Two sides of the same pill? Fertility control and mental health effects of the contraceptive pill

Franziska Valder*

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Abstract

I investigate the link between access to the contraceptive pill, mental health, education, and labor market outcomes. While liberalizing labor market effects of access to the pill are well established, a medical literature suggests a link between hormonal contraception and depression. Exploiting variation in access to the pill, I document substantial mental health effects of the pill. These mental health effects mitigate the fertility control effect of the pill on education and labor market outcomes and are associated with limitations at work and more disability periods.

Keywords: Mental Health, Contraceptive Pill, Fertility, Labor Market Outcomes
JEL-Codes: J16, J13, J18, J24, I0

*University of Copenhagen, Center for Economic Behavior and Inequality (CEBI), Email: franziskavalder@econ.ku.dk

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1 Introduction

When the contraceptive pill was first introduced in the US in the 1960s, it tremendously changed the way women made decisions with respect to childbearing, education, and labor market participation by offering more control over fertility. In 1999, an article in the Economist states that "the pill really did give a woman the right to choose" and that "technology really is liberation".[1] Several empirical studies that are often referred to as the "power of the pill" literature have indeed documented large liberalizing effects of the pill for women, in the form of delayed childbirth and marriage (Bailey, 2006), increased investment into lengthy education (Goldin and Katz, 2002), higher labor market participation, more hours worked, and higher wages (Bailey et al., 2012).

Recently, a medical literature has however uncovered a link between hormonal contraceptive use and mental health side effects such as first diagnosis of depression, anti-depressant use, and suicide attempts (Skovlund et al., 2016, 2018; Wit et al., 2020). The underlying mechanism suggested by these studies is the effect of the sex hormones progesterone and estrogen which have been discussed to cause depressive symptoms and are contained in many hormonal contraceptives. The results from these medical studies raise the concern that in addition to the liberalizing fertility control effect, the pill may also take a toll on women due to its mental health cost.

While the mental health effect of a widely-used contraceptive is interesting by itself, it can also have further implications for the findings from the "power of the pill" literature given the well-established negative impact of mental health problems on education and labor market outcomes.[2] The existence of a mental health cost of the pill can be expected to mitigate the positive fertility control effects of the pill, such that the total effect of the pill on education and labor market outcomes depends on the relative size of these two channels. This also means that previous estimates of the fertility control effect of the pill were potentially downward biased, as mental health costs were contained in its estimate.

In this paper, I re-investigate the effect of the pill on education and labor market outcomes in light of the link between hormonal contraception and mental health. This mental health channel has not been discussed or analyzed in the literature before. I first examine whether access to the pill leads to worse mental health later in life. For this, I use plausibly exogenous variation in access to the pill created by changes in laws governing access to the pill in the US between 1960 and 1977. I combine this information on variation in access with data from the National Survey of Families and Households (NSFH) and from the Health and Retirement Study (HRS) for women born between 1934 and 1958 which is a cohort that experienced differential access to the pill during

[1] "The Liberator", published December 23, 1999, in *The Economist*. Accessed October 2022, `https://www.economist.com/science-and-technology/1999/12/23/the-liberator`

[2] See for example, for education outcomes (Ding et al., 2009), and for labor market outcomes Banerjee et al. (2017).

adolescence. While mental health is measured between ages 28-54 in the NSFH, it enables to identify more immediate effects, whereas the analysis from the HRS provides an estimate of long-term effects as mental health is measured around age 60. Long-term effects are likely to arise due to the persistence of mental health problems. Fryers and Brugha (2013) document large correlations between mental health issues during childhood or adolescence and adulthood across different studies, referring to these patterns as "continuity of morbidity". I show that access to the pill during adolescence is related to worse self-reported mental health in both samples. Women with access to the pill during adolescence report 35 percent higher depression scores in the NSFH, and 20 percent higher scores in the HRS. Using data on polygenic scores, I show that this mental health effect of the pill is driven by individuals with higher genetic risk to develop depression. A placebo test on men does not show any statistically significant effect on mental health. I can also provide evidence that these findings are not driven by general changes in life trajectories for women with access to the pill, such as changed family formation or increased stress at work.

In a second step, I investigate the importance of this mental health cost for the liberalizing education and labor market effects established by the "power of the pill" literature. For this, I estimate the effect of the pill on education and labor market outcomes and explicitly take a pathway of the pill along mental health into account. For this, I use interactions between access to the pill variables and an indicator for above median genetic risk to develop depression. Accounting for an effect via mental health in this way increases the coefficients of pill access and shows negative and significant coefficients of the interactions with genetic risk. These patterns suggest that previous estimates are composed of two opposing effects: a positive fertility control effect of the pill that improves education and labor market participation and the mental health effect associated with the pill which worsens both outcomes. Along these lines, I also find that access to the pill interacted with above median genetic risk for developing depression increases the number of disability periods, the probability to ever report disability, the probability to report limitations at work, and the number of sick days.

With this paper, I contribute to two strands of the literature. First, I add to the abovementioned "power of the pill" literature by considering an important health outcome and its relationship to the labor market. The "power of the pill" literature was initiated by Goldin and Katz (2000) and Goldin and Katz (2002) providing evidence that trends such as the delay of marriage and higher rates of female college enrolment in professional programs coincided with the initial diffusion of the pill. The key underlying mechanism is that access to the pill reduces the price and increases the returns to (long-term) investment into education, by lifting both the penalty of abstinence and the uncertainty of pregnancy costs. These direct effects of the pill resulting in delayed fertility are demonstrated by Bailey (2006) and Bailey (2010). Resulting from the delay in fertility, Hock (2007) shows that access to the pill increased college enrolment rates of women by 5 percentage points and college completion rates by 0.9 percentage points. Steingrimsdottir

(2016) demonstrates that women with access to the pill were more likely to enroll in programs leading to more ambitious occupations and higher wages. Larger investments into education were followed by increases in labor force participation, working hours, and wages (Goldin and Katz, 2002; Hock, 2007; Madestam and Simeonova, 2013; Bailey et al., 2012; Bailey, 2006).
Few studies identify negative consequences of access to the pill, such as reduced female bargaining power within marriage (Altindag and Ziebarth, 2019) or an increase in out-of-wedlock births due to increased sexual activity (Akerlof et al., 1996). However, the focus of these studies remains on the fertility control channel of the pill. Other effects of the pill such as the effect on mental health have not been taken into account. In terms of methodology, most of the above-mentioned studies use exogenous variation in laws determining age of majority in the US to identify the liberalizing effects of access to the pill. I follow the same approach.

A recent evolution of this literature takes a more critical point of view toward the large role of the contraceptive pill claimed by the studies above. Myers (2017) addresses the relative importance of access to abortion versus access to the pill and argues that the effect of the pill is considerably smaller than the one of abortion - if existent at all. Myers (2017) argues that access to the pill did not only lead to improved fertility control but also increased sexual activity which given that the pill is not 100% effective, might have even led to increased fertility. It is, however, less clear whether the more or less zero effect of the pill on fertility masks heterogeneity in pill effects for specific groups of women. Using the same policy coding, Lindo et al. (2020) show positive but mostly insignificant effects of pill access on education. They cannot find an effect on earnings in women's 50s but a positive effect on the probability to work in a Social Security covered job during their 20s and 30s. With this paper I add one potential explanation for the small effects on education and labor market outcomes: mental health can be thought of as a mediator, preventing the pill from unfolding its true fertility control potential for labor market outcomes.

Second, I also contribute to the literature investigating the relationship between mental health, education, and labor market outcomes. Many studies have identified a substantial negative impact of mental health problems on education and labor market outcomes. Mental health problems have been shown to negatively affect school performance (Ding et al., 2009), and to increase school drop-out (Cornaglia et al., 2015). Effects of mental health on labor market outcomes are substantial: Mental health problems reduce labor supply on both the internal as well as external margin and increase absenteeism (Banerjee et al., 2017; Ojeda et al., 2010) The effect on earnings is also large: Biasi et al. (2021) find earnings penalties of mental illness, ranging from 34% for depression to 74% for schizophrenia. Most of these studies have defined mental health to be pre-determined but have not accounted for the potential role of other influences on mental health that equally affect labor market and education outcomes such as the pill.

Lastly, this paper is more broadly related to the findings from the medical literature that identifies the effect of hormonal contraceptive use on mental health. Skovlund et al. (2016) show that in the entire female population in Denmark, the use of hormonal contraceptives is associated with a 1.2-1.8 higher incidence rate of first anti-depressant usage. Adolescent users have a 1.7 higher rate of first diagnosis of depression. Using the same study from Denmark, Skovlund et al. (2018) demonstrate that the pill is also associated with a 1.9 higher incidence rate of suicide attempts. Wit et al. (2020) show similar similar patterns for the Netherlands with young women using hormonal contraceptives reporting a 21 percent higher depressive symptom score compared to non-users. The results of these studies can, however, not necessarily be interpreted as causal. The empirical identification is based on correlations between pill usage and mental health coming from cross-sectional variation or within-individual variation over time. Threats to causality such as selection into the use of hormonal contraceptives or selective attrition are not addressed here. I will mitigate such concerns by using plausibly exogenous variation in access to the pill.

From a policy perspective, this paper addresses two important areas of public health: mental and reproductive health. Given the increasing prevalence of mental health problems, the fight against mental illness has become a priority on political agendas around the globe. In 2020, 21% of adult Americans reported suffering from mental illness, as reported by the National Institute of Mental Health.[3] The large prevalence is accentuated by an unequal distribution: Hammarström et al. (2009) show that the likelihood of experiencing mental illness once in life is around two times higher for women. Recently, reproductive health has received a lot of public attention, mostly related to the overturning of Roe v. Wade in June 2022, a legislation that established access to abortion as a federal right. Increased barriers to abortion make healthy contraception even more important. Healthy contraception is also relevant in light of the gender imbalance in the bearing of potential mental health costs. While both, men and women benefit from the fertility control function, only women bear the potential costs.

The remainder of the paper is organized as follows: the next section provides background information on the legal environment creating variation in access to the pill. Section 3 describes the data and explains the empirical strategy. Section 4 presents results for the effect of access to the pill on mental health and Section 5 relates this mental health cost to education and labor market outcomes. Section 6 concludes.

[3] `https://www.nimh.nih.gov/health/statistics/mental-illness`, accessed October 10, 2022.

2 Background: Access to the Pill

In order to identify mental health effects of the pill, I use changes to laws governing access to the pill and their most recent legal coding by Myers (2017). In a robustness exercise, I also use an alternative coding of these laws by Bailey et al. (2012). The changes in laws are derived from general political but also health care access rights. When the first pill in the US, *Enovid*, was approved by the United States Food and Drug Administration (FDA) for contraceptive use in 1960, anti-obscenity statutes, also referred to as Comstock laws, did not grant access to the pill in some states. Struck down in Griswold v. Connecticut, by 1970 every state allowed access at least for married individuals. In 1972, Eisenstadt v. Baird enabled access for unmarried individuals but only above the age of majority or with parental consent. This ruling resulted in the fact that in many states, younger, unmarried women were initially excluded from the benefits of contraceptive technology. Over the course of two decades, changes to laws defining age of majority and medical consent age as well as mature minor doctrines successively lowered the access barriers for young, unmarried women. This is the variation that I will exploit here.

There are two different forms of access for young women. The first is legal access, determining whether a method was legally available but young unmarried women were not able to consent themselves and needed the consent of their parents. The second form of access is legal and consent access. With this type of access, women were able to consent themselves and did not need parental consent. I will refer to legal access for the former and to consent access for the latter for the remainder of the paper. Whether or not young women were able to consent themselves depended on the legal age of majority, medical consent laws for minors, and mature minor doctrines. The "power of the pill" literature considers consent access to be the more relevant type of access. Parental consent to obtain contraceptives is considered an interference with privacy rights, and therefore expected to not reflect full access. The changes governing age thresholds for majority age were plausibly exogenous since they were not related to underlying needs for contraceptives but to the unrelated lowering of legal majority age in light of Vietnam war drafting. The lowering of legal majority age was supposed to diminish the age gap between earliest Vietnam war drafting (age 18) and voting rights (age 21), in order to align voting rights with draft obligations (Bailey, 2006).

Consent access to the pill varied substantially across states. Table 1 provides an overview of the legislation as coded by Myers (2017). Legal access can be derived from the existence of laws restricting a minimum access age in Table 1. If no such law existed, access was not legal. The validity of using this variation in access laws heavily depends on whether the lowered access barriers indeed resulted in higher pill usage. The take-up of the pill is thus an implicit first-stage of this identification strategy. Data on pill usage during this time is, however, relatively scarce. Goldin and Katz (2002) rely on a cross-sectional snapshot of the National Study of Young Women and identify an increased pill usage of 4 percentage points for women aged 17 to 19 years. Bailey et al. (2012) use

retrospectively reported contraceptive usage data to additionally take into account state and cohort fixed effects. They find that the probability to use the pill before age 21 increased for women with legal access before age 21 by 16 percentage points, representing a 42 percent rise relative to the national average.

In addition to the mere possibility to obtain the pill, other access barriers might have been important. Insurance for financial coverage did not play a role for access to the pill, since insurance was only mandated with the Affordable Care Act in 2010 to provide birth control. The cost of the pill at the time of the introduction was around 100$ per year (Warsh, 2011), which is equivalent to 760$ in 2010 (Bailey, 2013). Within five years after the introduction, the price already dropped to 25$ per year. In addition to the pill, alternative forms of contraception existed at that time, such as condoms and diaphragms. These barrier methods were, however, also expensive and in contrast to the pill needed to be applied before intercourse and thus represented a higher variable cost of fertility control. They also had a higher failure rate than the pill (Bailey, 2006).

It is important to acknowledge that there is an overlap in timing between the improved access to the contraceptive pill and access to abortion. The advantage of using the coding of Myers (2017) is that she also provides information on legal and consent access to abortion. Table A1 in the appendix shows an overview of access to abortion over time. Abortion access is also important to take into account as it may have a mental health effect by itself. A priori, the effect of access to abortion on mental health is ambiguous and is widely discussed in public debates and in the medical profession. Recent results from the Turnaway Study in the US published in Foster (2020) suggest that denying women to have an abortion has negative mental health effects while receiving an abortion does not have detrimental effects. Similar null results of having an abortion are found in Janys and Siflinger (2021) for Sweden. Clarke and Mühlrad (2021) investigate the role of abortion legislation in Mexico and also find no effects on mental health.

Table 1: Legal and consent access to the pill - law changes coded by Myers (2017)

Age	>21	18-20	<18		>21	18-20	<18
Alabama	1960	1971	1971	Montana	1960	1960	
Alaska	1960	1960	1974	Nebraska	1965	1969	
Arizona	1962	1972	1977	Nevada	1963	1963	1975
Arkansas	1960	1960	1973	New Hampshire	1960	1971	1971
California	1963	1972	1976	New Jersey	1963	1973	
Colorado	1961	1971	1971	New Mexico	1960	1971	1973
Connecticut	1965	1971		New York	1960	1971	1971
Delaware	1965	1971	1972	North Carolina	1960	1971	1977
District of Columbia	1960	1971	1971	North Dakota	1960	1960	
Florida	1960	1972	1972	Ohio	1965	1965	1965
Georgia	1960	1971	1972	Oklahoma	1960	1960	
Hawaii	1960	1960		Oregon	1960	1971	1971
Idaho	1960	1960	1974	Pennsylvania	1960	1970	
Illinois	1961	1961	1969	Rhode Island	1960	1972	
Indiana	1963	1973		South Carolina	1960	1972	1972
Iowa	1960	1972		South Dakota	1960	1972	
Kansas	1963	1970	1970	Tennessee	1960	1971	1971
Kentucky	1960	1965	1972	Texas	1960	1973	
Louisiana	1960	1972		Utah	1960	1960	
Maine	1960	1969	1973	Vermont	1960	1971	
Maryland	1960	1971	1971	Virginia	1960	1971	1971
Massachusetts	1972	1974	1977	Washington	1960	1970	
Michigan	1960	1972		West Virginia	1960	1972	
Minnesota	1960	1973	1976	Wisconsin	1974	1974	
Missouri	1965	1977		Wyoming	1960	1973	
Mississippi	1965	1965	1965				

Note: The table shows years in which states enabled legal and consent access to the pill for a given age group. The coding of these laws is taken from Myers (2017).

3 Data and Empirical Strategy

3.1 Data on pill access

I combine the coding of laws granting access to the pill with data from the National Survey of Families and Households (NSFH) and the Health and Retirement Study (HRS).[4] The NSFH is suitable to establish a more immediate link between access to the pill and mental health as it measures mental health between age 28 and 54, for 60% of the sample before age 40. The measurement of mental health in the HRS takes place relatively late given the focus on individuals aged 50 or older. The HRS has a larger sample and very rich data which will be crucial for investigating the effect of the pill on labor market outcomes via mental health.

The NSFH is a nationally representative survey of 13,007 individuals who were interviewed for the first wave between 1987 and 1988. The HRS is a large panel study of a representative sample of around 20,000 individuals aged 50 and above with 14 waves between 1992 and 2018. The cohorts in both data sets are born early enough to be exposed to the early diffusion of the pill, between 1934 and 1958. The sharp differences in access laws across states and time for this generation of women provide the exogenous variation used to identify the effects of the pill. Women born before 1934 had access to the pill only in their late twenties and those born after 1958 had full access across most states. Myers (2017) argues for restricting the sample to not include women born after 1958 since this is the last birth cohort reaching age of majority before the definite legal status on consent access became unclear in many states given several Supreme Court cases.

I construct information on access to the pill for each individual in the NSFH using information on both, state at birth and state of residence at age 16. Restricting the data set to individuals for whom the state of residence did not change between these two measurements, allows to pin down precisely state of residence during adolescence.[5] In the HRS, I use information on the state respondents lived in at age 10, using restricted HRS geographic data.[6]

[4]More specifically, I use the first wave of the NSFH. For the HRS analysis, I use the RAND HRS Longitudinal File, an easy-to-use dataset based on the HRS core data. This file was developed at RAND with funding from the National Institute on Ageing and the Social Security Administration.

[5]This restriction is also reasonable given the possibility that at age 16, women in this generation already made important education and labor market choices, such that they could have moved from their residence at age 14 (important for pill access) by age 16.

[6]This approach is an improved measurement compared to most previous studies that had to rely on state of birth information which could have led to bias in the measurement of pill access if respondents moved during childhood. In the HRS, I only use the information on the state of birth if there is no information on the state of residence at age 10. I lack information on state of residence and use state of birth for around 5 percent of my sample. These individuals are on average slightly older, and more likely to be black or hispanic. Given that they are born earlier they have less access to the pill. My results in the later analysis are however robust to excluding these individuals. The exact HRS data set

I focus on access to the pill between age 14 and 21. I do so for several reasons. Importantly, this is the age range in which changes in access to the pill occurred as women above age 21 always had access starting in 1972. In this age bracket, individuals also make important decisions regarding human capital investment. In addition, this period is important for mental health development, since mental health is particularly malleable and sensitive to external influence during this time, as demonstrated by Kessler et al. (2005) and Kessler et al. (2007). When documenting the link between contraceptives and mental health, Skovlund et al. (2016) also found larger differences in incidence rates of depression between users and non-users of hormonal contraceptives for adolescent women aged 15-19 compared to all women.

Table 2 shows how access to the pill is distributed in the NSFH and the HRS samples. Columns headed by "legal access" depict the number of years an individual had legal but no consent access between ages 14 and 21. Columns headed by "consent access" show the same for legal and consent access. While the two types of access are mutually exclusive, it is possible for an individual to first have legal access for some years and then to have consent access for the following years. The distribution of access across these two measures differs strongly, suggesting to include them separately in the estimations later. Around 35% (NSFH) to 43% (HRS) of women had no legal access at all, while 48% (NSFH) to 59% (HRS) percent of women had no consent access at all. Around 22% (NSFH) and 20% (HRS) of women had more than four years of legal access, and only 13% (NSFH) and 10% (HRS) had more than four years of consent access.[7]

In a similar fashion, I construct exposure variables to abortion access, given the timing overlap and the potential importance of abortion availability for mental health. I include them as additional control variables in all estimations.

3.2 Data on Mental Health and Labor Market Outcomes

I use two measures of mental health, both derived from the self-reported Center for Epidemiological Studies Depression (CES-D) scale, developed by Radloff (1977). This scale has been used in the economic literature for the assessment of mental health in several life situations, such as bereavement (Siflinger, 2017), response to family health shocks (Rellstab et al., 2020), improved access or coverage of mental health care (Ma and Nolan, 2017; Ayyagari and Shane, 2015), and experience of major recessions (McInerney et al., 2013). The NSFH contains a 12-item scale, where respondents are asked to indicate the number of days during which they experience a specific negative item during the past week. This scale was converted to a frequency scale ranging from one to three, following the procedure by Pascoe et al. (2006). The scale ranges thus from 0-36. The HRS con-

used: HRS ([Cross-Wave Geographic Information (Detail) [1992-2018] - v8.2, Early]) restricted dataset. Produced and distributed by the University of Michigan with funding from the National Institute on Ageing (grant number NIA U01AG009740). Ann Arbor, MI, (1992-2018).

[7] Overall, individuals in the HRS have less access to the pill. This is due to the fact that the HRS sample is born a little earlier, as can be inferred from the descriptive Table 3.

Table 2: Years of pill access during adolescence (age 14-21)

	NSFH		HRS	
Years	Legal Access	Consent Access	Legal Access	Consent Access
0	34.72%	48.31%	42.50%	58.67%
1	5.35%	4.44%	6.04%	3.93%
2	7.69%	5.08%	7.87%	4.66%
3	5.26%	26.26%	4.63%	19.62%
4	25.07%	2.88%	18.92%	2.65%
5	5.26%	4.62%	5.25%	4.12%
6	4.57%	2.65%	4.38%	2.32%
7	12.08%	5.76%	10.42%	4.02%
N	2,186		6,671	

Note: The table presents the distribution of the number of years that women had legal or consent access to the pill in the NSFH and the HRS. Sample restricted to women born between 1934 and 1958 with mental health information available.

tains the 8-item version of the CES-D. This version contains six negative and two positive items, to which the respondents indicate whether or not they experienced them during the past week.[8] The resulting scale reflects the number of depressive items an individual experiences. In both CES-D scores, a higher value indicates higher levels of depression. The two scales from the NSFH and the HRS overlap in six items, but there is no evidence on usage or consistency of a CES-D score using only these six items. I, therefore, stick to the respective complete scales and use a log-transformation in most of the analysis to ease interpretability. I also use critical cut-offs in both scales: In the medical literature, a threshold value of the 8-item CES-D scale of three or larger is considered to indicate clinically significant levels of depression (Turvey et al., 1999). For the 12-item scale in the NSFH, a critical cut-off of a CES-D score larger than nine has been stated but it is less validated that the threshold for the 8-item scale and thus potentially less reliable (Pascoe et al., 2006).[9] For the NSFH, I use data from the first wave only, as it contains state of residence information and mental health measurements. In the HRS, the CES-D scale is collected in waves 2-14. I construct both, the log CES-D score as well as the

[8]For example: "I felt everything I did was an effort." Positive answers to negative items are added positively, while positive answers to positive items are counted as zero and vice-versa.

[9]Table A2 in the appendix provides an overview of the items of the scales in both data sets.

critical score as close as possible to age 60.[10,11]

Table 3 below shows descriptive statistics of variables I will use throughout the analysis. The upper panel shows the CES-D scores and critical values. In the NSFH the average CES-D score is 9.7, with 39% of individuals indicating a critical CES-D value. The average CES-D score is 1.59 in the HRS. Here, around 24% of the sample report at least one time a CES-D score above or equal to the critical threshold value of nine.[12]

The HRS also contains childhood health information from a retrospective module. This enables to also control for pre-existing conditions in a robustness test. The overall reliability of retrospective childhood information provided by elderly adults has been demonstrated by Havari and Mazzonna (2015) for the Survey of Health, Ageing and Retirement in Europe (SHARE), the European sister study of the HRS. I use an indicator for whether or not an individual reported depressive symptoms before age 13. Only a small fraction of 2 percent of my sample experience childhood depression.[13]

In the main analysis, I will use a set of demographic controls, such as exact age at measurement of the mental health variables, and two indicators for being black or hispanic. Given the age structure in the HRS, respondents in the HRS are with 60.47 years much older than those in the NSFH, who are on average 38.39. The share of Blacks is quite similar in both samples (22% and 23%) and the share of Hispanics is larger in the NSFH (7%) than in the HRS (4%). I also include controls for reforms in the employment sector and marriage regulation that take place at the same time: state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.

In a robustness exercise, I aim at providing a better understanding of the potential alternative channels at work when investigating the effect of access to the pill on mental health. For this, I use additional variables on family formation and stress at work. Descriptives of these variables can be found in Table A11 in the appendix. In a heterogeneity analysis and in the analysis of education and labor market outcomes, I also use genetic in-

[10]For some women, mental health information is already available during their 30s and 40s which would be more attractive to use to establish short-term effects. These women are however only included in the HRS because their partners are older than 50. These are few women and they are also potentially different from the rest of the sample given the large age gap to the husband. Therefore, I mainly focus on mental health measured as close as possible around age 60, where I have data on most individuals.

[11]My analysis naturally only focuses on individuals with mental health information available. Individuals without mental health information are born slightly later, and thus have slightly more consent access to the pill.

[12]The much larger share of individuals above the critical value in the NSFH is likely related to this being a less validated cut-off.

[13]Even though the paper by Havari and Mazzonna (2015) shows good reliability there might still be issues concerning recall bias and also issues related to the small incidence of childhood depression. Nevertheless, the next section will show that the effect of childhood depression on later-life mental health is large and statistically significant, suggesting that it still captures meaningful variation in pre-existing conditions.

Table 3: Descriptive statistics of variables for analysis of mental health effects of pill

	NSFH	HRS
Mental health variables		
CES-D Score	9.74	1.59
	(8.77)	(2.21)
CES-D critical threshold	0.39	0.24
	(0.49)	(0.43)
Childhood depression	/	0.02
		(0.14)
Pill access variables		
Fract. years with legal access pill (14-21)	0.40	0.34
	(0.36)	(0.36)
Fract. years with consent access pill (14-21)	0.26	0.21
	(0.31)	(0.29)
Demographic control variables		
Year of birth	1948.26	1946.21
	(7.48)	(7.73)
Age at measurement	38.39	60.47
	(7.49)	(3.24)
Black	0.22	0.23
	(0.42)	(0.42)
Hispanic	0.04	0.07
	(0.19)	(0.25)
Controls for other reforms		
Fract. years with legal access abortion(14-21)	0.05	0.05
	(0.12)	(0.11)
Fract. years with consent access abortion (14-21)	0.18	0.14
	(0.25)	(0.24)
Fract. years with state equal pay laws	0.79	0.72
	(0.38)	(0.43)
Fract. years with laws against racial	0.75	0.67
discrimination in employment	(0.40)	(0.44)
Fract. years with no-fault divorce	0.16	0.15
	(0.32)	(0.31)
N	2,229	6,671

Note: Means and standard deviations (in parentheses). Sample restricted to women born between 1934 and 1958 with mental health information available. The CES-D critical threshold equals one if the respondent reports a CES-D score greater than 9 in the NSFH and greater than or equal to three in the HRS.

formation provided in the HRS in form of polygenic scores. I explain those in Section 4.2.

In the second part of my analysis, I investigate the effect of the pill on education and labor market outcomes in the HRS.[14] For this, I use information on positive outcomes, such as the years of education, an indicator for whether an individual attended college, an indicator for whether an individual was ever in the labor force, and an indicator for whether an individual was in the labor force for more than five years. I also use information on negative outcomes such as the number of disability periods, a disability indicator, the reporting of limitations at work due to health problems, and average sick days. Table 4 shows descriptive statistics of those variables. Around half of the respondents have attended college, and have on average 13 years of education. Around 96% have ever been in the labor force and 92% have been in the labor force for more than five years. While 13% percent report to ever have a period of disability, the average number of disability periods is 0.35. On average 60 percent of individuals report to ever experience limitations at work due to health and report on average 5.6 sick days per year.

Table 5 shows how average mental health differs according to differential access to the pill. Across the two mental health measures and the two different access types, mental health in both datasets is worse when women had access to the pill, compared to no access. In the NSFH, individuals without access to the pill report a CES-D score of 8.86, those with legal access report scores of 10.11, and those with consent access report scores of 10.26, so 14-16% higher scores. Around 34% of individuals without access to the pill report a critical CES-D score (larger than nine). Among those individuals with access, 40-42% report a critical CES-D score. Repeating this exercise on data from the HRS provides a similar picture. Individuals without access report a CES-D score of 1.36, and those with access report scores between 1.69 (legal) and 1.77 (consent), so 23-24% higher scores. In the HRS, 21% of those without access report a critical CES-D score equal to or larger than three, while among those with access 25-26% report critical CES-D scores.

[14]For this, I only use data from the HRS as I rely on genetic information to identify whether the pill affected education and labor market outcomes also via mental health.

Table 4: Descriptive statistics of outcomes in education and labor market analysis

	HRS
Positive	
Ever college	0.51
	(0.50)
Years of education	13.13
	(2.58)
Ever in labor force	0.96
	(0.19)
Ever in labor force $>$ 5 yrs	0.92
	(0.28)
Negative	
Ever disabled	0.13
	(0.33)
Number of disability periods	0.35
	(0.82)
Ever limitations at work	0.60
	(0.49)
Av. sick days per year	5.62
	(14.95)
N	2,853-3,526

Note: Means and standard deviations (in parentheses). Sample restricted to women born between 1934 and 1958 with mental health information available.

Table 5: Descriptive Statistics of mental health according to pill access

	All	no access	legal access		consent access	
	mean	mean	mean	p-value	mean	p-value
	(1)	(2)	(3)	(4)	(5)	(6)
NSFH						
CES-D	9.74	8.86	10.11	0.005	10.26	0.002
	(8.77)	(8.80)	(8.86)		(8.65)	
critical CES-D	0.39	0.34	0.40	0.006	0.42	0.001
	(0.49)	(0.47)	(0.49)		(0.49)	
N	1,708	552	1,156		1,156	
HRS						
CES-D	1.59	1.36	1.69	0.000	1.77	0.000
	(2.12)	(1.90)	(2.22)		(2.27)	
critical CES-D	0.24	0.21	0.25	0.000	0.26	0.000
	(0.43)	(0.40)	(0.01)		(0.44)	
N	5,072	2,315	2,757		2,757	

Note: Shows means and standard deviations (below mean in parentheses). Column (1) shows means over all types of access. Column (2) shows means for no access at all. Column (3) shows means for legal access, and column (4) shows the p-value from a two-sided t-test, comparing means with no access in Column (2) versus legal access in Column (3). Column (5) shows means for consent access, and column (6) shows the p-value from a two-sided t-test, comparing means with no access in Column (2) versus consent access in Column (6). No access is defined when women did not have access (legal/consent) to the pill between age 14 and 21. Access is defined for women who had access (legal/consent) to the pill for at least one year between age 14 and 21. Sample restricted to women born between 1934 and 1958 with mental health information available. The CES-D critical threshold equals one if the respondent reports a CES-D score greater than or equal to three in the HRS and greater than nine in the NSFH. Note that the no access mean excludes individuals who had no access to one type of access (e.g. legal) but access to the other (e.g. consent). For example in Column (2), I do not consider individuals who had no legal but had consent access. In the analysis in the next section, I can take these individuals into account by using both access measures as independent variables. The number of observations is therefore higher in the next part of the analysis.

3.3 Empirical Strategy

In the coming analysis, I define pill access as an exposure measure for the years between age 14 and 21. I use the fraction of years between ages 14 and 21 in which a woman had i) legal but no consent access and ii) legal and consent access to the pill.[15] I estimate the effect of access to the pill in adolescence for woman i living in state s, born in year t with the following equation:

$$\begin{aligned} \textit{mental health}_{i,s,t} = \beta_0 + \beta_1 \textit{ legal pill access}_{s,t} + \beta_2 \textit{ consent pill access}_{s,t} \\ + \boldsymbol{\beta_3 x}_{i,s,t} + \mu_t + \nu_s + \epsilon_{i,s,t} \quad (1) \end{aligned}$$

I am interested in β_1 and β_2, the effects of exposure to legal and consent access to the pill during adolescence on mental health. As both variables represent the fraction of years between age 14 and 21 with access, β_1 and β_2 have to be interpreted as the effect of woman i having legal or legal and consent access to the pill during all seven years between age 14 and age 21.[16] Mental health is measured by the CES-D score and by an indicator for crossing the clinically relevant threshold of the CES-D. I estimate this equation using OLS, therefore as a linear probability model for the latter outcome. In every specification, I control for access to abortion, by adding the fraction of years between ages 14 and 21 in which woman i had legal or consent access to abortion, captured in $\boldsymbol{x}_{i,s,t}$. I also include age, a dummy for being black, and a dummy for being hispanic, in $\boldsymbol{x}_{i,s,t}$. State equal pay laws, state acts prohibiting racial discrimination in employment, and laws for no-fault divorce are also included in $\boldsymbol{x}_{i,s,t}$. Additionally, I add birth cohort and state fixed effects in all my regressions, here represented by μ_t and ν_s. I also include linear state-cohort trends in $\boldsymbol{x}_{i,s,t}$.[17,18]

[15] One important aspect in the coding of access is that the coding by Myers (2017) defines access for young unmarried women. As I have information about age at first marriage, I can define whether an individual had consent access to the pill before the respective age of consent because she got married. These women who received access through marriage married however particularly young. As young marriage by itself has been shown to have negative mental health effects, as for example demonstrated in Le Strat et al. (2011), I exclude these women from the main analysis. In Table A8, I show that my results are mostly similar when including those but that early marriage indeed plays an important role. Adding controls for early marriage and access through marriage does however raise endogeneity issues. Another problem with this excluded sample is that none of the fertility delaying effects can be replicated with them, as discussed in Section 4.1. In the main analysis, access to the pill therefore only varies at the state and birth cohort level.

[16] For inference on one additional year of access the coefficients need to be divided by seven. Also, note that the two environments are mutually exclusive at the same time but that women can first have some years of legal and then some years of consent access.

[17] The inclusion of the state-cohort trends is supposed to mitigate any bias of the estimates of legal and consent access due to unobserved trends in mental health of cohorts in states, that are correlated with the timing of the access laws. One example is the women's rights movement, which might be stronger in more liberal states which are more lenient toward pills access.

[18] Ideally, one would add more covariates in this analysis, such as education or fertility outcomes that also shape mental health in important ways. In this context, these would however be bad controls (Angrist and Pischke, 2008). Bad controls are variables that are also outcomes of the treatment itself.

In the second part of my analysis, I use a similar approach to investigate the effects of access to the pill on education and labor market outcomes, also taking the mental health cost of the pill into account. I first estimate the effect of the pill on different education and labor market outcomes, captured by $Y_{i,s,t}$. For this, I use the following equation:

$$Y_{i,s,t} = \alpha_0 + \alpha_1 \, legal\ pill\ access_{s,t} + \alpha_2 \, consent\ pill\ access_{s,t} + \boldsymbol{\alpha_3 x}_{i,s,t} + \rho_t + \phi_s + \upsilon_{i,s,t} \tag{2}$$

In $\boldsymbol{x}_{i,s,t}$ the same controls as before are included together with controls for genetic risk.[19] In the next step, I add interactions between pill access variables and an indicator for above median genetic risk for depression (depression risk).[20] If there is no effect of the pill on labor market outcomes via mental health, then the coefficients of these interactions should be close to zero.[21]

$$\begin{aligned} Y_{i,s,t} = {} & \gamma_0 + \gamma_1 \, legal\ pill\ access_{s,t} + \gamma_2 \, consent\ pill\ access_{s,t} + \\ & \gamma_3 \, legal\ pill\ access_{s,t} \times depression\ risk_i + \gamma_4 \, consent\ pill\ access_{s,t} \times depression\ risk_i \\ & + \boldsymbol{\gamma_5 x}_{i,s,t} + \theta t + \eta_s + \zeta_{i,s,t} \end{aligned} \tag{3}$$

I base my inference not only on the coefficients of the interactions (γ_3 and γ_4) but also on the difference between α_1 and γ_1, as well as between α_2 and γ_2. This comparison shows how taking mental health into account changes the effect of the pill on education and labor market outcomes.

In this case, it has been shown empirically by the "power of the pill" literature that the pill affects education and fertility decisions. I, therefore, do not include these variables. I investigate the role of fertility and family formation outcomes for mental health in a robustness analysis.

[19] I control in all specifications for genetic risk to develop depression and for the first 10 principal components of the matrix of genetic data. I also include additional polygenic scores (age at menarche, age at menopause, mental health cross-disorders, BMI, anxiety, and the number of children).

[20] The measurement of genetic risk will be discussed in more detail in Section 4.2

[21] I also include interactions of abortion access variables and the indicator for above median genetic risk for depression here.

4 The Mental Health Effect of Access to the Pill

In this section, I investigate the effect of access to the contraceptive pill during adolescence on mental health. Table 6 shows that consent access to the pill is associated with worse self-reported mental health. Having consent access to the pill during all years between age 14 and 21 is associated with a 34.5% higher CES-D score in the NSFH, and a 19.9% higher CES-D score in the HRS. Consent access to the pill also increases the probability to report a CES-D score above the clinically relevant threshold in the HRS by 10.1%, but this increase is only marginally statistically significant. There is no significant effect in the NSFH, potentially due to the less reliable cut-off. The effects for legal access are smaller and not statistically significant for any of the two measures and data sets.[22]

For the analysis with data from the HRS, the results depict a long-term effect of access to the pill on mental health. These can only be justified when assuming that mental health shocks during adolescence are extremely persistent. Persistence of poor mental health shocks is demonstrated in the psychological literature documenting that poor mental health during childhood or adolescence is strongly correlated with poor mental health in adulthood (Fryers and Brugha, 2013).[23] The identification of long-term effects in the medical studies documenting a mental health effect of the pill is limited due to the data horizon, and selective attrition in pill use. Skovlund et al. (2016) compare results from using and dropping individuals from the control group who have used the pill in the past and identify much larger effects when only comparing to never-users, suggesting that using former users leads to an upward bias. This could be driven by persistent detrimental mental health effects.[24]

Table 7 repeats the estimation for the HRS but adds a dummy for childhood depression. Including this control for mental health issues existing before access to the pill, only

[22]Table A3 in the appendix shows additionally the coefficients of all control variables. Table A4 shows the results for using the CES-D score instead of its log-transformation. Tables A6 and A7 show the results for omitting linear state cohort trends and for adding quadratic state cohort trends. Without linear trends, the estimates drop sharply and are no longer significant. The drop in coefficient size without linear trends is similar to the one observed in the analysis by Myers (2017), but not the drop in significance, potentially due to a larger sample there. This suggests that there are important dynamics over time that are captured in these linear state cohort trends. The inclusion of quadratic trends does not alter the results.

[23]A study by Kandel and Davies (1986) shows persistence of depressive mood in a period of nine years after adolescence in New York. Hofstra et al. (2002) demonstrate persistence in a 14-year-follow-up in the Netherlands. Weissman et al. (1999) show continuity of major depressive disorder in 10-15 year follow-up. Fombonne et al. (2001) find strong links between youth and adult depression in a 20-year-follow-up. Hofstra et al. (2001) show moderate persistence in a 10-year-follow-up. Clark et al. (2007) show persistence in a 45-year-follow-up of Affective and Anxiety Disorders. Reef et al. (2009) demonstrate continuity of psychopathology in a 24-year follow-up.

[24]The information value from these comparisons is however mitigated by the failure to account for selection into ever using contraceptives.

Table 6: Effect of pill access during adolescence (age 14-21) on mental health

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.161	0.006	0.071	0.036
	[0.154]	[0.080]	[0.057]	[0.033]
Fract. years with consent access pill	0.345**	0.015	0.199**	0.101*
	[0.161]	[0.108]	[0.080]	[0.059]
R-squared	0.09	0.09	0.27	0.18
N	2,229		6,671	
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

marginally changes the results as it renders the effects on the critical threshold statistically insignificant. This exercise also shows that mental health problems are indeed very persistent. Having suffered from depression during childhood increases the number of depressive items reported in the CES-D score by 35%, and increases the probability to report a clinically relevant score by 16.4 percentage points.

I also show my main results for an alternative policy coding, the one by Bailey et al. (2012). Table 8 shows that the results from this exercise are remarkably similar to the ones from Table 6.

Given that the clinically relevant threshold of the CES-D score is a dichotomous variable, I test whether my results are robust to an alternative specification by using a probit estimation. Table A5 in the appendix shows average marginal effects, that are in line with the results from the OLS in Table 6.[25]

[25]I also test the robustness of my results to the inclusion of those individuals who gained access through marriage and the implications for my results. These are 17% and 16% percent of the respective NSFH and HRS samples. The results are somewhat mixed. Table A8 in the appendix shows that while in the NSHF there is no effect on mental health when including those, the effect in the HRS is at first sight very similar, see columns (1) and (3). One issue in using this adapted coding is however the fact that those individuals married particularly early. As shown by Le Strat et al. (2011) early marriage itself can have large negative effects on mental health. I, therefore, also include a dummy for marriage before age 16, the minimum legal marriage age in most states at that time. This and the dummy for access through marriage that is also included are however likely endogenous. The results are showing that the coefficient for consent access drops by 18 percent in the HRS. The coefficient drop is larger in the

Table 7: Effect of pill access during adolescence (age 14-21) on mental health, controlling for childhood depression

	HRS	
	log CES-D	> critical threshold
	(1)	(2)
Fract. years with legal access pill	0.064	0.033
	[0.054]	[0.032]
Fract. years with consent access pill	0.190**	0.096
	[0.079]	[0.059]
Childhood depression	0.352***	0.164***
	[0.058]	[0.039]
R-squared	0.28	0.18
N	6,671	
Linear time trends	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. CES-D critical threshold in the HRS defined as CES-D equal or above three.

The size of the estimates presented in Tables 6, 7, and 8 is large, in particular when considering the fact that they measure an intention-to-treat effect. Bailey et al. (2012) report that take-up of the pill before age 21 increased by 42 percent with legal access alone. It is important to keep in mind that the coefficients represent having access for all years between age 14 and 21. It seems also reasonable to relate these findings to results found in the medical literature. Skovlund et al. (2016) report an 80 percent higher incidence rate of first diagnosis of depression for adolescents, which is even larger than my estimates. This is, however, potentially driven by analyzing the pure within-individual correlations over time and not accounting for selection. However, one needs to also consider the dosage of hormones in the pill women had access to. The medical studies reporting a mental health effect of hormonal contraceptives measure effects of contraceptive pills produced in the early 2000s, while I am measuring the effect of a drug administered in the 1960s and 1970s that entailed much higher doses of hormones. Liao and Dollin (2012) report that the first available pill contained around 9.5 milligrams (mg) of progestin while pills today contain only 0.1-3 mg.[26] Estrogen levels were also much

NSFH, but the coefficient is statistically insignificant. The early marriage coefficients are positive, large, and significant. Table A9 shows that my main results (without the access through marriage group) are robust to the inclusion of this early marriage dummy.

[26]Progestine is the synthetic hormone that mimics the body's own hormone progesterone. Both

Table 8: Effect of pill access during adolescence (age 14-21) on mental health, coding by Bailey et al. (2012)

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.156	0.005	0.083	0.040
	[0.138]	[0.073]	[0.056]	[0.032]
Fract. years with consent access pill	0.391*	-0.041	0.188**	0.091
	[0.198]	[0.125]	[0.089]	[0.056]
R-squared	0.09	0.09	0.27	0.18
N	2,234		6,559	
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

higher with 150 mg for the first pill, compared to 20-50 mg for the pill today. This could contribute to explaining the size of the effects.

The effect sizes can also be compared to other studies on the CES-D score in the NSFH and in the HRS. A study by Ettner (1996) finds that the effect of a one standard deviation increase in annual income lowers the CES-D score by around 29% relative to the mean in the NSFH. In another study using the NSFH, Boyd-Swan et al. (2016) study the effect of the Earned Income Tax Credit Expansion on mental health for mothers and find a 16% decrease in depression score. Ayyagari and Shane (2015) study the effect of Medicare Part D on the CES-D score in the HRS: They find a reduction of 0.2 depressive items after the Medicare introduction for eligible individuals and a 4-5 percentage points lower probability to report a CES-D score above the clinically relevant threshold. For drug coverage itself, they identify a reduction of the CES-D score of 1.6 items. Compared to the effect of the 2008 stock market crash on the CES-D score of individuals with stocks below the median before the crash identified by McInerney et al. (2013) using HRS data, my estimates are around 50% larger. In light of these effect sizes, my estimates seem not unrealistic.

One caveat for the interpretation of the results from the HRS, i.e. the long-term effects is the potential for survivorship bias. Those women that I have data on from the HRS

progesterone and estrogen have been discussed as the hormones causing depression.

are the ones that survived until then. If survival is positively related to good mental health, I might not capture the most severely mentally ill.

Given that my analysis argues for an effect of the pill on mental health through the biological mechanisms suggested in the medical literature, I perform a placebo test with a sample of men from the same birth cohort. Even though the reform coding is tailored to women and their age of majority which differed from that for men, this can be insightful in determining the role of other unobserved factors correlated with the timing of the increase in access to the pill.[27] If there are any other factors contributing to worse mental health associated with the timing and place of the law changes one should see positive coefficients for males. Table 9 below shows that there are no significant effects of the law reforms on self-reported mental health for men. Neither legal nor consent access to the pill have a statistically significant effect on mental health of men. Also, most of the coefficients are negative.

Table 9: Effect of pill access during adolescence (age 14-21) on mental health, males

	HRS	
	log CES-D	> critical threshold
	(1)	(2)
Fract. years with legal access pill	0.024	-0.025
	[0.062]	[0.031]
Fract. years with consent access pill	-0.067	-0.072
	[0.080]	[0.053]
R-squared	0.28	0.16
N	5,393	
Linear time trends	Yes	Yes

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. CES-D critical threshold defined as CES-D score equal or above three.

It is also important to mention that my analysis builds on variation in access caused by variation in the timing and location of law changes, so a staggered treatment on a state-birth cohort level. The recent advances in estimators that are robust to biases arising from problematic weighting of treatment effects (Goodman-Bacon, 2021) are however difficult to apply to my setting. My approach uses a "pseudo" DiD estimation exploiting a cohort design in which there is no data on never-treated and treated units for all periods

[27] I here focus only on the HRS sample due to small sample problems in the NSFH. Table A10 shows descriptive statistics of the main variables for males.

for each treatment timing group available. The definition of the two types of access to the pill after a cutoff, i.e. access for all cohorts born after a specific year, mechanically truncates the data to only cover certain birth cohorts for each treatment timing group.

4.1 Alternative channels

So far, I have motivated the results above as an effect of hormones contained in the contraceptive pill on mental health. There are however potentially alternative channels. Such channels concern all other behavioral changes that were triggered by access to the pill that might have affected mental health. By enabling women to take control over their own fertility, the pill has potentially shifted entire life trajectories. The effect that I identify might thus not measure an effect of the hormones contained in the pill but could be a result of the changed life patterns of women. There are two main avenues through which the pill might have affected mental health other than the pill. The first one is the changes, i.e. mostly the delay in family formation triggered by the pill. The second are the changed career paths, where women with access to the pill were enabled to invest more into education and to pursue more ambitious careers that are likely also more stressful. I investigate both these two alternative channels and show that they are not driving my results.

I use several outcomes for changes in family formation: age at first marriage and birth, an indicator for ever being married, and for ever having a child, indicators for birth and marriage before age 22 (following the age cut-off by Bailey (2006)), and an indicator for out-of-wedlock birth. The HRS provides two variables indicating more stressful careers: the average stress and the average time pressure at the job. Descriptive statistics for variables measuring family formation as well as stress at work can be found in the appendix in Table A11. Table 10 shows the effect of access to the pill for the different outcomes of family formation. Interestingly, legal access seems to be more important than consent access here. Legal access to the pill increases age at marriage, reduces the probability of ever getting married (HRS only), and reduces the probability to get married before age 22. Legal access also increases the age at first child, reduces the probability to ever have a child (HRS only), and reduces the probability to have a child before age 22. Legal access also increases the probability of out-of-wedlock birth, but only marginally statically significant in the HRS.[28] Differences between the two surveys regarding the outcomes ever married/ever a child are likely driven by the fact that the HRS reflects completed fertility and likely mostly completed marital history. Consent access which seems the relevant driver of mental health issues has only statistically significant effects on the probability to have a child before 22 (NSFH only). Nevertheless, as some of the coefficient sizes of consent access are not too small, I thoroughly investigate the effect of all of these family formation outcomes on mental health. If they have a negative effect on mental health, they might drive part of the effect of the pill on mental health that I identify.

[28] Some of these results can also be related to findings in the literature. The effect of access to the pill on fertility and marriage delay is quite large compared to the studies by e.g. Goldin and Katz (2002) and Bailey (2006) but differences can arise due to a) the exclusion of those with access through marriage and b) the construction of the pill variable as a fraction of year with access - in contrast to the "early legal access dummy" in Goldin and Katz (2002) and Bailey (2006). An increasing effect on out-of-wedlock birth is found by Beauchamp and Pakaluk (2019).

Table 10: Effect of pill access during adolescence (age 14-21) on family formation

	Age first marriage	Ever married	Married before 22	Age first child	Ever child	Child before 22	Out-of wedlock birth
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: NSFH							
Fract. years with legal access pill	1.983*	0.012	-0.314***	2.490**	0.051	-0.268***	0.117
	[0.998]	[0.073]	[0.099]	[0.838]	[0.057]	[0.073]	[0.106]
Fract. years with consent access pill	-0.733	0.025	0.084	0.504	-0.015	-0.115	0.008
	[1.430]	[0.085]	[0.184]	[1.399]	[0.060]	[0.146]	[0.145]
R-squared	0.13	0.09	0.15	0.14	0.07	0.14	0.15
N	1,998	2,334	1,998	1,919	2,335	1,919	1,919
Panel B: HRS							
Fract. years with legal access pill	3.614***	-0.056**	-0.405***	1.881***	-0.090**	-0.223***	0.119*
	[0.533]	[0.022]	[0.063]	[0.549]	[0.040]	[0.064]	[0.067]
Fract. years with consent access pill	0.260	-0.001	-0.100	0.691	0.063	-0.153*	0.096
	[0.790]	[0.041]	[0.112]	[0.752]	[0.050]	[0.091]	[0.096]
R-squared	0.13	0.04	0.12	0.10	0.04	0.07	0.08
N	5,979	6,836	5,979	5,476	6,838	5,476	5,476
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion.

Table 11 shows that almost all variables have a statistically significant effect on mental health in both data sets. Age at marriage and age at first child are not problematic as they have mental improving effects, and would thus lead to a downward bias in my estimation of the biological mental health effect. Even though the indicators for getting married before age 22 and for having a child before age 22 have negative mental health effects, they are also not problematic as they are reduced with access to the pill. One problematic factor is the probability to be ever married as it has a positive mental health effect but is reduced with access to the pill. The probability to ever have a child slightly worsens mental health but is reduced in the HRS, and has no significant association in the NSFH. Another problem is the probability for out-of-wedlock birth which has negative mental health effects and is increased with access to the pill. I, therefore, repeat my main analysis dropping first those individuals who never got married and then those with out-of-wedlock birth, to investigate whether they are driving my results. Results in Table 12, however, are very similar to the main results. The coefficients are even slightly larger and more precisely estimated. Therefore, a negative mental health effect through never being married or through out-of-wedlock birth seems not to drive my results.

Lastly, I investigate whether there exist adverse mental health effects through more stressful career paths. This would mean that the negative mental health effects I find are not driven by hormones but by the reforms affecting changes in career paths. For this, I investigate the effect of access to the pill on two measures of stress at the job. First, I use the amount of time pressure that individuals report, and second I use the reported stress level at their job. Table 13 shows that access to the pill is not related to a meaningful and significant increase in reported stress or time pressure at work. This suggests that potential shifts in career paths through the pill seem not to have resulted in more stressful jobs.

Table 11: Effect of family formation on mental health

	log CES-D						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: NSFH							
Age first marriage	-0.021***						
	[0.005]						
Ever married		-0.031					
		[0.053]					
Married before 22			0.156***				
			[0.041]				
Age at first child				-0.021***			
				[0.006]			
Ever children					0.112*		
					[0.065]		
Child before 22						0.216***	
						[0.051]	
Out-of-wedlock birth							0.151**
							[0.071]
R-squared	0.09	0.09	0.09	0.11	0.09	0.11	0.10
N	1,923	2,228	1,923	1,828	2,229	1,828	1,828
Panel B: HRS							
Age first marriage	-0.004*						
	[0.002]						
Ever married		-0.084***					
		[0.031]					
Married before 22			0.046**				
			[0.018]				
Age at first child				-0.013***			
				[0.001]			
Ever children					0.015		
					[0.020]		
Child before 22						0.140***	
						[0.017]	
Out-of-wedlock birth							0.164***
							[0.034]
R-squared	0.29	0.27	0.29	0.29	0.27	0.29	0.29
N	5,831	6,669	5,831	5,365	6,671	5,365	5,365
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.

Table 12: Effect of pill access during adolescence (age 14-21) on mental health, excluding never married and those with out-of-wedlock birth

	log CES-D			
	excl. never married		excl. oow birth	
	NSFH	HRS	NSFH	HRS
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.242	0.070	0.320*	0.082
	[0.160]	[0.057]	[0.172]	[0.054]
Fract. years with consent access pill	0.536**	0.227***	0.592***	0.242***
	[0.210]	[0.074]	[0.200]	[0.079]
R-squared	0.84	0.28	0.10	0.28
N	1,937	6,225	1,472	5,958
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.

Table 13: Effect of pill access during adolescence (age 14-21) on measures of stress at work (HRS)

	Time pressure at work	Mean stress level job
	(1)	(2)
Fract. years with legal access pill	0.033	0.085
	[0.130]	[0.102]
Fract. years with consent access pill	-0.090	-0.003
	[0.188]	[0.138]
R-squared	0.09	0.08
N	2,464	2,564
Linear time trends	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects. Time pressure and mean stress level of job range from 1-4, where a higher score indicates more stress.

4.2 Heterogeneity Analysis

In this subsection, I take a closer look at heterogeneity in the effect of the pill on mental health. I begin with heterogeneity according to age at access. Then, I also investigate the role of genetic predisposition for mental health problems for the effect of the pill on mental health.

Given that the duration of exposure to access to the pill varied substantially (as shown in Table 2), I investigate whether the identified effect varies according to the specific age at access. For this, I adopt an alternative specification of the pill exposure measure. Instead of using the fraction of years exposed, I use different dummies indicating access to the pill (0/1) during a specific age, namely between age 14 and 15, between age 16 and 17, and from age 18-20. Results in Table 14 show that the exposure variable masks some heterogeneity in the effects of consent and legal access to the pill according to age at access. It shows significant effects for the youngest group (14-15) and for the oldest group (18-20). Effects for the youngest groups are larger than for the oldest group. Results are however not statistically significant for the NSFH.[29]

Another important dimension of heterogeneity to consider, is whether or not the mental health effect of the pill varies for individuals with different predispositions for mental health illness. This can help to understand whether the pill raises mental health problems for everyone equally or whether it is more likely to "push" individuals with a higher predisposition to develop a mental health problem beyond a threshold. One way to measure predisposition toward certain illnesses and general biological characteristics (phenotypes) are so-called polygenic scores. Polygenic scores (PGS) are linear indexes summing up genetic variants. These scores are obtained from genome-wide association studies (GWAS) in which DNA material is scanned and reflect the propensity toward a specific phenotype. Polygenic scores have mostly been used in the economic literature to investigate the role of genes, different environments, and their interplay, for example, to better understand the effect of education on health (Barcellos et al., 2021) or returns to education (Papageorge and Thom, 2020). Barban et al. (2021) use polygenic scores to investigate the role of genes for a range of fertility outcomes in interaction with variation in access to the pill in the UK.

For a subset of the HRS sample, polygenic scores were collected between 2006 and 2012. A score related to general depressive symptoms is available where a higher score reflects a higher propensity for the respective phenotype. Domingue et al. (2017) use this score from the HRS to study heterogeneity in mental health response to the death of a spouse. They find that higher polygenic scores were associated with a larger increase in the CES-

[29]The heterogeneity according to age at access could reflect two things: first, higher malleability of mental health at younger ages could be related to larger health effects. Second, pill take-up should be higher for older individuals, due to sexual activity. This heterogeneity might therefore mask differences in the ATT and ITT for different groups which is challenging to identify separately.

Table 14: Effect of pill access on mental health, dummies for age at access

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Legal access pill age 14/15	0.184	-0.000	0.044	0.040
	[0.164]	[0.086]	[0.070]	[0.038]
Legal access pill age 16/17	0.160	-0.004	0.043	0.016
	[0.145]	[0.073]	[0.054]	[0.032]
Legal access pill age 18-20	0.239**	0.060	0.051	0.015
	[0.097]	[0.053]	[0.034]	[0.020]
Consent access pill age 14/15	0.160	-0.062	0.132*	0.089*
	[0.175]	[0.110]	[0.079]	[0.046]
Consent access pill age 16/17	0.136	-0.091	0.049	0.052
	[0.161]	[0.097]	[0.084]	[0.053]
Consent access pill age 18-20	0.095	0.004	0.073*	0.050*
	[0.096]	[0.489]	[0.037]	[0.028]
R-squared	0.09	0.09	0.28	0.18
N	2,229	2,229	6,671	6,671
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.

D score after the death of a spouse.[30]

I re-estimate my main model from equation (1) for the effect of the pill on the CES-D score adding an interaction between access to the pill and the polygenic scores. In the upper panel of Table 15, I interact the pill access variables with the depression PGS and also with an indicator for above median depression PGS. In the lower panel of Table 15, I instead use pill access dummies and interact them with the depression PGS and the indicator for above median depression PGS.[31] These four specifications show a similar pattern: the mental health effect of access to the pill seems to be driven by those with higher or above median PGS for depressive symptoms. This points toward the potential role of the pill as a trigger for mental illness for those already at genetic risk.

[30]One caveat in this type of analysis is the fact that the scores are obtained from GWAS on groups of individuals with a certain origin. The HRS provides polygenic scores for both, European and African ancestry but the majority of studies are on European ancestry groups. I, therefore, restrict my analysis using polygenic scores to individuals of European descent.

[31]In all specifications, I control for the genetic risk, so either for the polygenic score for depressive symptoms or for the indicator for above median PGS. I also include interactions with abortion access. I control for the first 10 principal components of the matrix of genetic data, a standard practice in this literature (Okbay et al., 2016). I also include additional polygenic scores, that are potentially related to mental health and to contraceptive use/fertility, such as age at menarche, age at menopause, mental health cross-disorders, BMI, anxiety, and the number of children. The results are robust to the exclusion of these additional polygenic scores.

Table 15: Effect of pill access on mental health, according to genetic risk

	log CES-D	
	(1)	(2)
Fract. years with legal access pill	-0.047	-0.043
	[0.072]	[0.078]
Fract. years with consent access pill	-0.105	-0.304*
	[0.162]	[0.158]
Fract. years with legal access pill x PGS depressive symptoms	-0.011	
	[0.033]	
Fract. years with consent access pill x PGS depressive symptoms	0.133*	
	[0.079]	
Fract. years with legal access pill x above median PGS		-0.018
		[0.059]
Fract. years with consent access pill x above median PGS		0.377*
		[0.192]
R-squared	0.11	0.11
Legal access pill (0/1)	0.001	0.011
	[0.037]	[0.046]
Consent access pill (0/1)	-0.034	-0.114*
	[0.053]	[0.064]
Legal access pill (0/1) x PGS depressive symptoms	-0.012	
	[0.029]	
Consent access pill (0/1) x PGS depressive symptoms	0.057	
	[0.039]	
Fract. years with legal access pill x above median PGS		-0.031
		[0.054]
Fract. years with consent access pill x PGS above median		0.156**
		[0.075]
R-squared	0.11	0.11
N	3,526	
Linear time trends	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, childhood depression, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. All columns also include interactions between genetic risk and abortion access variables.

5 Education and Labor Market Outcomes

A large part of the "power of the pill" literature has documented positive effects of access to the pill on education and labor market outcomes. These studies argue that the improved control over fertility due to the pill enabled women to make larger investments in education resulting in improved labor market outcomes. Other potential effects of the pill besides fertility control such as mental health have not been taken into account. From a theoretical perspective, mental health can be thought of as a (hidden) cost of fertility control. The effect of the pill on labor market outcomes then operates through two channels: the first one is the above-explained fertility control channel. This includes the aversion but also the timing of childbirth. As has been shown in the literature, this channel has positive effects on education, labor force participation, and wages. The second channel is mental health. As several empirical studies demonstrated, poor mental health has detrimental effects on education and labor market outcomes, ranging from high school completion to labor force participation and earnings. The two channels of the pill are therefore opposed. Mental health thus might mitigate the positive pill effect on labor market outcomes through the fertility channel. The total effect of the pill on education and labor market outcomes then depends on the relative size of both these channels.

I investigate this by estimating the effect of access to the pill on measures of education, labor force participation, limitations at work, and disability periods and take an effect of the pill via mental health explicitly into account. In a first step, I estimate the effect of access to the pill on years of education, college attendance, and labor force participation. This is the set-up of analyses from the "power of the pill" literature and is an estimate of the combined effect of both channels. In a second step, I add the indicator for above median risk of depression (as also used in Table 15) interacted with the pill access variables.[32] If there is no effect of the pill on education and labor market outcomes via mental health the coefficients of these interactions should be close to zero. Since the composite effect estimated in the first step had implicitly subtracted the mental health cost from the pill coefficient, the coefficients of pill access variables should become larger as they now only reflect the fertility control effect.

In addition to these positive labor market outcomes, it seems also reasonable to investigate indicators of reduced labor market productivity. Given that the HRS contains measures on disability periods, limitations at work, and sick days, I repeat the same exercise for these outcomes. This helps to understand whether the mental health cost of the pill is indeed detrimental for labor market productivity. If this is the case, one would expect a positive coefficient for the interaction between the pill access variables and the indicator for above median risk of depression.

[32] I control for the indicator itself in all specifications. I also include interactions with abortion access.

Table 16 shows the effect of the pill on years of education and college attendance, labor force participation, and labor force participation for more than five years. In the even-numbered columns, I control for the indicator for above median risk of depression, and in the odd-numbered columns, I include the interaction of this indicator with pill access variables. The even-numbered columns confirm the positive associations between access to the pill and education and labor market outcomes. Legal access is associated with a higher probability to attend college and more years of education. Consent access is positively associated with the probability to be in the labor force for more than five years.[33] The interactions between above median risk of depression and pill access variables are all negative and statistically significant for consent access. This suggests that for those individuals for which access to the pill had the strongest negative mental health effect, access to the pill negatively affects college attendance, years of education, and labor force participation. The coefficients of pill access increase when adding the interaction, suggesting that the fertility control effects of access to the pill are slightly larger than measured when ignoring the mental health effect. This means that estimates from the literature were a combination of both these effects, fertility control, and mental health effects. While the fertility effect of the pill increases education and labor force participation, the mental health effect reduces these. The composite effect in the literature thereby slightly underestimates the fertility effect, since it includes the effect of mental health costs.

[33]The results for years of education, college attendance, and labor force participation can also be compared to previous findings in the literature. The results for years of education are larger than the ones presented in Lindo et al. (2020), likely driven by excluding those with access through marriage. The results for college attendance are larger than findings by Hock (2007) or Bailey et al. (2012), likely for similar reasons. The results for labor participation are somewhat smaller than findings in Bailey (2006). This is potentially related to overall high labor force participation in the HRS sample, see Table 3.

Table 16: Effect of pill access during adolescence (age 14-21) on education and labor market outcomes

	Ever College		Years Educ.		Ever LFP		LFP > 5 yrs	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fract. years with legal access pill	0.202***	0.230***	1.026**	1.102**	0.006	0.016	-0.001	0.006
	[0.065]	[0.066]	[0.449]	[0.472]	[0.013]	[0.016]	[0.026]	[0.032]
Fract. years with consent access pill	-0.035	0.068	0.481	0.838	0.000	0.035	0.034	0.089***
	[0.115]	[0.129]	[0.786]	[0.825]	[0.022]	[0.027]	[0.027]	[0.027]
Fract. years with legal access pill x PGS		-0.064		-0.186		-0.018		-0.014
depressive symptoms above median		[0.040]		[0.221]		[0.014]		[0.021]
Fract. years with consent access pill x		-0.201***		-0.703*		-0.058**		-0.108**
PGS depressive symptoms above median		[0.069]		[0.373]		[0.025]		[0.046]
R-squared	0.154	0.156	0.163	0.165	0.037	0.042	0.042	0.045
N	3,525	3,525	3,515	3,515	3,526	3,526	3,526	3,526
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects and controls for childhood depression, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. Controls for above median genetic risk in every column.

Table 17: Effect of pill access during adolescence (age 14-21) on disability, limitations and sick days

	Disability periods		Ever disabled		Ever limitation		Av. sick days	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fract. years with legal access pill	-0.022	-0.097	-0.013	-0.048	-0.081	-0.082	-0.082	-1.812
	[0.103]	[0.104]	[0.041]	[0.040]	[0.065]	[0.068]	[1.451]	[1.813]
Fract. years with consent access pill	-0.116	-0.196	0.026	0.008	-0.101	-0.173	-1.420	-4.288
	[0.171]	[0.210]	[0.054]	[0.074]	[0.122]	[0.117]	[3.248]	[3.389]
Fract. years with legal access pill x PGS		0.119*		0.054***		-0.004		1.291
depressive symptoms above median		[0.070]		[0.020]		[0.044]		[1.551]
Fract. years with consent access pill x PGS		0.091		0.008		0.137*		5.643*
depressive symptoms above median		[0.131]		[0.072]		[0.071]		[2.994]
R-squared	0.049	0.063	0.044	0.057	0.136	0.137	0.085	0.088
N	3,526	3,526	3,526	3,526	3,526	3,526	2,853	2,853
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects and controls for childhood depression, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. Controls for above median genetic risk in every column.

In the next step of my analysis, I investigate whether this negative mental health effect of the pill is also associated with measures of reduced labor market productivity. I use the number of disability periods, an indicator for ever reporting disability, an indicator for ever reporting limitations at work due to health problems, and the average number of sick days. In the same fashion as above, in the even-numbered columns of Table 17, I control for the indicator for above median risk of depression, and in the odd-numbered columns, I include the interaction of this indicator with pill access variables. Table 17 shows no significant association between pill variables and measures of reduced labor market productivity. Interestingly, however, all interactions between pill access and the indicator for above median risk of depression are positive, and (marginally) statistically significant for legal access for the disability periods and the probability to ever report a disability, and (marginally) statistically significant for consent access for the probability to ever report limitations and the average number of sick days. This pattern paints a similar picture as above, where access to the pill for those with above median risk leads to reduced labor market productivity, here in the form of increased disability, limitations, and sick days.

6 Conclusion

In this paper, I investigate the mental health costs of a health technology considered to be one of the most powerful of the 20th century: the contraceptive pill. While previous economic literature has mainly focused on the liberalizing effects on fertility, labor market outcomes, and education, this paper is the first to add mental health as an outcome dimension. This is motivated by evidence from medical studies suggesting a link between hormonal contraceptive use and depression. I document large negative effects of access to the pill on mental health. Considering measures of family formation and work stress, I argue against other channels driving my results.

After providing evidence for a link between access to the pill and mental health, I investigate the importance of this link for the effect of the pill on education and labor market outcomes. Previous literature has established a positive effect of the pill on education and labor market outcomes due to its fertility control function. Adding a path via mental health when estimating the effect of the pill shows a small increase in the effect of the pill on education and labor force participation and shows negative coefficients of the interaction with an indicator for high genetic risk for depression. This suggests that previous estimates have been a combination of the positive fertility control effect of the pill and the negative mental health effect of the pill. They have thus slightly underestimated the role of fertility control on education and labor market outcomes. Access to the pill for those at high genetic risk for depression is also related to a higher probability to report limitations at work and to a higher number of disability periods.

From a policy perspective, my results can inform decision-making processes in the area of reproductive health. It seems important to carefully weigh the potential mental health effects for the prescription of hormonal contraceptives against their fertility control effect and to compare these to non-hormonal contraceptives. This is particularly important in light of the large changes in contraceptive behavior recently, as represented in Figure A1. Pill usage shares have dropped by about one-third in the last fifteen years. Part of that could be connected to the awareness of side effects that has been increasing over time, for example, reflected by an increase in Google searches for the term pill side effects (see Figure A2).[34] My results support the reasoning for more investment into research on non-hormonal contraceptive methods and research on male contraceptives as well as subsidies for non-hormonal contraceptives. The role of contraceptives has become more relevant given the increased barriers to abortion in the US. For policies related to mental health and the labor market, my findings show a substantial productivity cost of mental health effects of the pill. This is important to acknowledge, especially in light of gender differences in the prevalence of mental health problems and in their effect on labor market productivity, which may potentially accentuate gender wage gaps.

[34] Another potential reason for the drop in pill usage is likely related to the increased use of alternative contraceptives, such as for example long-acting reversible contraceptives (LARCs). While these methods bring more ease of use, they also contain hormones.

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Appendix I: Theoretical framework

I provide a short theoretical framework for the mental health effect of the pill that generates persistence in mental health shocks but also helps to formalize considerations about different channels at work. Some studies have applied the standard Grossman model (Grossman, 1972) of health production to mental health, (Cronin et al., 2020; Mendolia, 2014). Cronin et al. (2020) argue that mental health should - analogous to physical health - be analyzed as a type of human capital, given its strong connection to labor market outcomes. Mental health in this framework is defined as a stock that will depreciate over time but can be invested into.[35] Changes to the current mental health stock other than the depreciation over time are defined as investments, so as parts of the production function I_i.

$$H_{i+1} = (1 - \delta)H_i + I_i \tag{A1}$$

The production function I_i is typically modeled as a function of health care use M_i and time invested into health care use, T_i. Following Mendolia (2014), I define this function to also depend on initial mental health status H_0. I furthermore augment I_i to include pill use - which affects the health investment via the function $j(P_i)$. I rely on a function instead of a single parameter to capture the different channels through which pill use might affect mental health.

$$I_i = f(M_i, T_i, H_0, j(P_i)) \tag{A2}$$

The function $j(P_i)$ defines the effect of pill use to depend on four components: a biological effect through hormones, a family formation effect (governed e.g. by age at marriage, or age at first child), a career effect, and an error term (ϵ_i), capturing all remaining channels.[36] The biological effect reflects the evidence from the medical studies by Skovlund et al. (2016), Skovlund et al. (2018), and Wit et al. (2020) and is mostly concentrated at younger ages. The family formation effect captures the fact that the pill has changed family planning and formation significantly by enabling to delay marriage and first childbirth, as demonstrated by Bailey (2006) and Bailey (2010). This changed family planning and formation potentially affects mental health. If access to the pill improves mental health due to reduced stress since pregnancy uncertainty decreased (Goldin and Katz, 2002; Bailey, 2006), then estimates of access to the pill would be a mix of these positive stress-reducing and the negative biological mental health effects of the pill and thus provide a lower bound of negative biological mental health effect. More problematic are negative mental health effects, due to changes in family formation. One example is the increase in out-of-wedlock birth, due to increased sexual activity, (Akerlof et al.,

[35] In contrast to physical health, the depreciation of mental health over time is the subject of a scientific debate. Estimates of the evolution of mental health in old age are challenged due to large issues with selective attrition. Mirowsky and Reynolds (2000) present convincing evidence for a decline in mental health in the NSFH, that is veiled by selective attrition. Hauck and Rice (2004) show deterioration of mental health with age in the British Household Panel Survey.

[36] For simplicity, I assume that changes in sexual behavior, as well as their mental health effects, are captured in the family formation channel. This is motivated by the study by Akerlof et al. (1996) who find that access to the pill has resulted in increased sexual activity, and ultimately led to more out-of-wedlock birth. Other changes in sexual activity are not well-established.

1996). Similarly one could also imagine negative mental health effects following increased stress associated with the more ambitious careers that women were able to choose due to the pill, as demonstrated by Steingrimsdottir (2016) and Bailey et al. (2012). If such negative mental health effects exist, they would also be problematic as they would lead to an overestimation of the biological effect. The three different channels are captured in $j(P_i)$ by three different parameters, governed by the indicator $P_i \in \{0, 1\}$

$$j(P_i) = (\alpha + \beta + \gamma)P_i + \epsilon_i \tag{A3}$$

In an estimation that uses pill access policies to estimate the effect of the pill on mental health, the estimates potentially reflect a combination of the biological (α), fertility (β), and career effects (γ) of the pill. As mentioned above, one caveat in this analysis is thereby to wrongly attribute (over-estimate) negative mental health effects to the biological channel if they are actually caused by the other two channels. The empirical investigation in Section 4.1 shows that the mental health effect of most of these family formation and career channels is either negligible or positive. In case of positive mental health effects of the changes in fertility and careers, this leads to a downward bias of the biological effect.

Persistence of mental health shocks as motivated by evidence from the psychological literature is generated in the Grossman model in its simplest form as it models the health stock as an AR(1) process, where the health stock in the next period is a function of the current health stock. Without compensating health investments, any negative health investment will permanently shift the mental health curve downwards, due to the AR(1) process. In case of compensating health investments, a mental health shock is persistent if the discounted value of (the sum of) health investments is smaller than the discounted value of the health shock. An alternative approach to model health development, in particular with respect to ageing and the lifecycle is the model of health deficits by Dalgaard and Strulik (2014). Instead of relying on an abstract health capital stock, this approach formalizes ageing with the accumulation of health deficits. Persistence in this type of model is however inherent in a similar way as in the Grossman model: future deficits are a function of current deficits, and thus if not reduced by investments, carry onto the future persistently.

Appendix II: Tables

Table A1: Legal and consent access to abortion - law changes coded by Myers (2017)

Age	>21	18-20	<18		>21	18-20	<18
Alabama	1973	1973	1973	Montana	1973	1973	1973
Alaska	1970	1970	1977	Nebraska	1973	1973	1975
Arizona	1973	1973		Nevada	1973	1973	1976
Arkansas	1973	1973	1976	New Hampshire	1973	1973	1973
California	1969	1971	1971	New Jersey	1973	1973	1973
Colorado	1973	1973	1975	New Mexico	1973	1973	
Connecticut	1973	1973		New York	1970	1970	1970
Delaware	1973	1973	1977	North Carolina	1973	1973	1975
District of Columbia	1971	1973	1973	North Dakota	1974	1974	1979
Florida	1973	1973	1975	Ohio	1973	1973	1973
Georgia	1973	1973		Oklahoma	1973	1973	
Hawaii	1970	1970		Oregon	1973	1973	1973
Idaho	1973	1973		Pennsylvania	1973	1973	1973
Illinois	1973	1973	1973	Rhode Island	1973	1973	
Indiana	1973	1973	1975	SouthCarolina	1973	1974	1974
Iowa	1973	1973	1976	SouthDakota	1973	1973	
Kansas	1973	1973	1973	Tennessee	1973	1973	1979
Kentucky	1973	1973	1974	Texas	1973	1973	
Louisiana	1973	1973	1976	Utah	1973	1973	
Maine	1973	1973	1979	Vermont	1973	1973	
Maryland	1973	1973	1973	Virginia	1973	1973	
Massachusetts	1973	1974	1976	Washington	1970	1970	1975
Michigan	1973	1973	1977	West Virginia	1973		
Minnesota	1973	1973	1973	Wisconsin	1973		
Mississippi	1973	1973	1973	Wyoming	1973		
Missouri	1973	1974	1975				

Note: The table shows years in which states enabled legal and consent access to abortion for a given age group. The coding of these laws is taken from Myers (2017).

Table A2: CES-D items, NSFH and HRS

	NSFH	HRS
	Next is a list of the ways you might have felt or behaved during the past week. Circle your answer to each question. On how many days during the past week did you:	Now think about the past week and the feelings you have experienced. Please tell me if each of the following was true for you much of the time this past week.
feel bothered by things that usually don't bother you?	1-7	/
not feel like eating; your appetite was poor?	1-7	/
feel that you could not shake off the blues even with help from your family or friends?	1-7	/
have trouble keeping your mind on what you were doing?	1-7	/
feel depressed?	1-7	1/0
feel that everything you did was an effort?	1-7	1/0
feel fearful?	1-7	/
sleep restlessly	1-7	1/0
talk less than usual?	1-7	/
feel lonely	1-7	1/0
feel sad?	1-7	1/0
feel you could not get going?	1-7	1/0
feel happy?	/	1/0
enjoyed life?	/	1/0

Table A3: Effect of pill access during adolescence (age 14-21) on mental health, w. controls

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.161	0.006	0.071	0.036
	[0.154]	[0.080]	[0.057]	[0.033]
Fract. years with consent access pill	0.345**	0.015	0.199**	0.101*
	[0.161]	[0.108]	[0.080]	[0.059]
Fract. years with legal access abortion	0.583**	0.308***	-0.210**	-0.062
	[0.221]	[0.098]	[0.080]	[0.059]
Fract. years with consent access abortion	0.312	0.067	-0.255*	-0.033
	[0.353]	[0.134]	[0.145]	[0.095]
Black	0.198***	0.142***	0.160***	0.073***
	[0.049]	[0.029]	[0.027]	[0.017]
Hispanic	0.158	0.065	0.237***	0.125***
	[0.148]	[0.047]	[0.044]	[0.019]
Fract. years with state equal pay laws	0.465**	0.106	0.099	0.047
	[0.206]	[0.109]	[0.079]	[0.058]
Fract. years w. laws against racial discrimination in employment	-0.103	-0.0050	-0.024	0.002
	[0.144]	[0.075]	[0.055]	[0.039]
Fract. years with no-fault divorce	-0.201	-0.017	0.001	0.010
	[0.175]	[0.083]	[0.001]	[0.010]
R-squared	0.09	0.09	0.27	0.18
N	2,229		6,671	
Linear time trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, and controls for age flexibly with age dummies. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

Table A4: Effect of pill access during adolescence (age 14-21) on mental health, scores

	NSFH CES-D (1)	HRS CES-D (2)
Fract. years with legal access pill	0.839	0.287
	[0.130]	[0.178]
Fract. years with consent access pill	1.809	0.651**
	[1.459]	[0.306]
R-squared	0.08	0.21
N	2,229	6,671
Linear time trends	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic.

Table A5: Effect of pill access during adolescence (age 14-21) on mental health, probit

Average Marginal Effects	NSFH	HRS
	>critical threshold	
	(1)	(2)
Fract. years with legal access pill	0.041	0.010
	[0.033]	[0.080]
Fract. years with consent access pill	0.099*	0.044
	[0.060]	[0.106]
N	6,657	2,217
Linear time trends	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

Table A6: Effect of pill access during adolescence (age 14-21) on mental health, without state-cohort trends

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.082	-0.005	0.034	0.005
	[0.113]	[0.081]	[0.044]	[0.026]
Fract. years with consent access pill	0.064	-0.013	0.096	0.027
	[0.161]	[0.120]	[0.075]	[0.045]
R-squared	0.07	0.07	0.27	0.17
N	2,229		6,671	
Linear state-cohort trends	*No*	*No*	*No*	*No*
Quadratic state-cohort trends	*No*	*No*	*No*	*No*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

Table A7: Effect of pill access during adolescence (age 14-21) on mental health, with quadratic state-cohort trends

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	-0.192	-0.043	-0.009	0.003
	[0.248]	[0.134]	[0.109]	[0.053]
Fract. years with consent access pill	0.361*	0.001	0.195**	0.078
	[0.215]	[0.146]	[0.090]	[0.061]
R-squared	0.10	0.10	0.28	0.19
N	2,229		6,671	
Linear state-cohort trends	*Yes*	*Yes*	*Yes*	*Yes*
Quadratic state-cohort trends	*Yes*	*Yes*	*Yes*	*Yes*

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three.

Table A8: Effect of pill access during adolescence (age 14-21) on mental health, with individuals who obtained access through marriage

	NSFH		HRS	
	log CES-D	log CES-D	log CES-D	log CES-D
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.059	0.019	0.082	0.067
	[0.132]	[0.132]	[0.059]	[0.059]
Fract. years with consent access pill	0.124	0.049	0.197***	0.161**
	[0.160]	[0.157]	[0.073]	[0.076]
Access through marriage	-0.017	0.014	0.024	0.035
	[0.065]	[0.064]	[0.034]	[0.033]
Early marriage		0.439***		0.196***
		[0.195]		[0.072]
R-squared	0.08	0.08	0.28	0.28
N	2,686		7,903	
Linear state-cohort trends	*Yes*	*Yes*	*Yes*	*Yes*

*Note:*Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three. Early marriage is defined as getting married before age 16 which was the minimum legal marriage age in most states at that time, see Dahl (2005).

Table A9: Effect of pill access during adolescence (age 14-21) on mental health, with early marriage dummy

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.160	0.005	0.073	0.038
	[0.148]	[0.079]	[0.058]	[0.034]
Fract. years with consent access pill	0.350**	0.018	0.199***	0.101*
	[0.159]	[0.107]	[0.080]	[0.059]
Early marriage	0.404***	0.212***	0.173*	0.100*
	[0.122]	[0.070]	[0.090]	[0.053]
R-squared	0.09	0.09	0.28	0.18
N	2,229		7,903	
Linear state-cohort trends	*Yes*	*Yes*	*Yes*	*Yes*

*Note:*Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black, and being hispanic. CES-D critical threshold in the NSFH defined as CES-D score above nine, in the HRS as CES-D score equal or above three. Early marriage is defined as getting married before age 16 which was the minimum legal marriage age in most states at that time, see Dahl (2005)

Table A10: Descriptive statistics of variables for analysis of mental health effects of the pill, males

	HRS
Mental health variables	
CES-D Score	1.29
	(1.88)
CES-D critical threshold	0.18
	(0.38)
Childhood depression	0.01
	(0.11)
Pill access variables	
Fract. years with legal access pill (14-21)	0.39
	(0.37)
Fract. years with consent access pill (14-21)	0.20
	(0.28)
Demographic control variables	
Year of birth	1946,68
	(7.58)
Age at measurement	60.58
	(3.45)
Black	0.19
	(0.39)
Hispanic	0.07
	(0.26)
Controls for other reforms	
Fract. years with legal access abortion(14-21)	0.04
	(0.11)
Fract. years with consent access abortion (14-21)	0.14
	(0.24)
State equal pay laws	0.75
	(0.41)
Laws against racial discrimination in employment	0.70
	(0.42)
No-fault divorce	0.15
	(0.31)
N	5,393

Note: Means and standard deviations (in parentheses). Sample restricted to men born between 1934 and 1958 with mental health information available. The CES-D critical threshold equals one if the respondent reports a CES-D score greater than or equal to three.

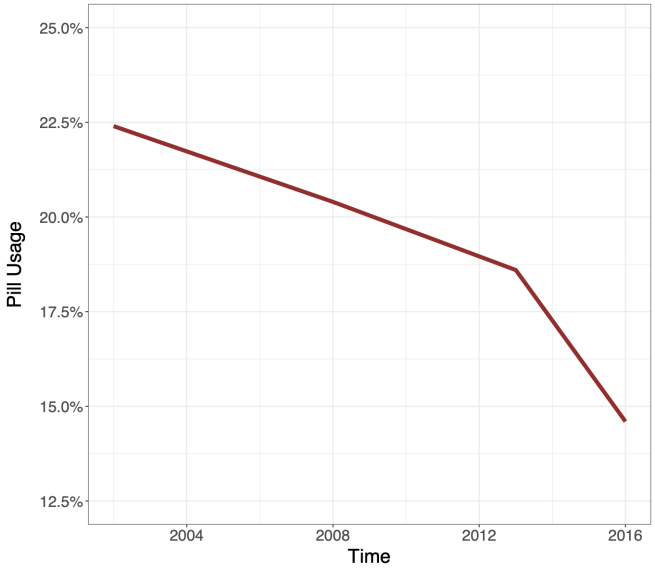
Table A11: Descriptive statistics of variables for channel analysis

	NSFH	HRS
Family formation		
Age at first marriage	21.55	22.61
	(4.27)	(5.78)
Ever married	0.86	0.93
	(0.34)	(0.25)
Married before age 22	0.56	0.52
	(0.50)	(0.50)
Age at first child	22.41	23.82
	(4.63)	(5.34)
No children	0.17	0.12
	(0.38)	(0.33)
Childbirth before age 22	0.49	0.39
	(0.50)	(0.49)
Out-of-wedlock birth	0.21	0.13
	(0.40)	(0.34)
Measures of stress at work		
Average time pressure	/	2.03
		(0.90)
Average stress at work	/	2.05
		(0.49)
N	1,919- 2,335	5,476-6,838

Note: Standard deviations in parentheses. Time pressure is measured on a scale agreeing to the sentence "whether respondent is under constant time pressure due to heavy workload" ranging from 1 (strongly disagree) to 4 (strongly agree). I average answers for each respondent over all waves available. This variable is only measured from waves 9-11. Stress on the job is measured on a scale agreeing to the sentence "current job involves much stress" ranging from 1 (strongly agree) to 4 (strongly disagree). I average answers for each respondent over all waves available and then revert the measure such that a higher value reflects more stress.

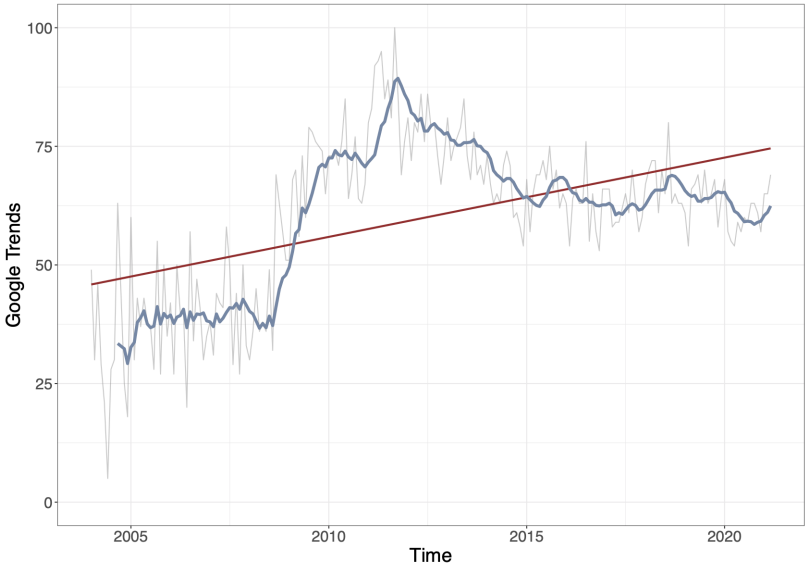
Appendix III: Figures

Figure A1: Share of current pill users among contraceptive users



Source: own configuration with data from Centers for Disease Control and Prevention, *Key Statistics from the National Survey of Family Growth* `https://www.cdc.gov/nchs/nsfg/key_statistics/c.htm#contraception`, accessed March 21, 2021

Figure A2: Google Trends: searches for the term “pill side effects"



Source: own configuration from `https://trends.google.com/trends/`. This figure depicts google searches in relation to the highest point between January 1st, 2004 - March 1st, 2021. A value of 100 reflects the highest popularity of searches for the term “pill side effects”.