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TWO SIDES OF THE SAME PILL? FERTILITY CONTROL AND MENTAL HEALTH EFFECT OF THE CONTRACEPTIVE PILL

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Abstract

I investigate the link between access to the contraceptive pill, mental health, education, and labor market outcomes. Liberalizing education and labor market effects of access to the pill via its fertility control function are well established. More recently, a medical literature however 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 are driven by individuals with a genetic predisposition for depression who then do not experience the positive effects on education and labor market outcomes.
Keywords: Mental Health, Contraceptive Pill, Fertility, Labor Market Outcomes

JEL-Codes: J16, J13, J18, J24, I0

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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 concerning 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, 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, suicide attempts, and self-reported mental health (Anderl et al., 2020; Johansson et al., 2023; Skovlund et al., 2016; Skovlund et al., 2018; Wit et al., 2020). The underlying mechanism suggested are the sex hormones progesterone and estrogen which are suspected to cause depressive symptoms and are contained in hormonal contraceptives. These findings 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 have further implications for the findings from the “power of the pill” literature given the well-established negative impact of poor mental health on education and labor market outcomes. 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. Therefore, 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 access to 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 using plausibly exogenous variation in access to the pill in the US between 1960 and 1977 combined with data from the National Survey of Families and Households (NSFH) and the Health and Retirement Study (HRS). I find that access to the pill during adolescence is related to worse self-reported mental health with 20-35% (HRS/NSFH) higher depression scores for women with pill access during their entire adolescence. In the HRS, these constitute long-term effects, in line with previous evidence (Johansson et al., 2023) and general

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

high persistence of mental health problems (Fryers and Brugha, 2013). Importantly, the mental health effect of the pill is driven by individuals with high genetic depression risk, derived from polygenic scores. I provide further evidence for a hormonal channel in a placebo test on men, and by showing that general changes in life trajectories for women with access to the pill do not drive the results.[2]

In a second step, I investigate the importance of this mental health cost for the liberalizing education and labor market effects. 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. I use interactions between pill access variables and an indicator for high genetic depression risk. This increases the coefficients of pill access and shows negative and significant coefficients of the interactions, suggesting that previous estimates are composed of a positive fertility control effect and a negative mental health effect. Access to the pill interacted with an indicator for high genetic depression risk also increases the number of disability periods, the probability of ever reporting disability, the probability of ever reporting limitations at work, and the number of sick days.

I contribute to two strands of the literature. First, I add to the "power of the pill" literature by considering an important health outcome and its relationship to the labor market. Goldin and Katz (2000, 2002) initiated this literature by showing that trends toward 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. This led to delayed fertility (Bailey, 2006, 2010; Guldi, 2008) which raised female college enrolment rates by 5 percentage points, college completion rates by 0.9 percentage points (Hock, 2007) and the probability to enroll in programs leading to more ambitious occupations and higher wages (Steingrimsdottir, 2016). Larger investments into education were followed by increases in labor force participation, working hours, and wages (Bailey, 2006; Bailey et al., 2012; Goldin and Katz, 2002; Hock, 2007; Madestam and Simeonova, 2013).
Few studies identify negative consequences of access to the pill, e.g. reduced female bargaining power within marriage (Altindag and Ziebarth, 2019) or increases in out-of-wedlock births due to increased sexual activity, given that the pill is not 100% effective (Beauchamp and Pakaluk, 2019). However, the focus of these studies remains on the fertility control channel of the pill.

Myers (2017) takes a more critical view by arguing that the effect of the pill is considerably smaller than the one of abortion - if existent at all. This more or less zero effect

[2]Notably, my findings reflect a net mental health effect, containing the negative hormonal effect and likely a positive mental health effect from adverting unplanned births. Since the total effect is negative, the negative hormonal effect outweighs the positive birth-adverting effect. The pure hormonal effect might thus be larger if women indeed experience positive mental health effects of adverting birth.

of the pill on total fertility is motivated by increased sexual activity, but it is unclear whether this masks heterogeneity 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 but a positive and significant effect on the probability of working in a Social Security-covered job during ages 20-34. I add one potential explanation for the small effects here: mental health prevents the pill from unfolding its true fertility control potential for labor market outcomes, in particular for women with high genetic depression risk.

Second, I contribute to the literature investigating the relationship between mental health, education, and labor market outcomes. Mental health problems have been shown to negatively affect school performance (Ding et al., 2009) and to increase drop-out (Cornaglia et al., 2015). They also reduce labor supply (internal and external margin) and increase absenteeism (Banerjee et al., 2017; Ojeda et al., 2010). Estimated earnings penalties of mental illness range from 34% for depression to 74% for schizophrenia (Biasi et al., 2021). Mental health is often treated as pre-determined, and factors affecting both mental health and labor market and education outcomes (like the pill) have not been considered.

Lastly, this paper is broadly related to the medical literature on the effect of hormonal contraceptive use on mental health. Large population studies from Denmark show that use of hormonal contraceptives is associated with a 1.2-1.8 higher incidence rate of first anti-depressant usage, a 1.7 higher rate of first diagnosis of depression for adolescents (Skovlund et al., 2016), and a 1.9 higher incidence rate of suicide attempts (Skovlund et al., 2018). Similar associations are found in the Netherlands (Wit et al., 2020) and also in the UK and the US for longer-term outcomes (Anderl et al., 2020; Johansson et al., 2023). These associations hold for a substantial share of women: Anderl et al. (2020) report that while only 5.7% of never users of oral contraceptives meet criteria for major depressive disorder, this share rises to 9.3% for first users during adulthood, and 16.1% for first users during adolescence. These results can, however, not necessarily be interpreted as causal, given that selection in and out of the use of hormonal contraceptives is rarely addressed. I mitigate such concerns by using plausibly exogenous variation in access to the pill. My findings on the role of genetic risk also contribute to a better understanding of mechanisms.

The paper addresses two important public health areas: mental and reproductive health. The fight against mental illness has become a priority on political agendas around the globe given its increasing prevalence. In 2020, 21% of adult Americans reported suffering from mental illness.[3] The large prevalence is accentuated by strong gender differences: women have a two times higher lifetime likelihood of experiencing mental illness (Hammarström et al., 2009). Recent increases in barriers to abortion access due to the overturning of Roe v. Wade in June 2022, make healthy contraception even more important.

[3] National Institute of Mental Health. https://www.nimh.nih.gov/health/statistics/mental-illness, accessed October 10, 2022.

This is particularly relevant in light of the gender imbalance in hormonal contraception. Both, men and women benefit from fertility control, but only women bear the potential mental health costs.

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

2 Background: Access to the Pill

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). 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 (Comstock laws) prevented access to the pill in some states. Struck down in Griswold v. Connecticut, by 1970, every state allowed access for married individuals. In 1972, Eisenstadt v. Baird enabled access for unmarried individuals but only above the age of majority (typically age 21) or for minors with parental or a guardian's consent. Thus, only women above the age of majority could consent to medical treatment themselves and obtain the pill, referred to as legal and consent access (called consent access from now onwards). Minors were not able to obtain the pill alone but had to bring a parent or legal guardian who could consent for them. This is referred to as legal access.[4]

Therefore, even after Eisenstadt v. Baird, in many states, younger, unmarried women were initially excluded from the benefits of contraceptive technology. However, over the following two decades, several types of laws changed successively which enabled access to the pill for women below the age of 21. These changes either directly lowered age of majority or provided more rights to minors, such as mature-minor-doctrines or medical consent laws.[5] The lowering of age of majority was plausibly exogenous since it was not related to contraceptive needs but to Vietnam War drafting, diminishing the age gap between earliest drafting (age 18) and voting rights (age 21) (Bailey, 2006).

The age at which women had either legal or consent access to the pill varied substantially across states and birth cohorts. The validity of using this variation depends on whether the lowered access barriers indeed resulted in higher pill usage. Goldin and Katz (2002) identify an increase in pill usage of 4 percentage points for women aged 17-19 years, relying on a cross-sectional snapshot of the National Study of Young Women. Bailey

[4] Consent access has been considered more relevant, since legal access required bringing one's parents or guardian - likely an interference with privacy rights. Nevertheless, legal access is important as it still enabled minors to obtain the pill.

[5] Bailey et al. (2011) provide a detailed overview of these laws and state-by-state timelines.

et al. (2012) consider state and cohort fixed effects and show that the probability to use the pill before age 21 increased for women with early legal access by 42%.

In addition, other access barriers likely were important. Financial coverage of birth control was only mandated in the Affordable Care Act in 2010 and had to be covered via private insurance before 2010. The cost of the pill at the introduction was around 100$ per year (Warsh, 2011), equivalent to 760$ in 2010 (Bailey, 2013). Within five years after the introduction, the price dropped to 25$ per year. Alternative forms of contraception, e.g. condoms and diaphragms, existed as well but were expensive and, in contrast to the pill, had to be applied before intercourse, thus representing a higher variable cost of fertility control. They also had a higher failure rate than the pill (Bailey, 2006).

Importantly, there is an overlap in timing between improved access to the pill and access to abortion. I will take this into account in the estimations. Abortion access is relevant as it may have mental health effects by itself. A priori, the effect is ambiguous and widely discussed. Results from the Turnaway Study (Foster, 2020) suggest that denying an abortion has negative mental health effects while receiving one does not have detrimental effects. Similar null effects are found in Janys and Siflinger (2024) for Sweden and in Clarke and Mühlrad (2021) for Mexico.

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).[6] The NSFH is suitable to establish a more immediate link between access to the pill and mental health as it measures mental health between ages 28 and 54, for 60% of the sample before age 40. The HRS measures mental health at a late age given the focus on individuals aged 50 and above but has a larger sample and rich data to investigate the effect of the pill on labor market outcomes via mental health.

The NSFH is a nationally representative survey of 13,007 individuals, interviewed for the first wave between 1987 and 1988. The HRS is a representative panel study of around 20,000 individuals aged 50 and above with 14 waves from 1992-2018. I focus on cohorts born from 1934-1958 which were exposed to early and differential access to the pill.[7] I

[6] I use the first wave of the NSFH (Bumpass et al., 1994). For the HRS, I use the RAND HRS Longitudinal File, developed at RAND with funding from the National Institute on Ageing and the Social Security Administration.

[7] Women born before 1934 only had pill access in their late 20s, those born after 1958 had full access in most states. After 1958, the definite legal status of consent access became unclear in many states given several Supreme Court cases (Myers, 2017).

construct access to the pill for individuals in the NSFH using information on state at birth and state of residence at age 16, and in the HRS using state of residence at age 10 or state of birth.[8]

I focus on access to the pill between age 14 and 21, for several reasons: First, changes in access to the pill occurred here. Women older than 21 always had access starting in 1972. Second, individuals make important decisions regarding human capital investment during that time. Third, mental health is particularly malleable and sensitive to external influence in adolescence due to ongoing brain development, with large susceptibility to sex hormones (Kessler et al., 2007, 2005), also reflected by larger effects of hormonal contraceptive use on mental health for adolescent women aged 15-19 (Skovlund et al., 2016). Table A1 in Appendix A shows how access to the pill is distributed in both samples. While the two types of access are mutually exclusive, it is possible to have legal access for some years and then consent access for the following years. The distribution of access through these two forms differs strongly, suggesting including them separately in the estimations. 35-43% of the respondents had no legal access and 48-59% had no consent access before age 21. 20-22% had more than four years of legal access, and 10-13% had more than four years of consent access. Abortion access is constructed similarly.

3.2 Data on Mental Health and Labor Market Outcomes

I use two measures of mental health, 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 situations, such as bereavement (Siflinger, 2017), response to family health shocks (Rellstab et al., 2020), pregnancy-related expansions to Medicaid (Guldi and Hamersma, 2023), improved access or coverage of mental health care (Ayyagari and Shane, 2015; Ma and Nolan, 2017), and experience of major recessions (McInerney et al., 2013). The NSFH contains a 12-item scale, and the HRS an 8-item scale (Table A2). The two scales overlap only in six items, but there is no evidence of consistency or usage of a 6-item scale. Therefore, I stick to the complete scales and log-transform them to ease interpretability. A higher value indicates higher levels of depression. I also use critical cut-offs, indicating clinically significant levels of depression.[9] For the NSFH, I use data from the first wave only, as it contains state of residence and mental health measurements. In the HRS, the CES-D scale is collected in waves 2-14, so I construct the measures as close as possible

[8] In the NSFH, I restrict the sample to individuals whose state of residence did not change between these two measurements. This allows to precisely pin down the state relevant for pill access. The results are robust to relaxing this restriction. In the HRS, I only use the state of birth if there is no information on the state of residence at age 10 (5% of sample) which is slightly older and more likely to be black or hispanic. The results are robust to excluding these individuals.

[9] For the 8-item CES-D scale (HRS), a CES-D ≥ 3 reflects clinically significant levels of depression (Turvey et al., 1999). For the 12-item scale (NSFH), a CES-D > 9 has been suggested but it is less validated (Pascoe et al., 2006).

to age 60.[10]

Table 1 shows descriptive statistics of variables used in the analysis. The upper panel shows that in the NSFH the average CES-D score is 9.75, with 39% of individuals indicating a critical CES-D value. The average CES-D score is 1.59 in the HRS with around 24% of the sample reporting critical CES-D value.[11] Table 1 further shows descriptives for control variables, such as age, indicators for being black, being hispanic, reporting childhood depression, and reform indicators for state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.[12]

In the second part of my analysis, I use information on education and labor market outcomes in the HRS.[13] I start with positive outcomes (years of education, indicators for college attendance, ever being in the labor force, being in the labor force for more than five years) and then use negative outcomes (number of disability periods, ever disability indicator, ever limitations at work due to health problems, average sick days). Descriptive statistics of those variables (Table 1) show that 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, 92% for more than five years. While 13% report ever having a period of disability, the average number of disability periods is 0.35. Around 60% of individuals report ever experiencing limitations at work due to health and report on average 5.62 sick days per year.

3.3 Empirical Strategy

I define pill access as an exposure measure. 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. 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:

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

The parameters of interest are β_1 and β_2, the effects of legal and consent access to the pill during adolescence. As both access variables represent fractions, β_1 and β_2 have to be interpreted as the effect of woman i having legal or consent access to the pill during all

[10] I focus on mental health measured around age 60 because I have data on most individuals here. For some women, mental health is even measured during their 30s and 40s but this is a particular group of women as they have partners who are older than 50.

[11] The large share of individuals above the critical threshold in the NSFH is likely related to this being a less validated cut-off.

[12] Respondents in the HRS are with 60.47 years much older than those in the NSFH (average 38.39). The share of Blacks is quite similar (22% and 23%) and the share of Hispanics is larger in the NSFH (7%) than in the HRS (4%).

[13] Here, I only use data from the HRS as I rely on genetic information.

Table 1: Descriptive statistics of variables for analysis

	NSFH	HRS
Mental health variables		
CES-D Score	9.75 (8.78)	1.59 (2.12)
CES-D critical threshold	0.39 (0.49)	0.24 (0.43)
Childhood depression	/	0.02 (0.14)
Pill access variables		
Fract. years w. legal access pill (14-21)	0.40 (0.36)	0.34 (0.36)
Fract. years w. consent access pill (14-21)	0.26 (0.30)	0.21 (0.29)
Demographic control variables		
Year of birth	1948.30 (7.43)	1946.22 (7.73)
Age at measurement	38.35 (7.44)	60.47 (3.32)
Black	0.22 (0.41)	0.23 (0.42)
Hispanic	0.04 (0.19)	0.07 (0.25)
Controls for other reforms		
Fract. years w. legal access abortion(14-21)	0.05 (0.12)	0.04 (0.11)
Fract. years w. consent access abortion (14-21)	0.17 (0.25)	0.14 (0.24)
Fract. years w.state equal pay laws	0.79 (0.38)	0.72 (0.43)
Fract. years w. laws against racial discr. in employment	0.76 (0.40)	0.67 (0.44)
Fract. years with no-fault divorce	0.16 (0.31)	0.15 (0.31)
Education and labor market outcome variables		
Ever college	/	0.51(0.50)
Years of education	/	13.13 (2.59)
Ever in labor force	/	0.96 (0.19)
Ever in labor force > 5 yrs	/	0.92 (0.28)
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	2,229	2,853-6,671

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 > 9 in the NSFH and ≥ 3 in the HRS.

seven years from ages 14-21. I estimate this equation using OLS, controlling for access to abortion (fraction of years between ages 14 and 21 with legal or consent access to abortion) in $\boldsymbol{x}_{i,s,t}$. I also include age, a dummy for being black, and a dummy for being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws for no-fault divorce in $\boldsymbol{x}_{i,s,t}$. I add birth cohort and state fixed effects in all regressions, μ_t and ν_s, as well as linear state-cohort trends in $\boldsymbol{x}_{i,s,t}$.[14]

The coding by Myers (2017) defines access for unmarried women. Using information on age at first marriage, I define whether a woman had consent access to the pill before the respective age of consent because she got married. Women receiving access through marriage married particularly young which has been shown to negatively affect mental health (Le Strat et al., 2011). Controlling for early marriage raises endogeneity issues, so I exclude these women from the main analysis and show results including them in a robustness test (Table A10 in Appendix A).

Next, I investigate the effects of access to the pill on education and labor market outcomes, taking the mental health cost into account. I first estimate the effect of the pill on different education and labor market outcomes ($Y_{i,s,t}$) with the following equation:

$$Y_{i,s,t} = \alpha_0 + \alpha_1 \; \textit{legal pill access}_{s,t} + \alpha_2 \; \textit{consent pill access}_{s,t} + \alpha_3 \textit{depression risk}_i \\ \boldsymbol{\alpha_4 x}_{i,s,t} + + \rho_t + \phi_s + \upsilon_{i,s,t} \quad (2)$$

depression risk$_i$ is an indicator for above median genetic depression risk, $\boldsymbol{x}_{i,s,t}$ includes the same controls as before in addition to controls related to the genetic risk measure.[15] In the next step, I add interactions between pill access variables and the indicator for above median genetic depression risk.[16] If there is no effect of the pill on labor market outcomes via depression risk, then the interaction coefficients should be close to zero.

$$Y_{i,s,t} = \gamma_0 + \gamma_1 \; \textit{legal pill access}_{s,t} + \gamma_2 \; \textit{consent pill access}_{s,t} + \gamma_3 \; \textit{depression risk}_i + \\ \gamma_4 \; \textit{legal pill access}_{s,t} \times \textit{depression risk}_i + \gamma_5 \; \textit{consent pill access}_{s,t} \times \textit{depression risk}_i \\ + \boldsymbol{\gamma_6 x}_{i,s,t} + \theta_t + \eta_s + \zeta_{i,s,t} \quad (3)$$

I base my inference not only on the interaction coefficients (γ_4, γ_5) but also on the difference between α_1 and γ_1, and between α_2 and γ_2. This difference shows how considering mental health changes the effect of the pill on education and labor market outcomes.

[14]The inclusion of the state-cohort trends mitigates bias due to unobserved trends in mental health correlated with the timing of the access laws. One example is the women's rights movement, which might be stronger in more liberal states that are more lenient toward pill access.

[15]The measurement of genetic risk will be discussed in Section 4.2. I control for the first 10 principal components of the matrix of genetic data (a standard practice in this literature (Okbay et al., 2016)) and additional polygenic scores related to mental health and contraceptive use/fertility (age at menarche, age at menopause, mental health cross-disorders, BMI, anxiety, number of children). Cragun (2021) documents the importance of controlling for age.

[16]I also include interactions with abortion access.

4 The Mental Health Effect of Access to the Pill

Table 2 shows that consent access to the pill is associated with worse self-reported mental health. Consent access to the pill during all years between ages 14 and 21 is associated with a 37.2% higher CES-D score in the NSFH, and a 19.9% higher CES-D score in the HRS (Columns (1) and (3)). Instead of assuming $exp(x) = 1 + x$, exponentiating the coefficients results in 45.06% and 22.02% higher scores for consent access. Consent access to the pill also increases the probability to report a CES-D score above the critical threshold by 10.1 percentage points (HRS, Column (4)). There is no significant effect in the NSFH, potentially due to the less reliable cut-off. The effects of legal access are smaller and not statistically significant.[17] For the HRS, the results depict a long-term effect of access to the pill on mental health. This is in line with Johansson et al. (2023) showing that pill usage is correlated with elevated lifetime risk of depression, and with evidence from psychology on general persistence of poor mental health, referred to as "continuity of morbidity" (Fryers and Brugha, 2013).[18] Appendix B describes how persistence in mental health shocks can be conceptualized in a Grossman framework (Grossman, 1972).

A retrospective module in the HRS contains information on childhood depression and enables to control for pre-existing depression. Columns (5) and (6) of Table 2 add an indicator for reporting depressive symptoms before age 13 (childhood depression).[19] The results change little but reflect persistence of mental health problems: childhood depression is associated with a 35% increase in the CES-D score, and a 16.4 percentage points increased probability to report a clinically relevant score.

Given the argument for a biological effect of the pill on mental health, I perform a placebo test with men from the same birth cohorts. If there are other, unobserved factors contributing to worse mental health correlated with the timing and place of the law changes granting access to the pill, one should also see positive and significant coefficients for men. Panel B of Table 2 shows that there are no significant effects on men's mental

[17] Appendix A contains additional tables, showing coefficients of control variables (Table A3), results for the CES-D score instead of its log-transformation (Table A4), for omitting linear state cohort trends and for adding quadratic state cohort trends (Tables A5 and A6). Without linear trends, the estimates drop sharply and are no longer significant. The drop in the coefficient size is similar to the one in Myers (2017), but not the drop in significance, potentially due to a larger sample there. This suggests the existence of important time dynamics captured in these linear state cohort trends. Table A7 shows average marginal effects from a probit estimation for the critical threshold, in line with the results from the OLS.

[18] Long-term effects in the other medical studies are often limited by selective attrition in pill use, which seems to downward bias results (Skovlund et al., 2016). Studies from psychology demonstrate persistence of poor mental health in various cases, see Fryers and Brugha (2013).

[19] Descriptives in Table 1. The reliability of retrospective childhood information provided by elderly adults has been demonstrated for the Survey of Health, Ageing and Retirement in Europe, the HRS sister study (Havari and Mazzonna, 2015). Concerns regarding recall bias and small incidence (2% report childhood depression) are mitigated by large and statistically significant associations between childhood depression and later-life mental health, suggesting meaningful variation in pre-existing depression.

health.[20] Table A9 shows remarkably similar results when using an alternative policy coding by Bailey et al. (2011), in line with Bailey et al. (2013).[21]

The size of the estimates in Table 2 is large, in particular since they measure an intention-to-treat effect which needs to be scaled by take-up, estimated to be around 42% (Bailey et al., 2012). It is important to emphasize that the coefficients represent having access for all years between ages 14 and 21, while on average women with consent access had only about 3.5 years of access. For those with average consent access, effect sizes thus would range between 18.6% (NSFH) and 10% (HRS), assuming a linear relationship. Even taking scaling into account, these effect sizes are comparable to Johansson et al. (2023) documenting 27% higher depression scores on the MHQ questionnaire for women who ever used oral contraceptives.[22] The hormonal dosage of the pill women had access to also matters. The medical studies reporting a mental health effect of hormonal contraceptives measure the effects of contemporaneous contraceptive pills, while I estimate the effect of a drug administered in the 1960s with much higher hormonal dosages.[23] An additional explanation for the large effect sizes comes from the limited availability and take-up of mental health care services during the 70s and 80s compared to nowadays. Small initial mental health effects may have grown over time due to lack of treatment, resulting in large long-term effects.

The effect sizes can also be compared to other studies on the CES-D score in the NSFH and HRS. In the NSFH, Ettner (1996) shows that a one standard deviation increase in annual income lowers the CES-D score by 29%, and Boyd-Swan et al. (2016) find a 16% decrease in depression score in response to the Earned Income Tax Credit Expansion. In the HRS, Ayyagari and Shane (2015) document a reduction in the CES-D by 0.2 items and a 4-5 percentage points lower probability to report a critical value of the CES-D in response to the Medicare Part D introduction for eligible individuals. Drug coverage itself reduces the CES-D score by 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, my effects are around 50% larger (McInerney et al., 2013). In light of these effect

[20] Note that the reform coding is tailored to women and their age of majority, such that the results above should not be interpreted as anything other than a placebo test. Table A8 shows descriptive statistics of variables for men.

[21] I also test the robustness of my results to the inclusion of women who gained access through marriage (17% in NSFH, 16% in HRS). The results are mixed. Table A10 shows similar effects in the HRS and no significant effects in the NSFH. When adapting the coding for access through marriage one needs to account for those women marrying particularly early which can have large negative effects on mental health (Le Strat et al., 2011). Indicators for access through marriage and early marriage are however endogenous. Controlling for early marriage leads to a drop in the coefficient for consent access by 18% in the HRS and even more in the NSFH. Table A11 shows that my main results (without the access through marriage group) are robust to the inclusion of this early marriage dummy.

[22] Skovlund et al. (2016) report very large effects with an 80% higher incidence rate of first diagnosis of depression for adolescents.

[23] Doses of both progesterine (synthetic hormone that mimics the body's progesterone) and estrogen are much higher in the first available pill with 9.5 milligrams (mg) of progestin (compared to 0.1-3 mg today) and 150 mg of estrogene (compared to 20-50 mg today) (Liao and Dollin, 2012).

sizes, my estimates seem realistic.[24]

My analysis builds on the variation in the timing and location of law changes. This introduces problematic weighting of treatment effects (Goodman-Bacon, 2021). In Appendix C, I discuss these issues and show results from two alternative estimators for a simplified version of my main estimation. The results suggest a limited role for problematic weighting driving my results.

Table 2: Effect of pill access during adolescence (age 14-21) on mental health

	NSFH		HRS			
	log CES-D	> crit. threshold	log CES-D	> crit. threshold	log CES-D	> crit. threshold
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Women						
Fract. years with legal access pill	0.181	0.012	0.071	0.036	0.064	0.033
	[0.156]	[0.082]	[0.057]	[0.033]	[0.054]	[0.032]
Fract. years with consent access pill	0.372**	0.019	0.199**	0.101*	0.190**	0.096
	[0.164]	[0.105]	[0.080]	[0.059]	[0.079]	[0.059]
Childhood depression					0.352***	0.164***
					[0.058]	[0.039]
R-squared	0.09	0.08	0.27	0.18	0.28	0.18
N	2,236		6,671			
Panel B: Men						
Fract. years with legal access pill	0.150	0.042	0.024	-0.026	0.026	-0.025
	[0.162]	[0.080]	[0.062]	[0.031]	[0.060]	[0.030]
Fract. years with consent access pill	0.038	0.052	-0.069	-0.073	-0.064	-0.070
	[0.415]	[0.172]	[0.081]	[0.053]	[0.079]	[0.052]
Childhood depression					0.452***	0.256***
					[0.104]	[0.062]
R-squared	0.10	0.08	0.28	0.16	0.28	0.16
N	1,681		5,392			
Linear state-cohort trends	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, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. Columns (5) and (6) additionally control for childhood depression. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

[24]One caveat for the interpretation of the long-term effects from the HRS is the potential for survivorship bias. If survival is positively related to good mental health, I might not capture the most severely mentally ill.

4.1 Alternative channels

The results were so far motivated as the biological effect of hormones in the pill on mental health. There exist however alternative channels through which access to the pill might negatively affect mental health. Access to the pill shifted women's life trajectories towards delayed family formation, more education, and more ambitious occupational choices. If these changes are associated with poorer mental health, I would overestimate the effect of hormones in the pill on mental health, by ignoring mental health effects driven by changed life trajectories. I discuss alternative channels and show that they do not drive the main results, thus providing support for the hormonal channel.

From a theoretical perspective, the pill reduced the uncertainty of pregnancy costs and lifted the penalty of abstinence. Both these mechanisms seem innocent at first as they provided women with more freedom but might have negative mental health effects given the multitude of outcomes they affected. First, Akerlof et al. (1996) argue that improved access to abortion and contraceptives decreased the moral responsibility of men to commit to shotgun marriage which worsened the competitive position of women relative to men. This particularly affects those women who do not want to use these technologies or who fail to do so properly, because they may engage in pre-marital sex without the promise of future care-taking.

This argument points to two potential mental health mechanisms, out-of-wedlock births and increased pressure to engage in pre-marital sex. Out-of-wedlock births were highly stigmatized and it was difficult to raise a child alone, thus likely negatively impacting mental health (DeKlyen et al., 2006). Two studies investigating the effect of pill usage on mental health suggest a limited role for increased pressure to engage in pre-marital sex, by showing that including prior sexual activity as a covariate does not alter results (Anderl et al., 2022) and that results are similar when focusing on women who had their first intercourse during adolescence (Anderl et al., 2020). Less commitment to shotgun marriage and the lifted penalty of abstinence likely also led to changes in match quality. Goldin and Katz (2002) and Christensen (2012) argue that access to contraceptives improves match quality, and empirical findings by Zuppann (2012) suggest that access to the pill seems to be associated with lower divorce rates. This points towards better matches, likely associated with better mental health.[25]

Second, the reduction in uncertainty of pregnancy costs also led to a delay in fertility (Bailey, 2006, 2010) which is typically associated with better mental health (Rackin and Brasher, 2016). However, a desired fertility delay might lead to involuntary childlessness. This is more likely with the pill given its low marginal costs, making quitting the pill unattractive (Bailey, 2010). The empirical evidence on unintended childlessness is mixed, negative mental health effects seem to mostly exist for women who cannot seek alter-

[25] Challenging are relationships that never turn into marriages because they cannot end up in divorce. This could however be captured by out-of-wedlock births.

native family formation, e.g. adoption (Maximova and Quesnel-Vallée, 2009; McQuillan et al., 2003). The delay of fertility has increased investment into education and led to more ambitious careers (Bailey, 2006). While the effect of education on mental health is mostly either positive or zero (Lleras-Muney, 2022), more ambitious careers could reflect more stressful occupations.

I test these alternative channels by first regressing access to the pill on variables reflecting family formation: age at first marriage and birth, indicators for ever being married, ever having a child, birth, and marriage before age 22, and out-of-wedlock birth. I also use a measure of stress at work as an outcome.[26] I then test whether these outcomes are associated with mental health and lastly include them in the main specification, for a comparison in spirit of a Gelbach-decomposition (Gelbach, 2016). Appendix B conceptualizes the role of these alternative channels in a Grossman framework.

Table 3 shows the effect of access to the pill on family formation outcomes and stress at work. Legal access to the pill overall delays fertility, in line with Bailey (2006, 2010), Beauchamp and Pakaluk (2019), and Guldi (2008).[27] The effect sizes are large compared to other studies (Bailey, 2006; Goldin and Katz, 2002) but differences can arise due to the exclusion of women with access through marriage, and to defining access as a fraction of years - in contrast to the "early legal access" dummy.[28] Table 3 also shows coefficients for access to abortion which suggest a delay in marriage, in line with Myers (2017) and Guldi (2008) but accelerated fertility in the NSFH, at odds with previous literature. There are several explanations for this, such as increased sexual activity as a response to the availability of abortion (Kane and Staiger, 1996), the exclusion of women with access through marriage, and more paternity deferments during Vietnam War in states that liberalized abortion associated with increased fertility rates in the late 60s (Bailey and Chyn, 2020). Another potential reason is that in the NSFH, 91% of the sample are still in childbearing age ($\leq$ age 49) so some of these outcomes may not have materialized. Column (9) shows that consent access to the pill reduces stress at work, suggesting that maybe more ambitious careers crowded out lower-quality, high-stress jobs.[29]

[26] Descriptive statistics in Table A12.

[27] It seems puzzling that legal access is more important for fertility outcomes (and for education outcomes later), while consent access drives the mental health effects. Legal access required to bring a parent or guardian who might be interested in fertility delay to enable investment into human capital and thus might encourage contraceptive use. Consent access might matter more for mental health due to differences in the timing of pill uptake. Goldin and Katz (2002) show that pill use before age 18 only increased strongly with the birth cohort 1953 while for older age groups pill usage increased earlier. Legal access for women younger than 18 existed before the 1953 birth cohort but consent access before age 18 increased sharply around that time. If consent access is associated with a lower pill usage age than legal access, this might explain the stronger effects of consent access on mental health given the stronger malleability of mental health in early adolescence.

[28] These results do not hold when including women who gained access through marriage as they already started family formation, in line with Guldi (2008) finding strongest birth rates-reductions for unmarried first mothers.

[29] Table A13 shows results for men which should be interpreted with caution since the access laws were tailored to women's age of majority. Even spillovers in couples would stem from pill access of a younger

Table 4 investigates the role of these alternative channels for the log CES-D score. Age at marriage and age at first child are not problematic as they have indeed mental health improving effects, and would thus downward bias the estimates. This also suggests a positive role of contraception for mental health, in absence of hormonal effects. The indicators for getting married, having a child before age 22, and ever having a child have negative mental health effects but are not problematic as these outcomes are reduced with access to the pill. Stress at work affects mental health negatively but is reduced with access to the pill. More problematic are the probability to be ever married as it improves mental health but is reduced with access to the pill, and out-of-wedlock birth as it has negative mental health effects and is more likely to occur with access to the pill (HRS legal access).

Tables 5 and 6 add the family formation variables and the stress variable into the main specification, one at a time and then once several variables together.[30] The four bottom rows of these tables conduct a Gelbach-style comparison - displaying the difference between coefficients from a base estimation (without the added family formation/stress variable, on the sample where the variable is non-missing) and the full estimation (coefficients in the first two rows), denoted as δ_{legal} and $\delta_{consent}$. The change in coefficients can be interpreted as the contribution of the respective variable. Problematic cases are where the full estimation coefficient is much smaller than the base coefficient (positive and large δs) since this would suggest that the added variable explains a large part of the effect of the pill on mental health. Tables 5 and 6 show that the coefficients of both, legal and consent access change little compared to the base specification without the added variables. In most specifications, the full specification coefficient is larger than the base.[31]

Given that out-of-wedlock birth and ever being married were the most problematic channels identified before, I conduct an additional test by dropping individuals who never got married and who had an out-of-wedlock birth, to make sure that they are not driving the results. Table A14 shows results very similar to the main results. All in all, these results suggest a limited role for family formation or work stress as alternative channels.

birth cohort given the typical age gap.

[30] I add the indicators for being married before age 22, for childbirth before age 22, for out-of-wedlock birth, and the stress at work measure. The other family formation variables cannot be added here due to collinearity.

[31] The increase in pill access coefficients when additional variables are added should be interpreted with caution due to the bad control problem arising from those variables being outcomes of the treatment themselves (Angrist and Pischke, 2008). Note that the coefficients from the base specification are larger than the main specification, the estimation here is on different subsamples of the data. E.g., column (1) conditions on ever being married, columns (4) conditions on ever having children.

Table 3: Effect of pill access during adolescence (age 14-21) on family formation and stress at work

	family formation							stress at work
	Age first marriage	Ever married	Married before 22	Age first child	Ever child	Child before 22	Out-of wedlock birth	Mean stress job
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: NSFH								
Fract. years with legal access pill	1.614*	0.001	-0.205**	2.637***	0.041	-0.192***	0.064	
	[0.907]	[0.062]	[0.098]	[0.892]	[0.049]	[0.066]	[0.078]	
Fract. years with consent access pill	-0.502	-0.044	0.012	1.138	-0.034	-0.178	-0.021	
	[1.354]	[0.080]	[0.152]	[1.475]	[0.063]	[0.127]	[0.107]	
Fract. years with legal access abortion	2.262	0.100	-0.047	-3.283***	-0.364***	0.083	-0.037	
	[1.513]	[0.108]	[0.289]	[1.022]	[0.108]	[0.138]	[0.083]	
Fract. years with consent access abortion	-0.252	-0.017	0.114	-6.288***	-0.148	0.410**	0.158	
	[1.879]	[0.118]	[0.310]	[1.382]	[0.127]	[0.163]	[0.096]	
R-squared	0.14	0.17	0.17	0.19	0.10	0.17	0.29	
N	1,927	2,235	2,218	1,833	2,236	2,226	2,226	
Panel B: HRS								
Fract. years with legal access pill	3.203***	-0.043***	-0.353**	2.803***	-0.093**	-0.231***	0.054*	-0.105
	[0.579]	[0.020]	[0.061]	[0.565]	[0.038]	[0.058]	[0.028]	[0.082]
Fract. years with consent access pill	0.265	-0.019	-0.118	0.497	-0.075	-0.144	-0.082*	-0.297***
	[0.742]	[0.036]	[0.095]	[0.828]	[0.048]	[0.088]	[0.044]	[0.110]
Fract. years with legal access abortion	-0.112	0.010	0.044	0.352	-0.055*	0.177*	-0.015	0.020
	[0.952]	[0.035]	[0.093]	[1.553]	[0.030]	[0.099]	[0.073]	[0.116]
Fract. years with consent access abortion	1.652	0.050	-0.013	-0.108	-0.056	0.097	-0.036	0.103
	[1.410]	[0.049]	[0.135]	[1.280]	[0.085]	[0.131]	[0.046]	[0.132]
R-squared	0.15	0.07	0.14	0.14	0.04	0.12	0.20	0.06
N	5,831	6,669	6,277	5,365	6,669	6,187	6,187	5,301
Linear state-cohort 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, 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. The variable mean stress job ranges from 1-4, where a higher score indicates more stress.

Table 4: Effect of family formation and stress at work on mental health

	log CES-D								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: NSFH									
Age first marriage	-0.021***								
	[0.005]								
Ever married		-0.035							
		[0.053]							
Married before 22			0.130***					0.086*	
			[0.038]					[0.046]	
Age at first child				-0.021***					
				[0.006]					
Ever children					0.112*				
					[0.065]				
Child before 22						0.223***		0.145**	
						[0.047]		[0.066]	
Out-of-wedlock birth							0.204***	0.168**	
							[0.059]	[0.071]	
R-squared	0.09	0.09	0.09	0.11	0.09	0.10	0.09	0.10	
N	1,927	2,235	2,218	1,833	2,236	2,226	2,226	2,210	
Panel B: HRS									
Age first marriage	-0.004*								
	[0.002]								
Ever married		-0.084***							
		[0.031]							
Married before 22			0.037**						-0.004
			[0.018]						[0.022]
Age at first child				-0.013***					
				[0.001]					
Ever children					0.015				
					[0.021]				
Child before 22						0.132***			0.086***
						[0.017]			[0.021]
Out-of-wedlock birth							0.156***		0.099***
							[0.028]		[0.032]
Mean stress at work								0.083***	0.085***
								[0.014]	[0.014]
R-squared	0.29	0.27	0.28	0.29	0.27	0.28	0.28	0.31	0.32
N	5,831	6,669	6,277	5,365	6,669	6,187	6,187	5,301	4,662
Linear state-cohort trends	Yes	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, 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. The variable mean stress job ranges from 1-4, where a higher score indicates more stress.

Table 5: Effect of pill access during adolescence (age 14-21) on mental health, adding mediating factors, **NSFH**

	log CES-D							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fract. years with legal access pill	0.350*	0.185	0.262	0.349	0.176	0.233	0.177	0.274
	[0.197]	[0.157]	[0.183]	[0.223]	[0.158]	[0.163]	[0.149]	[0.178]
Fract. years with consent access pill	0.590**	0.374**	0.411**	0.514*	0.376**	0.407**	0.371**	0.432**
	[0.233]	[0.164]	[0.189]	[0.263]	[0.164]	[0.166]	[0.153]	[0.180]
Age first marriage	-0.021***							
	[0.005]							
Ever married		-0.036						
		[0.054]						
Married before 22			0.131***					0.087*
			[0.039]					[0.046]
Age first child				-0.022***				
				[0.006]				
Ever child					0.117*			
					[0.065]			
Child before 22						0.227***		0.148**
						[0.048]		[0.067]
Out-of wedlock birth							0.206***	0.169**
							[0.060]	[0.072]
R-squared	0.09	0.09	0.09	0.11	0.09	0.10	0.09	0.10
N	1,927	2,235	2,218	1,833	2,236	2,226	2,226	2,210
Linear state-cohort trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
coeff. base legal	0.316*	0.185	0.235	0.291	0.181	0.190	0.190	0.239
δ_{legal}	-0.034	0.000	-0.027	-0.058	0.005	-0.043	0.013	-0.035
coeff. base consent	0.600**	0.375**	0.413**	0.490*	0.372**	0.366**	0.366**	0.404**
$\delta_{consent}$	0.010	0.001	0.002	-0.024	-0.004	-0.041	-0.005	-0.028

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. δ_{legal} is obtained by subtracting the coefficient Fract. years with legal access pill (first row) from coeff. base legal, $\delta_{consent}$ is obtained by subtracting the coefficient Fract. years with consent access pill (first row) from coeff. base consent.

Table 6: Effect of pill access during adolescence (age 14-21) on mental health, adding mediating factors, **HRS**

	log CES-D								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Fract. years with legal access pill	0.059	0.066	0.065	0.081	0.074	0.084	0.045	0.002	0.025
	[0.062]	[0.057]	[0.062]	[0.070]	[0.057]	[0.061]	[0.063]	[0.053]	[0.069]
Fract. years with consent access pill	0.219***	0.197**	0.194***	0.168*	0.202**	0.192**	0.186**	0.188**	0.183**
	[0.076]	[0.081]	[0.086]	[0.092]	[0.080]	[0.087]	[0.088]	[0.076]	[0.090]
Age first marriage	-0.003*								
	[0.002]								
Ever married		-0.084***							
		[0.031]							
Married before 22			0.037**						-0.005
			[0.017]						[0.022]
Age first child				-0.013***					
				[0.001]					
Ever child					0.015				
					[0.021]				
Child before 22						0.133***			0.086***
						[0.017]			[0.022]
Out-of wedlock birth							0.158***		0.099***
							[0.028]		[0.032]
Stress at work								0.084***	0.086***
								[0.014]	[0.014]
R-squared	0.29	0.28	0.28	0.29	0.27	0.28	0.28	0.31	0.32
N	5,831	6,669	6,277	5,365	6,669	6,187	6,187	5,301	4,662
Linear state-cohort trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
coeff. base: legal	0.048	0.070	0.052	0.054	0.073	0.054	0.054	-0.007	-0.002
δ_{legal}	-0.011	0.004	-0.013	-0.027	xxx	-0.033	0.013	0.005	-0.029
coeff. base: consent	0.218***	0.199**	0.190**	0.162*	0.201**	0.173*	0.173*	0.163**	0.132
$\delta_{consent}$	-0.001	0.002	-0.004	-0.006	-0.001	-0.019	-0.013	-0.025	-0.051

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. δ_{legal} is obtained by subtracting the coefficient Fract. years with legal access pill (first row) from coeff. base legal, $\delta_{consent}$ is obtained by subtracting the coefficient Fract. years with consent access pill (first row) from coeff. base consent.

4.2 Heterogeneity Analysis

Given the variation in age at pill access, I estimate an alternative specification with indicators for access to the pill at a specific age range (age 14/15, age 16/17, age 18-20). Table 7 shows that the exposure variable masks heterogeneity according to age at access. It shows significant effects for the youngest group (14-15) and 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.[32]

Another dimension of heterogeneity is whether the mental health effect of the pill varies for individuals with different predispositions for mental health illness. This helps to understand whether the pill raises mental health problems for everyone or whether it "pushes" individuals with a higher predisposition to develop mental illness beyond a threshold. Predisposition toward certain illnesses and general biological characteristics (phenotypes) can be measured with polygenic scores (PGS), linear indexes summing up genetic variants. They are obtained from genome-wide association studies (GWAS) in which DNA material is scanned. In the economic literature, PGS have been used to investigate the role of genes, environments, and their interplay, to better understand the effect of education on health (Barcellos et al., 2021), returns to education (Papageorge and Thom, 2020), or the role of genes for fertility outcomes in interaction with access to the pill (Barban et al., 2021). For a subset of the HRS sample, PGS were collected between 2006 and 2012. A PGS related to general depressive symptoms is available and was used in Domingue et al. (2017) showing that a higher PGS for depressive symptoms is associated with a larger increase in the CES-D score after a spousal death.[33]

I first regress the log-CES-D score on the PGS to assess the meaningfulness of the PGS for later-life mental health. I then re-estimate my main specification and add the PGS and an interaction between access to the pill and the PGS, using the PGS score and an indicator for above median depression PGS. I repeat this using pill access dummies. The upper panel of Table 8 shows that the PGS and the indicator for above median PGS are statistically significantly associated with the log-CES-D score. The two remaining panels show that the mental health effect of access to the pill seems to be driven by women with higher and 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.

[32] Note that this is equivalent to grouping according to the fraction of years with access since both are mechanically related. The fraction of years with access is the same for everyone with the same age at access. While it would be desirable to understand the independent contributions of both components, this is not feasible in this setting. The heterogeneous effects could reflect higher malleability of mental health at younger ages and higher pill take-up for older individuals. It might therefore mask differences in the ATT and ITT for different groups which are challenging to identify separately. Heterogeneity according to age has also been demonstrated by Bailey et al. (2013) showing non-linear effects of access to the pill for giving birth before different ages.

[33] GWAS are mostly performed on European ancestry groups with strongly limited predictive power for other ancestry groups. I restrict my analysis here to individuals of European descent.

Table 7: 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	0.208	0.009	0.044	0.040
	[0.171]	[0.085]	[0.070]	[0.038]
Legal access pill age 16/17	0.178	0.002	0.043	0.016
	[0.151]	[0.071]	[0.054]	[0.032]
Legal access pill age 18-20	0.236**	0.058	0.051	0.015
	[0.097]	[0.052]	[0.034]	[0.020]
Consent access pill age 14/15	0.193	-0.053	0.132*	0.089*
	[0.178]	[0.106]	[0.079]	[0.046]
Consent access pill age 16/17	0.169	-0.080	0.049	0.052
	[0.161]	[0.093]	[0.083]	[0.053]
Consent access pill age 18-20	0.104	0.007	0.073*	0.050*
	[0.095]	[0.048]	[0.037]	[0.028]
R-squared	0.09	0.09	0.28	0.18
N	2,236	2,236	6,671	6,671
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, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce.

Table 8: Effect of pill access on mental health, according to genetic risk

	log CES-D	
	(1)	(2)
PGS depressive symptoms	0.019**	
	[0.009]	
above median PGS		0.051**
		[0.022]
R-squared	0.33	0.33
Fract. years with legal access pill	-0.027	-0.021
	[0.062]	[0.070]
Fract. years with consent access pill	0.003	-0.134
	[0.142]	[0.139]
Fract. years with legal access pill x PGS depressive symptoms	-0.004	
	[0.029]	
Fract. years with consent access pill x PGS depressive symptoms	0.055	
	[0.067]	
Fract. years with legal access pill x above median PGS		-0.020
		[0.051]
Fract. years with consent access pill x above median PGS		0.255*
		[0.146]
PGS depressive symptoms	0.012	
	[0.013]	
above median PGS		0.026
		[0.027]
R-squared	0.33	0.33
Legal access pill (0/1)	0.031	0.034
	[0.032]	[0.039]
Consent access pill (0/1)	-0.003	-0.064
	[0.039]	[0.043]
Legal access pill (0/1) x PGS depressive symptoms	-0.007	
	[0.024]	
Consent access pill (0/1) x PGS depressive symptoms	0.025	
	[0.029]	
Legal access pill (0/1) x above median PGS		-0.013
		[0.046]
Consent access pill (0/1) x above median PGS		0.117***
		[0.042]
PGS depressive symptoms	0.013	
	[0.013]	
above median PGS		0.016
		[0.025]
R-squared	0.33	0.33
N	3,526	
Linear state-cohort trends	Yes	Yes

Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Uses HRS data only. 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. Further controls are the 10 principal components of the matrix of genetic data, and polygenic scores 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.

5 Education and Labor Market Outcomes

The "power of the pill" literature argues that improved control over fertility due to the pill enabled women to make larger investments in education resulting in improved labor market outcomes. Worsened 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: via the fertility control channel (aversion and timing of childbirth) and via mental health. Mental health thus might mitigate the positive pill effect via the fertility channel.

I estimate the effect of access to the pill on positive (years of education, college attendance, labor force participation, labor force participation for more than five years) and negative labor market outcomes (indicators of reduced labor market productivity: limitations at work, disability, sick days) while taking an effect via mental health explicitly into account. First, I estimate the effect of access to the pill on labor market outcomes (equation (2)), an estimate of the combined effect of both channels. Then, I add the indicator for above median risk of depression (used in Table 8) interacted with the pill access variables (equation (3)). Since the effect estimated in the first step had implicitly subtracted the mental health cost from the pill coefficient, the coefficients of pill access variables for the positive outcomes should become larger, now only reflecting the fertility control effect.

Columns (1)-(4) of Table 9, Panel A confirm the positive associations between access to the pill and education and labor market outcomes which are only significant for legal access and the probability to attend college and years of education.[34] Columns (5)-(8) show no significant association between pill variables and measures of reduced labor market productivity. Results in Panel B include the interactions of the depression risk indicator with pill access variables. Columns (1)-(4) show negative and statistically significant interaction coefficients for consent access, suggesting that individuals with above median genetic depression risk cannot benefit from the fertility control function. The coefficients of pill access increase when adding the interactions, suggesting that the fertility control effects are slightly larger than when ignoring the mental health effect. This suggests that earlier studies slightly underestimated fertility control. For reduced labor market productivity, Columns (5)-(8) of Panel B show positive and statistically significant interactions for legal access (disability periods and ever reporting disability), and for consent access (ever reporting limitations and average number of sick days). This paints a similar picture as above: access to the pill for those with above median genetic depression risk is associated with reduced labor market productivity.

[34] The results for years of education are larger than the ones presented in Lindo et al. (2020), and than those for college attendance (Bailey et al., 2012; Hock, 2007), likely driven by excluding those with access through marriage. The results for labor participation are smaller than findings in Bailey (2006), likely due to overall high labor force participation in the HRS sample, Table 1.

Table 9: Effect of pill access during adolescence (age 14-21) on education and labor market outcomes

	Ever College (1)	Years Educ (2)	Ever LFP (3)	LFP > 5 yrs (4)	Disability periods (5)	Ever disabled (6)	Ever limitation (7)	Av. sick days (8)
Panel A								
Fract. years with legal access pill	0.196***	1.005**	0.005	-0.004	-0.042	-0.013	-0.065	-2.112
	[0.065]	[0.439]	[0.014]	[0.027]	[0.106]	[0.043]	[0.067]	[1.606]
Fract. years with consent access pill	-0.047	0.454	0.003	0.037	-0.143	0.033	-0.071	-1.951
	[0.114]	[0.757]	[0.021]	[0.030]	[0.176]	[0.060]	[0.125]	[3.422]
R-squared	0.17	0.18	0.05	0.06	0.08	0.08	0.17	0.09
N	3,525	3,515	3,526	3,526	3,526	3,526	3,526	2,853
Panel B								
Fract. years with legal access pill	0.222***	1.075**	0.014	0.002	-0.098	-0.038	-0.060	-2.749
	[0.064]	[0.452]	[0.016]	[0.032]	[0.106]	[0.039]	[0.066]	[1.998]
Fract. years with consent access pill	0.056	0.849	0.035	0.093***	-0.191	0.029	-0.138	-4.709
	[0.125]	[0.788]	[0.027]	[0.029]	[0.216]	[0.078]	[0.111]	[3.640]
Fract. years with legal access pill x PGS	-0.060	-0.175	-0.017	-0.012	0.119*	0.053**	-0.011	1.378
depressive symptoms above median	[0.038]	[0.211]	[0.014]	[0.020]	[0.068]	[0.020]	[0.045]	[1.552]
Fract. years with consent access pill x PGS	-0.203***	-0.777**	-0.061**	-0.108**	0.097	0.011	0.131*	5.430*
depressive symptoms above median	[0.069]	[0.377]	[0.025]	[0.045]	[0.138]	[0.074]	[0.068]	[3.149]
R-squared	0.17	0.18	0.05	0.06	0.08	0.07	0.15	0.09
N	3,525	3,515	3,526	3,526	3,526	3,526	3,526	2,853
Linear state-cohort 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. Uses HRS data only. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, state equal pay laws, and state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce and above median PGS for depression. Further controls are the 10 principal components of the matrix of genetic data, and polygenic scores 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. Panel B also includes interactions between genetic risk and abortion access variables.

6 Conclusion

This paper investigates 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 focused on the liberalizing effects on fertility, labor market outcomes, and education, this paper is the first to add mental health as an outcome. This is motivated by medical studies suggesting a link between hormonal contraceptive use and depression. I document large negative effects of access to the pill on mental health driven by women with high genetic predisposition for depression.

Previous literature has established a positive effect of the pill on education and labor market outcomes due to its fertility control function. I show that this is a net effect combining a positive fertility control effect and a negative mental health effect for those at high genetic depression risk. This is reflected by slightly higher coefficients of fertility control when adding an interaction of pill access and genetic depression risk and negative interaction coefficients. Access to the pill for those at high genetic depression risk is also related to reduced labor market productivity, in form of disability, limitations at work, and sick days. These results show that women at high genetic depression risk could not benefit from the fertility control function of the pill.

It is important to emphasize that my results do not undermine the importance of access to contraception. They rather emphasize additional costs and suggest carefully weighing potential mental health effects against fertility control effects and comparing these to non-hormonal contraceptives. Since the negative mental health effects were driven by women with high genetic predisposition for depression, this also motivates thorough screening for (family) depression prevalence and increasing awareness of the linkage between genetic depression risk and the mental health effect of the pill. My results strengthen the case for more research on non-hormonal and male contraceptives as well as financial subsidies for those. This is particularly urgent given the increased barriers to abortion in the US, recent changes in contraceptive behavior (Figure A1), and increased awareness of side effects (Figure A2). My findings on the substantial productivity cost of mental health effects of the pill are also important 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.

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

A Tables and Figures

Table A1: Years of pill access during adolescence (age 14-21)

	NSFH		HRS	
Years	Legal Access	Consent Access	Legal Access	Consent Access
0	34.12%	48.35%	42.50%	58.67%
1	5.19%	4.70%	6.04%	3.93%
2	7.47%	5.19%	7.87%	4.66%
3	5.19%	26.21%	4.63%	19.62%
4	25.09%	2.82%	18.92%	2.65%
5	5.55%	4.52%	5.25%	4.12%
6	4.92%	2.59%	4.38%	2.32%
7	12.48%	5.64%	10.42%	4.02%
N	2,236		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. 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. Sample restricted to women born between 1934 and 1958 with mental health information available.

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

Note: In the NSFH, respondents are asked to indicate the number of days during which they experience a specific negative item during the past week. This scale is then converted to a frequency scale ranging from 1-3, following the procedure by Pascoe, Stolfi, and Ormond (2006). The CES-D-score ranges thus from 0-36. The HRS contains six negative and two positive items and respondents indicate whether or not they experienced them during the past week. Positive answers to negative items are added positively, while positive answers to positive items are counted as zero and vice-versa. The resulting scale reflects the number of depressive items an individual experiences.

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

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.181	0.012	0.071	0.036
	[0.156]	[0.082]	[0.057]	[0.033]
Fract. years with consent access pill	0.372**	0.019	0.199**	0.101*
	[0.164]	[0.105]	[0.080]	[0.059]
Fract. years with legal access abortion	0.559**	0.301***	-0.210**	-0.062
	[0.219]	[0.096]	[0.080]	[0.054]
Fract. years with consent access abortion	0.314	0.068	-0.255*	-0.033
	[0.356]	[0.135]	[0.145]	[0.095]
Black	0.190***	0.138***	0.160***	0.073***
	[0.051]	[0.029]	[0.027]	[0.017]
Hispanic	0.158	0.065	0.237***	0.125***
	[0.149]	[0.048]	[0.044]	[0.019]
Fract. years with state equal pay laws	0.438**	0.092	0.099	0.047
	[0.206]	[0.106]	[0.079]	[0.058]
Fract. years w. laws against racial discrimination in employment	-0.112	-0.046	-0.024	0.002
	[0.143]	[0.074]	[0.055]	[0.039]
Fract. years with no-fault divorce	-0.004	-0.006	0.001	0.010
	[0.170]	[0.081]	[0.092]	[0.057]
R-squared	0.09	0.08	0.27	0.18
N	2,236		6,671	
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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

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	0.954	0.287
	[1.370]	[0.178]
Fract. years with consent access pill	1.925	0.651**
	[1.470]	[0.306]
R-squared	0.08	0.21
N	2,236	6,671
Linear state-cohort 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.

Table A5: 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	0.103	0.001	0.034	0.005
	[0.122]	[0.082]	[0.044]	[0.026]
Fract. years with consent access pill	0.087	-0.008	0.096	0.027
	[0.151]	[0.113]	[0.075]	[0.045]
R-squared	0.06	0.06	0.27	0.17
N	2,236		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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

Table A6: 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	-0.185	-0.053	-0.009	0.003
	[0.253]	[0.137]	[0.109]	[0.053]
Fract. years with consent access pill	0.401*	0.005	0.195**	0.078
	[0.212]	[0.140]	[0.090]	[0.061]
R-squared	0.10	0.10	0.28	0.19
N	2,236		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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

Table A7: Effect of pill access during adolescence (age 14-21) on mental health, probit

	NSFH	HRS
Average Marginal Effects	>critical threshold	
	(1)	(2)
Fract. years with legal access pill	0.015	0.041
	[0.082]	[0.033]
Fract. years with consent access pill	0.047	0.099*
	[0.103]	[0.060]
N	2,224	6,657
Linear state-cohort 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. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

Table A8: Descriptive statistics of variables for analysis, males

	NSFH	HRS
Mental health variables		
CES-D Score	7.60	1.29
	(7.96)	(1.88)
CES-D critical threshold	0.28	0.18
	(0.45)	(0.38)
Childhood depression	/	0.01
	/	(0.11)
Pill access variables		
Fract. years with legal access pill (14-21)	0.43	0.39
	(0.36)	(0.37)
Fract. years with consent access pill (14-21)	0.25	0.20
	(0.30)	(0.28)
Demographic control variables		
Year of birth	1948.34	1946.68
	(6.96)	(7.58)
Age at measurement	38.33	60.58
	(6.97)	(3.45)
Black	0.17	0.19
	(0.37)	(0.39)
Hispanic	0.03	0.07
	(0.18)	(0.26)
Controls for other reforms		
Fract. years with legal access abortion(14-21)	0.04	0.04
	(0.10)	(0.11)
Fract. years with consent access abortion (14-21)	0.17	0.14
	(0.25)	(0.24)
State equal pay laws	0.80	0.75
	(0.37)	(0.41)
Laws against racial discrimination in employment	0.77	0.71
	(0.39)	(0.42)
No-fault divorce	0.16	0.15
	(0.31)	(0.31)
N	1,681	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 ≥ 3.

Table A9: Effect of pill access during adolescence (age 14-21) on mental health, coding by Bailey et al. (2011)

	NSFH		HRS	
	log CES-D	> critical threshold	log CES-D	> critical threshold
	(1)	(2)	(3)	(4)
Fract. years with legal access pill	0.173	0.009	0.083	0.040
	[0.146]	[0.075]	[0.056]	[0.032]
Fract. years with consent access pill	0.419**	-0.038	0.188**	0.091
	[0.192]	[0.121]	[0.089]	[0.056]
R-squared	0.09	0.09	0.27	0.18
N	2,241		6,559	
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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS.

Table A10: 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	0.091	0.049	0.082	0.067
	[0.141]	[0.141]	[0.059]	[0.059]
Fract. years with consent access pill	0.173	0.097	0.197***	0.161**
	[0.161]	[0.160]	[0.073]	[0.076]
Access through marriage	-0.032	0.000	0.024	0.035
	[0.065]	[0.065]	[0.034]	[0.033]
Early marriage		0.415***		0.196***
		[0.129]		[0.072]
R-squared	0.08	0.08	0.28	0.28
N	2,694		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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS. 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 A11: 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	0.180	0.011	0.073	0.038
	[0.159]	[0.082]	[0.058]	[0.034]
Fract. years with consent access pill	0.378**	0.022	0.199**	0.101*
	[0.164]	[0.104]	[0.080]	[0.059]
Early marriage	0.366***	0.192**	0.173*	0.100*
	[0.129]	[0.072]	[0.090]	[0.053]
R-squared	0.09	0.09	0.28	0.18
N	2,236		6,671	
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, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The CES-D critical threshold equals one if the respondent reports a CES-D score > 9 in the NSFH and ≥ 3 in the HRS. 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 A12: Descriptive statistics of variables for channel analysis

	NSFH		HRS	
	female	male	female	male
Family formation				
Age at first marriage	21.53	23.60	22.61	24.95
	(4.30)	(4.09)	(5.78)	(5.78)
Ever married	0.87	0.85	0.93	0.94
	(0.34)	(0.35)	(0.25)	(0.24)
Married before age 22	0.49	0.29	0.49	0.26
	(0.50)	(0.45)	(0.50)	(0.44)
Age at first child	22.45	25.21	23.82	27.34
	(4.63)	(4.70)	(5.34)	(6.26)
Ever children	0.82	0.72	0.88	0.86
	(0.38)	(0.45)	(0.33)	(0.35)
Childbirth before age 22	0.40	0.16	0.34	0.12
	(0.49)	(0.37)	(0.47)	(0.32)
Out-of-wedlock birth	0.16	0.08	0.12	0.08
	(0.37)	(0.27)	(0.32)	(0.28)
Measures of stress at work				
Average stress at current job	/	/	2.74	2.68
			(0.67)	(0.63)
N	1,828-2,229		5,476-6,838	

Note: Standard deviations in parentheses. 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.

Table A13: Effect of pill access during adolescence (age 14-21) on family formation and stress at work - men

	family formation							stress at work
	Age first marriage	Ever married	Married before 22	Age first child	Ever child	Child before 22	Out-of wedlock birth	Mean stress job
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: NSFH								
Fract. years with legal access pill	-0.959	0.072	-0.006	-0.356	-0.044	-0.119	-0.034	
	[0.931]	[0.086]	[0.078]	[1.297]	[0.079]	[0.085]	[0.033]	
Fract. years with consent access pill	-0.762	0.071	0.026	0.262	0.163	-0.052	0.113	
	[1.374]	[0.116]	[0.129]	[1.773]	[0.113]	[0.132]	[0.071]	
Fract. years with legal access abortion	0.672	-0.170	-0.392***	-1.340	-0.141	-0.057	-0.101	
	[1.173]	[0.118]	[0.119]	[2.658]	[0.149]	[0.128]	[0.082]	
Fract. years with consent access abortion	-3.244***	0.029	-0.054	-1.085	0.222	-0.057	-0.012	
	[1.130]	[0.074]	[0.171]	[2.902]	[0.233]	[0.134]	[0.127]	
R-squared	0.13	0.14	0.14	0.20	0.16	0.16	0.19	
N	1,424	1,680	1,668	1,215	1,681	1,676	1,676	
Panel B: HRS								
Fract. years with legal access pill	-0.236	-0.046**	-0.089	-0.056	-0.054	-0.022	0.003	0.023
	[0.648]	[0.022]	[0.056]	[1.005]	[0.033]	[0.030]	[0.030]	[0.068]
Fract. years with consent access pill	-2.421***	-0.015	0.105	-3.105**	0.004	0.077*	-0.057	0.147
	[0.838]	[0.037]	[0.083]	[1.182]	[0.047]	[0.041]	[0.063]	[0.103]
Fract. years with legal access abortion	-0.857	0.108	-0.077	-3.034***	0.233***	-0.009	0.029	-0.011
	[1.185]	[0.073]	[0.053]	[1.097]	[0.072]	[0.037]	[0.052]	[0.133]
Fract. years with consent access abortion	-0.234	0.183**	-0.022	-1.456	0.210	-0.065	0.053	-0.138
	[3.264]	[0.079]	[0.118]	[3.560]	[0.153]	[0.057]	[0.090]	[0.154]
R-squared	0.08	0.06	0.08	0.09	0.05	0.07	0.12	0.07
N	4,751	5,392	5,096	4,027	5,379	4,795	4,795	4,622
Linear state-cohort trends	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

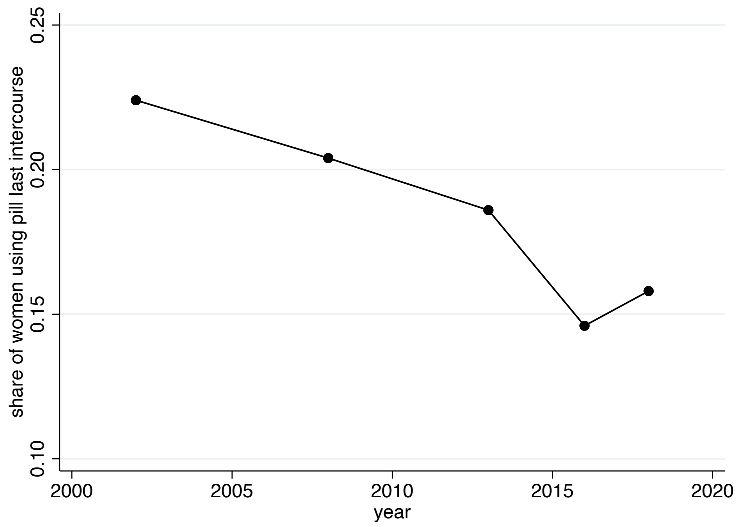
Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. The variable mean stress job ranges from 1-4, where a higher score indicates more stress.

Table A14: 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	0.257	0.070	0.213*	0.082
	[0.168]	[0.057]	[0.124]	[0.054]
Fract. years with consent access pill	0.555**	0.227***	0.463**	0.242***
	[0.208]	[0.074]	[0.189]	[0.079]
R-squared	0.08	0.28	0.08	0.28
N	1,945	6,225	1,880	5,958
Linear state-cohort trends	Yes	Yes	Yes	Yes

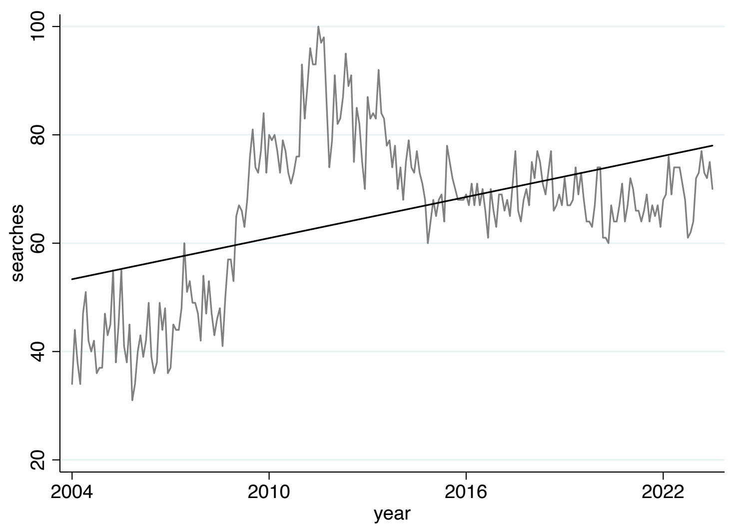
Note: Standard errors in brackets, clustered at the state level. *** p<0.01, ** p<0.05, * p<0.1. Includes state and year of birth fixed effects, as well as controls for access to abortion, age, being black and being hispanic, state equal pay laws, state acts prohibiting racial discrimination in employment,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

Figure A1: Share of women using pill during last intercourse



Note: own configuration with data from Centers for Disease Control and Prevention, *Key Statistics from the National Survey of Family Growth*, years represent midpoints of statistic years 2002, 2006-2010, 2011-2015, 2015-2017, 2017-2019, `https://www.cdc.gov/nchs/nsfg/key_statistics/c.htm#contraception` accessed August 1, 2023

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



Note: own configuration from `https://trends.google.com/trends/`. This figure depicts Google searches in relation to the highest point between January 1st, 2004 - July 31st, 2023. A value of 100 reflects the highest popularity of searches for the term "pill side effects".

B Theoretical framework

I provide a short theoretical framework for the mental health effect of the pill that generates persistence in mental health shocks and formalizes different channels at work. Some studies have applied the Grossman model (Grossman, 1972) of health production to mental health (Cronin, Forsstrom, and Papageorge, 2020; Mendolia, 2014). Cronin, Forsstrom, and Papageorge (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 is defined as a stock that will depreciate over time but can be invested in.[1] Changes to the current mental health stock other than the depreciation over time are defined as investments, 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, as motivated in Section 4.1: a biological effect through hormones, a fertility control effect, a career effect, and an error term (ϵ_i), capturing all remaining channels.[2] The three channels are captured in $j(P_i)$ by three different parameter vectors, governed by the indicator $P_i \in \{0, 1\}$.

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

Empirically, when using pill access policies to estimate the effect of the pill on mental health, the estimates potentially reflect a combination of the biological (α), fertility control (β), and career effects (γ) of the pill. It is thus dangerous to wrongly attribute (over-estimate) negative mental health effects to the biological channel if they are caused by the other two channels. Section 4.1 investigates these alternative channels empirically, suggesting a limited role in driving the negative mental health effect of pill access since most fertility control effects and career effects are positively impacting mental health. This means, that if strong enough they can counterbalance the negative biological effects

[1] 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 by 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.

[2] 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 Akerlof, Yellen, and Katz (1996) arguing that access to the pill resulted in increased sexual activity and led to more out-of-wedlock births. Other changes in sexual activity are not well-established.

of the pill. Whether these positive effects can counterbalance negative biological effects depends on several factors. First of all, it depends on the relative size of the parameters α versus β and γ. Second, it depends on the timing of those effects. Fertility control and career mental health effects of the pill are likely to materialize later than the biological effects given that the start of family formation and a career typically occur after initial pill use, thus importantly, after adolescence where mental health is most malleable. Given that negative shocks are likely persistent over time (see below), the earlier occurring biological mental health effects have potentially a larger impact. Below, I illustrate how the empirical findings of Section 4 are consistent with a Grossman framework, using a set of comparative statics.

1. Persistence: 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. The health stock in the next period is a function of the current health stock. This maps to the biological effect of sex hormones permanently affecting gene expression in the brain during adolescence (Anderl et al., 2022). Without compensating health investments, any negative health investment (i.e. a negative health shock) will permanently shift the mental health curve downwards, due to the AR(1) process. Figure B1 displays how a large health shock at age 20 drags mental health down permanently such that at age 50 health falls under a threshold value $\bar{H}$.[3]

2. Genetic predisposition: Section 4.2 demonstrates that the negative mental health effects of the pill are driven by individuals with a genetic predisposition to develop mental illness. Genetic predisposition can be modeled in the simple Grossman framework in two ways. First, one can assume that higher genetic predisposition can be translated into a lower initial health stock H_0. With an equally sized shock, high-predisposition (low H_0) individuals are more likely to fall below the threshold $\bar{H}$ (earlier) compared to individuals with low genetic predisposition (high H_0), see Panel A of Figure B2. Alternatively, higher genetic predisposition can be interpreted as a stronger reaction to a same-size health shock (Panel B of Figure B2), for example via the parameters α, β, or γ. That would imply that these parameters vary across individuals or types of individuals (e.g., low vs. high predisposition types). This is demonstrated in Panel B of Figure B2, where high genetic predisposition individuals (high shock impact) have e.g. α_{high}, and low genetic predisposition individuals (low shock impact) have e.g. α_{low}, with $\alpha_{high}>\alpha_{low}$.

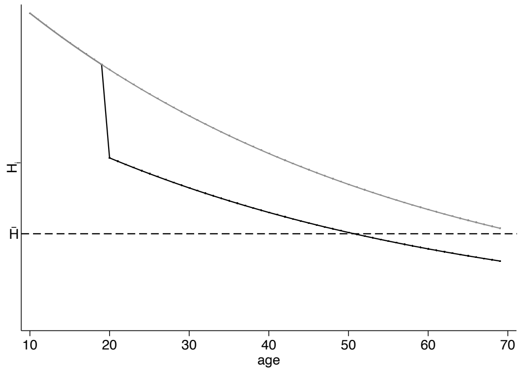
3. Compensating health investments: With compensating health investments, a negative mental health shock (negative health investment) is persistent if the discounted

[3] An alternative approach to model health development, in particular concerning aging 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 aging with the accumulation of health deficits. Persistence is here inherent similarly to the Grossman model: future deficits are a function of current deficits, and thus if not reduced by investments, carry onto the future persistently.

value of (the sum of) health investments is smaller than the discounted value of the health shock. The size of these health investments can depend on factors such as initial health or the strength of reactions to shocks, e.g. by expressing M_i and/or T_i as functions of H_0 and/or α, β, or γ. Figure B3 shows a case where the compensating investments are relative to shock impact. In general, compensating investments flatten the mental health curve and thus postpone or even avoid hitting the threshold $\bar{H}$. Panel A shows a case where the health investments for the high impact shock are so large that mental health at age 70 is at the same level as that of those hit by a low impact shock. Compensating investments thus are so large that they prevent mental health from falling below the threshold $\bar{H}$ - in contrast to the scenario in Panel B of Figure B2. Panel B of Figure B3 shows a case where the compensating investments are still relative to shock impact but are smaller than in Panel A. For the high impact shock, the compensating investments are now not sufficient to avoid falling below the threshold but postpone it compared to Panel B of Figure B2 by around 10 years.

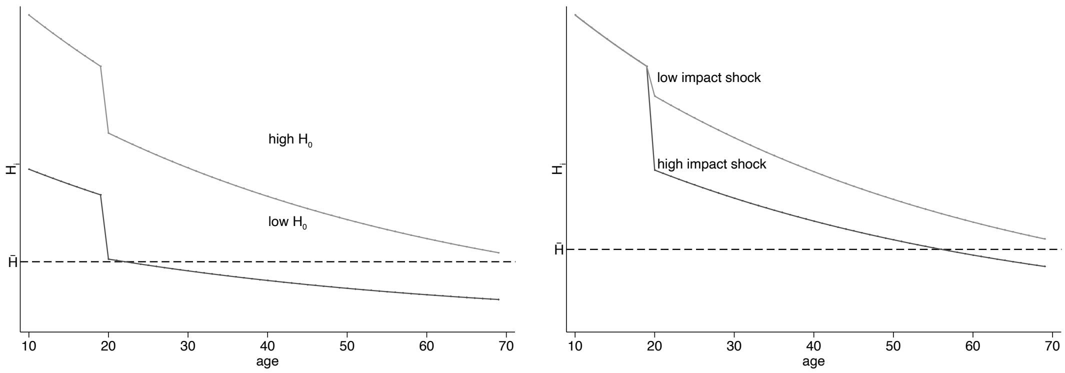
4. Timing: As argued above the impact of different types of health shocks varies with the relative size of the parameters α versus β and γ, and potentially also depends on the timing of those health shocks. While the case with different parameter sizes is trivial, I focus on the role of timing here. Motivated by the medical literature, we expect earlier shocks to matter more. This would be consistent with a Grossman model where the parameters α, β, and γ vary over time, i.e. decrease over the life cycle to reflect stronger malleability of mental health at younger ages. Figure B4 shows cases with a positive mental health shock (fertility control shock) and/or a negative mental health shock (biological shock) of the same size occurring either at the same or at different points in time. Here, the shock parameters α and β decrease over time to mimic greater sensitivity to mental health shocks at younger ages. In Panel A, the black line shows equally sized positive and negative shocks occurring at the same time, thus leading to a zero net change. The upper grey line depicts a positive fertility shock alone, and the lower grey line depicts a negative biological shock alone. Panel B shows the case where a negative biological shock occurs at age 20 whereas a positive fertility shock occurs at age 30. Since both α and β decrease over time, the effect of the earlier shock is much larger. Thus, an early negative biological shock cannot be entirely counteracted by a positive fertility shock later on.

Figure B1: Persistence



Note: Figure displays mental health over the life cycle, governed by the function $H_{i+1} = (1-\delta)H_i + I_i$. The grey line depicts mental health without a shock, while the black line shows how mental health evolves if a shock hits at age 20. The shock is modeled as a one-time negative health investment at age 20. $\bar{H}$ represents a threshold value, that could be e.g. mapping the critical threshold of the CES-D score. Source: Author's own illustration.

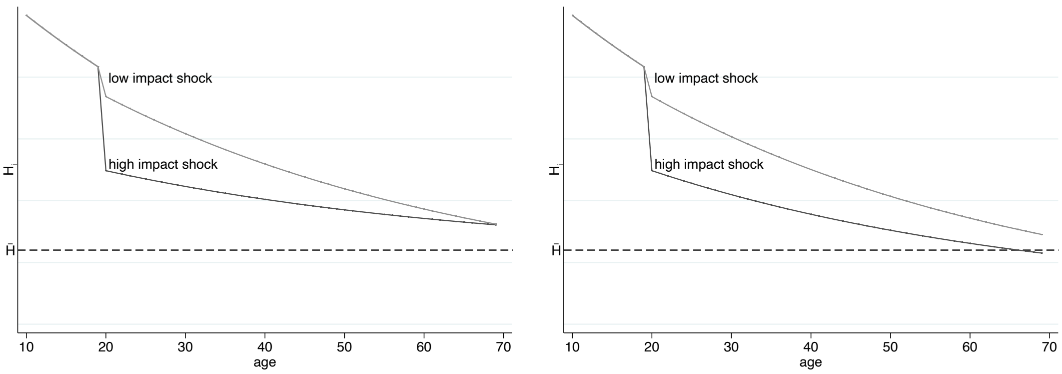
Figure B2: Genetic predispostition



(a) Panel A (b) Panel B

Note: Figure displays mental health over the life cycle, governed by the function $H_{i+1} = (1-\delta)H_i + I_i$. Here, mental health shocks differ for different individuals/types of individuals. In Panel A, the grey line depicts mental health for individuals with high initial health H_0 (low genetic risk) compared to individuals with low initial health (black line). Individuals with low initial health fall under the threshold $\bar{H}$. Panel B shows differentially strong reactions to the same-size health shocks - resulting in a larger fall in mental health for those with high genetic predisposition (high impact shock, black line) compared to those with low genetic predisposition (low impact shock, grey line). This could be resulting from e.g. two different α, where high genetic predisposition individuals have α_{high} and low genetic predisposition individuals have α_{low} and where $\alpha_{high} > \alpha_{low}$. Source: Author's own illustration.

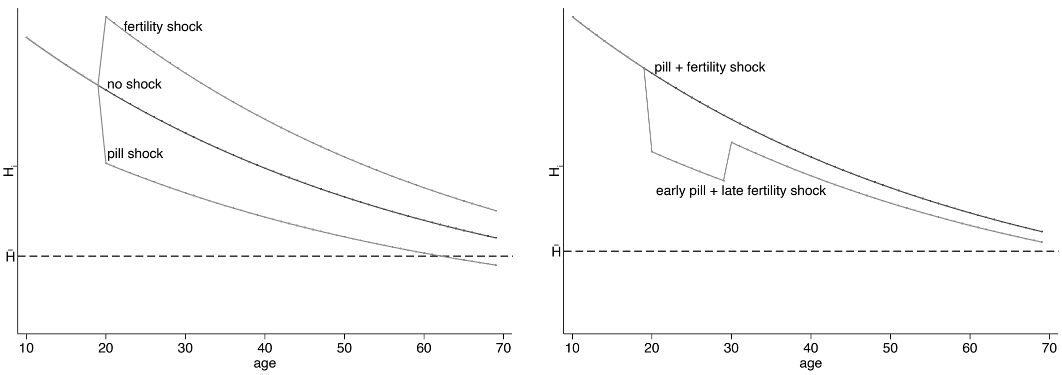
Figure B3: Compensating investments



(a) Panel A (b) Panel B

Note: Figure displays mental health over the life cycle, governed by the function $H_{i+1} = (1-\delta)H_i + I_i$. The figure uses the same parameterization for the shocks as above but now adds compensating health investments. In both Panels, the grey line depicts mental health for individuals with high initial health H_0 (low genetic risk) compared to individuals with low initial health (high genetic risk) on the black line. In both panels, compensating health investments are relative to shock impact. In Panel A, the compensating health investments are large while in Panel B they are small. In Panel A, high shock impact individuals are able to avoid falling below $\bar{H}$. In Panel B, they postpone falling below $\bar{H}$. Source: Author's own illustration.

Figure B4: Timing of shocks



Note: Figure displays mental health over the life cycle, governed by the function $H_{i+1} = (1-\delta)H_i + I_i$. The figure introduces positive shocks as fertility control shocks. The shock parameters α and β now decrease over time. In Panel A, shocks occur at the same time, and either one of the two shocks occurs or both occur jointly. In Panel B, shocks occur jointly but at different points in time. Source: Author's own illustration.

C Alternative DiD estimators

After the diagnostic evidence on problematic weighting of treatment effects in settings with variation in timing of treatment (Goodman-Bacon, 2021), several alternative estimators have been developed. These alternative estimators are however not straightforward to apply to a setting with two non-binary treatments (consent and legal access).[4] To nevertheless test the robustness of my results to the issues pointed out in this literature, I provide a robustness test based on a simplified specification. This simplified specification collapses the two non-binary treatment indicators into one single binary treatment, an indicator for whether a woman ever had access to the pill (legal and or/consent) which is straightforward to implement with alternative estimators. Figures C1 and C2 show the results from this exercise, comparing the baseline of ever pill access to the estimator by Callaway and Sant'Anna (2021) and the one by De Chaisemartin and d'Haultfoeuille (2022).[5]

Figures C1 and C2 show that in the new baseline, ever access to the pill is associated with worse mental health, but these effects are no longer significant in the NSFH. This is likely driven by heterogeneity in effects according to exposure duration during adolescence, as suggested by Table 7 of the paper. For the log CES-D score, we see that for the HRS, both alternative estimators provide larger point estimates (0.260 (Callaway and Sant'Anna, 2021) and 0.232 (De Chaisemartin and d'Haultfoeuille, 2022)) than the baseline of 0.120. For the log CES-D in the NSFH, the coefficients from the estimators by De Chaisemartin and d'Haultfoeuille (2022) and Callaway and Sant'Anna (2021) explode, potentially because of the small sample size due to sample restrictions imposed by the alternative estimators. Given those restrictions and the resulting small sample size, this result should be interpreted with caution. For the critical thresholds, results

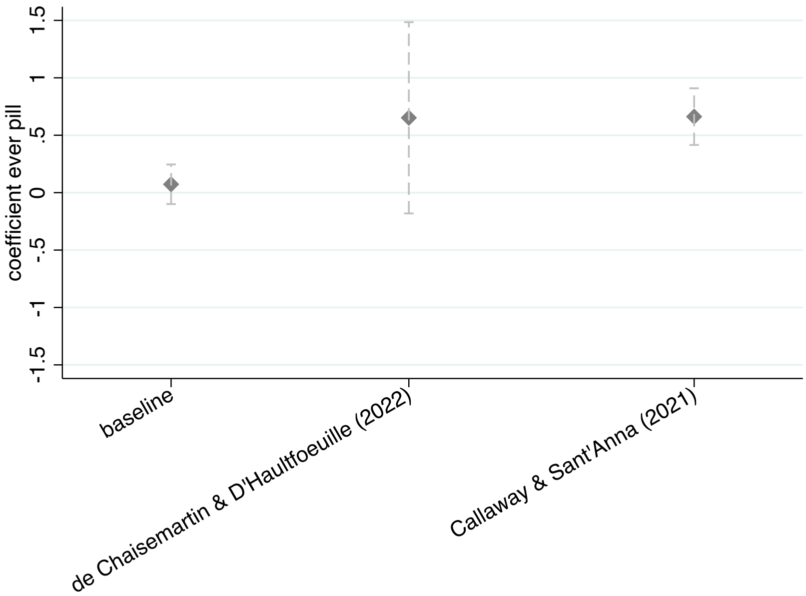
[4]While there exist estimators that can account for several non-binary treatment variables, these are not suited here as they require variation in one treatment while the other is constant. This is not feasible in my setting as the two treatment variables change mechanically with each other. As soon as consent (= legal and consent) access increases over birth cohorts legal access (only legal access) decreases.

[5]It is important to acknowledge that results from using a multi-valued treatment could only be interpreted without further assumptions as the average treatment effect on the treated and not necessarily as a dose response, see Callaway, Goodman-Bacon, and Sant'Anna (2021). The latter can only be recovered with substantially stronger assumptions, called "strong parallel" trends which require the outcome path for cohorts with different exposure to the pill would have been the same with the same exposure. The mechanical co-movement of both treatment variables further complicates recovering a dose response for each particular access type even under "strong parallel" trends. Results in Figures C1 and C2 do however show robustness to moving away from a multi-valued treatment. Table C1 below furthermore shows results from an exercise isolating the role of each access type by conditioning on a sample where only one type of access exists, focusing on log CES-D as an outcome. This exercise demonstrates that when isolating legal access, a statistically significant negative effect comes from legal access for one year. This could be explained by higher take-up of legal access in a sample that is particularly close to consent access by turning 21 soon but did not have consent access before. When isolating consent access it seems that the medium dosages of access matter. This is different from the exercise in Table 7 of the paper where the more extreme dosages matter when also legal access is available. These results should however be interpreted with caution given that restricting the sample to those with only legal or only consent access shrinks the sample size considerably.

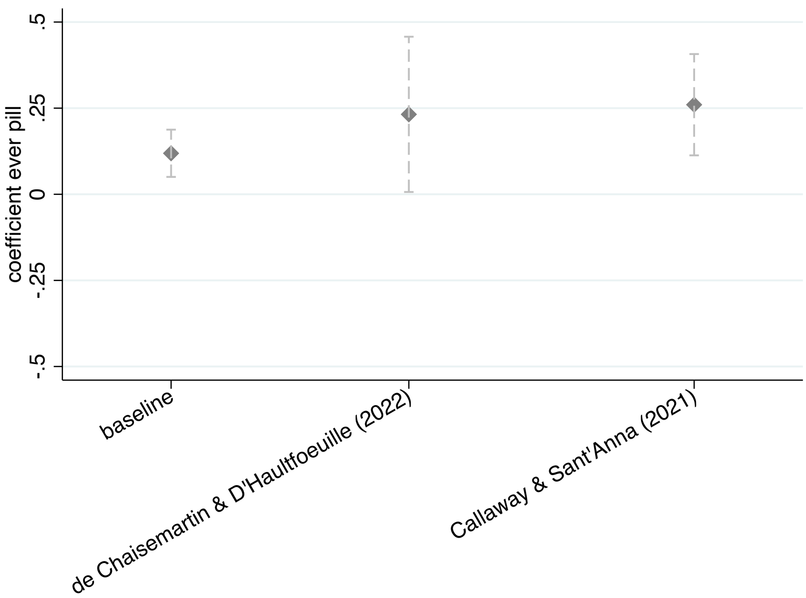
from the HRS are bigger with the De Chaisemartin and d'Haultfoeuille (2022) estimator and similar to the baseline with the Callaway and Sant'Anna (2021) estimator, but with much larger standard errors. For the NSFH, the De Chaisemartin and d'Haultfoeuille (2022) and Callaway and Sant'Anna (2021) estimator also show zero effects, but with much larger standard errors than the baseline. Overall, these results show a limited role for problematic weighting driving my results, since the coefficients of the alternative estimators are larger than the baseline in most cases.

Figure C1: Effect of ever pill on log CES-D - TWFE and alternatives

(a) NSFH



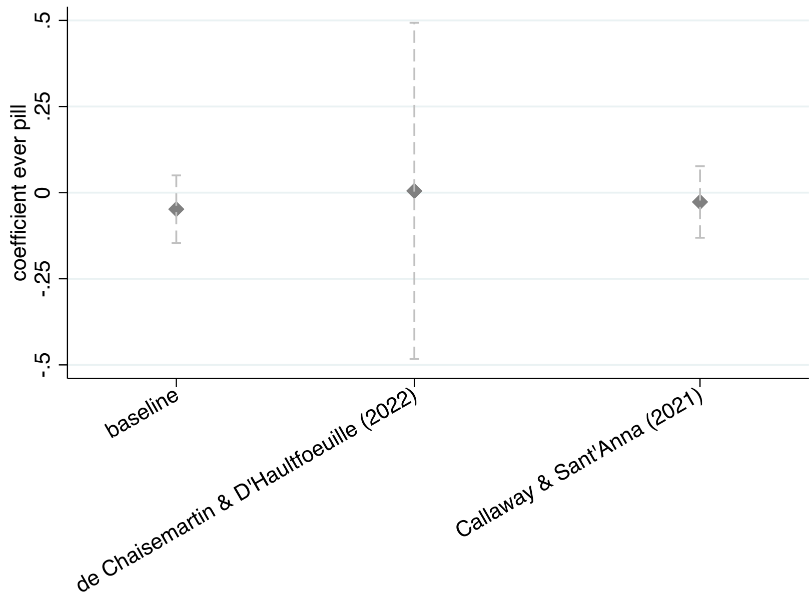
(b) HRS



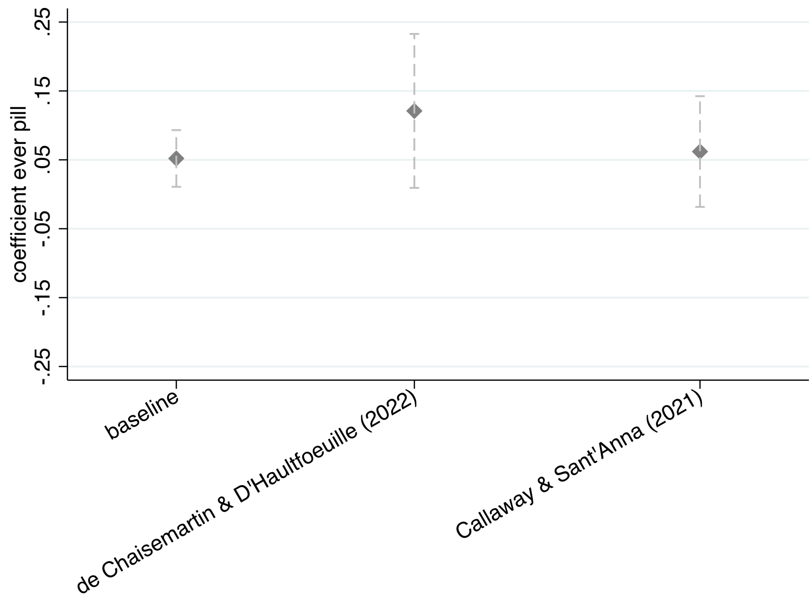
Note: All specifications includes state and year of birth fixed effects, controls for access to abortion (ever_abortion), age, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. For baseline, N=6,495 (HRS), N=2,213 (NSFH); when using estimator by De Chaisemartin and d'Haultfoeuille (2022), N=1,641(HRS), N= 383 (NSFH); when using estimator by Callaway and Sant'Anna (2021), N=3,411 (HRS), N= 941 (NSFH)

Figure C2: Effect of ever pill on > crit. threshold - TWFE and alternatives

(a) NSFH



(b) HRS



Note: All specifications includes state and year of birth fixed effects, controls for access to abortion (ever_abortion), age, state equal pay laws, state acts prohibiting racial discrimination in employment, and laws allowing no-fault divorce. For baseline, N=6,495 (HRS), N=2,213 (NSFH); when using estimator by De Chaisemartin and d'Haultfoeuille (2022), N=1,641(HRS), N= 383 (NSFH); when using estimator by Callaway and Sant'Anna (2021), N=3,411 (HRS), N= 941 (NSFH)

Table C1: Effect of pill access during adolescence (age 14-21) on mental health, isolation exercise

	log CES-D				
	no consent access			no legal access	
	NSFH	HRS		NSFH	HRS
	(1)	(2)		(3)	(4)
Years w. legal access			Years w. consent access		
1	0.611***	0.119**	1	0.000	0.106
	[0.225]	[0.051]		[0.308]	[0.070]
2	-0.169	0.049	2	0.031	0.199**
	[0.205]	[0.068]		[0.243]	[0.080]
3	0.094	0.047	3	0.284	0.130*
	[0.219]	[0.080]		[0.235]	[0.074]
4	0.130	0.104	4	0.649	0.356***
	[0.325]	[0.091]		[0.544]	[0.072]
5	-0.188	0.073	5	0.300	0.339***
	[0.262]	[0.117]		[0.722]	[0.105]
6	0.022	-0.000	6	0.241	0.056
	[0.317]	[0.103]		[0.902]	[0.171]
7	0.053	-0.045	7	0.555	0.186*
	[0.340]	[0.140]		[0.858]	[0.111]
N	1,081	3,914		763	2,835

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. Sample in columns (1) and (2) restricted to individuals with only legal access, and in columns (3) and (4) to individuals with only consent access.

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