X
Massachusetts	1987	X		X	
Montana	1987	X			
New Jersey	2001	X		X	
New York	1990	X			
Ohio	1990	X			
Rhode Island	1989	X		X	
Texas	1987		X		X
West Virginia	1977	X			

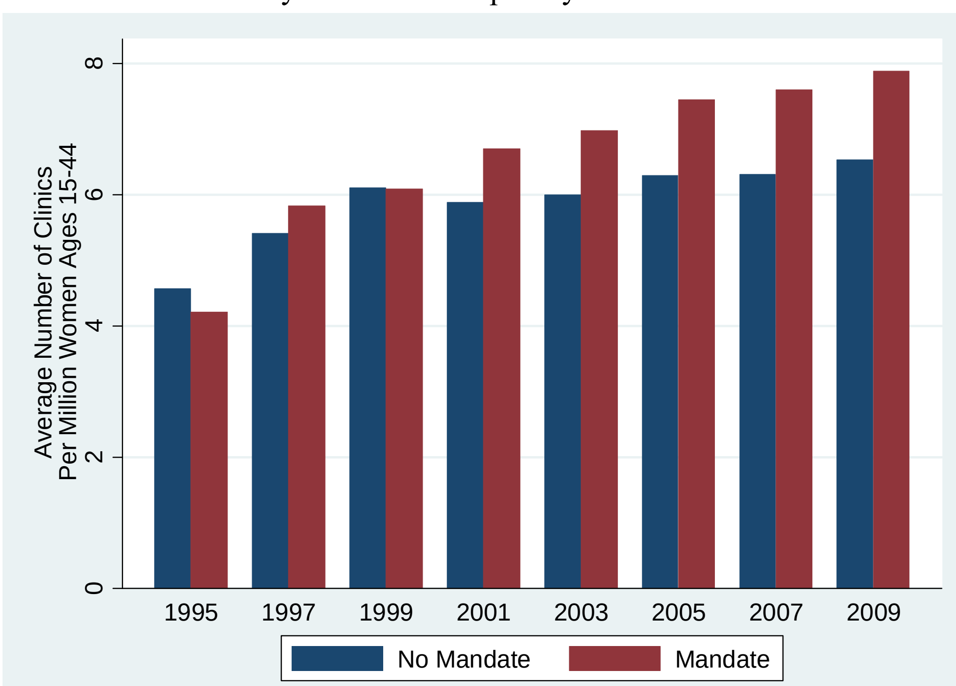
[25] Centers for Disease Control and Prevention, National Center for Health Statistics, VitalStats.

[26] Source: American Society for Reproductive Medicine (2011), RESOLVE (2011), Bitler and Schmidt (2012). Connecticut changed its mandate from a mandate to offer in its 1989 law to a mandate to cover in its 2005 law. According to RESOLVE (2011) and as in Bitler and Schmidt (2012), Louisiana is considered to have implemented a mandate to cover beginning in 2001. According to the American Society for Reproductive Medicine (2011) and as in Bitler and Schmidt (2012), West Virginia is considered to have implemented a mandate to cover beginning in 1977. As in Bitler and Schmidt (2012), New York is considered to have implemented a mandate to cover beginning in 1990.

Effects of the Mandates

This paper explores whether greater affordability of ART has impacted women's timing of marriage and childbearing using ART insurance mandates as a source of plausibly exogenous variation in the price of ART. To use this variation as an identification strategy, it is necessary to establish whether the mandates have actually resulted in increased use of infertility treatments. This could come about directly, by reducing the price of infertility treatment, or indirectly, by inducing a greater supply of fertility services and greater awareness of the availability of these services. In this way, while the direct effects of a fall in price might only affect users of ART covered by the insurance mandates, the indirect effects of the mandates of greater supply and knowledge of ART could also impact younger women through their expectations about their future fertility options regardless of whether they will ever actually use ART. Considering these indirect channels, Figure 6 shows the average number of fertility clinics per million women ages 15-44 over the 1995-2007 period during and after the implementation of the mandates. At the beginning of the period, it appears that the average per capita number of fertility clinics is quite similar between states with mandates and those without. Over time, the average per capita number of fertility clinics increases more quickly in states with mandates than in those without, which could indicate that the mandates are associated with an increase in supply of ART accompanying their effect on lowering the price of ART to consumers.

Figure 6: Number of Fertility Clinics Per Capita by State's Mandate Status 1995-2009[27]



[27] Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Division of Reproductive Health (2012).

Regardless of whether effects of the ART insurance mandates would come about through direct or indirect channels, extensive work in the economics literature finds effects of the ART insurance mandates on the utilization of ART and outcomes of treatment. Bundorf, Henne, and Baker (2007) find that use of infertility treatments is significantly greater in states adopting comprehensive mandates and that mandated coverage was associated with a relatively large increase in the probability of a multiple birth. Buckles (2012) also finds that strong mandate-to-cover laws are associated with an increase in multiple birth rates for married women, white women, and for women with a college degree. Hamilton and McManus (2012) find that comprehensive mandates result in large increases in access to treatment as well as significantly less aggressive treatment.[28] Bitler and Schmidt (2012) examine whether the mandates affect ART utilization for older, highly-educated women, and find that they have a large and significant effect for this subgroup. All of these papers suggest that the mandates are indeed associated with increased utilization of ART and that this increased utilization is associated with differential birth outcomes.

The economics literature has also begun to investigate if there are significant effects of the mandates on larger populations of women, not just the users of ART. The previous literature has focused on examining women at older childbearing ages because they are more likely to be infertile and demand treatment and because they tend to be privately insured at high rates. Several papers find that the mandates are associated with changes in birth rates. Schmidt (2007) uses Vital Statistics Detail Natality Data and Census population counts and finds that the mandates increase first birth rates for women over 35. Buckles (2005) uses Vital Statistics Detail Natality Data to show that mandates that cover IVF are associated with a higher age at first birth. Bitler (2008) finds that the mandates are associated with an increase in the probability of being a twin for children born to older mothers, an increase in the twin delivery rate for older women, as well as negative effects on health-related characteristics for samples of twins and, to a lesser extent, singletons. Only a few papers have considered the effects of the mandates on outcomes not related to births. Cohen and Chen (2011) find that the mandates are associated with increased adoption rates and Appleton and Pollak (2011) put these adoption results in context. Buckles (2005) finds that mandating insurance coverage increases labor force participation for women under 35 and decreases participation for women over 35 while increasing their wages. Lahey (2011) finds that for older women of childbearing age, the mandates do not appear to affect wages, but are associated with a decrease in total labor input.

This paper expands on the literature by considering the effect of greater affordability of ART on women's family timing. While most of the aforementioned papers focus primarily on examining the effects of the mandates on the users of ART, this paper considers the effects of the mandates on all women through their expectations of their future fertility regardless of whether they will

[28] In contrast to Bundorf, Henne, and Baker (2007) and Buckles (2012), Hamilton and McManus (2012) find that the mandates are actually associated with a decrease in the percentage of pregnancies with three or more fetuses. Their contradictory results with respect to the impact of the mandates on aggressiveness of treatment and multiple births could be due to alternative samples and econometric techniques accounting for changes in the population using ART versus changes in procedures and outcomes for the population that would have received treatment without the mandates.

ever actually use ART.[29] In addition, this paper adds to the existing literature by examining whether a fall in the price of ART is associated with changes in women's timing of family including marriage as well as childbearing. To identify channels through which a fall in the price of ART might impact women's decisions about timing of family, the paper next develops a theoretical framework that models the effect of greater affordability of ART on women's allocation of time on work and family investment when young and old to derive implications for effects on women's marriage and birth timing.

Theoretical Framework

As discussed previously, the empirical literature has found the ART insurance mandates associated with increased use of ART and increased birth rates. While it seems intuitive that making a fertility technology more affordable would impact its use as well as fertility outcomes for older women of childbearing age, it is less clear about whether it would also impact women's timing of childbearing and marriage over the lifetime. To develop a framework for understanding how greater affordability of ART could affect women's family timing, this section presents a theoretical model of ART use as well as time spent in work and family investment. This framework draws from Becker's (1981) model for the allocation of time.

Model Setup

A woman maximizes her utility (U) over two periods, young (Y) and old (O), subject to time and income constraints. Her utility is a function of consumption (C) and family (F). Consider a woman with preferences represented by the utility function:

$$U(C,F) = \alpha \ln(C) + (1-\alpha)\ln(F)$$

The woman can spend her time in family investment or in market work. For time spent working (TM), in the first period she earns a set wage w_Y and in the second period she earns a wage w_O determined by her work time in the first period. Family is formed by some fixed amount of time investment (TF) in marriage, childbearing, and child rearing either when young (I_Y=1, I_O=0) or when old (I_Y=0, I_O=1) such that:

$$\frac{\partial F}{\partial I_Y} = \frac{\partial F}{\partial I_O} = F$$

The model assumes that the likelihood of getting pregnant in the second period is lower than in the first. For simplicity, the model assumes that to pursue getting pregnant in the second period with the same likelihood as in the first, the woman must use ART, and that family investment in the second period cannot take place without ART. A woman chooses whether to invest in family in the first period by forgoing work time or to invest in family initiation in the second period by

[29] In a working paper, Ohinata (2011) has examined the effects of the mandates on women's timing of childbearing. Her preliminary results suggest the mandates are associated with delayed childbearing only for white women with higher education. This paper uses an alternative sample and different specifications and examines the effects of the mandates on family timing including marriage and childbearing in and out of wedlock rather than only the timing of first birth.

forgoing work time and paying an additional price to use ART (P_{ART}). The price of consumption is normalized to 1, and nonlabor income is denoted by μ. The utility function is maximized subject to time constraints such that the time spent in work and family investment in each period cannot exceed the total time available in each period and subject to a budget constraint such that consumption cannot excess nonlabor income and income earned from work in each period less expenditures on ART related to family investment in the second period:

$$TM_Y + TF * I_Y = 1$$

$$TM_O + TF * I_O = 1$$

$$C = \mu + w_Y - w_Y * TF * I_Y + w_O(M_Y) - (w_O(M_Y) + P_{ART}) * TF * I_O$$

The model makes several simplifying assumptions. The model assumes that ART and starting a family when younger without using ART and starting a family when older using ART are perfect substitutes. If women prefer to start families when younger, the cutoff values on the wage trajectory distribution would be higher to account for these non-monetary costs. The model also assumes that women know the price of ART and know about a change in the price of ART, and for simplicity, the model assumes ART is only used by older women of childbearing age.

Solving the Model

Using the utility function and time and income constraints, the Lagrangian follows:

$$\mathcal{L} = \alpha \ln(C) + (1-\alpha)\ln(F) + \lambda[\mu + w_Y - w_Y * TF * I_Y + w_O(M_Y) - (w_O(M_Y) + P_{ART}) * TF * I_O - C]$$

Solving for the first order conditions gives:

(1) $\frac{\partial \mathcal{L}}{\partial C} = \frac{\alpha}{C} - \lambda \leq 0$

(2) $\frac{\partial \mathcal{L}}{\partial I_Y} = (1-\alpha) - \lambda\left[w_Y * TF - \left(\frac{\partial w_O}{\partial I_Y}\right) * (1 - TF * I_O)\right] \leq 0$

(3) $\frac{\partial \mathcal{L}}{\partial I_O} = (1-\alpha) - \lambda[w_O(I_Y) * TF + P_{ART}] \leq 0$

(4) $\frac{\partial \mathcal{L}}{\partial \lambda} = \mu + w_Y * (T_Y - T * F_Y) + w_O(F_Y) * (T_O - TF_O) - P_{ART} * TF_O - C \geq 0$

Since the individual must choose to either invest in family in the first period or in the second period, only one of (2) and (3) can bind. Either (2) binds and (3) does not such that:

$$w_Y * TF - \left(\frac{\partial w_O}{\partial I_Y}\right) * (1 - TF * I_O) < w_O(I_Y) * TF + P_{ART}$$

Here, the foregone first period income and second period wage trajectory are lower than the foregone second period income and the price of ART. Thus, the woman invests in family in the first period, and not in the second.

Alternatively, the foregone first period income and second period wage trajectory may be greater than the foregone second period income and the price of ART:

$$w_Y * TF - \left(\frac{\partial w_O}{\partial I_Y}\right) * (1 - TF * I_O) > w_O(I_Y) * TF + P_{ART}$$

In this case, the woman invests in family in the second period, and not in the first.

From these results, it follows that the users of ART should include women who invest in careers with wage trajectories above some cutoff of the distribution of wage trajectories.

Effect of a Change in the Price of ART

The effect of a change in the price of ART differs for women depending on their wage trajectory. A decrease in the price of ART will lower the cost of investing in family in the second period and should induce women with wage trajectories just below the cutoff on the distribution to switch from investing in family in the first period to investing in family in the second period.

Testable Implications and Empirical Questions

Based on the theoretical framework, if ART insurance mandates act to lower the effective price of ART, more women would be expected to switch from starting families when younger to starting families when older consistent with a pattern of delayed marriage and childbearing. Thus, with the mandates, there should be delayed marriage and childbearing at younger ages, but accelerated childbearing and marriage at older ages. This delay should affect women differentially across the wage trajectory distribution with the effects of the mandates strongest for women just below the cutoff on the distribution. To examine these implications raised by the model, the empirical analysis will test whether the mandates are associated with delay or acceleration of marriage and childbearing at different ages and at different education levels. The theoretical framework implies that factors that affect wages and the utility from consumption and family investment, such as race, education, and age, should be controlled for in the empirical model.

While the model treats marriage and childbearing as a joint decision, it could be the case that the mandates are only impacting the timing of childbearing separately from marriage. By testing the effects of the mandates separately for marriage and childbearing, it can be determined whether the results are consistent for both choices. If the timing of both choices is impacted in a similar way, treating marriage and childbearing jointly should be appropriate. As a further test of this treatment, the analysis will examine the effects of the mandates on out-of-wedlock childbearing to determine if effects of the mandates on childbearing are associated with childbearing within wedlock or childbearing out of wedlock.

In addition, stronger effects of the mandates should be associated with stronger mandates since the effective price of ART would be lower and more women would switch to older childbearing. To examine whether this is the case, the analysis will test for differential effects of the mandates by the degree of coverage of the mandates. Further, since the response to the price change might be contingent on the diffusion of awareness about the mandates, the analysis will test to see whether the effects of the mandates increase in magnitude as the time since they were implemented increases. Differential effects driven by heterogeneity of the mandates and changes in the effects of the mandates over time since implementation will be examined as robustness checks.

The paper will proceed by outlining the data and empirical strategy used to examine these questions.

Data

The data used in the empirical analysis is the 1968-2009 PSID. The PSID is a longitudinal data set that began in 1968 with a sample of approximately 5,000 U.S. households and has been updated annually through 1997 and bi-annually thereafter. The PSID has attempted to follow all of the individuals from the initial 1968 sample as well as the new families formed by children of the original respondents. The benefit to using the PSID is that it collects data on sample individuals each year, and so it is possible to follow the sample of women through their marriage and childbearing years and identify the month and year of marriage or first birth as well as the state of residence during that time. The drawback to using the PSID data as compared to available datasets of repeated cross sections is that the sample sizes are considerably smaller, making it harder to detect effects of the mandates and limiting the ability to add controls for cohort effects, state time trends, and the like.[30]

The sample used in the analysis is comprised of at-risk women (single, never married in the case of the marriage analysis, childless in the case of the birth analysis) who enter the sample at age 18 and continue to be followed in the sample until "failing," by marrying in the case of the marriage analysis or having a first birth in the case of the birth analysis, or becoming censored.[31] Therefore, the analysis includes all women from the age of 18 who are single and never married, in the case of the marriage analysis, or have never given birth, in the case of the first birth analysis.[32] 18 was chosen as an appropriate age to begin the analysis since women would be old enough to be living on their own. Women were only included in years in which they were assigned a positive sampling weight,[33] and women with missing years of data were dropped.[34]

[30] Abramowitz (2012) uses Current Population Survey (CPS) data to estimate the mandates' effects on the difference in the proportion married for different age groups; that analysis is less precise, but benefits from a large sample size. The results from this analysis and Abramowitz (2012) can be seen as complementary.

[31] Given this criteria, the sample used in this analysis only includes women born between 1950 and 1991.

[32] 100 individuals who married at ages younger than 18 and 171 individuals who had a first birth at ages younger than 18 were excluded from the marriage and first birth analyses, respectively.

[33] Individuals with sampling weights equal to zero are not considered as sample members; these individuals joined panel families through marriage, cohabitation, or co-residency either as adults or the children of such adults. They are not included in the sample used in this analysis since these individuals may be more likely to enter the analysis

For the analysis of transitions to a first marriage, the dependent variable is the duration from the date of the woman's birth until the date of her first marriage, that is, her age at her first marriage, and is measured in months. For the analysis of transitions to a first birth, the dependent variable is the duration from the date of the woman's birth until the date of the birth of her first child, that is, her age at the birth of her first child, and is measured in months. A woman is considered as being affected by the mandate if a mandate was in place at for at least two years in the state in which she is living at the time of the survey.[35,36,37] The two-year lag is used to allow for time for the news of the implementation of the mandates to disseminate and to allow for the time it take to marry and give birth consistent with Schmidt (2007).[38]

Descriptive statistics for the sample can be found in Table 12. Since the samples for the marriage and first birth analyses differ slightly, descriptive statistics are presented for both samples. There are differences in the educational attainment and racial composition of the mandate and non-mandate states, and as such, these factors are controlled for in the empirical analysis. Women in states that ever have mandates appear to marry and have a first birth at older ages than women in states that never have mandates.

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due to experiencing an outcome of interest (marriage or birth) and because sample weights are unavailable for these individuals.

[34] Women are only included in the analysis if state of residence data is available for all years she is included in the analysis. Highest grade completed was imputed for women for whom this data missing if a measure of her highest grade completed was available for at least one year. Dropping women with missing values for highest grade completed from the analysis yielded qualitatively similar results.

[35] For 1997-2009, the PSID only covers odd-numbered years. Residence was extrapolated for even-numbered years.

[36] For the purposes of this analysis, all states with mandates are treated the same. As a robustness check, states with "strong" mandates, those that have mandates to cover and include coverage for IVF, and states with "weak" mandates, those that have mandates to offer or exclude coverage for IVF, are tested separately. This follows Schmidt (2007) and Bitler and Schmidt (2012). Given the small sample size, treating all mandates the same allows for more precise detection of effects of the mandates generally.

[37] The sample includes women who move across states. It could be a concern that women move across states in order to take advantage of the mandates. However, imposing the restriction that only non-movers be included in the sample results in a significant decrease in sample size. Therefore, the main analysis includes women who move across states, but an analysis excluding these individuals is estimated as a robustness check.

[38] As a robustness check, the specifications were estimated both allowing the mandate to have an effect in year of implementation as well as allowing the mandate to have an effect with a five-year lag; results are discussed subsequently.

Table 12: Descriptive Statistics[39]

	Marriage Analysis		First Birth Analysis	
Number of Individuals	6,032		5,659	
Number of Observations	41,749		36,173	
Mean Observations Per Individual	6.9		6.4	
	Non-Mandate	Mandate	Non-Mandate	Mandate
Percent High School or Less	0.46	0.39	0.44	0.38
	(0.51)	(0.47)	(0.51)	(0.47)
Percent Some College	0.31	0.35	0.32	0.35
	(0.48)	(0.46)	(0.48)	(0.46)
Percent College Graduate or More	0.24	0.26	0.24	0.27
	(0.44)	(0.42)	(0.44)	(0.43)
Percent White	0.79	0.73	0.82	0.76
	(0.42)	(0.43)	(0.40)	(0.41)
Percent Black	0.17	0.16	0.14	0.13
	(0.38)	(0.35)	(0.36)	(0.33)
Percent Other Race	0.04	0.11	0.04	0.10
	(0.21)	(0.30)	(0.20)	(0.29)
Median Annual Income ($)	21,996	24,083	21,953	24,099
	(2,809)	(2,795)	(2,798)	(2,793)
Top 10th Percentile Annual Income ($)	54,381	60,264	54,269	60,260
	(2,809)	(2,795)	(7,294)	(8,379)
Female Labor Force Participation Rate	0.56	0.55	0.56	0.55
	(0.08)	(0.06)	(0.08)	(0.06)
Female Unemployment Rate	0.06	0.06	0.06	0.06
	(0.02)	(0.02)	(0.02)	(0.02)
Mean Age at Failure[40]	23.5	24.5	24.3	25.0
	(4.5)	(5.1)	(4.8)	(4.8)

Empirical Specification

To investigate the effects of the ART insurance mandates on women's marriage and birth timing, the analysis uses the Cox proportional hazard model (Cox, 1972) in which the instantaneous hazard rates of first marriage and first birth, respectively, are specified for individual *i*, at age *t*, conditional on having remained single or childless until age *t*, as:

$$\lambda(t \mid \mathbf{X_{it}}) = \lambda_0(t)\exp(\beta\mathbf{X_{it}})$$

The baseline hazard, $\lambda_0(t)$, is a nonparametric, time-varying function; $\mathbf{X_{it}}$ is a vector of regressors that includes a dummy variable indicating whether the woman lived in a state with a mandate in place for at least two years; and β is the vector of coefficients to be estimated.

Exponentiating the estimated coefficients gives the hazard ratio for each of the model parameters, indicating the proportional difference in risk of failure associated with that parameter. Thus, the duration framework allows identification of whether parameters are

[39] Descriptive statistics are calculated using PSID population-representative weights. Standard deviations are in parentheses.
[40] Mean age at failure is calculated only including those individuals who failed.

associated with greater (or lesser) risk of failure which is equivalent to having a shorter (or longer) duration until failure. The duration framework also allows for the right censoring of individuals for whom no failure occurs by the end of the PSID sample period.

Several specifications are estimated to identify whether the mandates are associated with differences in the timing of first marriage and first birth and if there are differential effects of the mandates on women of varying ages and education levels. In all specifications, the data is weighted to be population-representative. First, an across-ages specification is estimated in which the effect of the mandates is assumed to shift the baseline hazard proportionally at all ages. The mandate regressor is an indicator variable equal to one if the woman has lived in a state with a mandate in place for at least two years. The hazard ratio estimated for the mandate regressor estimates the relative level of risk associated with the mandates as compared to the baseline hazard function without the mandates. The mandate will be associated with an increased risk of marriage and birth if the mandates result in women pursuing these earlier; the mandate will be associated with a decreased risk of marriage and birth if the mandates result in women delaying these. The specification includes state fixed effects, to control for time-invariant state characteristics that might affect the timing of marriage and birth; year fixed effects, to control for changes over time across states that might affect the timing of marriage and birth effects; controls for race and education, and controls for labor market conditions at the state level.[41]

Since the effects of the mandates are expected to vary for at-risk women at different ages, the assumption that the effect of the mandates results in a shift the baseline hazard proportionally at all ages may be overly restrictive and produce misleading results. To address this concern, an age group-interacted specification is estimated next, which includes the same controls as in the across-ages specification, but also includes interaction terms for the mandate and three age groups: 18-24, 25-29, and 30 and older.[42] In this specification, the effects of the mandates at each age group are estimated as the sum of the coefficients on the mandate regressor and each mandate-age group interaction term, which, when exponentiated as hazard ratios, reflect the relative level of risk associated with the mandates as compared to the baseline hazard function without the mandates for each age group. Using this specification, the effect of the mandates is still assumed to shift the baseline hazard proportionally within an age group, but can vary between age groups.

There might be some concern that pre-existing age group specific differences exist between states that would ever have mandates and those that would not in the timing of marriage or birth. To address this concern, the age group-interacted specifications are also estimated including an interaction of the dummy variable for whether the state ever enacted a mandate with the age group dummies as well as region controls instead of the state controls. Comparison of the results

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[41] To proxy for labor market conditions, the state female unemployment rate, female labor force participation rate, median annual income, and top 10th percentile annual income are included as controls.

[42] The bounds of these age groups are chosen as such because they each age group contains a large proportion of the failures in the data for each analysis. It would be interesting to include age groups the facilitate looking more closely at effects of the mandates on older age groups, but given the smaller sample size and small number of first marriages and first births that take place at ages greater than 35 or 40, including these age groups separately was not appropriate for this analysis.

of specifications with state controls and those with mandate state-age group interactions will be useful in identifying whether pre-existing age group-specific differences between states that would ever have mandates and those that would not are driving any results.

Next, since the theoretical framework predicts that the mandates may have differential effects on women with steeper wage trajectories than those with flatter ones, the analysis tests whether the mandates have differential effects by education level by estimating the age group-interacted specification separately for women with some college education or less and for those with at least a college degree.

While the Cox models above are used to estimate the likelihood of single, never married women to marry or childless women to give birth, it is necessary to use competing risks analyses to examine the effects of the mandates when several mutually exclusive outcomes are possible and there could be correlation between their failure times. For example, it could be the case that ART would induce a woman to wait to marry and then have a child rather than to have a child out-of-wedlock at earlier. In this case, not accounting for the effects on out-of-wedlock births could yield misleading results. Considering the pool of single, never married, childless women, there are two mutually exclusive channels for failure: marrying without children or having a first birth out of wedlock. Alternatively, considering the pool of childless women, there are again two mutually exclusive channels for failure: having a first birth within marriage or having a first birth out of wedlock. Estimating any of the above channels on their own would treat failure to the competing channel as censored and thus would not take into account possible effects on the competing channel and their impact on the channel of interest. Accordingly, competing risks specifications (Fine and Gray, 1999) were estimated to capture these effects.

To investigate whether the mandates are associated with women to "opting in" or "opting out" of marriage, the analysis examines the effects of the mandates on the subhazards of single, never married, childless women for having out-of-wedlock births and marrying without having had children. To investigate whether the mandates are affecting only births within marriage or only those out of marriage, the analysis examines the effects of the mandates on the subhazards of each of these outcomes for childless women. The model for each subhazard follows:

$$\overline{h}(t \mid \mathbf{X_{it}}) = \overline{h}_0(t)\exp(\beta \mathbf{X_{it}})$$

To address the first question, the subhazard is modeled as the instantaneous probability of having an out-of-wedlock birth (marrying without having had children) and is specified for individual *i*, at age *t*, conditional on having remained single *and* childless until age *t*. To address the second question, the subhazard is modeled as the instantaneous probability of having first birth out-of-wedlock (within marriage) and is specified for individual *i*, at age *t*, conditional on having remained childless, whether single or married, until age *t*. In both models, the baseline subhazard, $h_0(t)$, is a nonparametric, time-varying function; $\mathbf{X_{it}}$ is a vector of regressors that includes a dummy variable indicating whether the woman lived in a state with a mandate in place for at least two years; and β is the vector of coefficients to be estimated which follow the same form as in the age group-interacted specification.

The results of the across-ages, age group-interacted, education level, and competing risks specifications follow.

Primary Results

Across-Ages Specifications

Table 13 presents the results for the across-ages hazard model specifications of the transition to first marriage and motherhood. The results show no significant effect of the mandates on the hazard of marrying or on the hazard of having a first birth. As discussed previously, this specification assumes that the mandates affect the hazard of marriage and first birth proportionally across all ages, and since this might be an overly-restrictive assumption given that the mandates may affect the hazards differently at different ages, the age group-interacted specifications are estimated next.

Table 13: Across-Ages Mandate Hazard Ratio Effects

Hazard Ratios	Marriage	Marriage	First Birth	First Birth
Mandate	1.193*	1.176	1.174	1.131
	(0.125)	(0.116)	(0.119)	(0.110)
State Controls	X		X	
Mandate State-Age Group Controls		X		X
Individuals	6,032	6,032	5,659	5,659

Age Group-Interacted Specifications

Table 14 presents the results for the age group-interacted hazard model specifications of the transition to marriage and to motherhood. The results show the mandates are associated with a significant increase in the hazard of marrying for women ages 25 and older and a significant increase in the hazard of having a first birth for women ages 30 and older, but with no significant effect on the hazard of marrying or having a first birth for younger women. The estimations including state controls and those including mandate state-age group controls appear to yield qualitatively similar results.

Table 14: Age Group-Interacted Mandate Hazard Ratio Effects

Hazard Ratios	Marriage	Marriage	First Birth	First Birth
Age<25: Mandate	0.954	0.928	1.145	1.157
	(0.110)	(0.102)	(0.131)	(0.131)
Age 25-29: Age 25-29 X Mandate + Mandate	1.507***	1.551**	1.026	0.8
	(0.233)	(0.284)	(0.150)	(0.128)
Age>29: Age>29 X Mandate + Mandate	2.027***	2.278***	1.57**	1.857**
	(0.395)	(0.704)	(0.292)	(0.506)
State Controls	X		X	
Mandate State-Age Group Controls		X		X
Individuals	6,032	6,032	5,659	5,659

These results suggest that the mandates are not affecting younger women, but are speeding older women's transitions to marriage and motherhood. Of the women who remain single and childless until older ages, it is plausible that the mandates would induce these women to marry and have children. However, the results do not suggest that the mandates are associated with delay of marriage and childbearing. With regard to fertility, this could be consistent with the scenario that while the price of ART does not affect women's choice about when to begin trying to get pregnant, it may speed the time at which they actually do. With regard to marriage, it is possible that the mandates lead to marriage if an unmarried woman that does not have insurance coverage for ART because she does not work for an employer regulated by the mandate would choose to marry a man working for an employer that is regulated by the mandate in order to get coverage for ART. However, since the theoretical model predicts delay according to a woman's position on the wage trajectory distribution, these results estimated for the full sample may miss the effects of delay induced by the mandates for only some women on the wage trajectory distribution. To explore this question further, results estimated by education level proxying for wage trajectory follow.

Education Level

The results of the age group-interacted specification estimated separately for women with some college or less and for women with at least college degrees are presented next. Table 15 presents the results for the effects of the mandates on the hazard of marrying. These results suggest that for women ages 30 and older in both groups the mandates are associated with an increased hazard of marrying. However, for women with college degrees, the mandates also appear to be associated with women younger than 25 having a lower hazard of marrying. This is consistent with a pattern of marriage delay for more highly educated women as predicted by the theoretical model.

Table 15: Mandate-Age Group Effects for Marriage by Education Level

Hazard Ratios	Some College or Less	Some College or Less	College Graduate or More	College Graduate or More
Age<25: Mandate	0.943	0.984	0.696	0.637**
	(0.124)	(0.123)	(0.156)	(0.141)
Age 25-29: Age 25-29 X Mandate + Mandate	1.358	1.483	1.287	1.319
	(0.287)	(0.375)	(0.310)	(0.357)
Age>29: Age>29 X Mandate + Mandate	1.87**	1.766	1.921**	2.48**
	(0.514)	(0.867)	(0.559)	(0.962)
State Controls	X		X	
Mandate State-Age Group Controls		X		X
Individuals	4,898	4,898	1,134	1,134

Table 16 presents the results for the effects of the mandates on the hazard of having a first birth. Here it appears that for women with some college or less the mandates are associated with an increase in the hazard of having a first birth at all ages, but none of these effects are significant. For women with at least a college degree, the mandates appear to be associated with a lower hazard of having a first birth at younger ages and a higher (but not significant) hazard of having a first birth at older ages. This is consistent with a pattern of delay of first birth for more highly educated women as predicted by the theoretical model.

Table 16: Mandate-Age Group Effects for First Birth by Education Level

Hazard Ratios	Some College or Less	Some College or Less	College Graduate or More	College Graduate or More
Age<25: Mandate	1.108	1.131	0.76	1.032
	(0.139)	(0.138)	(0.237)	(0.360)
Age 25-29: Age 25-29 X Mandate + Mandate	1.276	1.113	0.778	0.494***
	(0.233)	(0.245)	(0.202)	(0.120)
Age>29: Age>29 X Mandate + Mandate	1.274	1.796	1.573*	1.535
	(0.375)	(0.849)	(0.419)	(0.490)
State Controls	X		X	
Mandate State-Age Group Controls		X		X
Individuals	4,547	4,547	1,112	1,112

Again, the estimations including state controls and those including mandate state-age group controls appear to yield quantitatively similar results, and as such, only results of specifications using state controls will be presented subsequently for brevity.

Next, to address whether effects of the mandates on out-of-wedlock childbearing are driving results, the competing risks specifications are presented subsequently.

Competing Risks Specifications

Table 17 presents the results for the age group-interacted specification of the competing risk analysis of the transition to first marriage treating marriage before birth and having an out-of-wedlock birth as competing risks. The results for marriage are consistent with those estimated previously: for single, never married women ages 25 the mandates are associated with an increased hazard of marrying. The results for out-of-wedlock births do not suggest that the mandates are associated with an increased hazard of having a first birth out of wedlock at any age.

Table 17: Competing Risks Mandate-Age Group Effects for First of Marriage or Birth

Hazard Ratios	Marriage without Children	Out-of-Wedlock Births
Age<25: Mandate	0.902	1.307
	(0.117)	(0.248)
Age 25-29: Age 25-29 X Mandate + Mandate	1.656***	1.018
	(0.279)	(0.414)
Age>29: Age>29 X Mandate + Mandate	1.957***	1.152
	(0.455)	(0.776)
State Controls	X	X
Individuals	5,600	5,600

Table 18 presents the results for the age group-interacted specification of the competing risk analysis of the transition to first birth treating birth within marriage and out-of-wedlock births as competing risks. The results for giving birth within wedlock are consistent with the first birth results estimated previously: for single, never married women ages 30 and older, the mandates are associated with an increased hazard of having a first birth within marriage.[43] However, the results do not suggest that the mandates are associated with an increased hazard of having a first birth out of wedlock.

Table 18: Competing Risks Mandate-Age Group Effects for First Birth

Hazard Ratios	Birth in Wedlock	Birth out of Wedlock
Age<25: Mandate	0.995	1.232
		(0.234)
Age 25-29: Age 25-29 X Mandate + Mandate	1.090	1.036
		(0.419)
Age>29: Age>29 X Mandate + Mandate	1.557	1.195
		(0.781)
State Controls	X	X
Individuals	5,520	5,520

[43] Standard errors were not estimable for the specification for birth within marriage; however, the magnitudes of the hazard ratio estimates are consistent with those estimated for births within and out of wedlock.

The results of both competing risks specifications suggest that the mandates are affecting women's timing of first birth within marriage, providing a basis for the results on timing of marriage presented earlier. However, these results do not suggest that the mandates are affecting women's timing of out-of-wedlock births. Interestingly, the results of acceleration of births appear to only be apparent for births within marriage suggesting that marriage may be a key channel for this effect. This would be consistent with the scenario that the mandates may induce women to marry in order to obtain the benefits associated with the mandates that they would not have otherwise had access to through their spouse's employer.

Thus far, the analysis has considered the effects of the mandates on the hazard of marrying and the hazard of having a first birth for the full sample and by education level at different ages as well as the hazards of having a first birth within and out of marriage. While the paper has addressed the main testable implications of the theoretical model, proceeding results investigate other potential effects of the mandates. Next the effects of the mandates conditional on marriage are examined considering only women who have married during the sample period in the analysis. Differential effects of the mandates by race and whether the mandates are associated with changes in men's timing of marriage and childbearing are subsequently examined.

Further Results

Mandate Effects Conditional on Marriage

Thus far, the analysis has considered the effects of the mandates on the hazard of marrying and the hazard of having a first birth both within and outside of marriage, but has not yet considered the effects of the mandates on behavior conditional on marriage. To establish whether the mandates are associated with changes in fertility timing conditional on marriage timing, the effect of the mandates on timing between marriage and first birth for those who have married is estimated. To understand whether the mandates are associated with longer lasting marriages, the effect of the mandates on the time between marriage and separation for those who have married is also estimate.[44] Results of these estimations are presented in Table 19.

Table 19: Mandate Effects Conditional on Marriage

Hazard Ratios	Time Between Marriage and First Birth	Time Between Marriage and Separation
Mandate	1.095	0.885
	(0.131)	(0.156)
State Controls	X	X
Individuals	2,085	2,755

[44] Both of these specifications include all of the controls used in the across-ages specification except for controls for age group. In addition. a control for age at marriage is included. The mandate term is not interacted with age group since the sample includes only married individuals and the specification includes controls for age at marriage.

Results show no significant effect of the mandates on either time between marriage and first birth or time between marriage and separation. Given that the sample sizes for these estimations are smaller due to the inclusion of only married individuals, additional analysis using larger samples could be beneficial.

Race

Thus far, the analysis has treated the effects of the mandates as the same for women of all races, but it may be the case that the effects of the mandates vary by race. Bitler and Schmidt (2006) find no evidence that the mandates ameliorate racial, ethnic, and education disparities in the use of infertility treatment suggesting that there may be differential effects of the mandates on these groups which could correspond to differences by race in the effects of the mandates on the timing of marriage and first birth.

Table 20 presents the results for the age group-interacted hazard model specifications of the transition to marriage and to motherhood separately for whites and blacks.[45] The results for white women are consistent with those for the full sample: the mandates appear to be associated with a significant increase in the hazard of marrying for women ages 25 and in the hazard of having a first birth for women ages 30 and older, but with no significant effects for marriage or first birth for younger women. For black women, the mandates are associated with a marginally significant increase in the hazard of a having a first birth over the 18-24 age range and a marginally significant decrease in the hazard of a having a first birth over the 25-29 age range, but with no significant effect for younger or older women. This is consistent with the findings of Bitler and Schmidt (2006) suggesting differential effects of the mandates by race.

Table 20: Mandate-Age Group Effects for Marriage and First Birth by Race

Hazard Ratios	Marriage Whites	Marriage Blacks	First Birth Whites	First Birth Blacks
Age<25: Mandate	0.931	1.689*	1.13	1.41
	(0.119)	(0.531)	(0.156)	(0.350)
Age 25-29: Age 25-29 X Mandate + Mandate	1.63***	1.303	1.124	0.481*
	(0.273)	(0.565)	(0.180)	(0.193)
Age>29: Age>29 X Mandate + Mandate	2.097***	1.959	1.761***	0.492
	(0.476)	(0.846)	(0.354)	(0.270)
State Controls	X	X	X	X
Individuals	2,962	2,687	2,956	2,348

[45] Since individuals of other races make up a very small proportion of the sample, specifications were only run separately for whites and blacks.

Men

Since any changes affecting women's marriage decisions have the potential to affect men's marriage decisions as well, the full specification was also estimated for men. Table 21 presents the results for the age group-interacted hazard model specification of the transition to marriage and fatherhood for men. The results show the mandates are associated with a significant increase in the hazard of marrying for men at all ages. However, the results do not show the mandates to be associated with any significant difference in the hazard of having a first birth for men at any age group. An explanation for this could be that as women at these ages become more likely to marry as a result of the mandates, they marry men at these ages and thus men are more likely to marry. Another explanation could be that the increased availability and affordability of ART makes older women more marriageable and men are finding marriage more attractive given the larger pool of marriageable women.

Table 21: Mandate-Age Group Effects for Men

Hazard Ratios	Marriage	First Birth
Age<25: Mandate	1.209	0.928
	(0.151)	(0.126)
Age 25-29: Age 25-29 X Mandate + Mandate	1.396**	0.771
	(0.209)	(0.123)
Age>29: Age>29 X Mandate + Mandate	1.665***	1.121
	(0.312)	(0.183)
State Controls	X	X
Individuals	6,218	6,164

Robustness

To consider the robustness of the analysis, alternative estimations are performed. These estimations account for heterogeneity of the mandates, time since mandate implementation, and moving across states.

Heterogeneity of Mandates

In the empirical analysis, all states with mandates related to ART were treated the same. The theoretical model predicts that more comprehensive versions of the mandates are associated with stronger effects. To understand whether different degrees of the mandates are associated with different outcomes for women's marriage and birth timing, the results were estimated with interacted controls for states with "strong" mandates, those having both mandate-to-cover laws and IVF coverage, and for states with "weak" mandates, those having either mandate-to-offer laws, exclusions of IVF coverage, or both.[46] Table 22 presents these results.

Table 22: Mandate-Age Group Effects – "Strong" Versus "Weak" Mandates

Hazard Ratios	Marriage	First Birth
Strong		
Age<25: Mandate	0.883	0.737
	(0.154)	(0.143)
Age 25-29: Age 25-29 X Mandate + Mandate	1.463	1.373
	(0.345)	(0.288)
Age>29: Age>29 X Mandate + Mandate	2.464***	1.777**
	(0.715)	(0.479)
Weak		
Age<25: Mandate	0.994	1.354**
	(0.136)	(0.177)
Age 25-29: Age 25-29 X Mandate + Mandate	1.535**	0.865
	(0.278)	(0.158)
Age>29: Age>29 X Mandate + Mandate	1.872***	1.486*
	(0.422)	(0.328)
State Controls	X	X
Individuals	6,032	5,659

In general, the results suggest similar effects of the mandates on both the hazards of marrying and having a first birth for women ages 30 and older across states with strong mandates and states with weak mandates, but the effects tend to be greater in magnitude in states with strong mandates. This is consistent with the expectation that stronger mandates should have stronger effects on women's behavior. An interesting result is that for women ages 18-25 the mandates appear to be associated with a lower hazard of having a first birth in states with strong mandates, but with a higher hazard of having a first birth in states with weak mandates.

Next, the question of whether the effects of the mandates have changed the longer the mandates have been in place is addressed.

Time since Mandate Implementation

In this paper's main analyses, a woman is considered as being affected by the mandate if she is living in a state with a mandate in place at for at least two years. As robustness checks, the specifications were estimated first allowing the mandate to have an effect in year of

[46] Specifications were also estimated separately for states with mandate-to-cover laws as compared to those with mandate-to-offer laws and those with IVF coverage and those without, and the results were found to be qualitatively similar: stronger effects were associated with more comprehensive mandates.

implementation and next allowing the mandate to have an effect only if it was in place at for at least five years. In both cases, the results were found to be similar.

These specifications assume that once a mandate has gone into effect, its impact is the same regardless of the time since its implementation. However, the effects of the mandates could change over time if, for example, diffusion of awareness about the mandates takes time. To investigate whether the effect of the mandate changes over time, instead of a mandate dummy variable, a control for years since mandate implementation was used and interacted with the age group controls. Table 23 presents the results of this specification for marriage and first birth. The marriage results show that an additional year since mandate implementation is associated with a significant increase in the hazard of marrying for women ages 25 and older but with no significant effect on younger women. The first birth results show that an additional year since mandate implementation is associated with a significant increase in the hazard of having a first birth for women ages 30 and older, but with no significant effect on younger women. These results suggest that the longer a mandate has been in place, the greater its effect, which is consistent with the idea that knowledge about the mandates has diffused over time.

Table 23: Years since Mandates Effects by Age Group for Marriage and First Birth

Hazard Ratios	Marriage	First Birth
Age<25: Years Since Mandate	0.992	1.012
	(0.008)	(0.008)
Age 25-29: Age 25-29 X Years Since Mandate + Years Since Mandate	1.022**	1.001
	(0.011)	(0.011)
Age>29: Age>29 X Years Since Mandate + Years Since Mandate	1.042***	1.039***
	(0.016)	(0.015)
State Controls	X	X
Individuals	6,032	5,659

Moving Across States

In this paper, women who moved across states over the sample period were included in the analysis. In order to address the concern the women might be moving across states in response to changes in states' mandate status, as a robustness check, the specifications were estimated including only women that did not move states from the age of 18 for the duration of their time in the sample. This reduced the sample's size, but the results were found to be similar.

<u>Discussion and Conclusions</u>

This paper examined the effects of greater affordability of ART on women's timing of family. The paper developed a theoretical model to understand the effect of a change in the price of ART on women's allocation of time on work and family investment when young and old and to derive implications for effects on women's marriage and birth timing. The implications of the model suggested that a fall in the price of ART induces more women along the wage trajectory distribution to use ART and switch from pursuing family when younger to pursuing family when older. The paper then used duration and competing risks analyses exploiting variation in the mandated insurance coverage of ART across U.S. states and over time to investigate whether the mandates have affected women's timing of first marriage and first birth. The findings suggest that the mandates are associated with delayed marriage and childbearing at younger ages and speeded transition to marriage and motherhood after age 30, but only for college graduate women, consistent with the theoretical framework's prediction that women with steeper wage trajectories should be more influenced by the mandates to delay family formation. For the full sample of women, the mandates appear to be associated with speeded transition to marriage after age 25 and motherhood within marriage after age 30, but not with delay at younger ages. This suggests that, for women with greater educational attainment, the mandates may be associated with substituting time when young from family investment to work and then spending more time in family investment when older along with using ART. For women with less educational attainment who may be less career-driven, the results do not suggest that the mandates are associated with a change in family investment or work-related behavior at younger childbearing ages, but only suggest that the mandates are associated with faster marriage and childbearing at older ages. With regard to fertility, this could be consistent with the scenario that while the price of ART does not affect women's choice about when to begin trying to get pregnant, it may speed the time at which they actually do. With regard to marriage, it is possible that the mandates lead to marriage if an unmarried woman that does not have insurance coverage for ART because she does not work for an employer regulated by the mandate would choose to marry a man working for an employer that is regulated by the mandate in order to get coverage for ART. Interestingly, the results of acceleration of births appear to only be apparent for births within marriage suggesting that marriage may be a key channel for this effect.

The paper's results are consistent with those using repeated cross-sections. With regard to first birth, Schmidt (2007) also finds that the mandates are associated with more births among women over age 35 using Vital Statistics Detail Natality Data. With regard to marriage, Abramowitz (2012) using the 1977-2010 Current Population Survey finds that for white women, the likelihood of marrying over the 30-34 to 35-39 age groups is 22 percent higher for the full sample, and for white women with at least a college degree, the likelihood of marrying over the 20-24 to 25-29 age groups is 13 percent lower, and the likelihood of marrying over the 30-34 to 35-39 age groups is 23 percent higher for women living in states with mandates as compared to those living in states that do not have mandates.

The results of the analysis are useful from a policy perspective. It does appear that the mandates are associated with an increase in births among women of older childbearing ages. However, while the mandates and greater availability of ART generally may have been intended to provide a means for women and couples with fertility problems to have a child, an unintended consequence may be that women then choose to delay marriage and childbirth in response to the mandates and greater availability of the technology, resulting in them being more likely to face fertility problems and pursue ART procedures, which as this paper highlighted, are very costly. However, while there is evidence of delay for women with some college education, who comprise 30 percent of the adult female population,[47] for the general population, the mandates only appear to make marriage and child birth an option when they otherwise would not be. In

[47] Of women ages 25 and older according to 2011 Current Population Survey data.

addition, while the mandates do appear to increase the likelihood of births within wedlock for women at older childbearing ages, it does not appear that the mandates are inducing women to "opt-out" of marriage to pursue single motherhood.

A limitation to interpreting the effects of the mandates as a proxy for access to ART is that knowledge and access to the mandates may be heterogeneous. While all women may be able to benefit by the lower price of ART due to the mandates, some women may have more knowledge of the mandates and their effects on the cost of ART than others. For instance, a 35-year-old woman who is concerned about her fertility options may have reason to obtain greater knowledge of her fertility options and their costs than a 25-year-old woman. On the other hand, if the diffusion of information is relatively widespread, the information gap between groups of women may be small. In addition, since the mandates can only affect the cost of ART through insurance markets, such an identification strategy may not capture the effect of lower costs and availability of ART on a larger scale. This may particularly be the case for lower income women, and could explain why the effects of the mandates estimated separately for women with less education appeared to be insignificant.

Overall, the paper makes several main contributions. First, the paper provides a theoretical framework for understanding the effect of greater ability to use ART on women's allocation of time on work and family investment when young and old and derives implications for effects on women's marriage and birth timing. Second, the results increase understanding of the factors that influence women's marriage and birth timing. Third, the paper uses panel data and duration analysis to gain a more thorough understanding of the effects of ART insurance mandates revealing that the mandates affect both highly educated women at younger childbearing ages through their expectations about their future fertility in addition to women at older childbearing ages.

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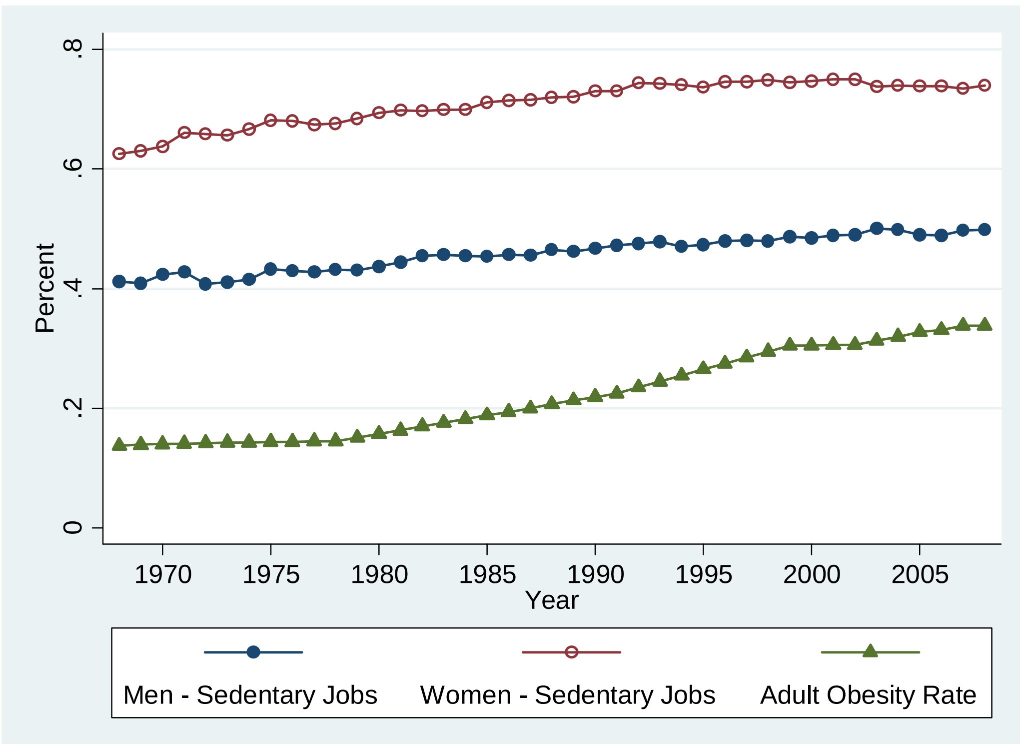
Chapter 3: The Connection between Working Hours and Body Mass Index: A Time Use Analysis

Introduction

Over recent decades, Americans have transitioned from working in active jobs to working in sedentary jobs. Over the same period, obesity rates among the adult population have increased markedly. Figure 7 below illustrates the concurrent increase in the proportion of workers in sedentary jobs and the adult obesity rate, which suggests a relationship between these two trends. As individuals work in more sedentary jobs, it is important to investigate the effects of time spent working on weight and health. The full consequences of increasing working hours in sedentary jobs are not explored in the literature and can have significant implications for labor and tax policy.

Figure 7: Trends in Sedentary Jobs and Adult Obesity 1968-2008[48]

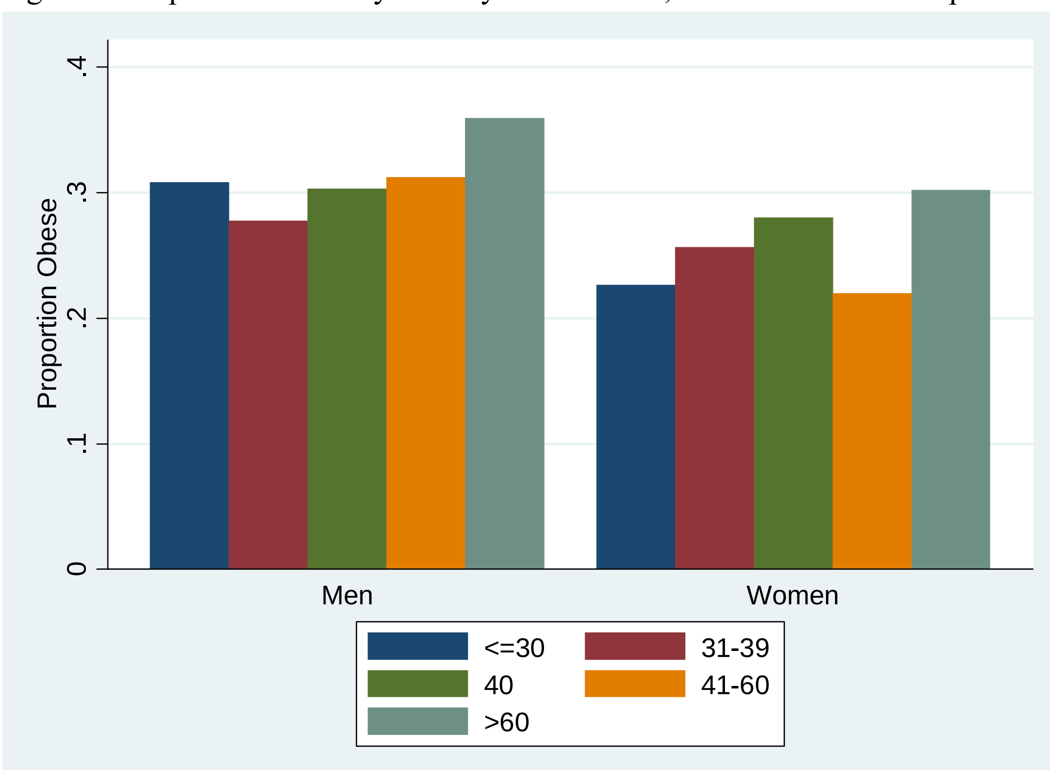


[48] From the Integrated Public Use Microdata Series Current Population Survey March Supplements, Flegal et al (1998), Ogden et al (2006), and Flegal et al (2010). Obesity data are not reported annually; values for missing years are interpolated. Here, sedentary jobs refer to those characterized by activities that generate metabolic equivalents (METs) of 2.5 or less. These jobs include occupations in the fields of management; business and financial; computer and mathematical; architecture and engineering; life, physical, and social science; community and social services; legal; education, training, and library; arts, design, entertainment, sports, media; healthcare practitioner and technical; sales and related occupations; and office and administrative support.

As individuals take more sedentary jobs, there are a number of channels through which increased working time could impact an individual's Body Mass Index (BMI). In general, BMI might increase with more hours spent working since as leisure time declines, the opportunity cost of time rises. As an individual works more hours, she has less leisure time available, and it thus becomes more costly to undertake health-producing activities such as exercise, food preparation, and sleep as well as to seek medical care. On the other hand, working could be associated with a lower BMI if it individuals use increased income to substitute away from time-intensive health investments to goods-intensive health investments. An increase in working in sedentary jobs could affect BMI in particular if individuals who were previously active during their working hours are now sedentary at work and do not proportionately increase activity in their non-work time.

Examining the relationship between working time and obesity for sedentary workers, Figure 8 shows the proportion obese for men and women by weekly work hours. Here we can see that for both men and women in non-strenuous occupations, working longer hours appears to be associated with a higher likelihood of being obese. Since it is important to control for other factors that might affect this relationship, more in-depth analysis of this question is valuable.

Figure 8: Proportion Obese by Weekly Work Hours, Non-Strenuous Occupations[49]



[49] From the 2006-2008 American Time Use Survey and Eating and Health Module. Here, non-strenuous jobs refer to those characterized by activities that generate metabolic equivalents (METs) of less than 3.3, following Zick, Stevens, and Bryant (2011). A METs value ≥ 3.3 includes occupations such as building and grounds cleaning and maintenance, farming, and construction and extraction.

Several papers have examined the connection between work, weight, and health. Ruhm (2000, 2003, 2005, 2007) shows that employment and unemployment indicators are positively related to mortality, incidence of certain medical conditions, and obesity incidence and are negatively related to exercise. Courtemanche (2009) uses long differencing methods and the National Longitudinal Study of Youth 1979 (NLSY) to find that longer hours increase one's own BMI and probability of being obese. Berniell (2012) uses the change in the legal maximum workweek hours in France enacted in 1998 to find that a reduction of working time is associated with a drop in the probability of smoking, in alcohol consumption, and in physical inactivity. Xu and Kaestner (2010) examine the effects of wages and working hours on health behaviors of men aged 25-55 with some college education and finds that increases in hours worked are associated with an increase in cigarette smoking, a reduction in physical activity, and fewer visits to physicians. The above papers have documented the positive relationship between time spent working and BMI. This paper contributes to that literature by using time use data to model the time use channels through which time spent working affects BMI.

The analysis uses the 2006, 2007, and 2008 American Time Use Surveys (ATUS) linked with Eating and Health module interviews, Current Population Survey (CPS) data, and the Compendium of Physical Activities. While other datasets provide information on individuals' market work time, the ATUS also provides insight into individuals' non-market work activities. Linked with the Eating and Health module, it permits inference to be drawn about individuals' time use in a variety of activities as well as measures relating to eating and health, including BMI. The linked ATUS and Eating and Health module data provides great insight into the relationship between time use and weight and health and can be very valuable in understanding the relationship between working time and BMI and health.

The analysis aims to identify channels through which time spent working could affect BMI.[50] To address this question, first, I replicate the results of other papers by estimating the effect of working time on BMI and find that increased working time is associated with a positive and significant effect on own BMI for both men and women. Next, I estimate a series of equations including controls for time spent in each of a variety of activities associated with eating, health investment, and physical activity to investigate the channels through which working time may impact BMI. This approach treats time spent in each activity as an omitted variable and tests whether its inclusion results in a significant difference in the effect of time spent working on own BMI. Because the relationships between one's own time spent working, one's own time in health-related activities, and one's own BMI may be due not only to a direct causal link, but also to some unobservable characteristics which result in these correlations, findings from this approach must be interpreted as highly suggestive and not necessarily causal.

A number of the tested channels appear to impact the effect of hours worked on BMI with strong significant effects found for exercise, active time, and screen time, and marginally significant effects were found for secondary eating and food preparation. No significant effects were found for primary eating, secondary drinking, grocery shopping, purchasing prepared food, sleeping,

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[50] This analysis focuses on the intensive margin (hours of work) and not the extensive margin (labor force participation).

housework, commuting, or own medical care. These results suggest the main channels through which working hours could be related to BMI are related to physical activity.

The rest of the paper is organized as follows. The next section provides some background on the literature examining the effects of time use on health. The section that follows presents a theoretical framework for understanding the channels through which time spent in work could affect BMI. The next sections present the data used in the analysis, outline the empirical specifications, and show results of the analysis. The last section concludes.

Effects of Time Use on Health

With the availability of time use data, much research has begun to investigate the impact of how individuals spend their time on their own health and the health of others. In one of the first papers to examine the effect of time spent working on time spent in non-market activities and to emphasize the importance of investments of time in activities related to health and productivity, Biddle and Hamermesh (1990) used the 1975-1976 Time Use Study to examine the relationship between time spent in the labor market and sleep. In cross-sectional and panel analysis, the paper found a significant negative relationship between time spent working and time spent sleeping, and, estimating a demand system for sleep and working, the paper found that people with higher predicted wages sleep less – men appear to shift time from sleep to leisure and women from market to non-market work. More recently, Hamermesh (2010) used the linked ATUS data to examine individuals' eating and grazing behavior. With regard to BMI and self-reported health status, the paper found that more time spent eating (and grazing) is associated with a lower BMI and with better self-reported health. Kolodinsky and Goldstein (2011) estimated the impacts of food expenditure and time use patterns on obesity in single female headed households of 31-50 years of age and identified a number of demographic characteristics associated with an increased probability of being overweight and that individual time uses related to food were insignificant in predicting the probability of being overweight, but that once an individual crosses the overweight threshold, these time uses are significant in predicting BMI. Zick, Stevens, and Bryant (2011) investigated the relationship between BMI and various uses of time including physical activity time, television/video viewing time, sleep time, primary eating time, secondary eating time, and food preparation time. While all of these papers considered different aspects through which individuals' time use can affect their health, this paper investigates channels for the relationship between working time, time in health-related activities, and BMI.

While the aforementioned papers examine time use on own outcomes, several papers have also examined how parents' working time affects time spent with children and children's health outcomes. Cawley and Liu (2012) used the ATUS to investigate the mechanisms through which maternal employment might be associated with childhood obesity. Using ordinary least squares models, the paper found that maternal employment is associated with working mothers spending less time grocery shopping, cooking, eating with children, playing with children, supervising children, and caring for children, and found little evidence that these decreases in time are offset by increases in time by husbands and partners. Fertig, Glomm, and Tchernis (2009) used the Child Development Supplement from the Panel Study of Income Dynamics to investigate the channels through which maternal employment affects childhood obesity and explore why the effect of maternal employment is more pronounced for children from higher socioeconomic backgrounds. The paper found some evidence that supervision and nutrition play significant but small roles in the relationship between maternal employment and childhood obesity. These papers investigated the effects of time spent in work on time spent in activities related to children; this paper will consider the relationship between time spent in work on one's own time spent in health-related activities and BMI.

The paper next presents a theoretical framework to suggest channels through which time spent working could affect time spent in health-related activities and BMI.

Theoretical Framework

Given the amount of time individuals spend working, it is important to consider the effects of work on health and the channels through which these might come about. To formally outline these channels, the theoretical framework used in this paper follows the model presented in Xu and Kaestner (2010) based on Grossman (1972, 2000). An individual maximizes his utility subject to time and budget constraints and health is included as a choice variable in his utility function. Health is generated according to a health production function reflecting investment in health-related commodities, time spent working, environmental factors, and genetic endowment. A change in hours worked could have several effects on health. The income effect of increased working time would be positively associated with the consumption of goods including health-related commodities and would thus lead to increased health. The substitution effect of increased working time would be negatively associated with time spent in other consumption including health-related commodities and would lead to decreased health. Since each of these effects act in opposite directions, the net effect would be ambiguous, but is likely to be positively (negatively) associated with consumption of goods that are relatively less (more) time-intensive.

There are several mechanisms through which work hours could affect weight and health. If an individual works more hours, her leisure time drops, which could increase her weight through four mechanisms. First, she might exercise less and spend less time in active pursuits, decreasing calories expended and leading to weight gain. Second, she might devote less time to food preparation and eating during meals, causing a substitution from home-prepared meals to snacking and eating unhealthy convenience food, such as fast food and prepared processed food. This substitution could increase caloric intake, as a variety of research links a higher frequency of eating fast food to greater consumption of calories, fat, and saturated fat and also to obesity. A third potential mechanism is sleep. Additional work may reduce time available for sleep, and research suggests that sleep deprivation is associated with weight gain. Fourth, she may devote less time to health-promoting activities such as seeking medical care and engaging in non-market work and activities.

Other papers have empirically documented a positive relationship between working hours and BMI. This paper will proceed by testing potential channels driving this relationship. The paper next presents the data used in the analysis, replicates other papers' findings for the relationship between working time and BMI, and presents the empirical strategy for investigating the question of this analysis.

Data

The analysis uses the 2006, 2007, and 2008 American Time Use Surveys (ATUS) linked with Eating and Health module interviews data. While other datasets provide information on individuals' market work time, the ATUS also provides insight into individuals' non-market work activities. Linked with Eating and Health module interviews, it permits inference to be drawn about individuals' time use in a variety of activities as well as measures relating to eating and health, including BMI. The ATUS collects detailed information on how respondents spend their time over a 24-hour period and provides valid, reliable measures of time spent in various activities. Each ATUS respondent is randomly selected from the members ages 15 and older of households that completed their final interview for the Current Population Survey in the preceding 2-5 months. In addition to the time use data, the ATUS data includes selected variables collected as part of the respondents' previous CPS interviews. In 2006, 2007, and 2008, the ATUS respondents were also asked a series of questions known as the Eating and Health module. The Eating and Health module interviews asked respondents about their time spent eating and drinking as well as their height and weight and self-reported health status. The linked ATUS and Eating and Health module data provides great insight into the relationship between time use and weight and health and can be very valuable in understanding the relationship between working time and BMI and health.

For this analysis, in order to estimate the total physically active time of the respondents and to identify the degree of strenuousness of work engaged in by each respondent, the analysis follows Tudor-Locke et al. (2009) who have linked the ATUS time use lexicon to the Compendium of Physical Activities. Following Zick, Stevens, and Bryant (2011), physical activity is measured as the sum of time spent in all activities in the ATUS activity lexicon that generate metabolic equivalents (METs) of 3.3 or more. Further, to consider occupational physical activity requirements in the analysis, a respondent who works in an occupational category designated with a MET value of 3.3 or more is considered to work in a strenuous occupation.[51]

The analysis includes only employed individuals working in non-strenuous occupations.[52] Individuals enrolled in school are excluded from the analysis since it is unclear whether time spent in schooling should be considered work or leisure. The sample was limited to individuals ages 25-64 since they are likely to be living on their own and have completed their schooling.[53] In addition, individuals who reported being pregnant were excluded from the BMI analysis since their reported BMI might be uncharacteristic of the general population. The full sample includes 12,469 individuals. Summary statistics for the sample are presented in Table 24.[54]

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[51] Following Zick, Stevens, and Bryant (2011), a METs value ≥ 3.3 is used as a cut-off as this captures occupations such as building and grounds cleaning and maintenance, farming, and construction and extraction.
[52] A positive relationship of working time and BMI was found only for individuals working in non-strenuous occupations. Therefore, only individuals working in non-strenuous occupations are included in the analysis: individual working in occupational categories associated with a MET of 3.3 or more were excluded from the analysis. This excluded 1,075 individuals from the analysis.
[53] This follows the methodology in Zick, Stevens, and Bryant (2011).
[54] Individuals with missing data are excluded from the analysis.

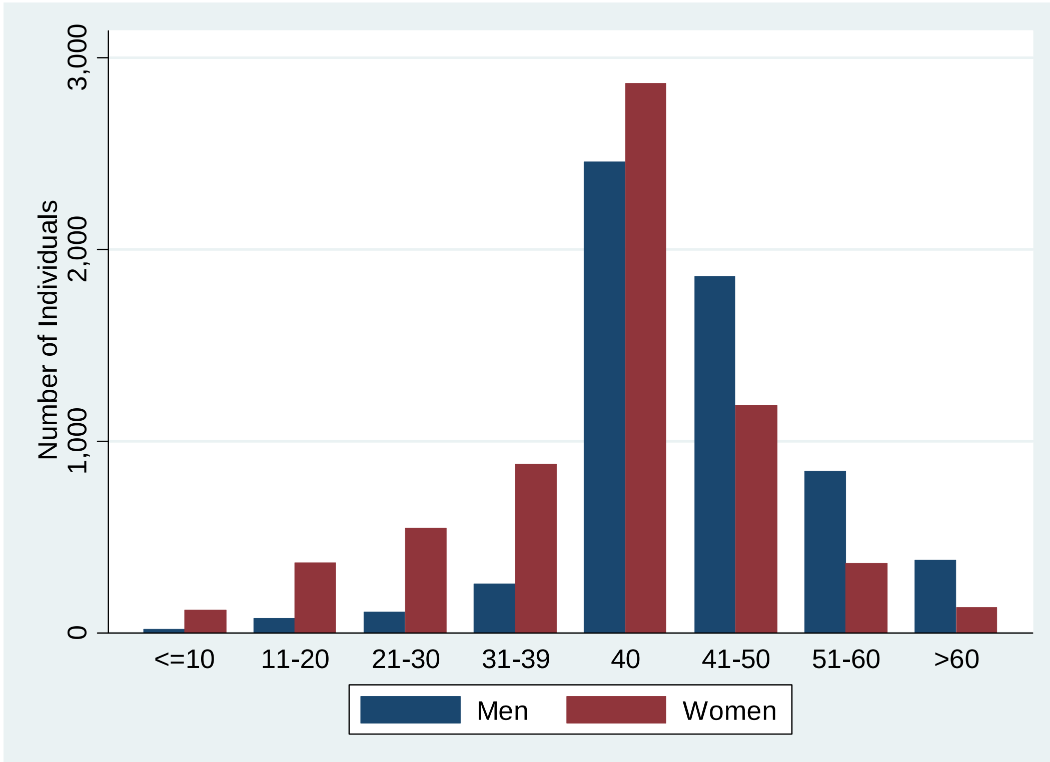
Table 24: Summary Statistics

Variable	Mean	Standard Deviation
Age	43.00	(10.49)
Proportion Men	0.53	(0.50)
Proportion Married/Cohabiting	0.70	(0.46)
Children Aged<18 in Household	0.46	(0.50)
Children Aged<6 in Household	0.20	(0.40)
Proportion Less than High School Diploma	0.06	(0.24)
Proportion High School Graduates	0.27	(0.44)
Proportion Some College	0.27	(0.44)
Proportion College Graduates	0.40	(0.49)
Proportion White	0.72	(0.45)
Proportion Black	0.10	(0.30)
Proportion Hispanic	0.11	(0.32)
Proportion Other Race	0.06	(0.24)
Own Weekly Income	931.86	(632.38)
BMI	27.62	(5.54)
Proportion Overweight	0.66	(0.47)
Proportion Obese	0.28	(0.45)
Proportion Reported Excellent Health	0.21	(0.41)
Proportion Reported Very Good Health	0.39	(0.49)
Proportion Reported Good Health	0.30	(0.46)
Proportion Reported Fair Health	0.08	(0.27)
Proportion Reported Poor Health	0.01	(0.09)
Usual Weekly Work Hours	42.59	(11.20)
Proportion with a Spouse Working Full-Time	0.53	(0.50)
Observations	12,469	

From the summary statistics, we see that the mean age in the sample is 43 years, 53 percent are men, 70 percent are married or living with a partner, 46 percent have children under the age of 18, 20 percent have children under the age of 6, 72 percent are white,. The average weekly income is $932, the average weekly work hours was 43. The mean BMI for the sample is 28, with a BMI of between 25 and 30 being classified as overweight. 66 percent and 28 percent of the sample are classified as overweight and obese, respectively. The majority reported at least very good health. The majority have at least some college education.

Looking closer at time spent working, Figure 9 shows the distribution of usual weekly work hours by sex. As can be seen in the figure, the majority of both men and women work 40 hours per week, and the proportion of the sample working 40 hours per week is similar for men and women. However, more men appear to work more than 40 hours per week, while more women appear to work less than 40 hours per week.

Figure 9: Usual Weekly Work Hours by Sex



Replication

Before investigating the mechanisms by which time spent working might affect BMI, it is useful to confirm that the empirical relationship between time spent working and BMI exists in the ATUS data. I construct control variables similar to those used in Courtemanche (2009).[55] I estimate ordinary least squares and loglinear specifications separately for men and women.[56]

Table 25 presents coefficient results for the ordinary least squares specifications and marginal effects for the loglinear specifications for effects on BMI. I find that additional time spent working is associated with a significantly higher BMI for both men and women. These results are consistent with those of other papers (Courtemanche, 2009; Berniell, 2010) who find that increased working time is associated with a higher BMI. Thus, this relationship appears to exist across several data sources.

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[55] The control variables include: spouse working full-time, age, age squared, race, sex, marital status, own weekly income, occupation, education, poor health, whether there are children younger than 18 living in the household, whether there are children younger than 6 living in the household, state, metropolitan status, season, an interaction for the winter season and the Northeast and Midwest regions, and year. Specifications including categorical controls for household annual income rather than own weekly income yielded qualitatively similar results.

[56] The data is weighted to be population-representative.

Table 25: Replication Results for Effect of Working Hours on BMI[57]

	Women OLS	Women Loglinear	Men OLS	Men Loglinear
Weekly Hours Worked (10 hours)	0.418***	0.414***	0.189**	0.188**
	(0.0956)	(0.0944)	(0.0871)	(0.0857)
Spouse Works Full-Time	-0.0116	-0.0071	-0.218	-0.217
	(0.2910)	(0.2910)	(0.1970)	(0.1950)
Age	0.104	0.107	0.238***	0.238***
	(0.0836)	(0.0830)	(0.0799)	(0.0799)
Age Squared	-0.000621	-0.000652	-0.00262***	-0.00262***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)
Black	2.693***	2.565***	0.224	0.222
	(0.3140)	(0.2920)	(0.3060)	(0.3000)
Hispanic	1.135***	1.136***	0.429	0.429
	(0.3360)	(0.3280)	(0.2860)	(0.2830)
Other Race	-1.032***	-1.094***	-0.907**	-0.944**
	(0.3610)	(0.3830)	(0.3900)	(0.4060)
High School Graduate	-0.0705	-0.0502	0.723**	0.716**
	(0.4850)	(0.4570)	(0.3510)	(0.3480)
Some College	-0.605	-0.56	0.779**	0.774**
	(0.4910)	(0.4640)	(0.3580)	(0.3540)
College Graduate	-2.117***	-2.105***	-0.401	-0.409
	(0.5060)	(0.4840)	(0.3710)	(0.3700)
Married	-0.770**	-0.756**	0.369	0.369
	(0.3110)	(0.3060)	(0.2570)	(0.2570)
Non-Metropolitan	0.156	0.149	0.319	0.311
	(0.2930)	(0.2860)	(0.2840)	(0.2770)
Children<Age 18 in Household	0.036	0.037	-0.104	-0.104
	(0.2290)	(0.2270)	(0.2320)	(0.2290)
Children<Age 6 in Household	0.509**	0.502**	-0.249	-0.246
	(0.2550)	(0.2540)	(0.2260)	(0.2250)
Poor Health	2.742**	2.504**	-0.0645	-0.0624
	(1.3660)	(1.1920)	(1.1050)	(1.0960)
Observations	6,468	6,468	6,001	6,001
R-squared	0.11		0.05	

[57] In all regressions, robust standard errors are in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Empirical Strategy

Estimation Methods

Having confirmed the relationship between time spent working and BMI, the goal of this paper is to investigate the channels that may be driving this relationship. The analysis posits that time spent working affects time spent in health-related activities, thereby affecting one's own BMI. To investigate this question, I examine whether the inclusion of controls for a variety of health-related time use channels significantly change the estimated effect of time spent working on BMI. The potential channels I examine include time spent in activities associated with eating, health investment, and physical activity. These activities, including summary statistics for minutes spent in various activities by individuals in the analysis sample, are presented in Table 26.

Table 26: Allocation of Time in Health-Related Activities

	Reporting Any Time on This Activity	# Minutes Spent on Activity if >0	Unconditional # Minutes Spent
Primary Eating	95.9%	68.8	66.0
Secondary Eating	58.0%	43.1	24.6
Secondary Drinking	41.5%	189.2	77.9
Food Preparation	55.9%	50.7	26.9
Grocery Shopping	16.0%	63.8	8.6
Purchasing Prepared Food	13.8%	10.1	1.3
Sleeping	99.9%	489.3	488.7
Exercise	16.7%	87.3	14.6
Active Time	33.6%	108.6	33.3
Housework	80.3%	136.6	104.1
Screen Time	79.7%	167.4	133.5
Commuting	49.6%	44.7	27.9
Own Medical Care	4.3%	109.9	5.7

Time spent in primary eating includes time spent where eating and drinking was the central activity being performed. Time spent in secondary eating and secondary drinking includes time spent where eating and drinking were performed while primarily performing another activity. Time spent in primary eating, secondary eating, secondary drinking, food preparation, grocery shopping and purchasing prepared food are examined because the more hours a person works, the less time she might have for devoting time to meals and meal preparation, but the more time she might eat or drink less healthy prepared foods while in engaged in other activities, which could lead to increased food consumption and weight gain. Time spent in sleeping, exercise, active time, housework, screen time, and commuting are examined because they involve energy expenditure in non-work activities and are used to capture how time spent working impacts the use of non-work time in active or sedentary activities. If individuals, substitute work time for sedentary activities, increased work time could be associated with a lower BMI; if individuals substitute work time for active activities, increased work time could be associated with a higher

BMI. Medical care time is examined as a measure of health investment since if individuals spend more time at work they might have less time to devote to medical care.

To identify whether any of these potential channels are associated with differences in the effect of working time on BMI, I follow the specification in Fertig et al (2009). All estimations are performed as both ordinary least squares and loglinear specifications. I first estimate a baseline specification to measure the relationship between time spent working and own BMI that does not include any possible channels, only control variables for individual characteristics, *X*. In the ordinary least squares specification, this follows:

$$y_i = \alpha_0 + \alpha_1 \text{WorkingTime}_i + \alpha_2 X_i + \varepsilon_i$$

where y_i represents BMI, measured continuously.[58] Working time (α_1) measures the usual hours spent in work each week in 10-hour increments.[59] I then estimate a regression equation for each of the potential channels for which there is data, where each additional equation consists of the baseline specification as well as one of the potential channels. For example, here, time spent in primary eating is added to the ordinary least squares specification:

$$y_i = \beta_0 + \beta_1 \text{WorkingTime}_i + \beta_2 \text{PrimaryEating}_i + \beta_3 X_i + \mu_i$$

Where ε and μ are idiosyncratic error terms with mean zero. I then test whether the coefficients on time spent working from the baseline and each specification are equal ($\alpha_1 = \beta_1$) and report the difference ($\alpha_1 - \beta_1$) and corresponding robust standard errors. This approach treats the potential channels as omitted variables and tests whether the inclusion of the channel results in a significant difference in the effect of time spent working on own BMI. The interpretation of this estimate follows that of an omitted variable such that:

$$\alpha_1 \approx \beta_1 + \beta_2 \rho$$

Where ρ represents the correlation between time spent working and the potential channel. A positive coefficient on the difference ($\alpha_1 - \beta_1$) indicates that $\beta_2\rho>0$ (<0), suggesting that the effect of the potential channel on own BMI and the correlation between time spent working and the potential channel are the same (opposite) sign. Thus, the sign of the correlation between time spent working and the potential channel is assumed, the sign of the effect of the potential channel on own BMI can be inferred. Loglinear specifications are similarly estimated.

All estimations include control variables for individual characteristics. The control variables include: spouse working full-time, age, age squared, race, sex, marital status,[60] own weekly

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[58] Specifications with overweight status and obesity status as the dependent variables, each measured as dummy variables equal to 1 if the individual is classified as being overweight ($BMI \geq 25$) or obese ($BMI \geq 30$), respectively, and equal to 0 otherwise were also estimated, and the results were qualitatively similar.
[59] Using log usual hours worked yielded qualitatively similar results.
[60] Marital status controls for whether the individual was living with a spouse or partner at the time of the CPS interview.

income,[61] occupation, education, poor health, whether there are children younger than 18 living in the household, whether there are children younger than 6 living in the household, state, metropolitan status, season, an interaction for the winter season and the Northeast and Midwest regions, and year.[62] In all regressions, specifications are estimated separately for men and women, the data is weighted to be population-representative and robust standard errors are used.

Interpretation of Estimated Effects

The estimated effects of the time spent in eating, health, and physical activity cannot be interpreted as the causal effects of time spent working. The decision of how much time to work is endogenous and may be determined by unobserved factors that directly affect time spent in eating, health, and physical activity.[63] I am not able to address the problem of endogeneity of hours worked because I lack an instrument for time spent working that is both powerful and valid. While previous studies have used unemployment rates to instrument for working status or working time (Anderson et al., 2003; Cawley and Liu, 2007), I share the concerns of Cawley and Liu (2012) that while unemployment rates might affect working time, they might also affect BMI and health through other channels. In addition, evaluating the relationship between one's own time spent working, one's own time in health-related activities, and one's own BMI ignores possible offsetting effects from spouses or other household members. Since data on spouses is not available in the ATUS, this cannot be tested directly, although differential effects for single and partnered individuals will be examined later would be interesting to examine in future analysis.

The contribution of this paper is that it documents the correlation between one's own time spent working, one's own time in health-related activities, and one's own BMI. These speculative mechanisms by which time spent working may influence BMI are then offered as hypotheses to be tested in the future by researchers with access to richer data within the household.

<u>Estimation Results</u>

Time Use Channels Results

The outlined specifications were estimated, and Table 27 presents results for each potential channel separately for women and men. The first row in Table 27 presents α_1 for the ordinary least squares specifications and the marginal effect associated with α_1 for the loglinear specifications from the regression not controlling for any channels, the effect of work hours on BMI with only individual characteristics controlled for in the specification. The rest of the table reports the difference between α_1 and β_1 for each of the potential channels included in the specification for both the ordinary least squares and loglinear specifications.

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[61] Specifications including categorical controls for household annual income rather than own weekly income yielded qualitatively similar results.
[62] Specifications excluding the income control yielded qualitatively similar results.
[63] For example, individuals with high levels of unobserved human capital may work longer hours and may also allocate their other time differently.

Table 27: Change in Effect of Working Hours on BMI by Channel[64]

	Women OLS	Women Loglinear	Men OLS	Men Loglinear
Baseline Effect				
Weekly Hours Worked	0.418***	0.414***	0.189**	0.188**
	(0.0950)	(0.0944)	(0.0865)	(0.0857)
Change in Baseline Effect by Channel				
Primary Eating	0.0076	0.0003	0.0028	0.0001
	(0.0064)	(0.0002)	(0.0048)	(0.0002)
Secondary Eating	-0.0083**	-0.0003**	-0.0011	0.0000
	(0.0041)	(0.0001)	(0.0021)	(0.0001)
Secondary Drinking	0.0069	0.0003	0.0032	0.0001
	(0.0056)	(0.0002)	(0.0042)	(0.0001)
Food Preparation	0.0135*	0.0005*	0.0016	0.0000
	(0.0073)	(0.0003)	(0.0060)	(0.0002)
Grocery Shopping	0.0021	0.0001	-0.0027	-0.0001
	(0.0041)	(0.0002)	(0.0025)	(0.0001)
Purchasing Prepared Food	0.0000	0.0000	-0.0015	-0.0001
	(0.0041)	(0.0001)	(0.0018)	(0.0001)
Sleeping	-0.0073	-0.0002	0.023*	0.0007*
	(0.0085)	(0.0003)	(0.0131)	(0.0004)
Exercise	0.0208***	0.0008***	0.007*	0.0002*
	(0.0070)	(0.0003)	(0.0036)	(0.0001)
Active Time	0.0137**	0.0005**	0.0085*	0.0003*
	(0.0059)	(0.0002)	(0.0044)	(0.0002)
Housework	0.0185	0.0006	0.0113	0.0004
	(0.0122)	(0.0004)	(0.0074)	(0.0002)
Screen Time	-0.0409***	-0.0015***	-0.042***	-0.0014***
	(0.0113)	(0.0004)	(0.0133)	(0.0004)
Commuting	-0.0115	-0.0004	-0.002	-0.0001
	(0.0074)	(0.0002)	(0.0066)	(0.0002)
Own Medical Care Time	-0.0072	-0.0002	-0.0002	0.0000
	(0.0058)	(0.0002)	(0.0012)	(0.0000)

A number of the tested channels appear to impact the effect of hours worked on BMI. Strong significant effects were found for exercise, active time, and screen time, and marginally significant effects were found for secondary eating and food preparation. No significant effects were found for primary eating, secondary drinking, grocery shopping, purchasing prepared food, sleeping, housework, commuting, or own medical care.

[64] In all regressions, robust standard errors are in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

The effects for exercise, active time, and food preparation were positive. Since all of these activities are negatively related to BMI, it follows that with working longer hours, individuals spend less time in these activities, and thus by including these in estimating the effect of hours worked on BMI, the effect of hours worked is lessened.

The effects for screen time and secondary eating were negative, suggesting that the inclusion of these effects actually results in hours worked having a greater effect on BMI. With regard to screen time, this follows since screen time is positively related to BMI and individuals engage in less screen time when they work more. With regard to secondary eating, Hamermesh (2010) shows that secondary eating is negatively related to BMI, so we can infer that individuals engage in more secondary eating when working longer hours.

These results suggest that the main channels associated with the positive relationship between working hours and BMI those involving physical activity, with little effect of time spent on food preparation and eating, medical time, and commuting time.[65]

Results Controlling for All Time Use Channels

Results of the main specification including all time use controls are presented in Table 29. Here we see that the positive effect of hours worked persists after the inclusion of the time use controls although the magnitude of the effect is smaller for women and larger for men. We see for both men and women significant negative effects of time spent in secondary eating and exercise on own BMI. For women, we see significant positive effects of time spent in purchasing prepared foods and negative effects of time spent in housework. For men, we see significant negative effects of time spent in primary eating and sleeping and a modestly significant negative effect of commuting time.

[65] Insignificant results for the effect of time spent in own medical care in mediating the effect of hours worked on BMI could reflect a problem of reverse causation, where individuals that spend more time in medical care may work less and may also have higher or lower BMIs.

Table 28: Results for Effect of Working Hours on BMI Including All Time Use Channels[66]

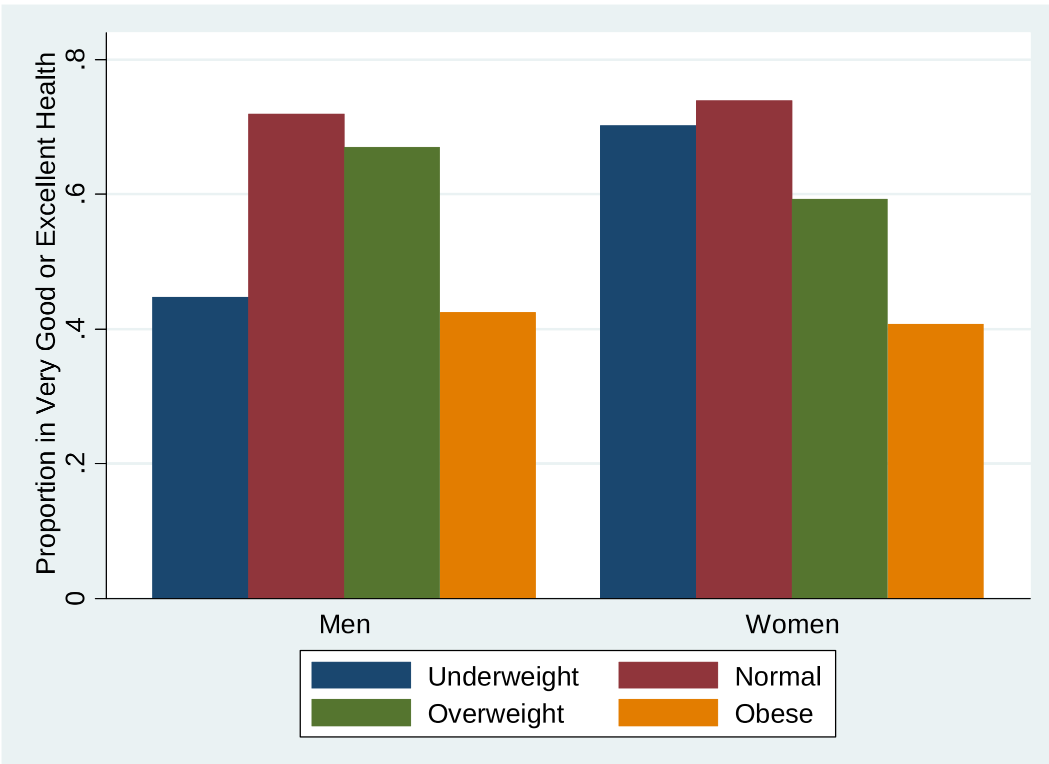
	Women OLS	Women Loglinear	Men OLS	Men Loglinear
Weekly Hours Worked	0.247***	0.246***	0.257***	0.255***
	(0.0769)	(0.0762)	(0.0667)	(0.0654)
Primary Eating	-0.00213	-0.00227	-0.00393***	-0.00399***
	(0.0016)	(0.0016)	(0.0012)	(0.0012)
Secondary Eating	-0.00218***	-0.00226***	-0.00120*	-0.00121*
	(0.0008)	(0.0008)	(0.0006)	(0.0006)
Secondary Drinking	0.000736*	0.000738*	0.00031	0.000308
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Food Preparation	-0.0022	-0.00223	-0.00125	-0.00125
	(0.0014)	(0.0014)	(0.0017)	(0.0017)
Grocery Shopping	-0.00447*	-0.00456*	0.00257	0.00258
	(0.0024)	(0.0024)	(0.0025)	(0.0025)
Purchasing Prepared Food	0.0456***	0.0433***	0.013	0.013
	(0.0127)	(0.0117)	(0.0148)	(0.0146)
Sleeping	-0.0000777	-0.0000801	-0.00138***	-0.00138***
	(0.0007)	(0.0007)	(0.0005)	(0.0005)
Exercise	-0.00892***	-0.00944***	-0.00427***	-0.00435***
	(0.0021)	(0.0022)	(0.0012)	(0.0012)
Active Time	-0.00026	-0.000272	0.000489	0.000493
	(0.0012)	(0.0013)	(0.0008)	(0.0008)
Housework	-0.00153**	-0.00155**	-0.000805	-0.000801
	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Screen Time	0.00300***	0.00290***	0.00206***	0.00204***
	(0.0007)	(0.0006)	(0.0005)	(0.0005)
Commuting	-0.00311	-0.00318	-0.00260*	-0.00261*
	(0.0026)	(0.0026)	(0.0013)	(0.0014)
Own Medical Care Time	0.00207	0.00199	0.00327	0.00311
	(0.0015)	(0.0014)	(0.0027)	(0.0024)

[66] In all regressions, robust standard errors are in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Additional Results

Given that a relationship was found between working time and BMI, and some eating, health investment, and physical activity channels were identified as mediating this relationship, the analysis proceeds to examine whether a similar relationship exists between time spent working and health status. Figure 10 shows the proportion reporting very good or excellent health status by weight status. As can be seen in the figure, normal weight individuals appear to have the highest proportion reporting at least very good health. As compared to normal weight individuals, a lower proportion of underweight individuals report at least very good health, and this relationship appears to be more pronounced for men. As compared to normal weight individuals, a lower proportion of overweight individuals and an even lower proportion of obese individuals report at least very good health. Thus it may follow that if individuals who work longer hours have higher BMIs, working longer hours may be associated with worse health.

Figure 10: Proportion Reporting Very Good or Excellent Health Status by Weight Status for Men and Women[67]



Given the results of the BMI analysis presented earlier, if individuals who work longer hours have higher BMIs because they engage in less physical activity, and increased physical activity

[67] Weight groupings are defined by the standards outlined by the Centers for Disease Control and Prevention: underweight includes individuals with a BMI of less than 18.5; normal includes individuals with BMIs greater than or equal to 18.5 and less than 25; overweight includes individuals with BMIs greater than or equal to 25 and less than 30; and obese includes individuals with BMIs greater than or equal to 30.

is associated with better health, it may follow that individuals who work longer hours also have worse health. In addition, while the other tested channels aside from those related to physical activity did not appear to strongly mediate the effect of working hours on BMI, health may be affected by working hours through these channels independently of BMI. Accordingly, the analysis examines whether working hours appear to have a significant effect on self-reported health status.

The health measure available in the ATUS is self-reported health status which consists of a scale from 1 (excellent) to 5 (poor). The analysis performs the baseline analysis using a logit specification and using as the dependent variable an indicator for self-reported health status of very good or excellent. Marginal effects for these specifications are presented in Table 29.[68] Results do not suggest a relationship between working time and self-reported health status. This could reflect that time spent working might affect BMI and not health status.

[68] Including a control for overweight status yielded qualitatively similar results.

Table 29: Logit Results for Effect of Working Hours on Health Status[69]

	Women	Men
Weekly Hours Worked (10 hours)	-0.00169	-0.00075
	(0.0079)	(0.0076)
Spouse Works Full-Time	-0.0303	-0.0215
	(0.0248)	(0.0186)
Age	-0.00154	-0.00482
	(0.0067)	(0.0073)
Age Squared	-1.49E-06	0.0000271
	(0.0001)	(0.0001)
Black	-0.146***	-0.0248
	(0.0228)	(0.0274)
Hispanic	-0.186***	-0.107***
	(0.0254)	(0.0257)
Other Race	-0.181***	-0.114***
	(0.0355)	(0.0356)
High School Graduate	0.0817**	-0.00402
	(0.0397)	(0.0355)
Some College	0.163***	0.0402
	(0.0398)	(0.0362)
College Graduate	0.261***	0.136***
	(0.0416)	(0.0381)
Married	0.0272	-0.0289
	(0.0253)	(0.0240)
Non-Metropolitan	-0.0136	-0.0276
	(0.0229)	(0.0242)
Children<Age 18 in Household	0.0359*	0.0111
	(0.0191)	(0.0218)
Children<Age 6 in Household	-0.0174	-0.0264
	(0.0215)	(0.0220)
Observations	6,468	6,001

[69] In all regressions, robust standard errors are in parentheses and *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

This paper investigates the channels that may be driving the relationship between time spent working and BMI. The analysis used the 2006, 2007, and 2008 American Time Use Surveys (ATUS) linked with Eating and Health module interviews and Current Population Survey (CPS) data. The analysis replicated the results of other papers finding a positive and significant relationship between working time and BMI for both men and women. The analysis then estimated a series of equations to determine whether a variety of potential mediators significantly change the estimated effect of time spent working on own BMI.

A number of the tested channels appear to impact the effect of hours worked on BMI with strong significant effects found for exercise, active time, and screen time, and marginally significant effects were found for secondary eating and food preparation. No significant effects were found for primary eating, secondary drinking, grocery shopping, purchasing prepared food, sleeping, housework, commuting, or own medical care. These results suggest the main channels associated with the positive relationship between working hours and BMI are those involving physical activity. Specifications examining the relationship between working hours and self-reported health status found no significant relationship.

While the distribution of time spent working is different for men and women, results suggest similar magnitudes of the effects of working hours on BMI and similar channels mediating these effects. These results suggest that there may be some potential for effective policy intervention since increased work time was found to be associated with a decrease in physically active time. Policies aiming to reduce obesity prevalence targeting working hours could result in individuals having lower BMIs as a result of be more physically active due to working less. Alternatively, policies could aim to increase individuals' physically active time on or off the job without targeting working hours to mitigate the effects of increased work hours on BMI. These programs could include fitness facilities and incentives at the workplace as well as improved recreational facilities and incentives outside of the workplace.

While the results of this analysis are valuable, there are several limitations to this analysis. Because the relationships between one's own time spent working, one's own time in health-related activities, and one's own BMI may be due not only to a direct causal link, but also to some unobservable characteristics which result in these correlations, findings from this approach must be interpreted as highly suggestive and not necessarily causal. In addition, the paper examines effects of working hours on BMI and self-reported health status and only finds significant effects for BMI. This could reflect that time spent working might affect BMI and not health status.

Further analysis on this question could examine mediating channels separately for single and married individuals and individuals with and without children. In addition, since a drawback of the dataset used in this analysis is that it is not possible to control for endogeneity, further work using data that allows for identification of an exogenous change in work hours would allow for a potential causal interpretation of results. A topic for future work could include examining more closely the role of physical activity on BMI and health over time and the relationship of physical activity to the consumption of unhealthy foods. It would also be interesting to examine if these relationships vary across ethnic groups and if there could be thyroid, metabolic, or genetic factors driving these results.

This paper contributes to the literature in several ways. While previous work has found a relationship between working time and BMI, this paper investigates the potential eating, health investment, and physical activity channels driving this relationship to obtain a fuller picture of how work time affects lifestyle choices that affect weight and health. This is valuable because as Americans transition to more sedentary jobs, the full consequences of increased work hours in those jobs are not explored in the literature and can have significant implications for labor and tax policy. Accordingly, the paper provides insights useful for designing effective policy interventions aiming to reduce obesity prevalence.

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