The Oral Contraceptive Pill, Adolescents' Mental Health and Socio-Economic Outcomes

Ana Costa-Ramón*
University of Zurich

N. Meltem Daysal
University of Copenhagen

Ana Rodríguez-González
University of Barcelona

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Abstract

This paper examines the mental health and socio-economic effects of oral contraceptive use among adolescents. Using Danish administrative data and two complementary identification strategies – an event study and provider prescribing variation – we find that initiation of the combined pill leads to short-run increases in psychiatric contacts, depression diagnoses, and antidepressant use. Evidence points to a biological mechanism rather than increased detection. Despite these short-term effects, we find no impact on academic performance, educational attainment, or labor market outcomes. Our findings highlight an important trade-off in adolescent contraceptive care.

Keywords: Contraceptive pill, mental health, adolescents, prescribing practices.
JEL Codes: I12, J13

*Costa-Ramón: University of Zurich (Department of Economics & Jacobs Center for Productive Child and Youth Development) & CEPR. Email: ana.costa-ramon@econ.uzh.ch. Daysal: University of Copenhagen, CEBI, CESifo, IZA. Email: meltem.daysal@econ.ku.dk. Rodríguez-González: Department of Econometrics, Statistics and Applied Economics and AQR-IREA, University of Barcelona. Email: anarodriguezgonzalez@ub.edu. We are grateful to Martha Bailey and Jonathan Zhang for their comments and suggestions. We also thank seminar participants at PUC-Chile, IFAU, Johannes Kepler University Linz, Jacobs Center for Productive Youth Development, University of Zurich, Linnaeus University, European University Institute, Lund University, and at the 2022 Swedish Economics Conference, the Zeuthen Workshop on Child Health and Public Policy, CESifo/CES Workshop on Economics of Children, the Barcelona Summer Forum, SEHO, ESPE, and EALE. We thank Elisa Alonso, Matthew Bonci, and Anna Valyogos for their excellent research assistance. Costa-Ramón gratefully acknowledges the support of the University Research Priority Program "Human Reproduction Reloaded" of the University of Zurich and the Jacobs Foundation. The activities of CEBI are financed by the Danish National Research Foundation, Grant DNRF134. Rodríguez-González thanks the Pontus Roos Memorial Foundation (Lund University) for financial support and the Spanish Ministry of Science, Innovation, and Universities for the funding of project no. PID2023-146073NB-I00.

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 is still 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 and Abma, 2018).[1]

While the introduction of the pill has had a transformative impact on women's socio-economic outcomes, it has also sparked ongoing controversy due to concerns about potential adverse mental health effects, particularly among adolescents (Skovlund et al., 2016, 2018; Zethraeus et al., 2017; Anderl et al., 2020). Moreover, the educational, labor market, and social landscape has changed considerably since the pill's initial introduction. These shifts may influence the channels through which contraceptive access affects outcomes, underscoring the need to re-examine its effects in a contemporary context. In this paper, we use Danish population-level administrative data and employ two complementary empirical strategies to study the impact of the combined oral contraceptive pill on teenage girls' mental health and socio-economic trajectories.[2]

We start by investigating the impact of pill use on short-term mental health outcomes (psychiatric visits, depression diagnosis, antidepressant use). Exploiting variation in the timing of pill initiation in an event study framework, we document that girls' mental health deteriorates shortly after they start using combined oral contraceptives. The findings we present are 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.[3] The richness of the register data allows us to test key identification assumptions in the event study design. Results are unchanged when excluding girls at higher risk of mental health issues—such as those with prior diagnoses, abortions, or emergency contraception use. We also find no evidence of increased risky behavior around pill initiation, as measured by alcohol-related hospital visits, STI screenings, or chlamydia diagnoses.

[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).

[2] We focus on the combined oral contraceptive pill, the most commonly prescribed form of hormonal contraception. Throughout the paper, we refer to it as "the pill" or "contraceptives," unless otherwise specified.

[3] The means of these outcomes one quarter before pill initiation are 1.1%, 0.11%, and 0.8%, respectively.

We next use variation across primary care providers (GPs) in their tendency to prescribe the pill to adolescents to validate the short-run effects.[4] To address endogeneity concerns, we assign girls to the GP they visited at age 12—before most begin contraceptive use. This provider is selected by parents from the pool of available providers in their catchment area, as children cannot choose their own GP before age 15. We measure GP prescribing tendency using a leave-one-out rate of pill prescriptions among other 12–18-year-olds seen at the clinic that year. There is substantial variation across providers, and importantly, this tendency is uncorrelated with observable child and parental characteristics or girls' mental health outcomes at age 12.

We find that GPs' tendency to prescribe the pill strongly predicts adolescents' contraceptive use: switching from a provider at the 10th percentile to one at the 90th percentile of the prescribing distribution increases the likelihood of pill use by age 16 by 3.5%, roughly 40% of the difference in pill use between girls whose mothers do or do not use oral contraceptives. This prescribing tendency also impacts girls' mental health outcomes at ages 16–18. Being assigned to a GP with one standard deviation higher pill prescribing propensity increases the likelihood of a psychiatric contact by 1.6%, a depression diagnosis by 5.4%, and antidepressant use by 3.9%.

Given the nature of this strategy, we cannot fully rule out that GPs with different tendencies to prescribe the pill may affect patient outcomes through other aspects of care. However, several pieces of evidence suggest that pill use is the primary channel in our context. First, we find no differences in mental health outcomes among adolescent boys assigned to physicians with varying pill prescribing tendencies, indicating that our results are unlikely driven by differential detection of mental health conditions. This finding holds for a broader measure of mental health prescriptions, including ADHD medications. In addition, we find no association between pill prescribing tendency and provider quality as proxied by hospitalizations for ambulatory care-sensitive conditions.

What explains the observed short-run decline in mental health following pill initiation? Two main mechanisms are plausible. Medical research points to a biological pathway, in which hormonal changes caused by the pill directly affect mood and emotional regulation. Alternatively, the effects may reflect increased detection and treatment of mental health issues due to greater contact with healthcare providers. To distinguish between these, we compare girls who start on the combined pill with those who initiate progestin-only contraceptives, which medical research associates with fewer mood-related side effects. We find no mental health deterioration among progestin-only users, despite similar patterns in GP visits around initiation. Together, these findings support a biological mechanism as the primary

[4]In Denmark, oral contraceptives require a prescription; in our sample, 95% are issued by GPs.

driver of the observed short-run mental health effects.

We next assess whether pill use impacts 9th grade test scores in math and Danish (typically taken at age 16). Given that we do not observe test scores before pill initiation, we rely on the variation in GP pill prescribing tendency. We find no effects on test scores. The estimated effects are both statistically and economically negligible, and we find no impact on test-taking behavior, suggesting limited scope for selection bias.

Turning to long-run outcomes measured between ages 18 and 30, we find persistent increases in pill use into early adulthood among girls exposed to high-prescribing GPs, with effects fading after age 25. Antidepressant use is also elevated until age 22 but not beyond that age. Despite these patterns, we find no impact on educational attainment or labor market trajectories. College graduation rates, employment, and earnings remain unaffected, and confidence intervals rule out even modest economically meaningful effects. Overall, while pill use appears to affect mental health in adolescence, we find no evidence of long-term consequences for human capital accumulation.

Our study contributes to several strands of research. First, we add to the extensive literature on the consequences of the introduction of the pill. Most of this work focuses on how access to the pill influenced women's fertility, marriage, and career trajectories (Goldin and Katz, 2002; Bailey, 2006; Bailey et al., 2012; Bailey and Lindo, 2018; Marie and Zwiers, 2023; Ragan, 2025). Only two recent studies in economics examine the relationship between the pill and mental health. Valder (2024) exploits variation in U.S. laws governing pill access to study the long-term consequences of its early diffusion, finding that access at ages 14 to 21 is associated with worse mental health outcomes at age 60. Ragan (2024) investigates the association between regional variation in hormonal contraceptive sales in Sweden and teen suicide rates during the 1960s and 1970s, finding no clear relationship. We contribute to this literature by providing novel evidence on the mental health effects of the pill, the persistence of these effects, and their implications for socio-economic outcomes in a contemporary setting.

Outside of economics, numerous correlational studies have explored the relationship between oral contraceptive use and mental health, with some reporting positive associations (Taggart et al., 2018) and others finding negative effects (Poromaa and Segebladh, 2012; Skovlund et al., 2016). Evidence from the few small-scale randomized controlled trials is similarly mixed, likely due to limited statistical power (Lundin et al., 2017; Zethraeus et al., 2017). These studies typically rely on self-reported well-being or symptom measures and have short follow-up periods. We contribute to this literature by examining objective indicators

of mental health over an extended time horizon.[5]

Our project is also closely related to the economic literature on the determinants of child mental health disorders. An extensive literature documents the 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). Previous studies also highlight the importance of economic resources (e.g. Baird et al., 2013; Golberstein et al., 2019; Akee et al., 2024), household stressors such as domestic violence (Bhuller et al., 2024), and the presence of a disabled sibling (Currie et al., 2024), as well as social media (Arenas-Arroyo et al., 2025; Braghieri et al., 2022) and peer composition (Bütikofer et al., 2023). Our study adds to this literature by examining the effects of a widely prescribed medication on the mental health outcomes of adolescent girls.

Finally, we contribute 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). Our study documents the variation in providers' tendency to prescribe the contraceptive pill and analyze its impact on patient outcomes.

2 Background

2.1 Organization and Delivery of Health Care Services

Denmark has a universal healthcare system with primary care delivered by general practitioners, who provide routine consultations and preventive care. GPs are self-employed and require a practice authorization number (*ydernummer*) to be reimbursed. The number of authorizations is regulated by the state, based on criteria like population density. In 2018, there were 3,476 GPs across 1,795 practices,[6] with a median of 14 practices per municipality (10th–90th percentile: 5–60). About half were solo practices,[7] and the average GP served 1,655 patients. GP income combines fee-for-service (about two-thirds) and capitation payments, with a fixed fee of 500 DKK (66 USD) per patient in 2022. GPs receive no financial incentives for prescribing medication.

[5] A notable exception is Skovlund et al. (2016), which follows Danish women aged 15–34 (with no prior depression diagnosis) and finds that pill use is associated with increased risks of depression and antidepressant use, especially among adolescents, with an average follow-up of six years.

[6] Available here, last accessed October 2023.

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

Individuals can freely choose a GP within 15 km (5 km in Copenhagen) of their residence if it is accepting new patients.[8] Changing providers is free after a residential move; otherwise, it incurs a fee (215 DKK or 29 USD in 2022). Children are registered with their parents' GP.[9]

Secondary care is provided by specialists and hospitals, with GPs acting as gatekeepers. Only 10% of visits result in referrals (Forde et al., 2016), though guidelines recommend universal referral for suspected mental health conditions in children. Mild cases are referred to private child psychiatrists, and severe cases to hospitals. Between 2008–2018, average pediatric psychiatric wait times fell from 71 to 24 days (mean: 48).[10]

The National Health Insurance Scheme covers all GP, psychiatric, and hospital services, with no out-of-pocket costs. Prescription drug subsidies have shifted over time—from fixed coinsurance (pre-2000) to a non-linear system where copay rates decline with accumulated annual spending.[11] Oral contraceptives are not subsidized but inexpensive (∼30 DKK or 4 USD for two months). Mental health prescriptions, on the other hand, are subsidized. Citalopram, a widely prescribed antidepressant, had a 25% coinsurance rate before Denmark adopted the non-linear subsidy scheme (Simonsen et al., 2021).

2.2 Contraceptive Use in Denmark

The Danish Family Planning Association, founded in 1956, aimed to reduce unwanted pregnancies by promoting contraceptive access. In the 1960s, family planning services were integrated into the National Health Insurance Scheme, making contraceptive counseling free for all residents. Oral contraceptives require a prescription, most of which are provided by GPs. Since age 15, adolescents can access the pill without parental consent.[12] Sex education has been mandatory in Danish schools since 1970, with consistent focus on contraception and STDs.

Contraceptive use is widespread in Denmark. Two types of oral contraceptives are available: combined oral contraceptives (COCs), containing estrogen and progestin, and progestin-only pills (Cooper et al., 2022). COCs vary by estrogen dose and progestogen

[8] Clinics may cap enrollment at 1,600 patients per GP. In 2021, 56% of clinics had reached this limit (PLO, 2021).

[9] Until age 15, children are automatically registered with the same GP. They may choose a different provider thereafter.

[10] Details available here, last accessed October 2023.

[11] Children typically pay 40–50% of the first 1,500 DKK (200 USD), 25% between 1,500–3,500 DKK (200–460 USD), and 15% thereafter, up to a stop-loss limit (24,000 DKK or 3,200 USD in 2021). See here, last accessed October 2022.

[12] Since July 2019, pharmacists can renew prescriptions for regular users aged at least 15, see here (last accessed October 2022).

generation. From 1995–2012, 85% of Danish girls had filled at least one hormonal contraceptive prescription by age 20 (Løkkegaard and Nielsen, 2014). COCs dominated the market, accounting for over 60% of total use and more than 70% among teenagers (Wilson et al., 2012). Adolescent use of hormonal contraceptives remains high: in 2019, more than 50% of women aged 15–24 used hormonal methods, with COCs comprising 80% of the market among teenagers. (Kristensen and Lidegaard, 2021). It is worth noting that oral contraceptives are not only used to prevent unwanted pregnancies but are also commonly prescribed to manage menstruation, acne, and endometriosis, contributing to their continued popularity among adolescents (Dayal and Barnhart, 2001).

2.3 Expected Effects of Hormonal Contraception

Mental Health: The Biological Link The impact of hormonal contraceptives on mood has been debated since their introduction, with mood changes often cited as a reason for discontinuation (Sanders et al., 2001; Poromaa and Segebladh, 2012). The medical literature suggests that hormonal contraceptives may affect mental health by altering estrogen and progesterone levels, which influence both the hypothalamic-pituitary-adrenal (HPA) axis and key neurotransmitters. The HPA axis regulates stress responses, metabolism, and immune function. Estrogen affects brain regions involved in emotional and cognitive processing, while progesterone promotes nerve growth in the hippocampus, the HPA axis's main regulator (Toffoletto et al., 2014). One hypothesis is that contraceptives blunt HPA activity, impairing stress regulation and increasing the risk of anxiety and depression. Hormonal changes may also affect neurotransmitters. Low progesterone is associated with reduced GABA function, which supports calmness and sleep, while low estrogen is linked to decreased serotonin and dopamine, which regulate mood and reward processing. A second hypothesis argues that by flattening the natural hormonal fluctuations—particularly the estrogen peak mid-cycle—contraceptives disrupt these mood-regulating systems. Most pills maintain steady hormone levels for 21 days, followed by a sharp drop during the final 7 days.

Socio-Economic Outcomes The theoretical impact of expanding contraceptive access is ambiguous because it depends on behavioral responses that vary across populations and technologies. Contraceptives may substitute for less effective methods or reduce fertility directly, but they can also increase sexual activity or delay childbearing without reducing lifetime fertility.[13] Effects on mental health may also be a channel through which pill use influences socio-economic outcomes. Economic research shows that health shocks can harm

[13]For an overview of the empirical literature on the impact of access and use of contraception on women's outcomes, see Bailey and Lindo (2018).

educational and labor market trajectories (Almond and Currie, 2011b,a). If the pill affects mental health during key developmental stages or if these effects persist, socio-economic outcomes may suffer as a result.

3 Empirical Strategy

Event Study Design We first exploit the variation in the timing of pill initiation in an event study framework to examine changes in girls' mental health trajectories after starting combined oral contraceptives. 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.[14] 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.[15] 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 (girls who start using the pill in the last quarter of our sample) 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.[16] Standard errors are clustered at the individual level.

[14] To ensure complete outcome data for all individuals during the event window and a sufficient number of pill initiations in each quarter, we focus on girls who began using the pill between 2001 and 2016, inclusive.

[15] According to Sun and Abraham (2020) and Borusyak et al. (2024), 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.

[16] 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. In our main specification, cohorts are defined based on the calendar quarter of pill initiation. Given (potentially non-linear) trends in mental health outcomes by age, we control non-parametrically for age fixed effects in each calendar quarter. Our results are robust to controlling instead for calendar quarter fixed effects, or to defining cohorts based on the age of first pill use (note that we cannot simultaneously control for calendar quarter and age fixed effects, as these will be collinear given the inclusion of individual fixed effects).

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 (i.e., those who initiate oral contraception in different calendar quarters) 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 earlier in our sample have unobserved characteristics that make them more likely to develop mental health problems over time. While we cannot test 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 changes 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 study the effects of contraceptive use on socio-economic outcomes measured between ages 18 and 30. Since these outcomes are not observed prior to pill initiation, the event study design is not applicable. Instead, we adopt an alternative identification strategy that leverages variation in primary care providers' tendency to prescribe the pill to adolescents. We first use this approach to validate the event study findings, then turn to analyzing long-run outcomes.

To the best of our knowledge, no quantitative evidence exists on the variation in GPs' tendencies to prescribe the contraceptive pill. However, there are good reasons to expect

substantial differences in prescribing practices. 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 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).

Following recent work linking practice variation to patient outcomes (Cuddy and Currie, 2020; Currie and Zwiers, 2023; Bhalotra et al., 2023; Dalsgaard et al., 2014; Eichmeyer and Zhang, 2022, 2023), we exploit 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 clinic 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:[18]

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

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:

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

where Y_i is an outcome variable of child i at age a, PP_i is the oral contraceptive prescribing tendency of the assigned GP clinic, 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

[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.

[18] Our data does not include individual physician identifiers. For that reason, we construct the provider prescribing tendency at the clinic level. As detailed in section 4, half (70%) of the clinics in our sample have at most two (three) physicians.

care clinic that 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. Assigning children to the provider who treats them at age 12, when contraceptive pill use is very low, alleviates concerns of a bias from endogenous patient-GP clinic matches. 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 clinic'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' (mental health) outcomes measured at age 12, when rates of oral contraceptive use are very low.

Primary care providers with differing tendencies to prescribe oral contraceptives may influence girls' outcomes either by affecting their likelihood of pill use or through other aspects of care correlated with their prescribing behavior. As such, we do not use GP clinic's prescribing tendency as an instrument for oral contraceptive use. Since almost all contraceptive use originates from primary care clinics, understanding how GP practice style can impact the mental health and socio-economic outcomes 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 clinic's combined oral contraceptive prescribing tendency and the mental health outcomes of adolescent boys. Second, we show that GP clinic's tendency to prescribe progestin-only contraceptives strongly predicts girls' likelihood of using that type of contraceptive but has no relation to their mental health. Third, we document that the GP prescribing tendency is unrelated to patient hospitalizations for ambulatory care-sensitive conditions, suggesting that high-prescribing clinics are unlikely to provide different quality of care in other dimensions. Finally, we show that our results are unaffected when we control for observable characteristics of the physicians working at the clinic, as well as for the characteristics of the pool of adolescent patients served by the clinic. 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 for the period 1997 to 2020.

Outcome Variables Our mental health outcomes capture health care utilization: psychiatric visits, depression diagnosis, and antidepressant use. We measure psychiatric visits using the *Psychiatric Central Research Register* and the *Health Insurance Register*. The former includes all inpatient, outpatient, and ER visits to psychiatric departments in public and private hospitals. The latter captures reimbursements to private clinics (GPs and specialists) for services covered by national health insurance.[19] We define psychiatric visits as outpatient or ER visits to hospital psychiatric departments or private psychiatric clinics.[20] Among hospital-based visits, we define a depression indicator using ICD-10 codes "F32" and "F33".[21] We measure antidepressant use with the *National Prescription Register*, which records all prescriptions filled at Danish pharmacies, including ATC codes and product names. We define an indicator for filling a prescription with ATC code "N06A". Mental health outcomes are measured either around the time of first contraceptive use (event study) or between ages 16–30 (GP practice variation).

Our primary socio-economic outcomes are educational attainment and income. We use the *Academic Achievement Register* to measure 9th grade exit exam scores in Danish and math, typically taken at age 16, and the *Education Register* to capture highest completed schooling, from which we define indicators for college graduation between ages 18 and 30. Labor market outcomes are drawn from the *Income Statistics Register*. We define indicators for having positive wage income and examine annual wage income levels (converted into 2015 DKK), both measured between ages 18 and 30.[22]

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. Our main analysis focuses on the combined oral contraceptive pill, but we also consider progestin-only contraception.[23]

[19] This register does not include diagnosis information.

[20] Most mental health treatment occurs on an outpatient basis; inpatient care is primarily used for schizophrenia (Serena, 2024).

[21] This includes a small number of PMDD cases (F32.8). Excluding them does not affect our estimates; results available upon request. The last available year in this register is 2017, limiting the sample size for depression diagnoses.

[22] We winsorize annual wage income at the 1st and 99th percentiles of the distribution in order to reduce the influence of outliers.

[23] 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).

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 at ages 16–30.

Control Variables We observe a rich set of child and parent characteristics. The *Population Register* provides annual demographic snapshots, allowing us to link individuals to parents and siblings and to measure sibling count and parental age. Parental education comes from the *Education Register*, labor force participation from the *Register-Based Labour Force Statistics*, and income from the *Income Register*. We include the following variables as controls, measured at child age 11: birth order, number of siblings, number of GP visits, parental marital/cohabitation status, average parental income, mother's use of contraceptives, and each parent's age, education level (indicators for compulsory education or college degree), employment status, and antidepressant consumption.[24]

In the GP practice variation design, we also use the *Provider Register*, which includes information on all specialists eligible for reimbursement under the National Health Insurance plan.[25] We use these data to test robustness to controlling for clinic characteristics measured when the child is 12: an indicator for multi-provider practices, the share of female physicians, share with immigrant background, average physician age, and average tenure.

To account for neighborhood and school catchment characteristics, we use the *Health Insurance Register* to construct profiles of other 12-year-olds attending the same clinic in the same year.[26] Specifically, we control for average parental income and the share of parents who are married/cohabiting, have only compulsory education, have a college degree, use antidepressants, or (for mothers) use oral contraceptives.

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

[24] We also include indicators for the few instances when parental characteristics are missing.

[25] The data provide annual snapshots of characteristics at the end of the calendar year between 1995-1998, quarterly snapshots at the end of each quarter between 1999-2009, and is continuously updated after 2009.

[26] School identifiers are unavailable, so we cannot include peer characteristics or school fixed effects.

providers, we drop girls who do not visit a primary care physician at age 12.[27] 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 clinic 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*). When studying long-term outcomes, we lose the younger cohorts as we consider older ages.

Descriptive Statistics Appendix Table A1 presents descriptive statistics, separately for the full sample, the event study sample, and the GP sample. About 21% of girls in the full sample fill an oral contraceptive prescription by age 15, rising to 40% by age 16 (see Appendix Figure A1a). Nine percent have an immigrant background, and the average girl has two GP visits at age 11. Mothers are, on average, 40 years old when the child is 11; 30% have a college degree, 4% only compulsory schooling, 33% use oral contraceptives, and 9% use antidepressants. Fathers are typically 43 years old, with education levels similar to mothers but lower antidepressant use. Parents have high employment rates (86% of fathers, 81% of mothers). Two-thirds of parents are married or cohabiting.

Compared to the full sample, girls in the event study have higher rates of contraceptive use by ages 15 and 16. This sample includes fewer girls with an immigrant background and slightly more disadvantaged parental characteristics (lower education, income, and cohabitation rates), though parental antidepressant use is similar. Maternal contraceptive use is slightly higher (35%).

Girls in the GP sample also have higher contraceptive use at ages 15 (23%) and 16 (44%), but their GP visits at age 11 remain similar to the full population. Parents in this sample are slightly younger, have higher income and employment, but their education and antidepressant use resemble the full population.

The average primary care clinic in the GP sample prescribes the pill to 20% of 12–18-year-old girls and treats about 248 girls annually in this age group. 21.45% of clinics are two-physician practices, 16.82% have three physicians, 12.75% have four physicians and 16.65% have at least five physicians.[28]. On average, 37% of providers are female, 5% have an immigrant background, with a mean age of 52 and tenure of 12.4 years. The characteristics

[27] Our results are robust to using alternative ages.

[28] This is due to the requirement that clinics in our sample treat a minimum of 25 girls aged 12 to 18. In the full sample, during the period 1998–2014, 58.6% of clinics were solo-practices, 19.62% had two physicians, 10.39% had three physicians, 5.91% had four physicians, and 5.5% had at least five physicians.

of the adolescent patients' parents closely resemble those in the full population.

5 Effects of the Pill On Short-Run Outcomes

This section presents the short-run effects of the pill on adolescent mental health, first using the event-study design and then the GP prescribing variation. Each case is followed by empirical evidence on the plausibility of the key identifying assumptions. Finally, we examine the effects on subject-specific test scores from 9th grade qualifying exams.

5.1 Effects on Mental Health: Event-Study Design

Figure 1 displays the event-time coefficients from equation (1) along with the 95% confidence intervals. Panel (a) presents the probability of a psychiatric visit in a given quarter. We observe a marked trajectory break after pill initiation: the probability increases by 0.2 percentage points (17%) one quarter after starting the pill, relative to the quarter before initiation. This increase persists, with a similar effect four quarters later.[29] Panel (b) shows the probability of receiving a depression diagnosis after an outpatient or ER psychiatric visit. Pre-pill trends are flat, but one quarter after initiation, the likelihood of a diagnosis rises by 40% compared to the baseline in $t = -1$. Panel (c) examines antidepressant use. The flat pre-trends once more indicate no worsening of mental health before pill initiation. Afterward, usage increases steadily, reaching a 0.5 percentage point rise (65%) by four quarters.

Identification Checks A key concern in interpreting our results as causal is that the timing of pill initiation may coincide with other events or conditions that independently affect mental health. Although we find no evidence of pre-trends in mental health care use, we cannot fully rule out unobserved deterioration prior to starting the pill.

To address this, we first examine common medical reasons for pill initiation—such as menstrual irregularities, dysmenorrhea, acne, abortion, or use of emergency contraception—that could also affect mental health. Appendix Figure B1 shows an increase in these conditions at the time of pill initiation ($t = 0$), followed by declines, consistent with their role as motivating factors.[30] We next show that our results are robust to excluding girls with these conditions (see Appendix Figure B2).

[29] 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.

[30] 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.

Appendix Figure B3 considers changes in behavior that could confound the effect. Panel (a) shows no evidence that girls initiate contraception following a pregnancy (teen births are rare in our sample, with a prevalence of just 0.3%, and decline after pill use begins). Panel (b) shows no increase in the likelihood of risky behaviors before pill initiation, and a decrease afterward.[31]

We next check whether our main results are driven by girls with a history of mental health issues by estimating the model on a subsample of girls with no psychiatric contact before the start of the event-study window (five quarters prior to first pill use). Panel A in Appendix Figure B4 shows similar patterns in this group, indicating that the results are not solely driven by pre-existing mental health conditions.

We also consider the role of GPs in prescribing antidepressants. Focusing only on antidepressant prescriptions issued by specialists, we confirm a consistent post pill-initiation increase (see Panel B in Appendix Figure B4). The overall pattern remains remarkably stable, with a relatively smaller effect size.

Overall, these checks support the interpretation that contraceptive use, rather than confounding events or provider interactions, is the likely driver of the mental health effects. In Section 5.3 we further compare the trajectories of girls starting on pills with different hormonal composition.

5.2 Effects on Mental Health: GP Practice Variation

Contraceptive Use We begin by examining how GP practice style influences contraceptive use. Appendix Figure C1 plots our leave-one-out measure of GP tendency to prescribe oral contraceptives to girls aged 12–18, residualized by municipality-by-birth-year fixed effects. The distribution reveals substantial variation: clinics at the 90th percentile prescribe at rates 16.6 percentage points higher than those 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 Appendix 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] Row A of Table 1 presents the corresponding regression estimates. We

[31] 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).

[32] Appendix Figure A1b shows that girls assigned to high-prescribing clinics (above the 75th percentile) are more likely to start the pill earlier than those at low-prescribing clinics (below the 25th).

find that a one standard deviation increase in GP prescribing tendency raises the likelihood of pill use by age 16 by 0.7 percentage points. These results are robust to controls for child and parental characteristics (column 2) as well as clinic characteristics that include proxies for neighborhood characteristics (column 3). Moving from a GP that prescribes at 10th percentile to one that prescribes at the 90th percentile raises pill use by 3.5%. For context, this effect is about 40% of the difference in pill use between girls whose mothers do or do not use oral contraceptives.

Mental Health We next examine mental health outcomes between ages 16–18: psychiatric visits, depression diagnoses, and antidepressant use.[33] Rows B–D of Table 1 show that being assigned to a GP with one standard deviation higher pill prescribing tendency increases the probability of any psychiatric contact by 0.136 percentage points (1.64%), depression diagnosis by 0.071 points (5.4%), and specialist-prescribed antidepressant use by 0.116 points (3.9%). As with contraceptive use, these findings are robust to including an extensive set of controls.

The Pill as the Main Channel While the quasi-random assignment of patients to clinics supports a causal interpretation of our estimates, this alone does not prove that oral contraceptive use is the channel. GP clinics with different pill prescribing tendencies may also differ in other ways that affect adolescent mental health. Although we cannot test for equivalence across all provider dimensions, we conduct three checks that support contraceptive use as the primary driver of our results.

First, we exploit a natural placebo test by examining whether GP practice style affects boys' mental health. If high-prescribing clinics differ in general care quality, this should also be reflected in boys' outcomes. We assign each boy to their main provider at age 12 and use that provider's pill prescribing tendency. Rows A–C of Appendix Table C1 show no relationship between GP prescribing style and boys' psychiatric visits, depression diagnoses, or antidepressant use. All coefficients are small and statistically insignificant, and we reject equality of effects between girls and boys at the 5% level. To address concerns that null effects for boys may reflect gender differences in mental health prevalence, we examine broader mental health prescriptions, including ADHD medications that are more common among boys.[34] Panel D again shows no significant association with GP pill prescribing tendency,

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

[34]This includes antidepressants (N06A), benzodiazepines (N05BA), antipsychotics (N05A), and ADHD medications (e.g., N06BA01, N06BA04).

suggesting these providers do not systematically produce worse mental health outcomes or detect more disorders among their patients.

Finally, we assess whether GPs with different pill prescribing tendencies may be more effective in their care for patients. Following Currie and Zhang (2023), we examine ER visits and hospitalizations 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.[35] Using these indicators as outcomes in our baseline model, we document precise null effects across acute, chronic, vaccine-preventable, and overall ACSCs, indicating no systematic difference in provider quality (see Appendix Table C2).

While we cannot test all aspects of care, we cautiously interpret the evidence as supporting our conjecture that contraceptive use is the primary channel linking provider type to adolescent mental health.

Identification Checks We provide suggestive evidence that patient selection is orthogonal to GP clinics' propensity to prescribe the pill, based on a check of balance of observable characteristics. In the left panel of Figure C2, a linear regression shows that contraceptive use by age 16 is strongly predicted by a rich set of individual and family characteristics (joint F-statistic = 599). In contrast, the right panel shows no significant relationship between these characteristics and GP pill prescribing tendency (F-statistic = 6.3). While a few individual differences are statistically significant, the effects are small and the sign of most of the effects suggest that girls in high-prescribing clinics may be slightly positively selected, if at all.

We visually summarize this finding in Appendix Figure C3 where we overlay a local linear regression of predicted pill use (based on a linear model regression including the individual and family observable 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 Appendix Table C3, show that there is no association between GP prescribing tendency and patient's outcomes prior to pill use. Together, these results suggest no evidence of selection bias based on observables into GP clinics with different prescription practices.

[35]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).

5.3 Unpacking Mechanisms: Biology or Increased Detection?

The results thus far reveal a robust link between pill use and declines in mental health, consistent across two identification strategies with distinct assumptions. These findings align with prior medical studies documenting short-run negative associations between mental health and contraceptive use (Poromaa and Segebladh, 2012; Skovlund et al., 2016; Lundin et al., 2017). In this section, we explore two alternative explanations for the observed effects. As outlined in Section 2.3, the medical literature suggests a biological pathway: the pill alters brain function by affecting hormone levels. A competing explanation is that the effects are driven by increased detection and treatment of mental health issues through greater contact with healthcare providers.

We provide two pieces of evidence supporting a biological mechanism. First, motivated by clinical findings that progestin-only pills are less likely to be related to mood-related side effects (FSRH, 2022; Kuntz et al., 2016; Worly et al., 2018), we compare antidepressant use among users of the combined pill and progestin-only pill. Progestin-only pills are typically prescribed to girls at risk for thrombosis (Mantha et al., 2012); in our data, these users are slightly more likely to have a personal or family history of cardiovascular conditions but are otherwise similar to combined pill users in characteristics such as the age at initiation. Panels (a) and (b) of Figure 2 present event-study estimates by type of pill. While results for progestin-only users are noisier due to smaller sample size (Panel b), we find no evidence of mental health deterioration in this group and can reject equality of four-quarter effects across groups.[36]

We confirm these results using the GP practice variation strategy. Row A of Table 2 shows that GP prescribing tendency for progestin-only pills strongly predicts use: a one standard deviation higher prescribing tendency increases the probability of progestin-only pill use by age 16 by 0.6 percentage points. However, the remaining rows of the table show no association between this tendency and mental health outcomes.

Finally, we examine GP visits around the time of pill initiation for combined and progestin-only users. Panels (c) and (d) of Figure 2 show flat pre-trends and a post-initiation increase in GP visits in both groups, but mental health deterioration is observed only among combined pill users. Overall, these findings support the interpretation that the pill has a short-run adverse impact on mental health, rather than effects being driven by increased healthcare contact.

[36]Due to the small number of new users each quarter, we estimate effects using a two-way fixed effects (TWFE) model. Panel (a) replicates the antidepressant results for combined pill users using TWFE, yielding results nearly identical to those in Figure 1c. For progestin-only users, we also find null effects for psychiatric visits and depression diagnoses.

5.4 Effects on Test Scores

Does the pill affect short-run educational outcomes? We examine this by analyzing the impact on 9th grade math and Danish test scores, typically taken at age 16. Since we lack pre-treatment grades, our analysis relies solely on variation in GP prescribing tendencies. The results, presented in Appendix Table C4, show no meaningful impact on test scores. The estimated effects are statistically insignificant and economically negligible: a one standard deviation increase in GP pill prescribing tendency lowers test scores by only 0.001–0.002 standard deviations.[37]

6 Effects of the Pill on Long-Run Outcomes

In this section, we examine the long-run effects on health, educational attainment, and labor market outcomes, measured between ages 18 and 30.[38] As these socio-economic outcomes are not observed prior to pill initiation, this analysis also relies exclusively on variation in GP prescribing tendencies.

Contraceptive Use and Mental Health Panel (a) of Figure 3 explores whether the effect of GP prescribing tendency on contraceptive pill use persists beyond adolescence. The results show a significantly higher likelihood of pill use at ages 16–19 among girls exposed to high-prescribing GPs. Although the magnitude of the effect declines with age, the coefficients remain consistently positive through approximately age 25, indicating persistence in contraceptive behavior into early adulthood. From age 26 onward, the estimates diminish and become statistically indistinguishable from zero, suggesting that differences in contraceptive use driven by GP practice style gradually fade over time.

Panel (b) focuses on the effects on antidepressant use.[39] The results show significantly higher antidepressant use at ages 17 and 18, with positive but statistically insignificant coefficients through age 22. At later ages, however, we find no evidence that girls exposed to high–pill-prescribing GPs have higher rates of antidepressant use.

[37] While there are no blanket exemptions from these tests for students with mental health conditions, individual exemptions can be granted. We find no effect of GP prescribing tendency on the likelihood of taking the test, suggesting that selection into test-taking is unlikely to bias our results.

[38] Analyzing longer-run educational attainment helps address the concern that test scores may be measured too early to capture any negative effects.

[39] We focus on antidepressant use because prescription data include filled prescriptions from providers both within and outside the national health insurance system, while data on psychiatric contacts only cover visits to within-network providers. Moreover, clinical guidelines do not recommend universal referral to specialists for adults.

Educational Attainment and Labor Market Outcomes Panel (c) presents the effects on the likelihood of college graduation. We find no evidence that GP prescribing tendency influences long-run educational attainment. At age 25, the average college graduation rate is 39.3%. Based on the confidence interval, we can rule out positive effects larger than approximately 0.004 (about 1% of the mean) and negative effects greater than 0.003 (roughly 0.76% of the mean). These findings align with the absence of effects on 9th grade test scores.

The remaining panels turn to labor market outcomes. Panel (d) of Figure 3 shows the effects on employment. The estimated coefficients remain close to zero across all ages, suggesting that exposure to a high-prescribing GP does not meaningfully affect the likelihood of being employed in early adulthood. We can reject employment effects—positive or negative—larger than about 0.24%. Panel (e) examines annual wage income. While the estimated effects are generally positive, particularly from the mid-twenties onward, they are modest in magnitude and statistically insignificant. At age 25, the (non-significant) coefficient corresponds to roughly 0.38% of the mean wages at that age, rising slightly to 0.41% by age 30.

Taken together, we find no evidence of adverse effects on educational attainment or labor market outcomes. This suggests that any mental health deterioration associated with pill use does not translate into long-run consequences for human capital accumulation.

7 Conclusions

More than six decades after its introduction, the oral contraceptive pill remains a cornerstone of adolescent reproductive healthcare. Yet despite its widespread use, concerns persist about its potential mental health side effects, particularly for teenage users. In this paper, we use rich Danish administrative data and two complementary empirical strategies to examine the short- and long-term effects of the combined oral contraceptive pill on mental health and socio-economic outcomes among adolescent girls.

Our findings point to a clear short-run deterioration in mental health following pill initiation. Using an event study framework, we show that within one year of starting the pill, the likelihood of a psychiatric contact, depression diagnosis, and antidepressant use increases by 17%, 40%, and 65%, respectively. A complementary design based on variation in provider prescribing behavior corroborates these findings: being assigned to a GP with a one standard deviation higher tendency to prescribe oral contraceptives increases the probability of a psychiatric contact between ages 16 and 18 by 1.6%, a depression diagnosis by 5.4%, and antidepressant use by 3.9%. A comparison of outcomes between users of the combined and progestin-only pill further suggests that these effects are more likely driven by a biological

mechanism than by increased detection or clinical monitoring.

Despite this short-run decline in mental health, we find no evidence of effects on short-term educational outcomes or long-run socio-economic trajectories. Ninth-grade test scores remain unaffected, and we detect no impact on college graduation, employment, or earnings by age 30. These findings suggest that while the pill may trigger adverse mental health effects during adolescence, these do not translate into meaningful long-term consequences for human capital accumulation.

Taken together, our results highlight the importance of recognizing potential mental health side effects of hormonal contraceptives, particularly among adolescents, even as these remain highly effective tools for fertility control. Understanding these trade-offs is essential for both patients and policy-makers navigating adolescent reproductive health.

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Tables and Figures

Table 1: Effect of GP pill prescribing tendency on girls' contraceptive use and short-run mental health

	(1)	(2)	(3)
A. Contraceptive use by age 16			
PP	0.007***	0.007***	0.006***
	(0.001)	(0.001)	(0.001)
N	237985	237985	237985
Outcome mean	0.440	0.440	0.440
Adjusted R^2	0.027	0.082	0.082
F-stat PP	37.56	34.72	31.96
B. Psychiatrist visit, ages 16–18			
PP	0.158**	0.168**	0.136**
	(0.067)	(0.066)	(0.067)
N	237985	237985	237985
Outcome mean (x 100)	8.262	8.262	8.262
Adjusted R^2	0.012	0.033	0.033
C. Depression diagnosis, ages 16–18			
PP	0.065**	0.066**	0.071**
	(0.027)	(0.027)	(0.028)
N	225374	225374	225374
Outcome mean (x 100)	1.304	1.304	1.304
Adjusted R^2	0.003	0.005	0.005
D. Antidepressant use, ages 16–18			
PP	0.114***	0.114***	0.116***
	(0.040)	(0.040)	(0.041)
N	237985	237985	237985
Outcome mean (x 100)	3.008	3.008	3.008
Adjusted R^2	0.002	0.008	0.008
Municipality x YOB FE	Yes	Yes	Yes
Family controls		Yes	Yes
Clinic Controls			Yes

This table shows the results of regressions of outcomes indicated in each row on the standardized GP pill prescribing tendency. 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

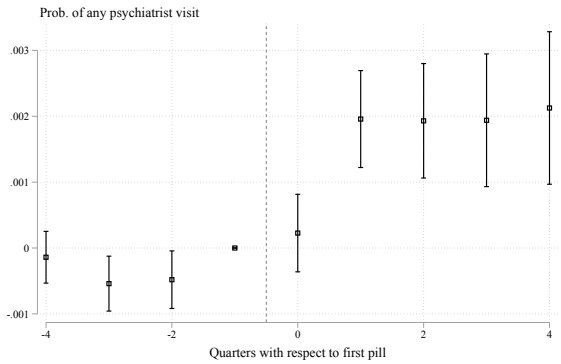
Table 2: Effect of GP progestin-only pill prescribing tendency on girls' contraceptive use and short-run mental health

	(1)	(2)	(3)
A. Progestin-only contraceptive use by age 16			
POC PP	0.007***	0.006***	0.006***
	(0.001)	(0.001)	(0.001)
N	237985	237985	237985
Outcome mean	0.029	0.029	0.029
Adjusted R^2	0.010	0.025	0.025
F-stat PP	41.89	40.05	39.35
B. Psychiatrist visit, age 16–18			
POC PP	0.027	-0.012	-0.015
	(0.068)	(0.066)	(0.066)
N	237985	237985	237985
Outcome mean (x 100)	8.262	8.262	8.262
Adjusted R^2	0.012	0.033	0.033
C. Depression diagnosis, age 16–18			
POC PP	-0.010	-0.016	-0.019
	(0.029)	(0.029)	(0.029)
N	225374	225374	225374
Outcome mean (x 100)	1.304	1.304	1.304
Adjusted R^2	0.003	0.005	0.005
D. Antidepressant use, age 16–18			
POC PP	0.009	-0.005	-0.006
	(0.045)	(0.045)	(0.045)
N	237985	237985	237985
Outcome mean (x 100)	3.008	3.008	3.008
Adjusted R^2	0.001	0.008	0.008
Municipality x YOB FE	Yes	Yes	Yes
Family controls		Yes	Yes
Clinic Controls			Yes

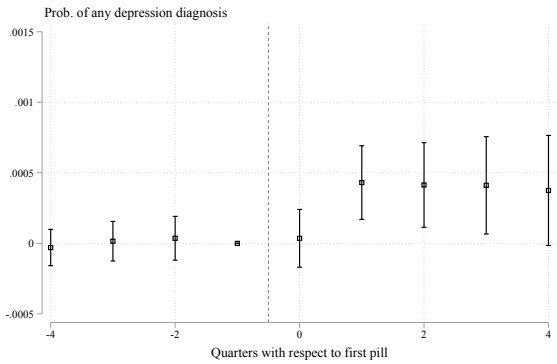
This table shows the results of regressions of outcomes indicated in each row on the standardized GP progestin-only contraceptive prescribing tendency. See equation (3) for details. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds). Standard errors in parentheses are clustered at the GP level. * p<0.1, ** <0.05, *** p<0.01

Figure 1: Effect of pill use on short-run mental health, event-study design

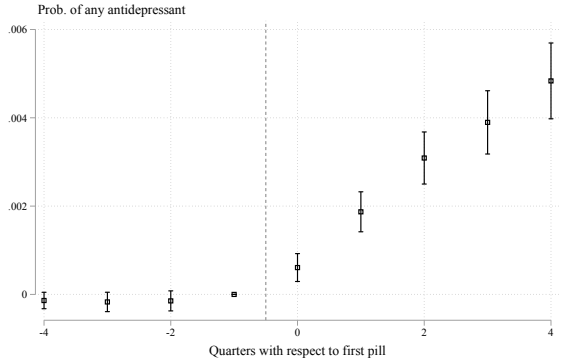
(a) Any psychiatrist visit



(b) Any visit with a depression diagnosis



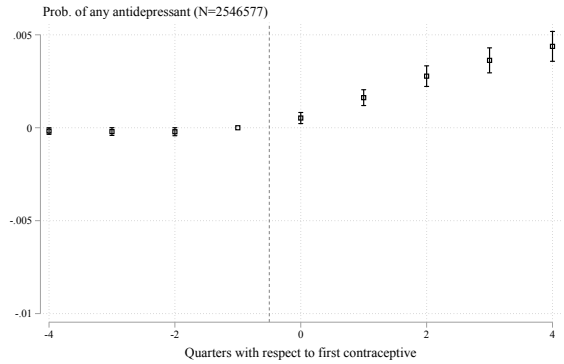
(c) Antidepressant medication



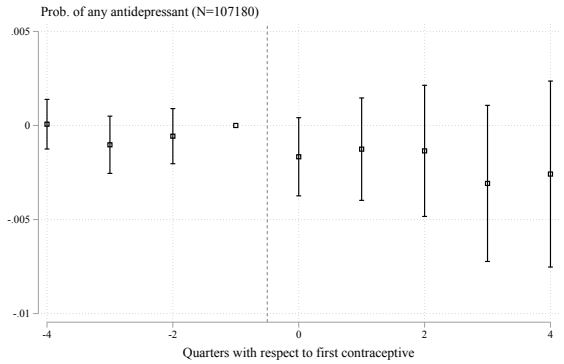
Notes: This figure plots the event time dummies' coefficients for the probability of having any psychiatrist visit (in panel (a)), the probability of being diagnosed with depression during a medical visit (in panel (b)), and the probability of redeeming any prescription for antidepressant medication (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: Effect of pill use by type of hormonal contraceptive

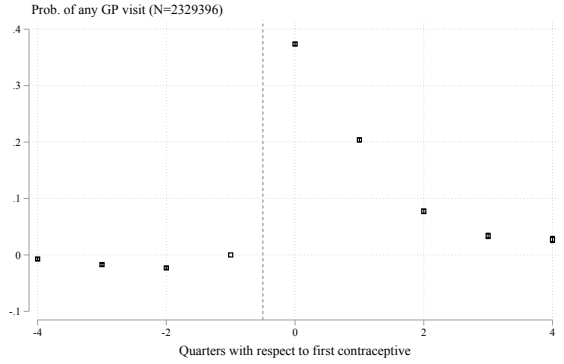
(a) Antidepressants – Combined pill



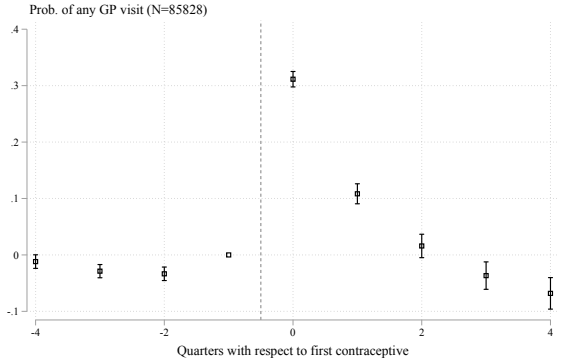
(b) Antidepressants – Progestin-only contraceptives



(c) GP visits – Combined pill



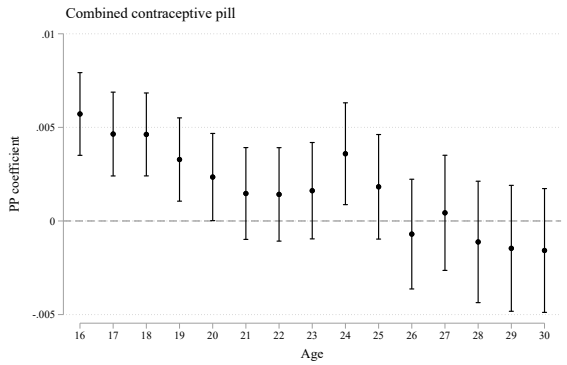
(d) GP visits – Progestin-only contraceptives



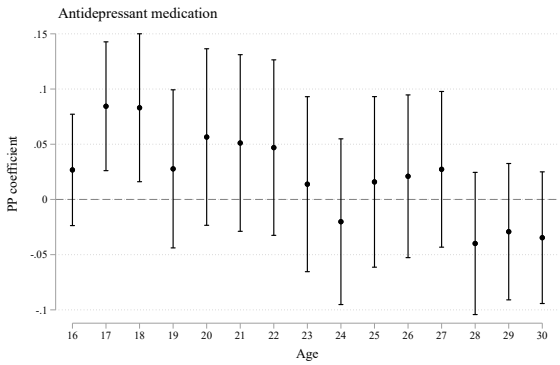
Notes: This figure plots the event time dummies' coefficients and 95% confidence intervals (from a two-way-fixed effect estimation of equation (1)) for the probability of filling an antidepressant prescription (panels (a) and (b)) and the likelihood of a GP visit (panels (c) and (d)) in each quarter around the time of first pill use for girls using different types of hormonal contraceptives: the combined pill in panels (a) and (c) and a progestin-only contraceptive in panels (b) and (d). 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 3: Effect of GP pill prescribing tendency on long-run outcomes, ages 18 to 30

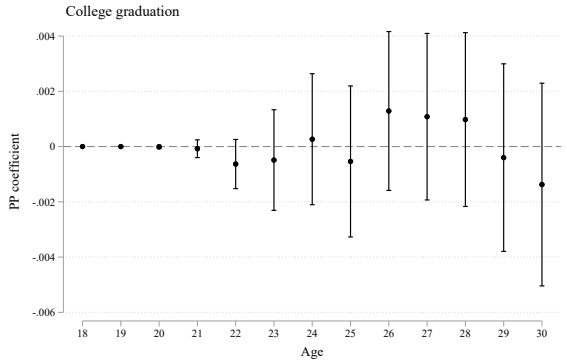
(a) Contraceptive pill use



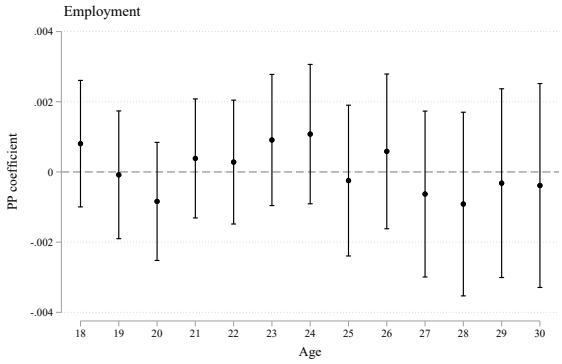
(b) Antidepressant medication



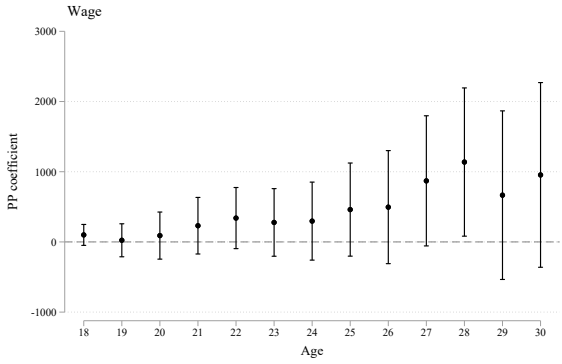
(c) College graduation



(d) Employment



(e) Wages

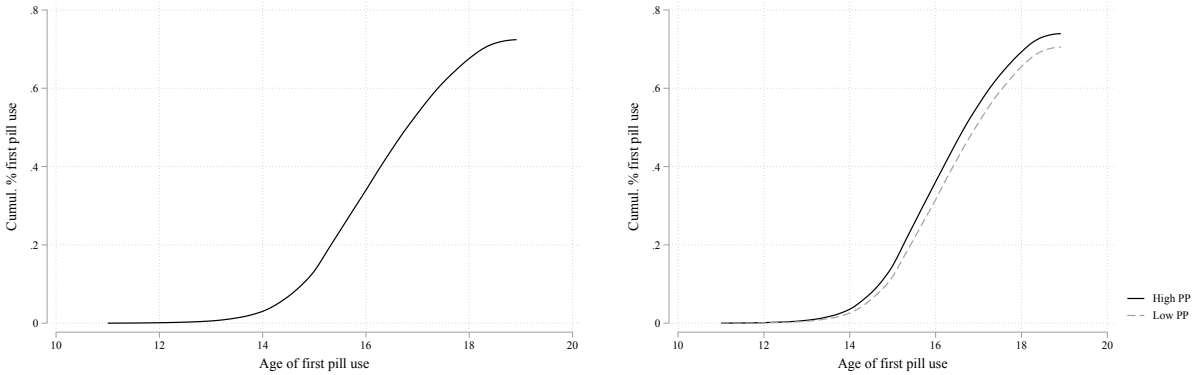


Notes: This figure plots the coefficients and 95% CI of regressing the probability of taking the pill (panel (a)), taking antidepressant medication (panel (b)), college graduation (panel (c)), being employed (panel (d)), and wages (panel (e)), by age, on the propensity to prescribe of their GP clinic (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). From age 19 onward, we lose the younger cohorts of our sample as we consider older ages. Standard errors clustered at the GP level.

Appendix A – Descriptive Statistics

Figure A1: Cumulative distribution of contraceptive use by age

(a) Full sample (b) By GPs' tendency to prescribe



Notes: This figure plots the cumulative distribution of first pill use by age for the whole sample in the left panel and by GP's tendency to prescribe in the right one. In the right panel, we divide 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

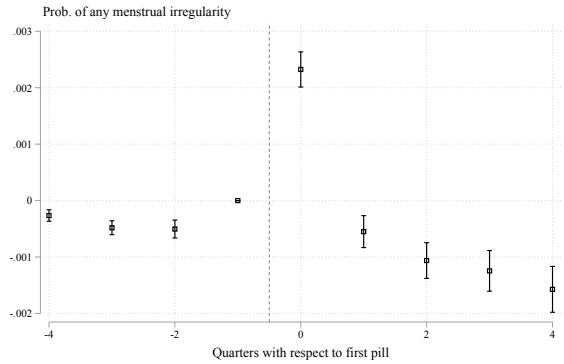
	Full sample		Event study sample		GP sample	
	Mean	SD	Mean	SD	Mean	SD
Contraceptive use						
Any pill by age 15	0.206	0.404	0.596	0.491	0.234	0.424
Any pill by age 16	0.397	0.489	0.973	0.162	0.440	0.496
Child characteristics						
Eldest sibling	0.522	0.500	0.538	0.499	1.000	0.000
No. of siblings	1.353	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
Mean family income	332017.8	394626.1	326160.5	387916.3	339116.4	328754.3
Missing information of family income	0.103	0.304	0.107	0.309	0.054	0.227
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
Mother is employed	0.809	0.393	0.820	0.384	0.829	0.376
Mother uses oral contraceptive	0.192	0.394	0.346	0.476	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
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
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
Clinic with multiple physicians					0.679	0.470
Share of female physicians					0.369	0.344
Share of immigrant physicians					0.045	0.163
Average age of physicians					51.558	6.519
Average tenure					12.411	6.804
Missing clinic characteristics					0.002	0.044
Mean family income among patients					339557.8	101636.6
Patient share with married parients					0.656	0.157
Patient share whose mother has a college degree					0.310	0.182
Patient share whose father has a college degree					0.280	0.175
Patient share whose mother has only mandatory ed.					0.020	0.045
Patient share whose father has only mandatory ed.					0.044	0.066
Patient share whose mother uses oral contraceptives					0.201	0.122
Patient share whose mother uses antidepressants					0.083	0.085
Patient share whose father uses antidepressants					0.046	0.062
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. Income variables are expressed in nominal Danish krones (DKK).

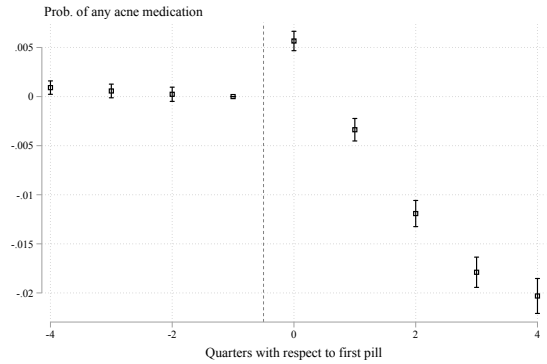
Appendix B – Additional Results Event Study Design

Figure B1: Potential Reasons for Contraceptive Use

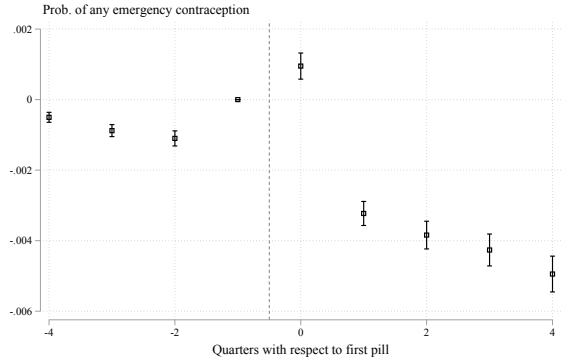
(a) Any menstrual irregularity



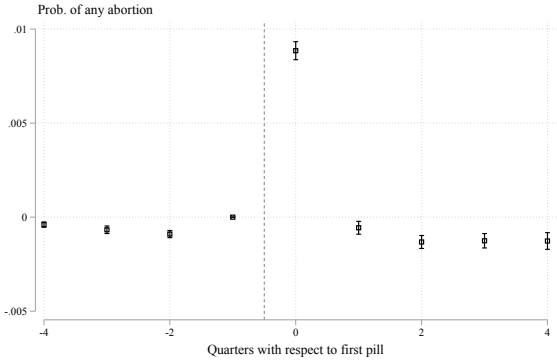
(b) Any acne medication



(c) Any emergency contraception



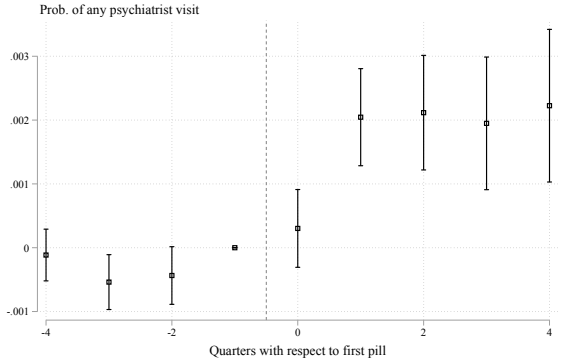
(d) Any abortion



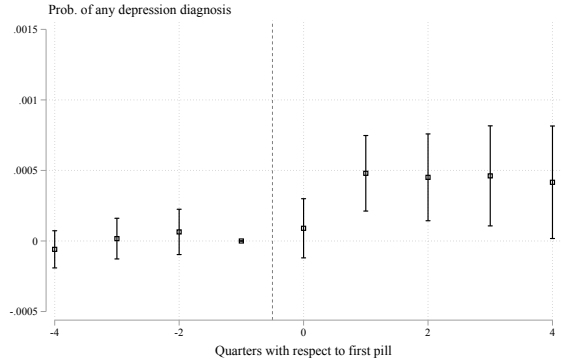
Notes: This figure plots the event time dummies' coefficients for the probability of having any menstrual irregularity (in panel (a)), any acne prescription (in panel (b)), having emergency contraception (in panel (c)) and of having an abortion (in panel (d)), estimated using Sun and Abraham (2020)'s 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 B2: Excluding Those with Other Shocks at t=0

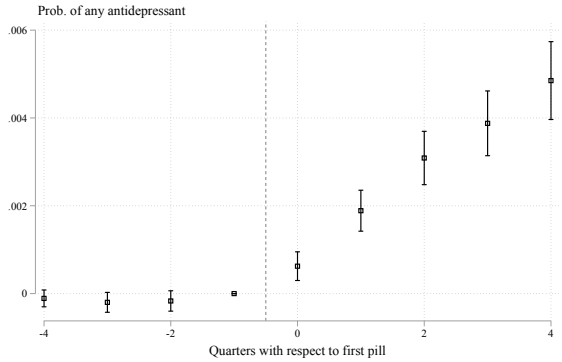
(a) Any psychiatrist visit



(b) Depression diagnosis



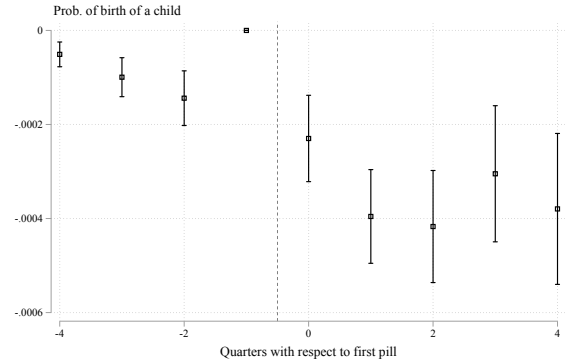
(c) Antidepressant medication



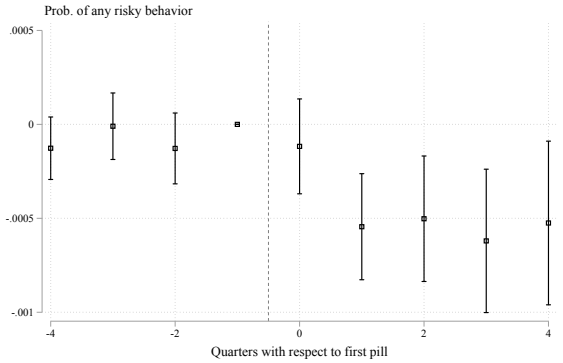
Notes: This figure plots the event time dummies' coefficients for the probability of having any psychiatrist visit (in panel (a)), any depression diagnosis (panel (b)), and of redeeming any prescription for antidepressant medication (in panel (c)), estimated using Sun and Abraham (2020)'s IW estimator (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 B3: Evolution of Risky Behaviors

(a) Any birth



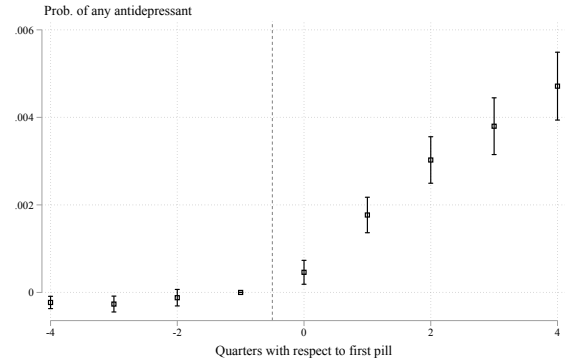
(b) Any risky behavior



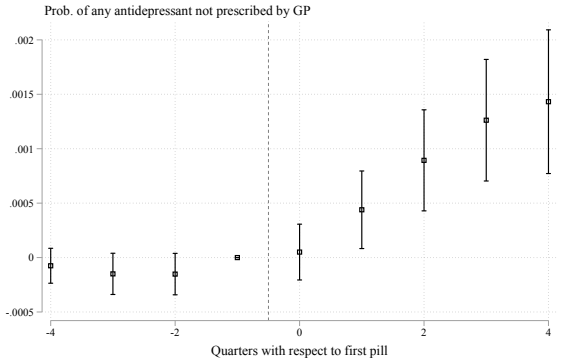
Notes: This figure plots the event time dummies' coefficients for the probability of giving birth (panel (a)) and having a hospital visit due to alcohol abuse or sexually-transmitted diseases (panel (b)). Our sample consists of a balanced panel of girls born from 1986 to 2002 who started taking the pill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

Figure B4: Robustness Checks: Antidepressant Use Around First Pill Use

(a) Excluding girls with prior mental health diagnosis



(b) Excluding antidepressants prescribed by GPs



Notes: This figure plots the event time dummies' coefficients for the probability of filling an antidepressant prescription around the time of first pill use. Panel (a) excludes girls with a prior mental health diagnosis. Panel (b) analyzes prescriptions issued by specialists only. 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.

Appendix C – Additional Results GP Practice Variation

Table C1: Effect of GP pill prescribing tendency on boys' mental health outcomes at ages 16–18

	(1)	(2)	(3)
A. Psychiatrist visit, ages 16–18			
PP	-0.036	-0.027	-0.016
	(0.050)	(0.049)	(0.050)
N	246897	246897	246897
Outcome mean (x 100)	5.071	5.071	5.071
Adjusted R^2	0.009	0.028	0.028
B. Depression diagnosis, ages 16–18			
PP	-0.021	-0.020	-0.017
	(0.015)	(0.015)	(0.016)
N	233707	233707	233707
Outcome mean (x 100)	0.435	0.435	0.435
Adjusted R^2	0.000	0.001	0.001
C. Antidepressant use, ages 16–18			
PP	-0.046*	-0.044	-0.044
	(0.027)	(0.027)	(0.028)
N	246897	246897	246897
Outcome mean (x 100)	1.347	1.347	1.347
Adjusted R^2	-0.001	0.003	0.003
D. MH prescription, ages 16–18			
PP	0.047	0.047	0.022
	(0.049)	(0.048)	(0.050)
N	246897	246897	246897
Outcome mean (x 100)	4.783	4.783	4.783
Adjusted R^2	0.008	0.031	0.031
Municipality x YOB FE	Yes	Yes	Yes
Family controls		Yes	Yes
Clinic Controls			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 C2: Effect of GP pill prescribing tendency on hospitalizations for ACS conditions at ages 16-18

	Any ACS		Acute ACS		Chronic ACS		Vaccine-preventable ACS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
PP	-0.018	-0.019	-0.044	-0.051	0.024	0.027	-0.004	0.000
	(0.048)	(0.049)	(0.038)	(0.040)	(0.029)	(0.030)	(0.010)	(0.010)
N	225374	225374	225374	225374	225374	225374	225374	225374
Adjusted R^2	0.022	0.022	0.023	0.023	0.006	0.006	-0.000	-0.000
Outcome mean (x 100)	4.063	4.063	2.513	2.513	1.470	1.470	0.187	0.187
Municipality x YOB FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Clinic 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

Table C3: Effect of GP pill prescribing tendency on girls' mental health outcomes at age 12

	Psychiatrist visit			Depression diagnosis			Antidepressant		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
PP	0.005	0.004	0.001	-0.005	-0.005	-0.004	-0.001	-0.002	-0.004
	(0.024)	(0.024)	(0.024)	(0.004)	(0.004)	(0.004)	(0.009)	(0.009)	(0.009)
N	237985	237985	237985	237985	237985	237985	237985	237985	237985
Adjusted R^2	-0.000	0.006	0.006	-0.002	-0.001	-0.001	-0.002	-0.000	-0.000
Outcome mean (x 100)	1.028	1.028	1.028	0.032	0.032	0.032	0.166	0.166	0.166
Municipality x YOB FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes	Yes		Yes	Yes		Yes	Yes
Clinic 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 C4: Effect of GP pill prescribing tendency on girls' 9th grade test scores

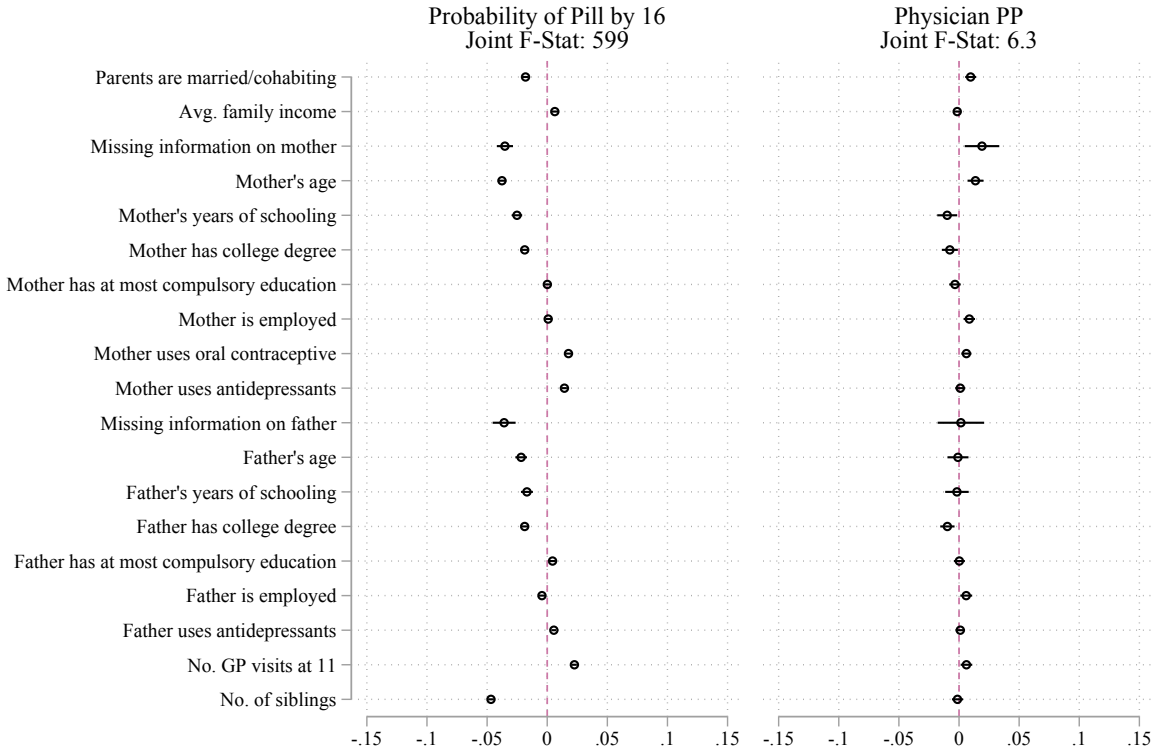
	Math			Danish		
	(1)	(2)	(3)	(4)	(5)	(6)
PP	-0.002	-0.000	-0.001	-0.004	-0.002	-0.002
	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
N	218603	218603	218603	219831	219831	219831
Adjusted R^2	0.031	0.179	0.180	0.019	0.108	0.109
Outcome mean	0.016	0.016	0.016	0.332	0.332	0.332
Municipality x YOB FE	Yes	Yes	Yes	Yes	Yes	Yes
Family controls		Yes	Yes		Yes	Yes
Clinic Controls			Yes			Yes

This table shows the results of regressions of 9th grade test scores on the standardized GP pill prescribing tendency. 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

Figure C1: GP's pill prescribing tendency and contraceptive use by age 16

Notes: This figure plots the histogram of the PP (equation (2)), residualized of municipality by birth year fixed effects. 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. We use our GP sample from Table A1, which includes girls born from 1986 to 2002 (first-borns, and from non-immigrant backgrounds).

Figure C2: Selection into pill use and GP's pill prescribing tendency



Notes: The left panel plots the coefficients and 95% CI from a regression of the probability of taking the pill by age 16 on observable characteristics. The right panel plots the coefficients and 95% CI from a regression of the GP's pill prescribing tendency 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).

Figure C3: GP's pill prescribing tendency and predicted pill use by age 16

Notes: This figure plots the histogram of the PP (equation (2)), residualized of municipality by birth year fixed effects. It 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).