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Abstract

What is the impact of the oral contraceptive pill on the mental health of adolescent girls? Using administrative data from Denmark and exploiting the variation in the timing of pill initiation in an event study design, we find that the likelihood of a depression diagnosis and antidepressant use increases shortly after pill initiation. We then uncover substantial variation in primary care providers' tendency to prescribe the pill to adolescents, unrelated to patient characteristics. Being assigned to a high prescribing physician strongly predicts pill use by age 16 and leads to worse mental health outcomes between ages 16-18.

Keywords: Contraceptive pill, mental health, adolescents, prescribing practices.

JEL Codes: I12, J13

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1 Introduction

The introduction of the oral contraceptive pill in 1960 represents one of the most remarkable medical advances of the twentieth century. Numerous studies document that the pill improved women's educational and labor market outcomes by allowing them to effectively and easily control their fertility (Goldin and Katz, 2002; Bailey and Lindo, 2018). More than 50 years since it became available, the pill remains to be the most popular form of prescribed contraceptive among adolescents. In the United States, for example, between 2015–2017, 16.6% of women under the age of 20 were current users of the pill (Daniels et al., 2018).[1] While the importance of the pill for women's socio-economic outcomes is indisputable, the pill has also been the center of much controversy due to concerns that hormone-based contraception could have adverse side effects on mental health, especially among adolescents (Skovlund et al., 2016, 2018; Zethraeus et al., 2017; Anderl et al., 2020).

The medical literature hypothesizes that the changes in the levels of the two female-sex hormones—estrogen and progesterone—induced by hormonal contraception could impact the functioning of the central nervous system and the endocrine system responsible for stress management, and thus the risk of mood disorders (Skovlund et al., 2016). However, credible causal evidence on this link is scarce, with the handful of randomized controlled trials yielding mixed results, in part due to small sample sizes and short follow-up periods (Zethraeus et al., 2017; Lundin et al., 2017). In this paper, we use population-level Danish administrative data and implement two complementary empirical strategies to study the impact of the combined oral contraceptive pill on teenage girls' mental health outcomes (psychiatric visits, depression diagnosis, and antidepressant use).

We first exploit variation in the timing of pill initiation in an event study framework and document that girls' mental health deteriorates shortly after they start using oral contraceptives. The findings we present are highly compelling: there is no evidence of pre-trends for any of the outcomes we analyze; however, one quarter after the first pill prescription, the probability of a psychiatric visit and a depression diagnosis increases by 17% and 40%, respectively. We also show that one year after the first combined oral contraceptive prescription the probability of antidepressant use is 65% higher.

[1] This is similarly true in the Danish context, where our study is based: in 2013, more than 40% of girls aged 15 to 19 were using the pill (Lindh et al., 2017).

The richness of the register data allows us to probe the key identification assumptions in the event study design. For example, our results remain virtually unchanged when we exclude girls who are at risk of developing mental health problems around the time of pill initiation (e.g., girls who receive an abortion or use emergency contraception). Similarly, we find no evidence of increased risky behavior, as proxied by hospital visits due to alcohol abuse or intoxication, screening for sexually-transmitted diseases (STIs), or chlamydia diagnosis, surrounding the time of oral contraceptive initiation. We also present evidence of treatment heterogeneity consistent with a biological pathway. Medical studies suggest weaker associations between the use of progestin-only pills (as opposed to combined oral contraceptives) and mental health outcomes. Consistent with this, we show that there is no evidence of mental health deterioration around the time of pill initiation among girls who use progestin-only contraceptives. Finally, we document that children whose first pill prescription have different hormonal composition have similar trajectories in their GP visits, suggesting that the observed mental health effects are unlikely to be due to increased interactions between patients and physicians (e.g. to refill prescriptions).

In the second part of the paper, we quantify the impact of primary care provider (GP) type, given by their propensity to prescribe oral contraceptives to adolescents, on mental health outcomes.[2] We circumvent key endogeneity concerns related to patient-provider matches by assigning children to the provider treating them at age 12, when extremely few children use the pill. This provider is chosen by the child's parents (as children cannot choose their own GP before age 15) from the pool of available providers in their catchment area. We measure GP prescribing tendency as a leave-one-out combined oral contraceptive prescription rate among the other 12 to 18 year olds that were seen in that clinic in that year. We document that there is substantial variation in primary care providers' tendency to prescribe the pill. Importantly, GPs' pill prescribing tendency is orthogonal to a rich set of observable child and parental characteristics as well as to girls' outcomes measured at age 12, suggesting that the assignment of provider is unrelated to the determinants of girls' contraceptive use and mental health outcomes.

Our results suggest that the GP practice style strongly predicts use of oral contraception: switching from a provider at the 10th percentile of the distribution to one at the 90th percentile

[2] In Denmark, women require a medical prescription to obtain oral contraceptives. In our sample of adolescents, 95% of the prescriptions are issued by primary care physicians.

increases the likelihood of contraceptive use by age 15 by 6.5% and by age 16 by 4%. Primary care physicians' pill prescribing tendency also impacts girls' mental health outcomes. We find that assignment to a GP with one standard deviation higher pill prescribing tendency increases the likelihood of having a psychiatric contact between ages 16 to 18 by 2.2%, the likelihood of a depression diagnosis by 5.2%, and the probability of using antidepressants by 4%.

In order to shed light on the mechanisms linking GP practice style and the mental health outcomes of adolescent girls, we first examine the relationship between GPs' oral contraceptive prescribing tendency and the mental health outcomes of adolescent boys. We find no differences in the mental health outcomes of boys assigned to physicians with different pill prescribing tendencies. We also find no evidence that physicians with different pill prescribing tendencies have different effects on hospitalizations for ambulatory care-sensitive conditions, a proxy for their quality of care. While we cannot rule out that primary care providers with different oral contraceptive prescribing tendencies impact patient outcomes by not only changing patients' likelihood of using oral contraceptives but also through other dimensions of care that are correlated with their prescribing tendency, we cautiously interpret these findings as indicating that in our context, contraceptive use is likely the main channel.

Our study is closely related to the extensive body of work examining the consequences of the introduction of the pill. The majority of this literature focuses on the effects of access to the pill on women's fertility, marriage, and career trajectories (Goldin and Katz, 2002; Bailey, 2006; Bailey et al., 2012). One exception is the study by Valder (2022) that exploits variation in laws governing access to the pill in the US to examine the long-term consequences of the early diffusion of the pill. In addition to the well-documented impacts on education and labor market outcomes, this paper also finds a link between pill access at ages 14 to 21 and worse mental health outcomes at age 60. Given the long period between when these women gained access to the pill and when their mental health outcomes are measured, these results may not only reflect the impact of the pill on mental health but also the broader shifts in life trajectories. We add to this literature by providing novel evidence of the direct effect of the contraceptive pill on mental health.

Our paper also contributes to the literature examining the impact of provider practice styles on patient outcomes. Former studies documented consequences of variation in physician prescribing tendency in ADHD medications (Dalsgaard et al., 2014), opioids (Eichmeyer and Zhang, 2022, 2023), and antidepressants (Bhalotra et al., 2023; Currie and Zwiers, 2023; Cuddy and Currie, 2020). We document the variation in providers' tendency to prescribe the contraceptive pill and analyze its impact on patient outcomes.

Finally, our project is related to the rapidly growing economic literature on the determinants of mental health disorders. The majority of this research documents effects of in-utero conditions on mental health during adulthood (e.g. Adhvaryu et al., 2019; Almond and Mazumder, 2011; Chorniy et al., 2020), with emerging evidence indicating the onset of these conditions during early childhood (Persson and Rossin-Slater, 2018). Studies investigating the postnatal environment mainly focus on the effects of economic resources (e.g. Baird et al., 2013; Golberstein et al., 2019; Ridley et al., 2020; Schaller and Zerpa, 2019) or educational environment (e.g. Dee and Sievertsen, 2018; Jakobsson et al., 2013; Marcus et al., 2020; Rossin-Slater et al., 2020).[3] Our study adds to this literature by examining the effects of a widely prescribed medication on the mental health outcomes of adolescent girls.

Mental health disorders affect 15% of children and adolescents globally and are now the leading cause of childhood disability (Polanczyk et al., 2015). The broad concern on adolescent mental health issues has reached new heights in recent years, leading some to declare that the United States is now in a mental health "crisis" (American Academy of Pediatrics, 2021). Given these, child mental health is likely to remain a global priority in the coming years and understanding the causal drivers of childhood mental health disorders is of paramount interest. Our results underscore the importance of a widely-used medication, oral contraceptives, as a contributor to adolescent girls' mental health problems.

2 Background

2.1 Organization and Delivery of Health Care Services

Denmark has a universal healthcare system. Children's health care is organized in primary and secondary systems. Primary care is provided by general practitioners (GPs), who are responsible for regular consultations and the provision of preventive health examinations. GPs are self-employed

[3] A few papers have also studied the link between mental health and sexual health behaviors. See, for example, Janys and Siflinger (2021).

and need a practice authorization number (*ydernummer*) in order to be reimbursed for their services. The number of practice authorizations is determined by the state as a function of various criteria, such as population density. In 2018, there were 4,086 GPs in Denmark, organized in 1,795 practices.[4] The median number of practices per municipality was 14 (10th and 90th percentiles were 5 and 60, respectively). Roughly half of these were single-physician practices.[5] The typical GP served 1,655 patients. GPs receive income through a mixture of fee-for-service and capitation, with fee-for-service payments making up roughly two-thirds of the total income. In 2022, the fixed capitation fee per patient was 500 DKK (around 66 USD). Importantly, GPs do not have any financial incentive for prescribing medications as they receive no fee from prescriptions.

Children are typically registered in the primary care practice of their parents.[6] Individuals can freely choose a GP in their municipality of residence as long as it is located within 15km of their primary residence (5km in the Copenhagen Metropolitan Area) and is accepting new patients.[7] Patients can change their primary care provider free of charge if they move to a residence that is further than the allowed distance from their current clinic. Provider changes in other circumstances require an administrative fee. In 2022, this fee was 215 DKK (approximately 29 USD).

Children receive secondary care from privately practicing specialists and public hospitals. GPs act as gatekeepers for specialist treatment, with only around 10% of consultations for the general population leading to a referral (OECD, 2016). The Danish Health and Medicines Authority, however, recommends universal referral for certain conditions, including suspected mental health disorders among children. According to clinical guidelines, GPs should refer mild cases to private practice child psychiatrists while more severe conditions are referred to hospitals with psychiatric departments.

The National Health Insurance Scheme provides full coverage for all services provided by GPs, child psychiatrists, and public hospitals, thus patients do not incur any out-of-pocket expenses for these treatments. However, costs of prescription drugs are not fully covered, and subsidies have changed over time. Until March 2000, prescription drugs were subsidized using a fixed coinsurance

[4] Available here, last accessed in October 2022.

[5] 25% of practices had two physicians, 14% had three physicians, 7% had four physicians, and 4% had 5 or more physicians.

[6] Up until the age of 15, a child is automatically registered to the same GP as their parents. At the age of 15, they can decide to have another GP.

[7] Clinics are allowed to impose a ceiling of 1,600 patients per general practitioner. According to PLO (2021), 56% of clinics reached this ceiling in 2021.

rate, depending on the therapeutic type of the drug. Since then, subsidies are based on a non-linear plan such that the coinsurance rate declines as prescription drug spending accumulates over a coverage year.[8] Oral contraceptives are not subsidized but they are inexpensive, with a two-month of supply typically costing around 30 DKK (4 USD). Mental health prescriptions, on the other hand, are eligible for subsidy. According to Simonsen et al. (2021), Citalopram (a commonly prescribed antidepressant) was among the top-10 prescribed medications and had a coinsurance rate of 25% before Denmark switched to the non-linear subsidy scheme.

2.2 Contraceptive Use in Denmark

The Danish Family Planning Association was founded in 1956 with the aim of reducing unwanted pregnancies by disseminating information on access to contraception. During the 1960s, family planning services were placed within the National Health Insurance Scheme, making contraceptive counseling available and free of charge to all residents. Women need a prescription to obtain an oral contraceptive, the majority of which are provided by GPs. Children aged 15 and above can request oral contraceptives from their GP without needing parental consent.[9] Sex education is a compulsory part of the Danish public school system since 1970. While the specific contents of the curriculum changed over time, contraceptives and sexually transmitted diseases have always been a focus area.

In Denmark, contraceptives are widely used. Currently, two different groups of oral contraceptives are available on the Danish market: combined oral contraceptive pills (COCs), which release both estrogen and progestin hormones, and progestin-only pills (Cooper et al., 2022). Oral contraceptives are further classified according to their estrogen dose and to the type or generation of progestogen they include. According to Løkkegaard and Nielsen (2014), between 1995 to 2012, on average, 85% of Danish girls had at least one hormonal contraceptive prescription by the age of 20. During this period, third-generation COCs dominated the market. Between 1998 and 2010, the market share of third-generation COCs exceeded 60%. Third generation COCs were even more

[8]There have been changes to the thresholds corresponding to the step-function as well as the coinsurance rates but children typically pay 40-50% of the first 1,500 DKK (200 USD), 25% of costs between 1,500-3,500 DKK (200-460 USD) and 15% of costs afterwards. There is a stop-loss amount, which was approximately 24,000 DKK (3,200 USD) in 2021. For details, see here, last accessed in October 2022.

[9]Since July 2019, pharmacists can renew a prescription for regular pill users aged 15 and above. For more information, see here (last accessed October 2022).

popular among younger women, with a market share above 70% among women aged less than 20 (Wilson et al., 2012).

In light of evidence of increased risk of venous thromboembolism associated with third-generation COCs, the Danish Health and Medicines Authority issued a guideline in 2014 recommending the use of second-generation COCs as the first choice of oral contraception for women under the age of 30.[10] Despite concerns of serious side-effects, hormonal contraceptive use among adolescents and young adults remains high to this day: more than 50% of 15 to 24 year-old women used hormonal contraceptives in 2019, with combined oral contraceptives as the most used method (Kristensen and Lidegaard, 2021).[11] That same year, the market share of second-generation COCs was 80% among women younger than 20. It is worth noting that oral contraceptives are not only used to prevent unwanted pregnancies but are often prescribed to young women to regulate or lessen menstruation, improve acne, and treat endometriosis-associated pain (Dayal and Barnhart, 2001). As such, in addition to the ease of use, accessibility, and lack of invasiveness, these conditions may contribute to the steady prevalence of oral contraceptives among adolescents.

2.3 Hormonal Contraception and Mental Health: The Biological Link

The impact of hormonal contraceptives on mood changes has been debated since the early days of the pill and several studies report negative mood alterations as an important reason for discontinuing oral contraceptives (Sanders et al., 2001; Poromaa and Segebladh, 2012). The medical literature argues that hormonal contraceptives may impact mental health by altering the levels of the two female sex hormones—estrogen and progesterone— which are in turn related to the functioning of the hypothalamic-pituitary-adrenal (HPA) axis as well as certain neurotransmitters.

The HPA axis is a neuroendocrine system that plays a central role in mediating the effects of stressors by regulating the metabolism, immune responses, and the nervous system. Brain imaging studies suggest that estrogen regulates the activation of brain regions associated with emotional and cognitive processing, while progesterone is known to promote new nerve growth in the hippocampus, which is the main regulator of the HPA axis (Toffoletto et al., 2014). One hypothesis suggests that hormonal contraceptives blunt an individual's HPA axis and the resulting deterioration in stress

[10] More information can be found here. Last accessed on 12 September 2022.

[11] The corresponding figure for women of ages 30 to 45 ranged between 31 to 34% (Kristensen and Lidegaard, 2021).

management leads to anxiety and depression.

Neurotransmitters are chemicals that carry messages from one nerve cell (neuron) to the other cells (glands, muscles, or other neurons) in the body. Female sex hormones affect the activity of certain neurotransmitters. For example, low levels of progesterone are linked with low GABA function, an inhibitory neurotransmitter that promotes calmness, good mood, and sleep. Similarly, low estrogen levels are linked with low serotonin and dopamine, two modulatory neurotransmitters that are vital in the brain's processing of moods and rewards. A second hypothesis argues that hormonal contraceptives interfere with the proper functioning of these neurotransmitters by changing the natural variation in sex hormones. During a typical 28-day menstrual cycle, estrogen levels reach their peak around day 14. At this time many women report high levels of physical and emotional well-being. Most hormonal contraceptives smooth this mountain-shaped hormonal cycle into an even line for the first 21 days. Then the levels of estrogen and progesterone plunge during the final 7 days.

Despite the widely known hypotheses suggesting detrimental mental health effects of oral contraceptives, causal empirical evidence on this is scarce. We are aware of only one recent study in economics that links access to pill during ages 14-21 to worse mental health at age 60, exploiting variation in access to the pill across US states (Valder, 2022). Outside of economics, numerous correlational studies investigate the link between oral contraceptive use and mental health, with some studies documenting a positive association (Taggart et al., 2018) and others finding a negative association (Poromaa and Segebladh, 2012; Skovlund et al., 2016).[12] Evidence from the few small-scale randomized controlled trials on the subject also yields mixed results.[13] Overall, whether and how the contraceptive pill affects mental health remains an open question.

[12]A well-known study by Skovlund et al. (2016) focuses on Danish women aged 15-34 with no prior depression diagnosis and compares mental health outcomes of women who use oral contraceptives with the outcomes of never and former users. The results show that taking the pill is associated with a higher risk of a depression diagnosis and antidepressant use, especially among adolescents.

[13]The largest and most recent RCTs are Lundin et al. (2017) and Zethraeus et al. (2017). In Lundin et al. (2017), 84 women were assigned to the treatment group receiving COCs while 94 women were assigned to the placebo group. The results indicated a small but statistically significant increase in mood side effects in the intermenstrual phase. Zethraeus et al. (2017) conducted an RCT with 332 healthy women aged 18-35 and found that taking the oral contraceptive pill (in comparison with placebo) did not have a significant effect on depressive symptoms within the three-month follow-up period, but led to a significant decrease in an index of general well-being.

3 Empirical Strategy

Event Study Design To estimate the causal effect of oral contraceptives on girls' mental health outcomes, we first exploit the variation in the timing of pill initiation in an event study framework. In particular, we construct a balanced panel of girls who started using the combined oral contraceptive pill between the ages of 12 and 17, both included, with observations dating from five quarters before and four quarters after the pill initiation. We then estimate the coefficients of indicator variables for quarters relative to the event of the first filled oral contraceptive prescription ("event time") with the following equation:

$$Y_{is} = \alpha_i + \sum_{t \neq -1, t=-4}^{t=4} \gamma_t \times I_t + \omega_{is} + \epsilon_{is} \tag{1}$$

where Y_{is} is a measure of mental health for girl i in quarter s, α_i are individual fixed effects, I_t are event time fixed effects, and ω_{is} are age in calendar quarter fixed effects. Following Sun and Abraham (2020), we omit two event time dummies ($t = -1$ and $t = -5$) to avoid multicollinearity.[14] Hence, the event time coefficients measure the impact relative to these two periods. We implement the interaction weighted (IW) estimator proposed by Sun and Abraham (2020), with the last treated cohort as control, to address the fact that, in the presence of treatment heterogeneity, the two-way fixed effects regression can result in estimates with uninterpretable weights.[15] Standard errors are clustered at the individual level.

Interpreting these coefficients as representing a causal impact of contraceptive use requires two conditions: (i) that in the absence of the treatment – starting oral contraception – the mental health trajectories of girls with different times of pill initiation would have followed similar trends (parallel trends), and (ii) that individuals do not adjust their behavior prior to pill initiation in ways that impact mental health outcomes (no anticipatory behavior). These assumptions could be violated if, for example, girls who initiate oral contraception early have unobserved characteristics that make them more likely to develop mental health problems over time. While we cannot test

[14] According to Sun and Abraham (2020) and Borusyak et al. (2021), one multicollinearity comes from the relative period indicators summing to one for every unit, and the other multicollinearity comes from the linear relationship between two-way fixed effects and the relative period indicators.

[15] Sun and Abraham (2020) show that in settings with variation in treatment timing across units, the coefficient on a given lead or lag can be contaminated by effects from other periods.

these assumptions directly, we bring suggestive evidence on their plausibility in several ways. First, we show that girls in the treatment and control group have very similar mental health trajectories before starting oral contraception: the coefficients corresponding to pre-pill initiation quarters are all very close to zero. The sharp increase in mental health disorders is only visible after pill initiation. Second, we show that our results are robust to excluding girls who are at risk of having mental health problems around the time of pill initiation for independent concurrent reasons (e.g., girls with an unwanted pregnancy), or girls who have a history of mental health problems. Third, we show that there is no evidence of increased risky behaviors—proxied by hospital visits due to alcohol abuse or intoxication, screening for sexually-transmitted diseases, or chlamydia diagnosis—surrounding the time of oral contraceptive initiation. In addition, we provide evidence consistent with a biological pathway by examining treatment heterogeneity by the type of first contraceptive prescription. The medical literature points at a weaker link between progestin only contraceptives (compared to combined pills) and mental health outcomes. Consistent with this, we find no evidence of mental health deterioration around the time of first pill use among girls who use progestin-only products. Finally, we show that children whose first pill prescription have different hormonal composition have similar trajectories in their GP visits, suggesting that the observed mental health effects are unlikely to be due to increased interactions between patients and physicians (e.g. to refill prescriptions).

GP Practice Variation In the second part of the paper, we quantify the impact of primary care providers' practice style on the mental health outcomes of adolescent girls. As discussed in Section 2.2, women in Denmark need a prescription to obtain an oral contraceptive and the overwhelming majority of these prescriptions are provided by the GP. To the best of our knowledge, there is no quantitative evidence documenting the variation in physicians' prescription practices regarding the contraceptive pill.[16] Yet, several papers discus the variation in doctors' attitudes and preferences in this context. For example, survey-based research documents substantial variation in doctors' beliefs about the appropriateness of the pill use for non-contraceptive reasons, such as menstrual disorders (Chen et al., 2016). Evidence also suggests that there is a notable shortfall in doctors' knowledge of the WHO guidelines regarding the use of COCs (Grove and Hooper, 2011; Sannisto

[16] Several papers document variation in physician practice styles and their consequences in other contexts. See, for example, Dalsgaard et al. (2014); Bhalotra et al. (2023); Eichmeyer and Zhang (2022, 2023).

and Kosunen, 2010), and that many doctors are unlikely to alter their prescribing practices when informed about it (Grove and Hooper, 2011; Briggs et al., 2013). As such, we expect there to be substantial variation in family doctors' tendency to prescribe oral contraceptives to teenagers.

Our empirical strategy follows recent work linking practice variation to patient outcomes (Cuddy and Currie, 2020; Eichmeyer and Zhang, 2022, 2023) and exploits variation in primary care providers' tendency to prescribe oral contraceptives to girls aged 12 to 18. In particular, we assign each child i the primary care provider j they visited most at age 12.[17] We then construct the GP prescribing tendency as a leave-one-out combined oral contraceptive prescription rate among the other 12-18 year olds that were seen in that clinic in that year:

$$PP_i = \frac{1}{N_{-ij(i)}} \sum_{i \in (N \setminus i)} Pill_{ij} \tag{2}$$

Leaving out a child's own prescription use from their GP's prescribing tendency measure allows us to eliminate the mechanical bias from the patient's own case entering into the GP prescribing tendency measure. For ease of interpretation, we standardize the provider tendency to have a mean of 0 and a standard deviation of 1. The key estimating equation is given by:

$$Y_i = \alpha + \beta PP_i + \theta X_i + \mu_{mob} + \gamma_m \times \delta_{yob} + \epsilon_i \tag{3}$$

where Y_i is an outcome variable for girl i capturing contraceptive use or a measure of mental health, PP_i is the oral contraceptive prescribing tendency of their GP, X_i is a set of child and family characteristics measured when the child was eleven years old, μ_{mob} are month of birth fixed effects, and $\gamma_m \times \delta_{yob}$ are municipality by year of birth fixed effects. Standard errors are clustered at the provider level.

The key coefficient of interest in model (3), β, measures the impact of having a primary care provider who prescribes combined oral contraceptives to adolescents at a one standard deviation higher rate. Interpreting β as causal requires quasi-random assignment of children to providers. In order to circumvent endogeneity concerns related to patient-GP matches, we assign children to

[17]Information on primary care providers is obtained from the Health Insurance Register, which includes claims for services rendered. Since patients may receive several services in a single visit, we aggregate services claimed in intervals of two weeks to avoid confounding the match to the most visited GP at age 12. Our results are robust to defining the most visited GP using alternative aggregation methods.

the provider who treats them at age 12, when contraceptive pill use is very low. This provider is chosen by the child's parents (as children cannot choose their own GP before age 15) from the pool of available providers in their catchment area. In addition, we only focus on the oldest girls in the family to limit the possibility that parents select or change their GP based on the physician's pill prescribing rate to adolescents. We provide empirical evidence on the plausibility of the quasi-random assignment assumption by showing that the provider prescribing tendency is orthogonal to a rich set of observable child and parental characteristics as well as to girls' outcomes measured at age 12, when rates of oral contraceptive use are very low.

Primary care providers with different oral contraceptive prescribing tendencies may impact patient outcomes by changing patients' likelihood of using oral contraceptives or through other dimensions of care that are correlated with their prescribing tendency. As such, we do not use GP's prescribing tendency as an instrument for oral contraceptive use. Since almost all contraceptive use originates from primary care physicians, understanding how GP practice style can impact the mental health of adolescent girls is interesting in its own right. That said, we provide several pieces of evidence pointing to contraceptive use as the most plausible channel. First, we find no relationship between GP's oral contraceptive prescribing tendency and the mental health outcomes of adolescent boys. Second, we document that the GP prescribing tendency is unrelated to patient hospitalizations for ambulatory care-sensitive conditions, suggesting that high-prescribing providers are unlikely to provide different quality of care in other dimensions. While none of these checks are individually sufficient to claim contraceptive use as the main channel linking provider type and adolescent mental health, taken together, they provide consistent evidence this is likely to hold in our context.

4 Data and Sample

We use several population-level administrative data sets from Denmark in our analysis. These data include individual-level records with unique personal identifiers, allowing us to follow the entire population over time and to link family members. We use information from these registers from 1997 to 2020.

Outcome Variables Our primary outcome variables capture mental health care utilization during adolescence: psychiatric visits, depression diagnosis, and antidepressant use. We measure psychiatric visits using the *Psychiatric Central Research Register* and the *Health Insurance Register*. The *Psychiatric Central Research Register* is a dataset on all inpatient admissions, outpatient visits, and emergency rooms (ER) visits to psychiatric departments in public and private hospitals, along with International Classification of Disease (ICD) codes (Mors et al., 2011). The *Health Insurance Register* provides information on reimbursements to private practices – both general practitioners and specialists – for all patient-related services covered by the national health insurance.[18] We define psychiatric visits as an outpatient or ER visit to a hospital psychiatric department or a visit to a private psychiatric clinic (based on physician's specialty code "24" or "26" in the *Health Insurance Register*).[19] For the subsample of hospital-based psychiatric visits, we define an indicator for having a depression diagnosis as determined by ICD-10 codes starting with F32 and F33.[20] Finally, we study antidepressant consumption using the *National Prescription Register*, a database of all prescriptions filled at Danish pharmacies, including information on the Anatomical Therapeutic Chemical (ATC) Classification System and product name (Kildemoes et al., 2011). In particular, we define an indicator for filling a prescription with an ATC code of "N06A". We measure the outcome variables either in a short window around the time of the first contraceptive prescription (event studies design) or at ages 16-18 (GP practice variation).

Contraceptive Use We obtain the dates of filled oral contraceptive prescriptions from the *National Prescription Register*. We follow Skovlund et al. (2016) and use detailed ATC codes to classify prescriptions as hormonal contraceptives. We mostly focus on the combined oral contraceptive pill, but consider also progestin-only contraception.[21] In the event study design, we focus on the date of the first filled prescription. When we exploit variation in practice behavior, we examine the effects on an indicator for filling an oral contraceptive prescription by ages 15 or 16.

Control Variables We observe a rich set of child and parent characteristics. We use the *Population*

[18] This register does not include diagnosis information.

[19] Most patients receive mental health treatments on an outpatient basis. Inpatient care is mainly used for patients with schizophrenia (Serena, 2021)

[20] The last available year of the *Psychiatric Central Research Register* in our database is 2017. Hence, we have a smaller number of observations when studying depression diagnoses.

[21] For the combined pill, we consider the following ATC codes: G03AA01, G03AA03, G03AA05, G03AA07, G03AA09, G03AA10, G03AA11, G03AA12, G03AB03, G03AB04, G03AB05, G03AB06, G03HB. Our definition of progestin-only contraception includes the following codes for the progestin-only pill (G03AC01, G03AC02, G03AC03, G03AC09) and the progestin-only implant (G03AC08).

Register, which provides a snapshot of demographics on all Danish residents as of January 1st of each year, to link each individual to their parents and siblings. Using these data, we measure number of siblings and parental age. We use the *Education Register* to obtain information on parents' highest level of completed schooling and the *Register-Based Labour Force Statistics* to characterize parental labor force participation. We include the following variables as controls, measured at child age 11: number of siblings, parental marital/cohabitation status, each parent's age, education level (indicators for compulsory education or college degree), and employment status.[22]

Analysis Samples To construct our analysis sample, we begin with the universe of 722,366 girls born between 1986 and 2002. In order to ensure that we have children's complete history of oral contraception use, we keep children who are observed every year between the ages of 11 and 18. This leaves us with a balanced sample of 539,247 girls (*full sample*). Based on this full sample, we construct our two analysis samples as follows. For the event study analysis, we focus on girls who ever use the combined oral contraceptive pill between ages 12 to 17, both included. This is a sample of 266,344 girls (*event study sample*). For the analysis relying on provider prescribing variation, we make the following restrictions starting from the full sample. First, since this design requires us to link children and primary care providers, we drop girls who do not visit a primary care physician at age 12.[23] Second, in order to reduce noise in our measure of provider leniency, we drop children matched with a primary care provider with less than 25 patients aged 12-18. Third, we only keep first-born children with the aim of limiting the possibility that parents choose their child's physician based on the provider's prescribing tendency (e.g.by observing their prescribing behavior to older daughters). Finally, we exclude girls with an immigrant background in order to reduce heterogeneity in the attitudes toward oral contraception use. The resulting sample consists of 238,006 girls (*GP sample*).

Descriptive Statistics Appendix Table A1 presents descriptive statistics, separately for the full sample, the event study sample, and the GP sample.

Around 21% of girls in the full sample fill an oral contraceptive prescription by age 15. The rate of oral contraceptive use sharply increases with age (see Appendix Figure A1), with around 40%

[22] We also include indicators for the few instances when parental characteristics are missing.
[23] Our results are robust to using alternative ages.

of girls filling an oral contraceptive prescription by age 16. In the full sample, 9% of girls have an immigrant background, and the average girl has around 2 GP visits at age 11. The table shows that mothers are, on average, 40 years old when the child is 11. About 30% of mothers have a college degree, and 4% have completed at most compulsory schooling. Around 33% of mothers use oral contraceptives and almost 9% have an antidepressant prescription in that year. When the child is 11 years old, fathers are, on average, 42.8 years old, 29% have a college degree, 6% have only compulsory education, and 5% use antidepressants. 81% of mothers and close to 86% of fathers are employed. Approximately 66% of parents are married or cohabiting. Between ages 16 and 18, 7.3% of girls have at least one psychiatric visit, and 1.2% have a depression diagnosis. 4.8% of girls fill at least one antidepressant prescription at those ages, with 3% having prescriptions issued by specialists.

The average girl in the event study and GP samples resembles those in the full population in terms of most characteristics. Girls in the event study sample have, by construction, a higher probability of using the pill by ages 15 and 16. Between ages 16 and 18, they also have a higher likelihood of visiting a psychiatrist (9%), having a depression diagnosis (1.5%), and having an antidepressant prescription (6.2%). Compared to those in the full sample, they are less likely to have an immigrant background, and they have parents who are slightly less educated and less likely to be married or cohabiting, but who have similar rates of antidepressant use. Their mothers are slightly more likely to also use oral contraceptives (35%).

Compared to the full sample, parents in the GP sample are similar in terms of education, but they are slightly younger and have slightly higher rates of employment. While maternal use of oral contraceptives is lower in this sample (23%), parental antidepressant use is very similar to the full population. Children in the GP sample have similar GP visits at age eleven but higher rates of contraceptive use at adolescence (around 23% use it at age 15 and 44% at age 16). Around 8.3% of children in the GP sample have a psychiatric visit between the ages of 16 and 18. Rates of depression diagnosis and antidepressant use are similar to the full population of girls.

Appendix Table A2 provides estimates from OLS models that relate contraceptive pill use by age 16 to mental health outcomes between ages 16–18. Consistent with previous findings in the medical literature, pill use during adolescence and mental health outcomes are negatively correlated: contraceptive use before age 16 is associated with a 50% increase in the probability of having a psychiatrist visit during ages 16-18, a 59% higher probability of being diagnosed with depression, and a 56% higher probability of filling an antidepressant prescription.

5 Results – Event Study Design

5.1 Effects on Mental Health Outcomes

In this section, we present the results from the event study design that uses variation in the timing of pill initiation. Figure 1 plots the coefficients for the event time dummies from equation (1) along with the 95-percent confidence intervals. The coefficients corresponding to pre-pill initiation quarters allow us to shed light on our key identification assumption. In panel (a), we examine the impact on the probability of having a psychiatric visit in a given quarter. There is no evidence of a pre-trend. However, we observe a marked increase in the probability of having a psychiatric visit one quarter after starting on the contraceptive pill. This represents a 17% increase with respect to the average probability of a psychiatric visit in the quarter prior to pill initiation. The effect is persistent, and we observe a similar increase in visits four quarters later.[24]

Panel (b) examines the effects on the likelihood of a depression diagnosis following an outpatient or emergency psychiatric visit at the hospital. We again document flat trajectories before starting on the pill. In contrast, the results suggest that one quarter after pill initiation, the probability of receiving a depression diagnosis increases by 40% compared to the mean in $t = -1$.[25]

Finally, in panel (c), we document the effects on antidepressant use. The flat pre-trends again suggest that girls are unlikely to suffer a deterioration in mental health prior to initiating contraceptive use. However, there is an increased probability of taking antidepressants after starting the pill. In fact, the effect seems to grow over time: four quarters after pill initiation, the likelihood of taking an antidepressant increases by around 0.5 percentage points (a 65% increase when compared to the mean in $t - 1$).

[24] In 2011, the Danish Health and Medicines Authority tightened the guidelines on antidepressant treatment for children, recommending that children and young adults always see a psychiatrist before initiating treatment for mental health conditions.

[25] It is also important to note that the timing of our results are in line with waiting times for psychiatric referrals in Denmark: in 2015 the average waiting time for children was 22 days. For details, see here, last accessed in April 2023.

5.2 Identification Checks

The key concern in interpreting these results as causal is that the timing of pill initiation may be correlated with other events or behaviors that impact adolescent girls' mental health trajectories. The medical literature suggests that adolescents may use oral contraceptives due to heavy menstrual bleeding, dysmenorrhea pain, and other irregularities (Davis et al., 2005; Fraser and McCarron, 1991; Davis et al., 2000), acne conditions (Redmond et al., 1997), after an abortion or after using the emergency contraceptive pill.[26] Some of these conditions may have independent effects on mental health trajectories. In Appendix Figure A2, we investigate the trends in these potential reasons of pill use surrounding the pill initiation. Panel (a) shows the impact on the likelihood of having an ICD code for menstrual irregularities, diagnosed during a hospital visit. In panel (b), we examine the effect on the likelihood of filling a prescription for acne. Panels (c) and (d) investigate the likelihood of using an emergency contraception or having an abortion, respectively. Across all the figures, we document an increased likelihood at $t = 0$, followed by a reduction in other quarters. These results suggest that all these conditions may be contributing to pill initiation.[27] Appendix Figure A3 checks the sensitivity of our main findings to excluding such cases and shows that our main results remain unchanged.

In Figure A4, we examine the evolution of risky behaviors around the pill initiation. Panel (a) shows the effects on teen births. Even though teen pregnancies are extremely rare in Denmark, we can reject that girls initiate pill use after a pregnancy.[28] As we would expect, we see a decrease in teen pregnancies after pill initiation. In panel (b), we examine the effects on risky behaviors. We follow the previous literature and define risky behaviors with an indicator for hospital visits due to alcohol abuse or intoxication, screening for sexually-transmitted infections, or chlamydia diagnosis (Janys and Siflinger, 2021; Cawley and Ruhm, 2011; Mulligan, 2016).[29] Our results indicate no evidence of elevated risky behavior before pill initiation and a decrease in risky behaviors in the

[26]Menstrual irregularities are defined with the following ICD-10 Codes: N91-N94. Acne medications are defined as prescriptions with the ATC code D10. Abortions are defined based on hospital records with ICD-10 codes O04-O06. Emergency contraceptives are defined as prescriptions with ATC codes G03AD.

[27]The results also suggest that, consistent with the medical literature, the pill helps to improve menstrual disorders and acne conditions.

[28]In our sample, we have only 778 cases of teen births (0.3%).

[29]We define an indicator for risky behavior equal to 1 if the girl had, in a given quarter, any hospital visit with ICD-10 codes F10 (Mental and behavioral disorders due to use of alcohol), T51 (Toxic effect of alcohol), A55 or A56 (Chlamydia), or Z11.3 (Screening for STIs other than HIV).

quarters after starting contraception.

Appendix Figure A5 explores the role of biology in driving these effects. In panel (a), we check whether the main results are driven by girls who have a history of mental health problems: we estimate our model among the sample of girls who had not had any contact with a psychiatrist for at least up to five quarters before the first pill use (the start of the event study window). The figure shows that the baseline effects are not solely driven by girls with pre-existing mental health conditions, as we find similar effect sizes also in this group. Panels (b) and (c) compare how the mental health effects differ depending on the hormonal composition of the first contraceptive prescription. While research on the mental health effects of different types of hormonal contraceptives is limited, studies indicate a weaker association between the use of the progestin-only pill and mood deterioration or depression (FSRH, 2022; Kuntz et al., 2016; Worly et al., 2018). Motivated by this, we compare our main results for combined pill users (panel (b)) with the effects of contraceptive initiation for girls who instead use a progestin-only product (panel (c)).[30] While the estimates are more noisily estimated in the progestin-only group due to smaller sample size, they indicate no evidence of a change in mental health outcomes, and we can rule out that the effects four quarters after pill start are the same in both groups.[31] We cautiously interpret these patterns as indicative of a biological pathway between the pill and mental health outcomes.

Finally, in Figure A6, we probe the possibility that the baseline results are the product of repeated interactions between the GPs and adolescent girls (e.g. to receive repeat pill prescriptions). We first examine effects on GP visits. Panel (a) shows no pre-trends in health care utilization prior to the first combined pill prescription, and a substantial increase in the probability of visiting a GP by more than 0.3 percentage points in the quarter of pill initiation. Panel (b) documents that these patterns are very similar for users of progestin-only contraceptives. This suggests that the effects found on mental health are unlikely to be driven by differences in healthcare utilization. The last

[30] The main reason why girls are prescribed a progestin-only product is if they present risk factors for suffering a thrombosis (Mantha et al., 2012). Consistent with this, we see in our data that girls who use progestin-only pills or implants as their first hormonal contraceptive are more likely to have a personal or family history of cardiovascular problems. These girls are otherwise similar to other pill users in e.g. the age of pill start.

[31] Given the smaller sample of progestin-only pill users, we see relatively few girls who start using them in each quarter. This implies a small number of observations in each "cohort," in the sense of Sun and Abraham (2020)'s estimator. To gain precision we instead estimate these regressions with a two-way fixed effects (TWFE) estimator as described in equation (1). We replicate in panel (b) the results on antidepressant prescriptions for combined pill users using also a TWFE estimator (and present them on the same scale for comparability). The comparison of Figures 1c and A5b show that both estimators yield virtually identical results.

panel of the figure turns to the role of GPs in prescribing antidepressants. We examine the impact on antidepressant use focusing only on prescriptions issued by specialists. The results show a very consistent result: there is a significant increase in antidepressant utilization after starting the pill. The overall pattern of effects remains remarkably stable, with a relatively smaller effect size.

Overall, these results provide robust evidence indicating that the timing of pill initiation is unlikely to be correlated with a deterioration of mental health, or that changes in behavior are driving the impact on mental health. Instead, our findings support the interpretation that the observed impact is driven by the hormonal changes associated with the pill.

6 Results – GP Practice Variation

6.1 Effects on Contraceptive Use

We next turn to quantifying the impact of primary care provider's practice style on contraceptive use. Figure 2 shows the identifying variation in our data. In particular, we plot our leave-one-out measure of GP tendency to prescribe combined oral contraceptives to girls aged 12 to 18, after residualizing municipality-by-birth-year fixed effects. The histogram shows that there is substantial variation in physicians' oral contraceptive prescribing tendencies. For example, providers at the 90th percentile of the distribution have a prescribing rate that is 16.6 percentage points higher than the providers at the 10th percentile. The difference in an interquartile shift is 8 percentage points. These differences are large when compared to the mean prescribing rate of 20% (see Table A1).

The solid line in the figure presents estimates from a local linear regression documenting how the probability of filling a combined oral contraceptive prescription by age 16 changes as a function of GPs' prescribing tendency. The figure suggests that the probability of using the pill is monotonically increasing in GPs' prescribing tendency and that this relationship is close to linear.[32] Table 1 presents the corresponding regression estimates. The first two columns examine the effects of GP practice style on contraceptive use by age 15 while the last two columns estimate the effects for filling a prescription by age 16. For each outcome, we first present results from a model controlling

[32] Figure A7 shows the cumulative distribution of contraceptive use by GPs' tendency to prescribe. In particular, we divide the sample into two groups: girls assigned to a GP with a high prescribing tendency (defined as those above the 75th percentile), and girls assigned to a GP with a low prescribing tendency (defined as those below the 25th percentile). The gap in the probability of taking the pill in these two groups is visible starting at age 13 and widens with age.

for municipality-by-birth-year fixed effects. We then check the sensitivity of the estimates to adding additional observable characteristics on children and their parents, as described in Section 4.[33] The results suggest that a provider with one standard deviation higher propensity to prescribe the pill increases the probability of taking the pill by age 16 (15) by a statistically significant 0.7 (0.6) percentage points. Our findings are virtually unchanged when we control for the rich set of observable characteristics on children and parents. These results impply that switching from a provider at the 10th percentile of the distribution to one at the 90th percentile would increase the likelihood of contraceptive use by ages 15 and 16 by 6.5% and 4%, respectively. In order to gauge the magnitude of these estimates, we can compare them to the role of background characteristics in predicting adolescent pill use. The 4% increase amounts to 40% of the difference in the probability of taking the pill by age 16 between girls whose mother is a contraceptive pill user and girls whose mother is not, holding other observables constant.

6.2 Effects on Mental Health Outcomes

Having established the important role of primary care providers in adolescent girls' oral contraceptive use, we now turn to adverse consequences on mental health outcomes, measured between ages 16 to 18: psychiatric visits, depression diagnosis, and antidepressant use.[34]

The results in columns (1)-(2) of Table 2 suggest that assignment to a GP with one standard deviation higher propensity to prescribe oral contraceptives increases the likelihood of having a psychiatric contact by 0.181 percentage points (an increase of 2.19% at the mean). In columns (3) and (4), we analyze the impact on receiving a depression diagnosis at a psychiatric hospital. We find that having a provider with a standard deviation higher pill prescribing tendency increases the probability of depression diagnosis by 0.068 percentage points, a 5.2% increase relative to the mean. Finally, we examine the effects on antidepressant use. Consistent with our finding of increased likelihood of a depression diagnosis, our results suggest that assignment to a high pill prescribing physician leads to higher antidepressant use: having a GP with a one standard deviation higher contraceptive prescribing tendency increases the likelihood of filling an antidepressant issued

[33] The number of observations in these regressions is slightly smaller than that presented in Table A1 for the GP sample, as a few observations are singletons in terms of municipality-year of birth.

[34] To avoid concerns that GPs with a higher propensity to prescribe oral contraceptives would also be more likely to prescribe antidepressant medication, we restrict our attention to antidepressant prescriptions issued by specialists.

by specialists by 0.121 percentage points, an increase of 4% at the mean. Similar to the results in Table 1, the addition of controls does not change any of the estimates; if anything, they become slightly larger.

6.3 Identification Checks

The key identifying assumption that would allow us to interpret these findings as causal is quasi-random assignment of patients to physicians. We bring suggestive evidence on the plausibility of this assumption through a check for balance on observable characteristics. In the left panel of Figure 3, we estimate a linear regression to document the relationship between contraceptive use by age 16 and a comprehensive set of family and individual characteristics. The results show that observable characteristics are highly predictive of pill use with a joint F-statistic of almost 674. The right panel turns to the relationship between GP's prescribing tendency and the same set of observable characteristics. In contrast to panel (a), we do not find any evidence that observable characteristics jointly predict physician propensity to prescribe oral contraceptives (the corresponding F-statistic is 6.3). While we observe some individually significant differences, the estimated effects are very small. Interestingly, most of these have the opposite sign to the differences observed in the left panel, suggesting that, if anything, these girls might be slightly positively selected.

We visually summarize this finding in panel (b) of Figure 2 where we overlay a local linear regression of predicted pill use (based on a linear model regression including a comprehensive set of demographic variables) on GPs' pill prescribing tendency. As the figure shows, girls' predicted oral contraceptive use is not correlated with the physician practice style: the coefficient on the slope parameter is neither economically nor statistically significant.

Finally, we conduct a placebo check where we regress girls' mental health outcomes at age 12, when the majority of girls are not on the pill yet, on GP's tendency to prescribe the pill. The results, presented in Table 3, show that there is no association between GP prescribing tendency and patient's outcomes prior to pill use.

Overall, we do not find evidence of any violations of quasi-random assignment on a rich set of observable characteristics, alleviating concerns of selection of patients based on unobservable determinants of mental health outcomes.

6.4 Mechanisms

While the quasi-random assignment of patients to physicians allows us to interpret the results presented so far as the causal impact of a lenient prescriber, this assumption is not sufficient to attribute the results to use of oral contraceptives. In particular, GPs with different pill prescribing tendencies may differ along other dimensions that impact adolescent mental health outcomes. While we cannot directly test that providers are identical along all dimensions except for their oral contraceptive prescribing tendency, we conduct two checks indicating contraceptive use as the most likely driver of the results we find.

First, an advantage of our context is that we have a very clear placebo test: we can examine whether GP practice style impacts outcomes of boys. To the extent that high pill prescribing physicians differ in other dimensions of care, this should be reflected in the outcomes of boys. To implement this falsification check, we assign each boy to their most visited provider at age 12 and use the prescribing tendency of that provider. Table 4 shows the results of estimating equation (3) for boys' outcomes. We find no evidence of a relationship between physician pill prescribing tendency and their mental health. Columns (1)-(6) examine effects on psychiatric visits, depression diagnosis, and antidepressant use. Across all columns, the estimated effects are small and statistically insignificant. We can reject the null hypothesis that the estimated effects for girls and boys are the same at 5% level.

One may be concerned that the lack of a statistical relationship in columns (1)-(6) is a reflection of the fact that mental health conditions such as depression are more common among girls. To address this concern, columns (7) and (8) examine the effects on a more general measure of mental health prescriptions, including treatments such as ADHD medications that are more common among boys.[35] The results again show no relationship between physicians' oral contraceptive prescribing tendency and boys' likelihood of using mental health drugs. These results suggest that high pill prescribing physicians are not more likely to yield worse mental health outcomes for all their patients. They also indicate that high prescribing physicians are not more likely to detect mental health disorders.

We next ask whether physicians with different pill prescribing tendencies may be more effective

[35] In particular, this general measure of mental health prescriptions includes antidepressants (N06A), benzodiazepine derivatives (N05BA), antipsychotics (N05A), as well as ADHD medications (N06BA01, N06B04, N06BA0).

in their care for patients. Following Currie and Zhang (2023), we focus on hospitalizations or ER visits for ambulatory care-sensitive conditions (ACSC) as a measure of provider effectiveness and create separate indicators for any ACSC, acute ACSC, chronic ACSC, and vaccine-preventable ACSC between ages 16 and 18.[36] We then estimate our baseline model using these as the outcome. The results yield very precise zeros across the board (Table 5), suggesting that GP's pill prescribing tendency is not correlated with the provider's general quality of care.

While we cannot test all dimensions of care, we cautiously interpret the results of these two checks as evidence for our conjecture that the main channel linking provider type and adolescent mental health is contraceptive use.

7 Conclusions

The contraceptive pill is a medical treatment used by millions of women around the world (151 million in 2019, according to the UN).[37] It is indisputable that the ability to control and delay fertility was and is crucial for women's lives and careers. That said, understanding the potential connection between the pill and adolescent mental health is highly important, especially considering that one in seven 10-19-year-olds experience a mental health disorder (WHO, 2021). While this connection has been debated since the introduction of the pill itself, there is scarce causal evidence on it.

This paper provides novel evidence on the causal impact of the contraceptive pill on young girls' mental health. We first use an event study framework to show a very clear break in teenage girls' mental health trajectories: soon after initiating oral contraception, there is an increase in the likelihood of psychiatric contact, of a depression diagnosis, and of antidepressant use. The effect sizes are economically significant. One quarter after pill initiation, the likelihood of a psychiatric visit and of a depression diagnosis increases by 17% and 40%, respectively. Four quarters after starting oral contraceptives, the probability of using antidepressants increases by 65%.

In the second part of the paper, we focus on an important determinant of girls' pill consumption: primary care doctors' tendency to prescribe oral contraceptives to adolescents. We show that there

[36] Some examples of conditions include asthma; diabetes complications; ear, nose, and throat infections. We construct ACSC hospitalizations using the full list of conditions in Appendix 1 in Barker et al. (2017).

[37] Available here. Last accessed in October 2022.

is substantial variation in GPs' pill prescribing tendency and that moving from the 10th percentile of this distribution to the 90th percentile increases the likelihood of oral contraceptive use by ages 15 and 16 by 6.5% and 4%. We next document how physician pill prescribing behavior affects adolescent mental health outcomes. Our results suggest that having a GP with a one standard deviation higher oral contraceptive prescribing tendency increases the likelihood of a psychiatric visit between ages 16 and 18 by 2.2%, the likelihood of a depression diagnosis by 5.2%, and the likelihood of antidepressant use by 4%.

What do these results imply about the role of oral contraceptives in the increased use of antidepressants among adolescent girls? To answer this question, we perform a back-of-the-envelope calculation. We observe a rise of 16% in oral contraceptive use by age 16 among cohorts born between 1986 and 1994. Our results imply that the pill increases the probability of antidepressant use by 65%. This translates into an increase in antidepressant consumption of 10.4% among these cohorts. The raw data shows that the use of antidepressants during teenage years among these cohorts increased by 71%. Therefore, approximately 15% of the upsurge in antidepressant utilization among adolescent girls can be attributed to increased oral contraceptive use.

Our findings offer compelling evidence of a substantial negative effect of the contraceptive pill on the mental health of adolescent girls. Therefore, it is crucial for women, physicians, and policymakers to carefully weigh the individual benefits derived from the pill against the potential costs among this population. Our results also suggest that primary care providers have a significant influence on their patients' oral contraceptive use. Given the substantial variation in pill prescribing tendency across GPs, this finding highlights the possibility of addressing the detrimental consequences of the pill on adolescent mental health through supply-side education policies.

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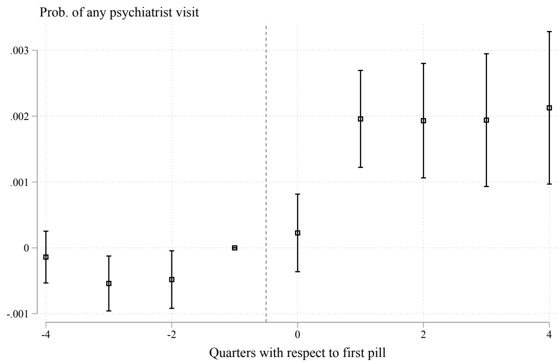
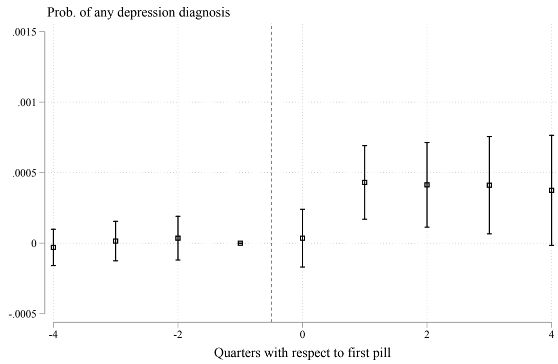
Figure 1: Event Study

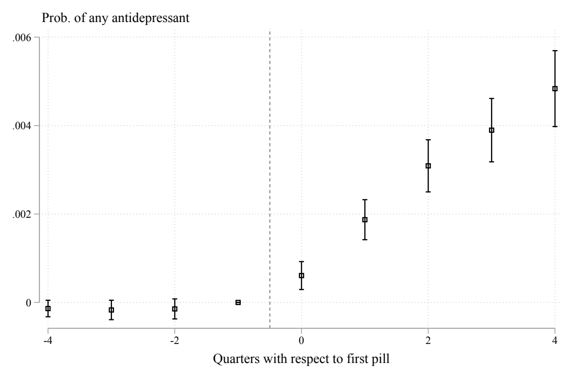
(a) Any psychiatrist visit



(b) Any visit with a depression diagnosis



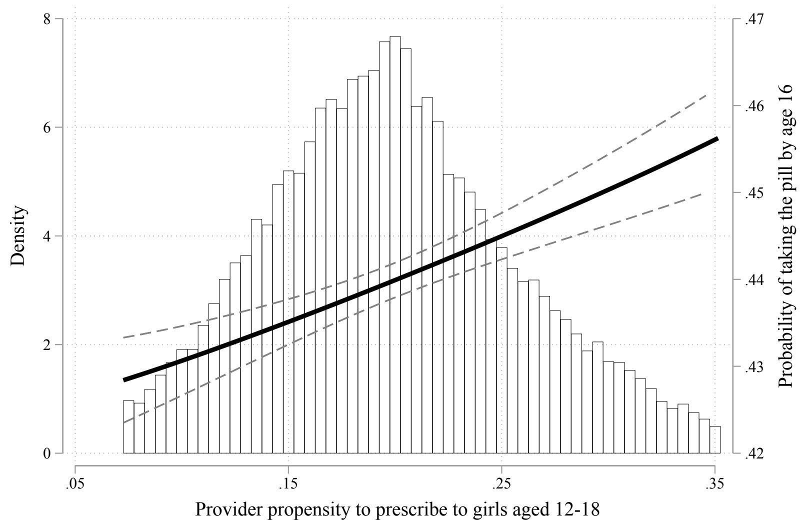
(c) Antidepressant medication



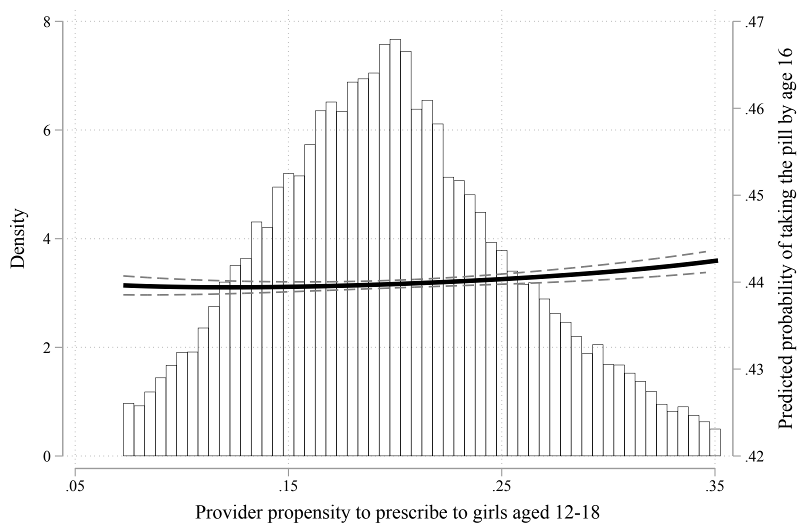
Notes: This figure plots the event time dummies' coefficients for the probability of having any psychiatrist visit (in panel (a)), the probability of being diagnosed with depression during a medical visit (in panel (b)), and the probability of redeeming any prescription for antidepressant medication (in panel (c)), estimated using Sun and Abraham (2020)'s IW estimator (see equation (1) for details). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill between the ages of 12 to 17 (event study sample in Table A1). Standard errors are clustered at the individual level.

Figure 2: Physicians' tendency to prescribe (PP) and selection

(a) Variation in physicians' PP

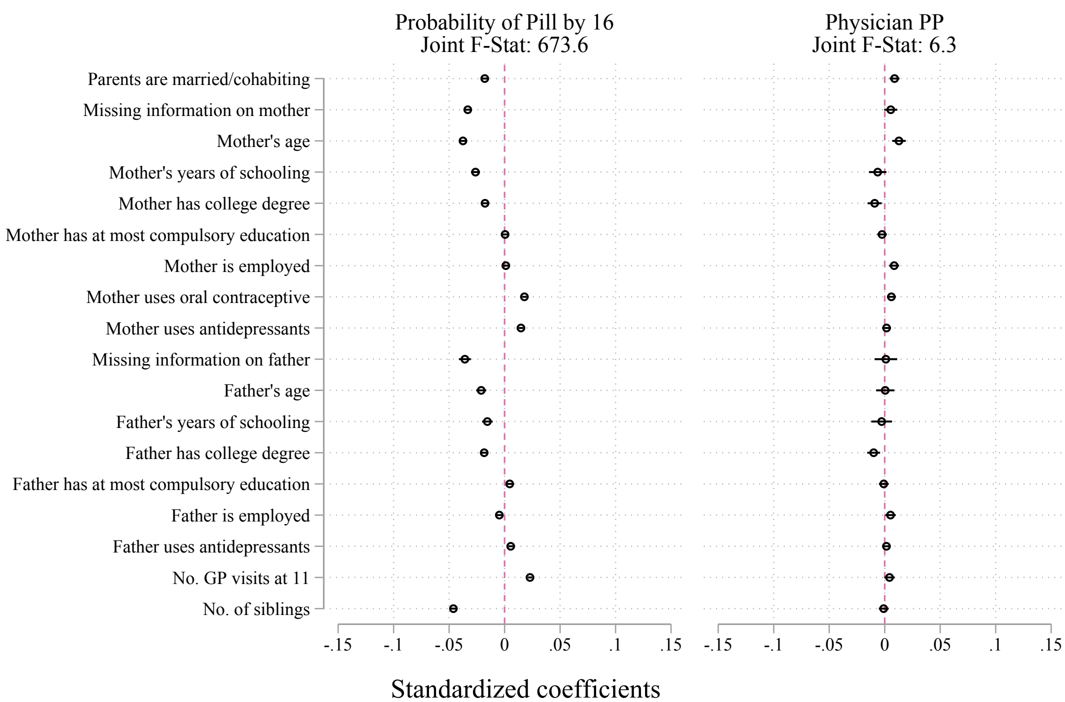


(b) Physicians' PP and predicted pill



Notes: This figure plots the histogram of the PP (equation (2)), residualized of municipality by birth year fixed effects. In panel (a), a local-linear regression of the fitted probability of filling a contraceptive pill prescription by age 16 on the PP, residualized of municipality by birth year fixed effects, is overlaid and displayed on the right y-axis. Panel (b) overlays a local linear regression of predicted contraceptive pill prescription on the PP, where contraceptive pill prescription status by age 16 is predicted using a comprehensive set of demographic variables. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds).

Figure 3: Selection into pill-taking and by provider's PP



Notes: The first panel of this figure plots the coefficients and 95% CI of regressing the probability of taking the pill by age 16 on a comprehensive set of family and girl characteristics. The panel on the right plots the coefficients and 95% CI from a regression of the provider's PP on the same set of variables. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds).

Table 1: Contraceptive pill use

	Any pill by 15		Any pill by 16	
	(1)	(2)	(3)	(4)
PP	0.006***	0.006***	0.007***	0.007***
	(0.001)	(0.001)	(0.001)	(0.001)
N	237985	237985	237985	237985
Adjusted R^2	0.022	0.073	0.027	0.077
Outcome mean	0.234	0.234	0.440	0.440
F-stat PP	32.48	34.27	37.56	37.32
Municipality x Year FE	Yes	Yes	Yes	Yes
Family controls		Yes		Yes

This table shows the results of regressions of the probability of having taken the pill by ages 15 and 16 the propensity to prescribe of their GP clinic (standardized). See equation (3) for details. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

Table 2: Impact of GP's propensity to prescribe on girls' mental health outcomes (ages 16-18)

	Psychiatrist visit		Depression diagnosis		Antidepressant	
	(1)	(2)	(3)	(4)	(5)	(6)
PP	0.158**	0.181***	0.065**	0.068**	0.114***	0.121***
	(0.067)	(0.066)	(0.027)	(0.027)	(0.040)	(0.040)
N	237985	237985	225374	225374	237985	237985
Adjusted R^2	0.012	0.026	0.003	0.004	0.002	0.003
Outcome mean (x 100)	8.262	8.262	1.304	1.304	3.008	3.008
Municipality x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes		Yes		Yes

This table shows the results of regressions of mental health outcomes at ages 16-18 on the propensity to prescribe of their GP clinic (standardized). See equation (3) for details. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

Table 3: Impact of GP's propensity to prescribe on girls' mental health outcomes (age 12)

	Psychiatrist visit		Depression diagnosis		Antidepressant	
	(1)	(2)	(3)	(4)	(5)	(6)
PP	0.005	0.008	-0.005	-0.005	-0.001	-0.001
	(0.024)	(0.024)	(0.004)	(0.004)	(0.009)	(0.009)
N	237985	237985	237985	237985	237985	237985
Adjusted R^2	-0.000	0.002	-0.002	-0.002	-0.002	-0.002
Outcome mean (x 100)	1.028	1.028	0.032	0.032	0.166	0.166
Municipality x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes		Yes		Yes

This table shows the results of regressions of mental health outcomes at age 12 on the propensity to prescribe of their GP clinic (standardized). See equation (3) for details. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

Table 4: Impact of GP's propensity to prescribe on boys' mental health outcomes (ages 16-18)

	Psychiatrist visit		Depression diagnosis		Antidepressant		MH prescription	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PP	-0.036	-0.024	-0.021	-0.020	-0.046*	-0.043	0.047	0.051
	(0.050)	(0.049)	(0.015)	(0.015)	(0.027)	(0.027)	(0.049)	(0.049)
N	246897	246897	233707	233707	246897	246897	246897	246897
Adjusted R^2	0.009	0.022	0.000	0.000	-0.001	0.000	0.008	0.019
Outcome mean (x 100)	5.071	5.071	0.435	0.435	1.347	1.347	4.783	4.783
Municipality x Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes		Yes		Yes		Yes

This table shows the results of regressions of boys' mental health outcomes at ages 16-18 on the propensity to prescribe of their GP clinic (standardized). See equation (3) for details. We use the sample of boys born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

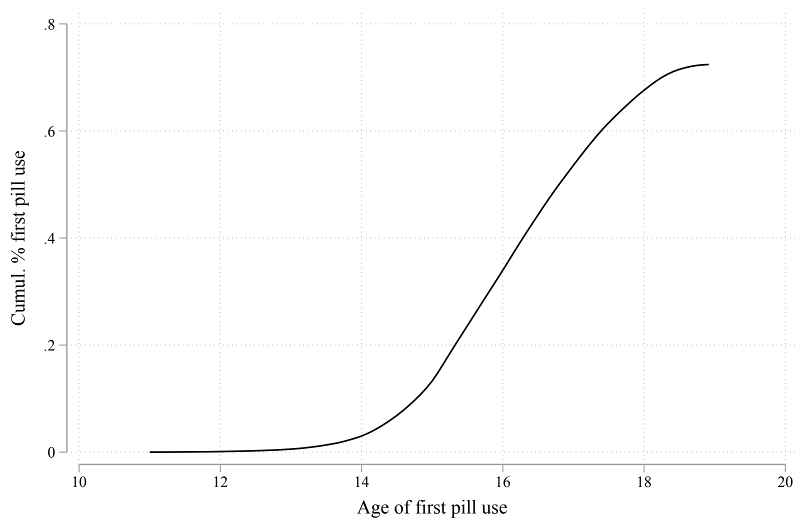
Table 5: Impact of GP's propensity to prescribe on hospitalizations for ambulatory care-sensitive conditions

	Any ACS	Acute ACS	Chronic ACS	Vaccine-preventable ACS
	(1)	(2)	(3)	(4)
PP	-0.011	-0.041	0.027	-0.004
	(0.048)	(0.038)	(0.029)	(0.010)
N	225374	225374	225374	225374
Adjusted R^2	0.018	0.022	0.003	-0.001
Outcome mean (x 100)	4.063	2.513	1.470	0.187
Municipality x Year FE	Yes	Yes	Yes	Yes
Family controls	Yes	Yes	Yes	Yes

This table shows the results of regressions of hospitalizations for ambulatory care-sensitive conditions at ages 16-18 on the propensity to prescribe of their GP clinic (standardized). See equation (3) for details. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

Appendix

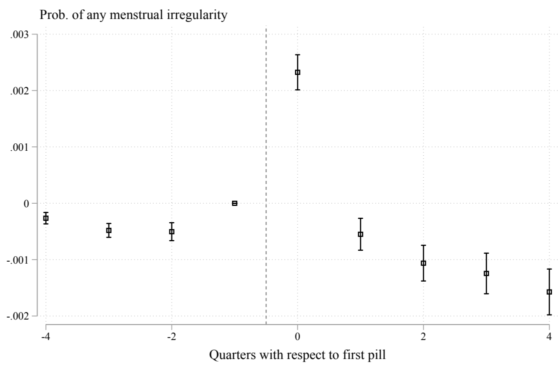
Figure A1: Cumulative distribution of contraceptive use by age



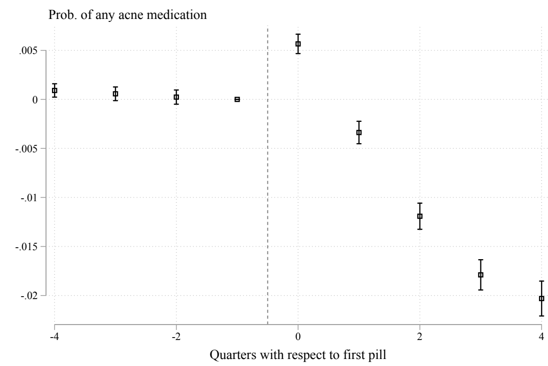
Notes: This figure plots the cumulative distribution of first pill use by age. We use our GP sample from Table A1, which includes girls aged 11 to 18 born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds).

Figure A2: Potential Reasons for Contraceptive Use

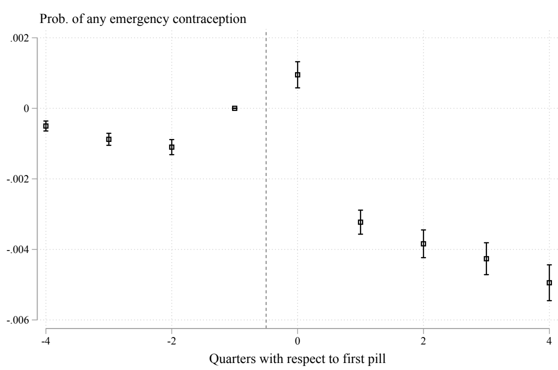
(a) Any menstrual irregularity



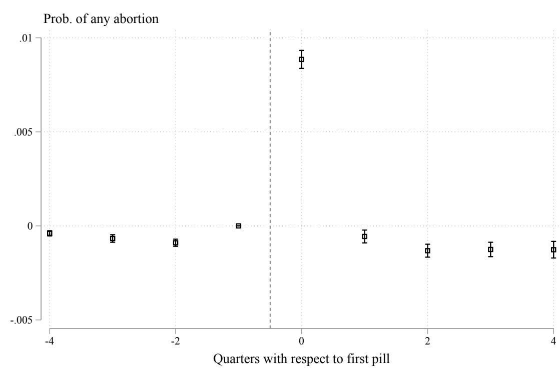
(b) Any acne medication



(c) Any emergency contraception



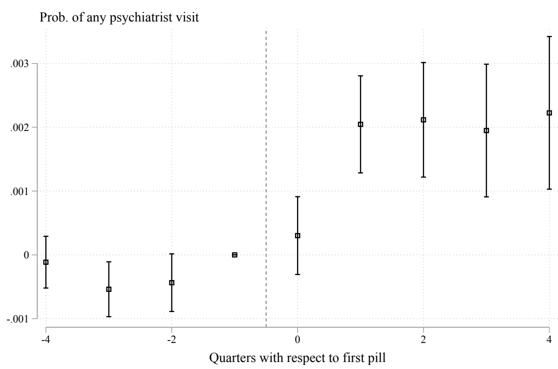
(d) Any abortion



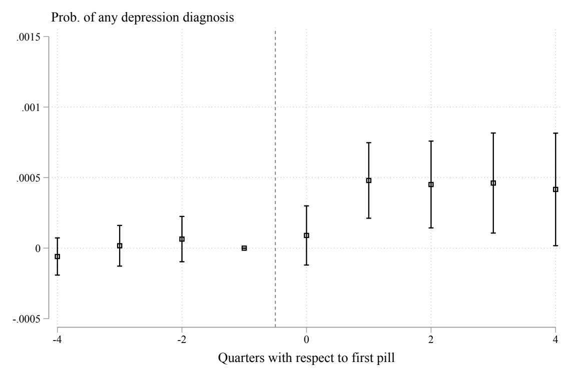
Notes: This figure plots the event time dummies' coefficients for the probability of having any menstrual irregularity (in panel (a)), any acne prescription (in panel (b)), having emergency contraception (in panel (c)) and of having an abortion (in panel (d)), estimated using Sun and Abraham (2020)'s IW estimator (see equation (1) for details). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill between the ages of 12 to 17 (event study sample in Table A1). Standard errors are clustered at the individual level.

Figure A3: Excluding Those with Other Shocks at t=0

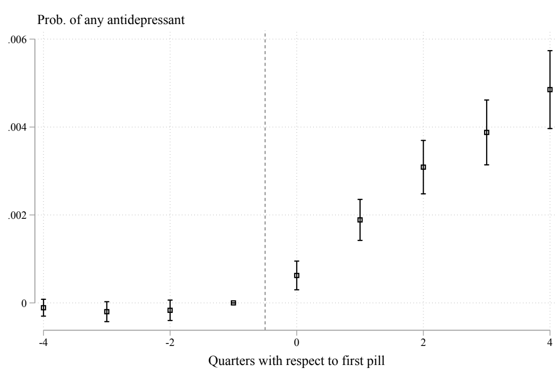
(a) Any psychiatrist visit



(b) Depression diagnosis



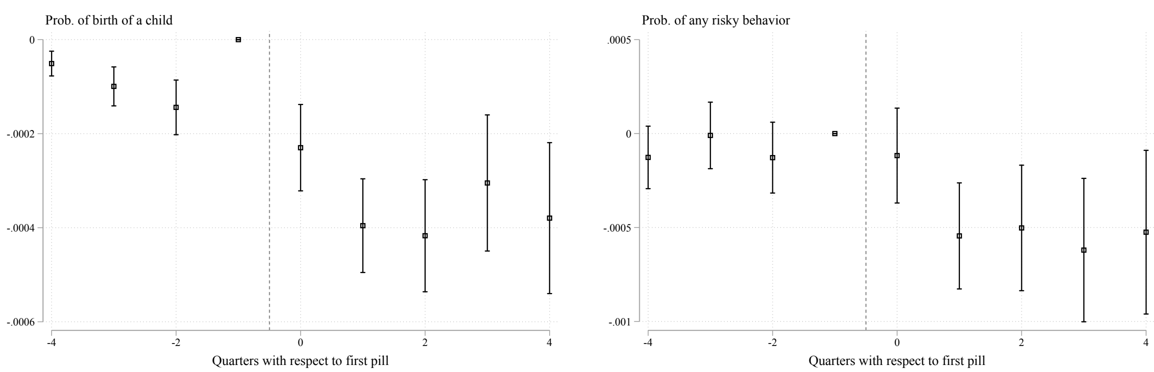
(c) Antidepressant medication



Notes: This figure plots the event time dummies' coefficients for the probability of having any psychiatrist visit (in panel (a)), any depression diagnosis (panel (b)), and of redeeming any prescription for antidepressant medication (in panel (c)), estimated using Sun and Abraham (2020)'s IW estimator (see equation (1) for details). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill between the ages of 12 to 17 (event study sample in Table A1). We exclude girls who, in the same quarter of pill start, have a diagnosis for any menstrual irregularity, have any acne prescription, have an abortion, or use emergency contraception. Standard errors are clustered at the individual level.

Figure A4: Evolution of Risky Behaviors

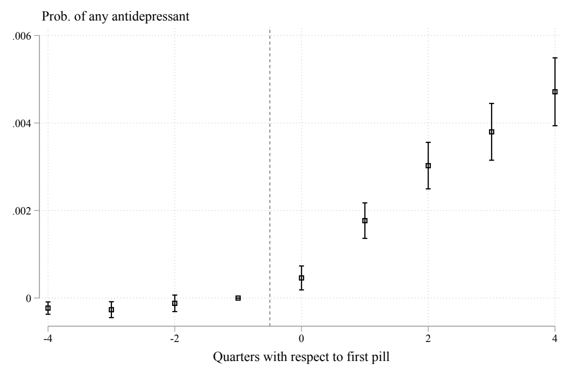
(a) Any birth (b) Any risky behavior



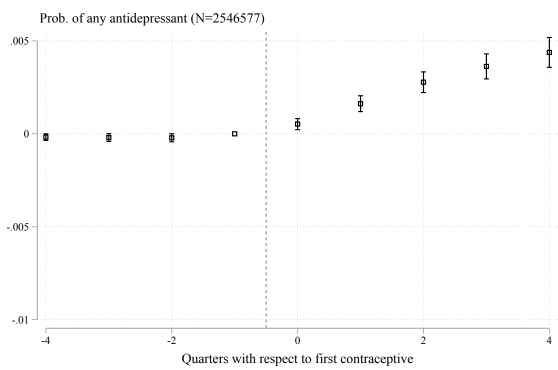
Notes: This figure plots the event time dummies' coefficients for the probability of giving birth (panel (a)) and having a hospital visit due to alcohol abuse or sexually-transmitted diseases (panel (b)). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill between the ages of 12 to 17 (event study sample in Table A1). Standard errors are clustered at the individual level.

Figure A5: The Role of Biology: Antidepressant Prescriptions

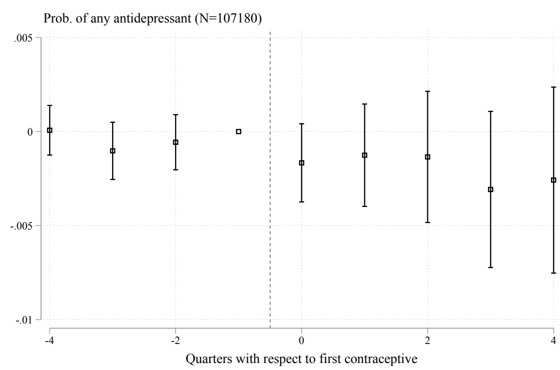
(a) Excluding girls with a previous mental health history



(b) Combined pills



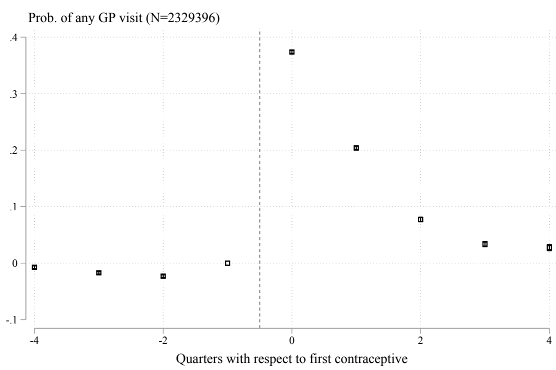
(c) Progestin-only contraceptives



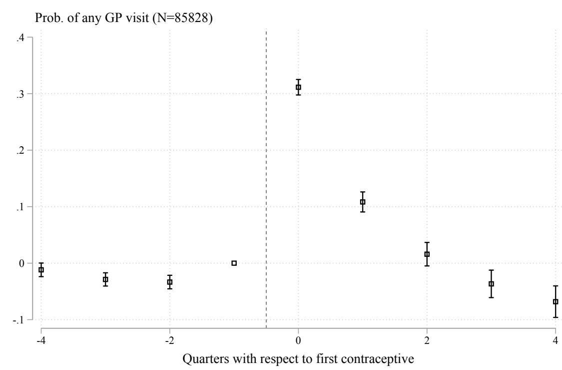
Notes: This figure plots the event time dummies' coefficients for the probability of filling an antidepressant prescription around the time of first pill use: for girls with no previous history of mental health diagnosis in panel (a); in panel (b), for girls who start on the combined oral contraceptive pill (as in Figure 1c) and, in panel (c), for girls who start on a progestin-only pill or implant. Panel (a) is estimated with Sun and Abraham (2020)'s IW estimator, while panels (b) and (c) are estimated with a two-way-fixed effect estimator (see equation (1) for details). Across all panels, the samples are part of a balanced panel of girls born from 1986 to 2002 who started taking the corresponding pill between the ages of 12 to 17. Standard errors are clustered at the individual level.

Figure A6: The Role of GPs

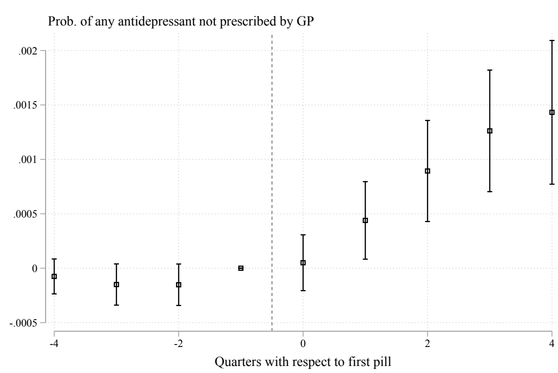
(a) GP visits



(b) GP visits for progestin-only pill users

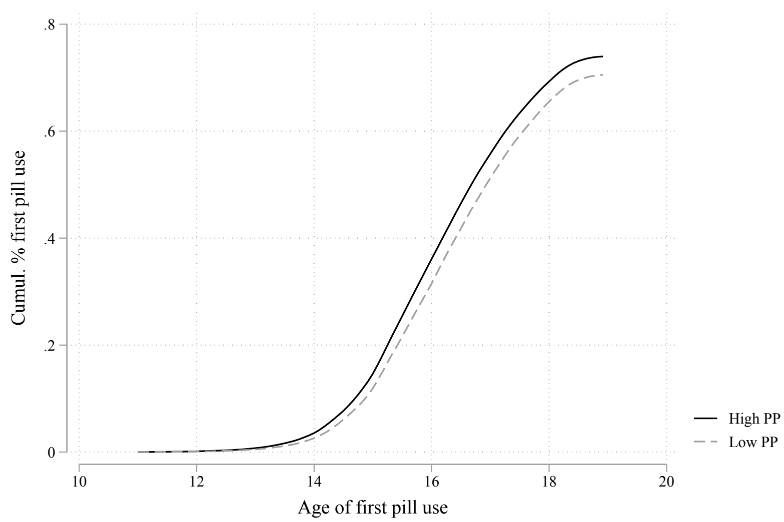


(c) Antidepressants excluding prescriptions from GPs



Notes: This figure plots the event time dummies' coefficients for the probability of visiting a GP for girls starting on the combined oral pill (panel (a)) and those starting on progestin-only contraceptives (panel (b)), and for the probability of filling an antidepressant medication issued by a specialist around the time of the first combined oral contraceptive pill use (panel (c)). Panels (a) and (b) are estimated with a two-way-fixed effect estimator, while panel (c) is estimated with Sun and Abraham (2020)'s IW estimator (see equation (1) for details). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill between the ages of 12 to 17. Standard errors are clustered at the individual level.

Figure A7: Cumulative distribution of contraceptive use by GPs' tendency to prescribe



Notes: This figure plots the cumulative distribution of first pill use by age, dividing the sample into two groups: girls assigned a GP with a high tendency to prescribe the pill (above the 75th percentile) and those with a low-prescribing GP (below the 25th percentile). We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds).

Table A1: Summary statistics

	Full sample		Event study sample		GP sample	
	Mean	SD	Mean	SD	Mean	SD
Contraceptive use						
Any pill by age 15	0.206	0.404	0.596	0.491	0.234	0.424
Any pill by age 16	0.397	0.489	0.973	0.162	0.440	0.496
Child characteristics						
Eldest sibling	0.522	0.500	0.538	0.499	1.000	0.000
No. of siblings	1.353	1.126	1.192	0.976	0.848	0.754
Immigrant background	0.089	0.284	0.025	0.155	0.000	0.000
No. GP visits at 11	2.134	2.310	2.275	2.361	2.346	2.418
Family characteristics (at age 11)						
Parents are married/cohabiting	0.661	0.474	0.615	0.487	0.603	0.489
Missing information on mother	0.016	0.126	0.014	0.116	0.006	0.075
Mother's age	40.066	4.870	39.113	6.618	38.847	4.759
Mother's years of schooling	13.737	2.619	13.358	2.830	13.854	2.391
Mother has college degree	0.306	0.461	0.249	0.432	0.306	0.461
Mother has at most compulsory education	0.039	0.194	0.026	0.160	0.020	0.139
Missing information on maternal education	0.031	0.173	0.009	0.094	0.012	0.110
Mother is employed	0.809	0.393	0.820	0.384	0.829	0.376
Mother uses oral contraceptive	0.325	0.469	0.350	0.477	0.227	0.419
Mother uses antidepressants	0.087	0.282	0.094	0.291	0.087	0.282
Missing information on father	0.047	0.211	0.045	0.207	0.038	0.191
Father's age	42.849	5.757	40.463	10.363	41.396	5.722
Father's years of schooling	13.901	2.651	13.035	3.755	13.913	2.529
Father has college degree	0.292	0.455	0.226	0.418	0.281	0.450
Father has at most compulsory education	0.057	0.232	0.054	0.227	0.044	0.205
Missing information on paternal education	0.066	0.248	0.015	0.123	0.050	0.218
Father is employed	0.858	0.349	0.850	0.357	0.874	0.331
Father uses antidepressants	0.050	0.217	0.050	0.218	0.047	0.212
Mental health outcomes (ages 16-18)						
Any psychiatrist visit	0.073	0.260	0.089	0.285	0.083	0.275
Any depression diagnosis	0.012	0.108	0.015	0.122	0.013	0.113
Any antidepressant prescription	0.048	0.214	0.062	0.241	0.054	0.226
Any antidepressant prescription (specialist)	0.027	0.162	0.032	0.175	0.030	0.171
Provider characteristics (at age 12)						
GP's propensity to prescribe the pill to 12-18-y-o					0.200	0.074
Number of 12-18-y-o girls treated during year					248	188
Number of patients					4835	3511
Observations	539247		266344		238006	

This table presents descriptive statistics for the full sample, the event study sample, and the GP sample. The full sample comprises girls born from 1986 to 2002 that are observed in the data every year from age 11 to 18. The event study sample consists of girls from those cohorts who start using the pill at some point between ages 12 to 17. The GP sample consists of girls from those cohorts who can be linked to their general practitioner (GP) clinic at age 12, whose GP clinic attended more than 25 patients aged 12 to 18 in that year, and who are first-born children from non-immigrant backgrounds.

Table A2: Association of contraceptive pill use with mental health outcomes (ages 16-18)

	Psychiatrist visit		Depression diagnosis		Antidepressant	
	(1)	(2)	(3)	(4)	(5)	(6)
Any pill by 16	4.125***	3.163***	0.802***	0.670***	3.100***	2.582***
	(0.077)	(0.080)	(0.034)	(0.035)	(0.064)	(0.066)
N	539210	539210	508201	508201	539210	539210
Adjusted R^2	0.016	0.025	0.004	0.005	0.010	0.014
Outcome mean (x 100)	7.321	7.321	1.176	1.176	4.815	4.815
Municipality x Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes		Yes		Yes

This table shows the results of regressions of mental health outcomes at ages 16-18 on an indicator for having taken the pill by age 16. We use our full sample from Table A1, which includes girls born from 1986 to 2002. Family controls consist of parental age, parental absence, parental employment status, education of each parent (college degree, at most comprehensive schooling, missing information on education), married parents indicator, number of siblings, immigrant background, and birth order and month of birth fixed effects. Robust standard errors in parentheses. * $p<0.1$, ** <0.05, *** $p<0.01$