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ABSTRACT

Time of Change: Health Effects of Motherhood*

This paper combines German claims and survey data to provide a comprehensive picture of the health dynamics surrounding the transition into motherhood. Event-study estimates reveal good mental health around birth, but declines afterward, as reflected by increasing mental illness diagnoses and antidepressant and psychotherapy use during the first four years of motherhood. Painkillers, headaches, obesity, and other potentially stress-related physical illnesses, as well as survey evidence on well-being, show a similar pattern. A sustained reduction in sleep, sports, and other leisure activities, coupled with childcare obligations and possible psychosocial distress, may contribute to the long-term adverse effects of motherhood.

JEL Classification: J13, I10, I12
Keywords: maternal health, mental health, claims data

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1 Introduction

The transition to motherhood is a particularly vulnerable time for women's health. Care around the clock, sleep disruptions, income decline, socio-psychological stress, and reduced time for self-care put mothers at an increased risk for mental and physical health problems (Saxbe et al., 2018). Maternal exhaustion is a viral topic in (social) media and popular readings.[1] But how does stress-related health, measured by medicine use, medical diagnoses, and self-assessment, evolve in the general population of mothers?

Health problems at the beginning of motherhood can have a long-lasting impact on physical and mental health and chronic diseases in midlife (Stowe and Nemeroff, 1995; Rooney et al., 2005; Currie and Zwiers, 2023). Health constitutes an important component of life satisfaction; it is associated with child well-being (Aizer et al., 2016; Liu et al., 2017; Menta et al., 2023; Kendall-Tackett, 2023) and may affect future fertility (Halla et al., 2020), as well as labor market participation and wages (Biasi et al., 2021; Bütikofer et al., 2020). Restructuring caregiving (e.g. by family policies that address fathers) and support programs (easy access to mental health counseling, mother-child clinics, and health insurance-sponsored household helpers) can alleviate maternal stress and health risks. To design and evaluate such policies, we need to understand the health dynamics around the transition to motherhood. Taking into account different ways of measuring health, such as prescriptions, diagnoses, and self-assessment, as well as manifestations of potential stress and overload, such as depressive symptoms, pain, increased susceptibility to infection, or obesity provides a comprehensive picture.

In this paper, we establish causality through visual event studies on a variety of stress-related diagnoses and prescriptions from two years before to four years after entering motherhood. As the first paper in the non-medical literature, we use claims data from the German Pharmacoepidemiological Research Database (GePaRD), which covers approximately 20% of the

[1] Consider for example the following books and, if applicable, the number of followers the author has on Instagram (as of February 2024): "Bindung ohne Burnout" [Attachment without Burnout] Nora Imlau (116k), "Mama kann nicht mehr" [Mom Can't Take It Anymore] Julia Knoernschild (126k), "Der Supermutti Burnout" [The Supermom Burnout] Jessica Severin in Germany and "Mommy Burnout" Sheryl Ziegler, "All Joy and No Fun: The Paradox of Modern Parenthood" Jennifer Senior in the USA, or tools like the "MamaZen App - Parenting Anxiety, Burnout & Stress Solution" (156k, US-based).

population in Germany. The detailed structure of the data, including in- and outpatient diagnoses, procedures, and prescriptions, allows us to identify pregnancies ending in a live birth, through data-specific algorithms, and to focus on different outcome dimensions. Prescriptions are an important health measure because they signal a condition a physician deems serious enough to recommend or approve medical intervention. Diagnoses add more specific information about the nature of the condition and include cases that do not require treatment. We focus on potentially stress- and lifestyle-related health outcomes. These include mental disorders (depression, other mental disorders, and sleep disorder), obesity, and pain (back pain, headache, prescriptions of painkillers).[2] We include respiratory diseases and antibiotic prescriptions in our set of outcomes since stress, exhaustion, and general mood can suppress immune resistance and increase the likelihood of infection, including the common cold (e.g. Seiler et al., 2020).

We supplement our analysis of claims data with survey information from the *German Socio-Economic Panel* (SOEP) and the *Panel Analysis of Intimate Relationships and Family Dynamics* (Pairfam), covering subjective assessments of mood, mental health, and life satisfaction, as well as information on sleep duration, time use, and breastfeeding. The focus of our paper is on claims data for several reasons. First, longitudinal surveys lack a sufficient sample size to measure specific illnesses in new mothers. Second, measuring well-being and health based on surveys involves the drawback of desirability bias. This may be particularly relevant in the context of entering parenthood, accompanied by strong social expectations of how parents are supposed to feel. Claims data helps to overcome recall, desirability, and justification biases (Baker et al., 2004). Third, the use of antidepressants may affect how survey participants evaluate their mood and related outcomes, as noted by Ahammer et al. (2023). However, survey data complements our analysis due to its advantage of capturing slight adjustments in health and mood, not resulting in changes in physician visits, diagnoses, or prescriptions.

[2] Whitaker et al. (2014) show that stress from parenting, such as isolation, attachment, and depressive symptoms, as well as overall life stress, are accompanied by postpartum weight retention. Headaches, back pain, and the need for painkillers often coincide with stress (e.g. Schramm et al., 2015; Puschmann et al., 2020)

Our results indicate that the period immediately after childbirth is characterized by relatively few prescriptions related to mental disorders and diagnoses of depression, other mental disorders, and sleep disorder, suggesting a period of good mental health.[3] With complementary survey data, we further alleviate potential concerns that this improvement is merely attributable to precautionary behavior against medication during pregnancy and lactation, or a reluctance to record diagnoses. After the first childbirth, the prevalence of mental disorders, as captured by claims data, increases each subsequent quarter, starting from relatively low levels. Four years into motherhood, most records of mental disorders tend to exceed pre-pregnancy levels. For mothers whose results are not confounded by a subsequent birth, the prescription of antidepressants increases by 44%, 8% for depression diagnoses, and 18% for sleep disorder. The probability of other mental disorders, such as anxiety and adjustment disorders, decreases by 9% and mothers rely to a lesser extent on psychotherapy despite the increased incidence of depression and the use of antidepressants. Additional survey questions on feeling happy and sad, which encompass the full range of emotions beyond mental disorders, yield strikingly similar findings, despite a small sample size. Physical illnesses and prescriptions that are potentially stress- and lifestyle-related follow a similar pattern. While painkillers and antibiotics are rarely prescribed during and shortly after pregnancy, motherhood increases these prescriptions by 30% and 34% in the long term.[4] Related diagnoses also show an increase, again to a lesser extent than prescriptions. Finally, claims as well as survey data suggest an increase in obesity rates.

Complementary analyses support the argument that a sustained reduction in sleep, sport, and other leisure activities, coupled with extensive involvement in childcare and possible psychosocial distress, may be important channels to explain the deterioration in health. We further find that lactation cannot affect the results beyond the second year after birth, nor do adjustments in physician visits play an important role. Our heterogeneity analysis on education reveals substantial absolute pre-pregnancy differences for some outcomes, while the relative

[3] During pregnancy, the picture is more mixed, with high rates of diagnosis for some types of mental disorders.

[4] Note that these numbers pertain to mothers for whom there is no confounding subsequent birth.

effects of entering motherhood remain small. The effects of motherhood are similar across East and West German mothers, with slightly higher relative effects for physical outcomes in East Germany. One notable difference arises in the diagnoses of depression: in West Germany, but not in East Germany, motherhood has a long-term effect on depression levels of about 10%.

This paper provides the first comprehensive picture of different margins of maternal health and its dynamics around childbirth using nuanced process-generated claims data. Related to our research, Hart et al. (2023) measure mental health-related primary care consultations for Norwegian parents. Similar to our findings, their event study shows a continuous increase in consultations in the first years of motherhood after a small decrease before pregnancy. The paper, however, does not explore underlying diagnoses or prescribed treatments. The increased use of antidepressants we find also aligns with Ahammer et al. (2023). Applying an event study with Danish and Austrian claims data, they show that entering parenthood has strong and long-lasting effects on antidepressant use for mothers, but much less for fathers. Mothers' higher investment in childcare seems to contribute to the gap in antidepressants between mothers and fathers. In a similar vein, Angelov et al. (2020) and Fontenay and Tojerow (2020) analyze the effect of motherhood relative to fatherhood on sick leave. While these studies, like our paper, use claims data and a design-based approach, their focus is on examining and explaining whether there is a motherhood penalty (relative to fathers) on health in addition to the well-known motherhood penalty on earnings (Kleven et al., 2019).[5]

We complement our analysis with survey data to gain further insights into perceived health dynamics around birth. Thereby, our paper brings together two strands of literature: the event studies based on claims data and the studies using more traditional longitudinal models based on survey data. The latter studies examine self-assessed mental health or mental well-being with panel survey data using fixed-effects or linear spline models. They find a peak in well-being starting before or during pregnancy and later either a return to about baseline (e.g. Assel-

[5] Kravdal et al. (2017) compare the use of antidepressants between women with different numbers of children and childless women with claims data from Norway and find that women with one child are more likely to use antidepressants than childless women, but also more than women with more children.

mann et al., 2022) or long-term effects of well-being above (e.g. Mckenzie and Carter, 2013; Metzger and Gracia, 2023) or below baseline levels (e.g. Giesselmann et al., 2018). Giesselmann et al. (2018) and Asselmann et al. (2022) employ the Mental Component Summary Score (MCS) of the German SOEP as we do.[6] Based on the UK Longitudinal Household Survey, Metzger and Gracia (2023) break the effects down to specific domains of mental health, such as role, vitality, and social and emotional functioning. They find that emotions such as "feeling happy and cheerful" drive the positive results, while for more physical outcomes like "vitality," there is a pre-birth drop and levels remain below baseline.

We also relate to the medical and psychological literature with its primary focus on causes, prevalence, and treatments for depression in early motherhood (Kendall-Tackett, 2023). In early motherhood, depression affects a relatively high share of otherwise healthy women without a history of depression. The prevalence increases six months postpartum (Shorey et al., 2018) and involves a risk of chronic depression (Stowe and Nemeroff, 1995). There is less evidence on the development of other mental disorders and on the relative use of antidepressants versus psychotherapy after entering motherhood. Studies on how physical illness is related to the transition to motherhood are scarce. Migraine is known to often go into remission during pregnancy and to recur in the first months after childbirth (Hoshiyama et al., 2012). With its focus on physical functioning, the study by Asselmann et al. (2022) uses the ST12 physical component score from the SOEP, including physical fitness, pain, limitations, and perceived general health. The results suggest a large decline in physical functioning during pregnancy, an improvement up to pre-pregnancy levels after birth, a small decline after the first year of motherhood, and a stable pattern thereafter. The risk of obesity has been studied more intensively among young mothers. Whitaker et al. (2014) show an association of stress and isolation

[6] Related to mental health outcomes Myrskylä and Margolis (2014) and Baetschmann et al. (2016) both use the SOEP and focus on feeling happy and satisfied with life. Myrskylä and Margolis (2014) find that feeling happy increases in the years around entering motherhood and later returns to baseline levels. Baetschmann et al. (2016) state that inappropriate control groups or neglect of prior trends may have led to overly negative views of the effect of parenthood on feelings of happiness. They find strong positive effects of motherhood on life satisfaction around childbirth, and some of this persists over the long term. A discussion of older studies, which often use cross-sectional comparisons between mothers or small selective samples, is summarized e.g. in Baetschmann et al. (2016) and Giesselmann et al. (2018).

with postpartum weight retention. Rooney et al. (2005) find that postpartum weight loss, exercise, and prolonged breastfeeding are associated with a lower BMI 15 years after entering motherhood, with a high BMI being a predictor of (pre)diabetes and heart disease in this study. Umberson et al. (2011) find that parents gain weight more rapidly compared to adults without children. We complement these findings by focusing on the extent of overweight with medical implications and by revealing a long-term positive effect of motherhood on obesity based on a design-based approach.

The manuscript is organized as follows. Section 2 describes the data, while Section 3 explains our event-study approach. Section 4 discusses the findings on mental health and stress-related physical health. Section 5 explores possible explanations and Section 6 important heterogeneities. Section 7 concludes.

2 Data

2.1 German Pharmacoepidemiological Research Database (GePaRD)

For our main analysis, we use data from the German Pharmacoepidemiological Research Database (GePaRD) for the years 2004 to 2019. GePaRD covers process-generated data on claims of roughly 25 million individuals (approximately 20.7% of the German population) from four major statutory health insurers from all regions of Germany (Haug and Schink, 2021; Scholle et al., 2022). The database contains demographic characteristics, information on medication dispensations, and in- and outpatient diagnoses and services.

Identifying mothers in German claims data poses a challenge, as this information is not directly reported. We identify pregnancies ending in live births based on database-specific algorithms by Wentzell et al. (2018) and Schink et al. (2020), which consider maternal in- and outpatient diagnoses, operations and procedures (OPS), and outpatient treatments (EBM). This allows us to accurately determine live births and hence biological mothers without relying on the co-insurance of children or the take-up of prenatal care. The anchor date or event time zero is the quarter that we identify as the first childbirth.[7]

[7] The quarter of childbirth is estimated by applying the algorithms by Wentzell et al. (2018) and Schink et al. (2020) to maternal information.

We exclude mothers who gave birth before age 15 or after 49. By this means, we obtain a sample of 1,468,892 women with at least one live birth between 2004 and 2019. A comparison with administrative birth statistics by age and the share of C-sections across federal states and years confirms the overall representativeness of our approach, despite minor discrepancies (Figure A.1).

To estimate the effect of the transition to motherhood, we restrict the sample to the first observed childbirth of women. We aim to capture mothers 8 quarters (2 years) before and 16 quarters (4 years) after childbirth. However, we do not observe the full timeframe around childbirth for all mothers. If a childbirth occurs before January 2006 or after December 2015, we are left with fewer quarters, as GePaRD covers the years 2004 to 2019 only. Similarly, the timeframe is incomplete if a mother joins the insurance less than 8 quarters before childbirth or if she terminates coverage within 16 quarters after childbirth.[8]

A major strength of GePaRD lies in its inclusion of both diagnoses and prescriptions, as well as in- and outpatient data. The inclusion of in- and outpatient data alleviates concerns about shifts between both groups related to motherhood, although most diagnoses and prescriptions typically originate from outpatient data. Finally, the large sample size allows a precise analysis of rare diagnoses such as sleep disorder.

Outcome Variables

For the previously defined sample of mothers, we obtained a customized dataset originating from GePaRD. It includes indicator variables for pre-selected diseases and prescriptions, as well as count variables on the number of physician and psychotherapist visits and diagnoses, along with additional demographic characteristics. If not stated otherwise, diseases' dummies turn one if a mother receives one or more diagnoses associated with a certain disease in a specific quarter. We include depression, other mental disorders – such as anxiety, somatoform, and adjustment disorders – sleep disorder, back pain, headaches, obesity, and respiratory diseases.

[8] We use an unbalanced panel, but obtain similar results, with some deviations at the end of the observation period under the extreme choice of using a completely balanced sample of mothers observed over the full 25 quarters.

Table A.1 outlines the ICD-10 codes of each outcome. To indicate potentially acute diseases like back pain, headaches, and respiratory conditions, we only require the occurrence of one quarterly incidence, either in the inpatient or outpatient data. The definition of obesity relies on a confirmed inpatient or outpatient diagnosis, or a weight loss surgery during the corresponding quarter (Schröder et al., 2020). The coding of chronic diseases, including depression, other mental disorders, and sleep disorder, follows slightly stricter conditions to avoid overestimation of diseases. Respective dummies turn one if a hospital codes a diagnosis, or if outpatient diagnoses in the relevant quarter are followed by at least one in- or outpatient coding in the same quarter or in the subsequent three quarters.

Regarding medication, GePaRD contains information based on the German modification of the Anatomical Therapeutic Chemical (ATC) Classification System. The database includes information on medication that is dispensed in a pharmacy and reimbursed by the health insurance provider. Information on over-the-counter (OTC) medicine purchases is unavailable.[9] Dummy variables equal one if medication from a certain group of substances is dispensed during the respective quarter. We focus on antidepressants (ATC: N06A), painkillers (N02), and antibiotics (J01). In addition, we consider the number of days spent in hospital, outpatient physician visits based on the number of distinct treatment cases, and a dummy variable for at least one psychotherapist visit in a given quarter. Based on the first three digits of the ICD-10 codes, we also include a count variable on the number of distinct inpatient and outpatient diagnoses. Dividing this variable by the number of physician and psychotherapist visits and days spent in hospital, we obtain the number of diagnoses per visit.

Table A.2 presents pre-pregnancy summary statistics of the outcome variables. In the fifth quarter before birth, 2% of all mothers in our sample receive prescriptions for antidepressants and 2.9% undergo psychotherapy; 4.6% are diagnosed with depression, 8.1% with another mental disorder, and 0.5% with a sleep disorder. Each quarter, 13.2% of the women receive

[9]Note the relatively strict regulations on drug dispensation in Germany. Particularly, stronger medications such as antibiotics, antidepressants, as well as common painkillers at higher doses require a valid prescription from a doctor and are not available over the counter.

antibiotics and 3.3% painkillers. The most prevalent illness under consideration is respiratory diseases (17.7%), followed by back pain (10.6%). The headache incidence is 6.7% and obesity is at 3.1%. On average, mothers see a physician 2.2 times during the fifth quarter before birth, receiving 1.4 diagnoses per visit, including new and follow-up diagnoses.

Sociodemographic Characteristics

Table A.3 presents summary statistics on individual characteristics included in GePaRD. The average age at the first identified birth is 30.7 years. Since individuals with strong labor market attachment are typically self-insured in Germany, we consider mothers who have been self-insured throughout the full two years before childbirth as working.[10] According to this proxy, before pregnancy, approximately 81.2% of women work. We also measure the educational attainment of an individual with the degree most frequently reported for her. In principle, the employer should transmit an occupational code indicating the type of employment and education level at least annually for each self-insured worker. As we only observe the occupational code for women with some employment history, only 4% of mothers have low education levels, 43% have intermediate education levels, and 20% are highly educated, while for the other 33% there is no information.

Two-thirds (67%) of women have no additional child. These mothers represent a crucial subgroup for our analysis, as health dynamics are not confounded by subsequent pregnancies and births. While some of these women never have more than one child, some may have additional children that we do not observe in our data. The latter are births that occur before 2004, after 2019, or while a woman is insured with another provider. We refer to mothers with a single birth in our dataset as "one-child mothers."

[10] Statutory health insurance providers allow free co-insurance of children, spouses, or registered partners if their monthly earnings are below 570 EUR or if they spend less than 18 hours per week on self-employment (Rieder, 2022). Because an individual must be self-insured if she exceeds these thresholds, we can interpret insurance status as a proxy for labor market attachment. It is however important to note that self-insurance covers many women under parental leave who maintain an employment contract but are currently not working. Consequently, this approximation is only applicable to women before motherhood.

Table A.3 compares the overall sample of mothers to the subsample of "one-child mothers" along basic demographics. At first birth, "one-child mothers" are 0.8 years older. Other differences are small and tend to be mechanically driven by missing information, which is more prevalent for individuals with shorter observational periods. Pre-pregnancy health outcomes (Table A.2) are also quite similar, with a slightly higher incidence of overall diagnoses and prescriptions among "one-child mothers."

2.2 SOEP and Pairfam

By integrating survey data from the *German Socio-Economic Panel* (SOEP) and the *Panel Analysis of Intimate Relationships and Family Dynamics* (Pairfam) into our analysis of administrative claims data, we enhance our understanding of health dynamics around birth. While claims data provides an objective measure of health, it lacks insights into individual living conditions, occupational status, and physical activities (Haug and Schink, 2021). In addition, claims data may not capture adjustments in health that do not result in physician visits, diagnoses, or prescriptions. Conversely, claims data may show changes in medication aimed at protecting the fetus instead of revealing improvements in health. Particularly, before conception, during pregnancy, and while breastfeeding, prescriptions may therefore not reflect changes in maternal health accurately.

We use the SOEP to gain additional insights into personal well-being, life satisfaction, daily activities, and breastfeeding. The SOEP is an annual representative survey of households and their members (see Wagner et al., 2007). Currently, approximately 30,000 individuals in nearly 15,000 households are surveyed, covering aspects of their living, housing, family, and labor market situation. It is the largest and oldest German long-term study. Following the GePaRD analysis, we include the survey years 2004 to 2019 in our analysis.

Pairfam is an annually conducted representative panel survey on partnership and family dynamics in Germany covering the years 2008 to 2023. The dataset comprises three birth cohorts (1971-73, 1981-83, 1991-93) based on more than 12,000 initially selected anchor persons, along with their respective partners and children. We include waves 1 to 11 (2008 to 2019), using data release 14.0 (see Brüderl et al., 2023 and a detailed description by Huinink et al., 2011). Regarding health and family, SOEP and Pairfam include several similar questions. We pool the datasets to increase sample size.

The SOEP allows one to extend the pre-birth period to four years before and after the birth of the first child. Some information, for instance on the BMI and breastfeeding, is only available in certain waves of one of the two surveys. This results in different numbers of observations per outcome. In Table A.4, we provide an overview of the included survey waves and data sources for each outcome, along with the overall number of observations. Table A.6 complements this overview and outlines summary statistics prior to pregnancy for each outcome. Depending on the sample size, we report the outcomes on a quarterly, half-yearly, or yearly level. At baseline, roughly 1.5 years before birth, women indicate, for instance, that they sleep 8.6 hours per night, spend 2.8 hours per week on leisure activities and hobbies, and 0.8 hours on sport. The means are quite similar for the whole sample and the subsample of "one-child mothers."

Table A.5 shows basic demographic characteristics of the combined SOEP and Pairfam sample. Overall, differences to GePaRD are small and plausible. Educational attainment is higher in GePaRD, as it is only observable for mothers closer attached to the labor market. Finally, the share of mothers with no further observed children ("one-child mothers") and age at birth tend to be higher in GePaRD due to the limited number of pre-periods.

3 Empirical Strategy

Drawing on a visual event-study approach, we leverage differences among mothers in the timing of their first childbirth. In doing so, we follow recent studies investigating the child penalty on earnings (e.g. Kleven et al., 2019; Andresen and Nix, 2022), with the notable difference that we refrain from using fathers as a comparison group. Equation 1 formalizes our

empirical approach:

$$Y_{i\tau t} = \sum_{j=-8, j\neq -5}^{16} \delta_j 1[j=\tau] + \alpha_{age_{it}} + \alpha_t + \varepsilon_{i\tau t} \tag{1}$$

with $Y_{i\tau t}$ indicating a measure of health, like a dummy variable for a particular diagnosis, for individual i at event-time quarter τ and calendar-year quarter t. Using $\tau = -5$ as the omitted category, we compare health dynamics around birth with the event time approximately one quarter before conception. We also include a full set of maternal age dummies, defined as $\alpha_{age_{it}} = \sum_{k=14}^{53} \beta_k 1[k = age_{it}]$, to control for confounding age patterns. With year quarter fixed effects, captured by $\alpha_t = \sum_{l=1/2004}^{4/2019} \gamma_l 1[l = t]$, we flexibly account for time-varying shocks. δ_j provides the effect of entering motherhood at event time τ. Note that later pregnancies and further childbirths may still confound post-birth dynamics if we consider the sample of all mothers. We therefore always outline the results for the full sample of mothers and the subsample of women identified as "one-child mothers."

For a causal interpretation of our estimates, the parallel trends assumption has to hold. This assumption requires that women giving birth in different calendar quarters would have experienced the same health changes over time in the counterfactual situation of not having a child. Because this assumption is not testable, we provide indirect evidence, looking at pre-trends and potential anticipation effects between event time $\tau = -8$ and $\tau = -5$.[11] In case of short-term pre-trends, we further consider the eighth quarter before birth as a reference point. For outcomes where we observe pre-trends beyond the observation period, we interpret our estimates as a descriptive picture of the health dynamics around motherhood, accounting for age and time effects. Without any control variables, δ_j is equal to the mean value of the outcome

[11] Some outcomes are likely to be correlated with the transition to parenthood: mothers may be more likely to plan a pregnancy in phases of remission of chronic illnesses, while improvements in physical and mental health might increase the chances of conception. Some women may also resign from medication when attempting to conceive, while others may rely more heavily on healthcare in this phase due to spontaneous abortions or fertility treatments.

variable at event time τ. The means are informative about the overall health dynamics around birth, without being prone to econometric issues that may arise in event studies relying for instance on the assumption of homogenous treatment effects (Roth et al., 2023). For the main outcomes, we show the raw means in addition to our regression results.

Following Kleven et al. (2019), we interpret the coefficients of our event-time dummies in percentage changes. $P_\tau = \frac{\mathbb{E}\left(\hat{Y}_{i\tau t} - \tilde{Y}_{i\tau t}|\tau\right)}{\mathbb{E}\left(\tilde{Y}_{i\tau t}|\tau\right)}$ captures the effect of childbirth in quarter τ relative to the counterfactual without a child. $\mathbb{E}\left(\hat{Y}_{i\tau t}|\tau\right)$ defines the predicted value of $Y_{i\tau t}$ at event time τ, having a child, and $\mathbb{E}\left(\tilde{Y}_{i\tau t}|\tau\right)$ the predicted value at event time τ, leaving out the effect of having a child, i.e. $\tilde{Y}_{i\tau t} = \hat{Y}_{i\tau t} - \hat{\delta}_\tau$.

4 Results

The results section has two subsections: The first presents our findings on mental health outcomes and the second our analysis of physical health. In both subsections, we consider treatments (prescriptions of medication and psychotherapy) first. In a second step, we examine respective diagnoses. In a third step, we complement our analysis of claims data with survey evidence.

4.1 Mental Health

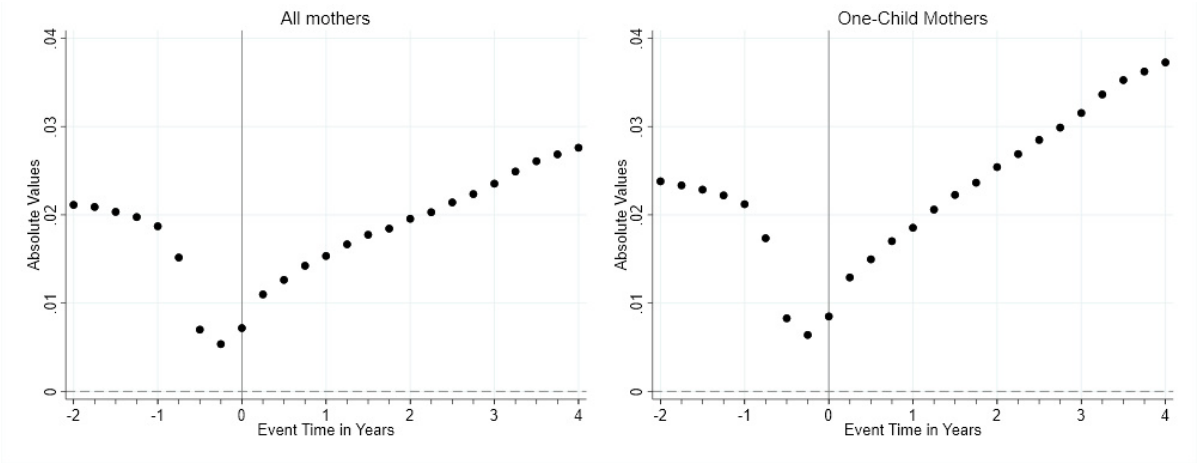
Antidepressants and Psychotherapy

We first assess mental health by focusing on the prescription of antidepressants as it signals a condition that a physician deems severe enough to require medication. Figure 1 shows the unconditional prescription rate of antidepressants surrounding the transition into motherhood: in the left panel for the overall sample of mothers and in the right panel for the subset of "one-child mothers", meaning women for whom we observe no subsequent birth.[12] The use of antidepressants follows a V-shaped pattern. Before pregnancy, 2.0% of all women (2.2%

[12] For other outcomes, we only discuss event-study graphs and show the figures with unconditional means in the Appendix (for the main outcomes) (Figures A.3b to A.8). The graphical representation of unconditional means and conditional event-study estimates reveal quite similar patterns, which alleviates potential concerns about econometric issues that may arise in event studies.

of "one-child mothers") receive prescriptions for antidepressants in a given quarter. During pregnancy, the rate drops to 0.5% (0.6%). After entering motherhood, the rate gradually increases and reaches 2.8% (3.7%) four years later. Hence, women use 40% (68.2%) more antidepressants in the first four years after becoming a mother.

Figure 1: Unconditional Means – Antidepressants



This figure shows health dynamics around the transition into motherhood, with the grey solid line at $t = 0$ indicating the first live birth. Each point indicates the quarterly unconditional mean of an outcome variable: in the left panel for the overall sample of women with at least one live birth and in the right panel for the subset of "one-child mothers", meaning women for whom we observe no subsequent birth.

In Figure 2a, we present event-study estimates on the prescription of antidepressants as percentage changes relative to the pre-pregnancy baseline, while accounting for age and calendar fixed effects. The inclusion of controls attenuates the postpartum increase slightly, suggesting that prescriptions of antidepressants would also experience a modest rise with time or age in the counterfactual case of not having a child. The overall pattern remains similar to the unconditional descriptives. Right before pregnancy, prescriptions of antidepressants decline by 8% for all mothers, possibly due to women fearing the risk of fetal malformations, despite inconclusive evidence (Becker et al., 2016; Muzik and Hamilton, 2016). Alternatively, women may conceive during periods of improved mental health. During pregnancy, antidepressant use decreases further by 73% in the last quarter before childbirth. This decline may coincide with doctors being less inclined to prescribe antidepressants to pregnant women, even if they have similar mental health problems as non-pregnant women.

In the first four years after birth, the number of mothers receiving prescriptions for antidepressants increases with each quarter. In the left panel of Figure 2a, this increase is attenuated by subsequent pregnancies, since it includes the decrease in prescriptions due to further pregnancies. The right panel with "one-child mothers" is not confounded by the mechanical effect of subsequent births, but might suffer from selection effects, as people who experience mental health issues after the first birth are probably less likely to have more children. The prescription rate for "one-child mothers" (for all mothers) reaches pre-pregnancy levels one and a half years (three years) after childbirth and continues to increase thereafter. Four years postpartum, "one-child mothers" are 44% more likely to receive a prescription for antidepressants compared to the pre-pregnancy quarter, taking into account maternal age and calendar time at this point. Compared to two years prior to pregnancy, this increase still amounts to 36%.

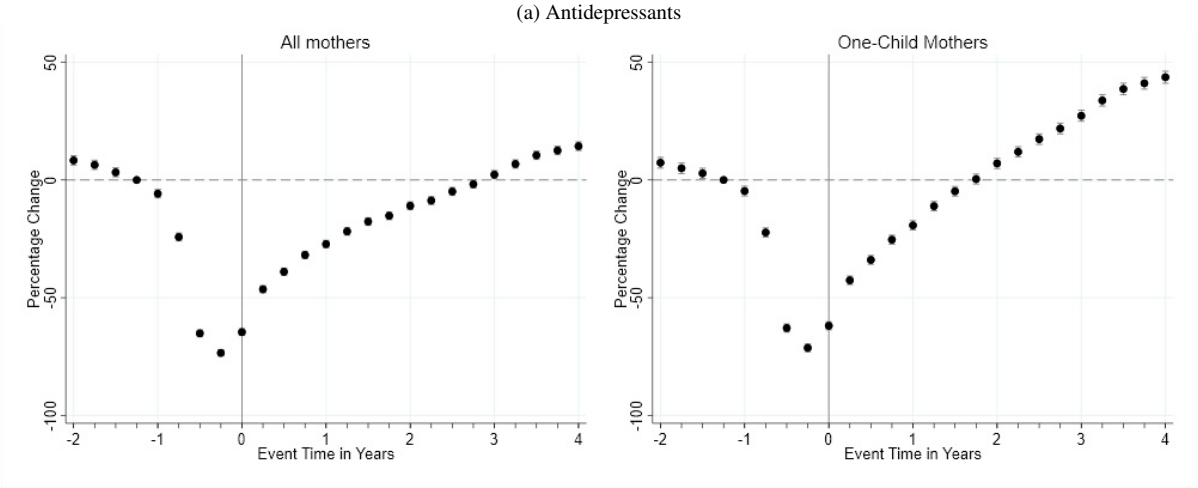
The effect size for antidepressants is similar to what Ahammer et al. (2023) estimated for Austria. Since the pre-trend could exceed the observation period, the true effect may be smaller in magnitude. Overall, however, there is strong evidence that motherhood causally increases antidepressant use over the medium to long term.

The decline in the uptake of psychotherapy prior to conception (Figure 2b) coincides with antidepressant use, which mitigates the notion of precautionary behavior during pregnancy against pharmacological treatments. During pregnancy, there is a further decline in psychotherapy, possibly because expectant women refrain from starting therapy with a planning horizon of several months, or because mental health issues requiring psychotherapy are less common during this period. Similar to antidepressants, after childbirth the rate of mothers using additional psychotherapy increases every quarter over the four years observed. Unlike the antidepressant rate, the therapy rate does not exceed pre-pregnancy levels four years after childbirth. For the overall sample of mothers (left panel of Figure 2a), the rate remains 17% lower, and for the subset of "one-child mothers" (right panel), it is 2% lower. The additional time required for each psychotherapy session poses a hurdle for mothers, which may contribute to this difference.

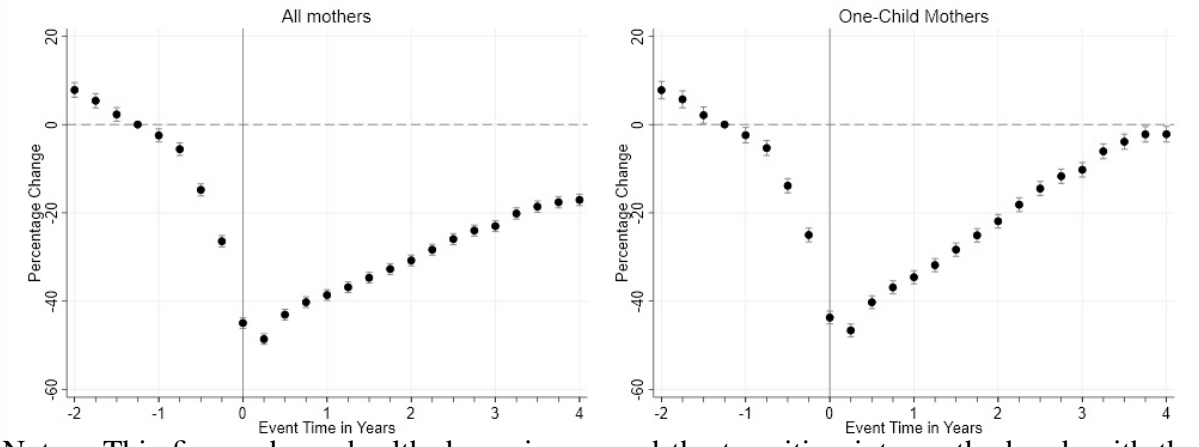
Taken together, our findings regarding the increase in antidepressants align with the analysis by Ahammer et al. (2023) on Austria and Denmark. In addition, we show that psychotherapy increases to a lesser extent (and not beyond pre-pregnancy levels), potentially due to time constraints.

Figure 2: Event Study – Mental Health Treatments

(a) Antidepressants



(b) Psychotherapy



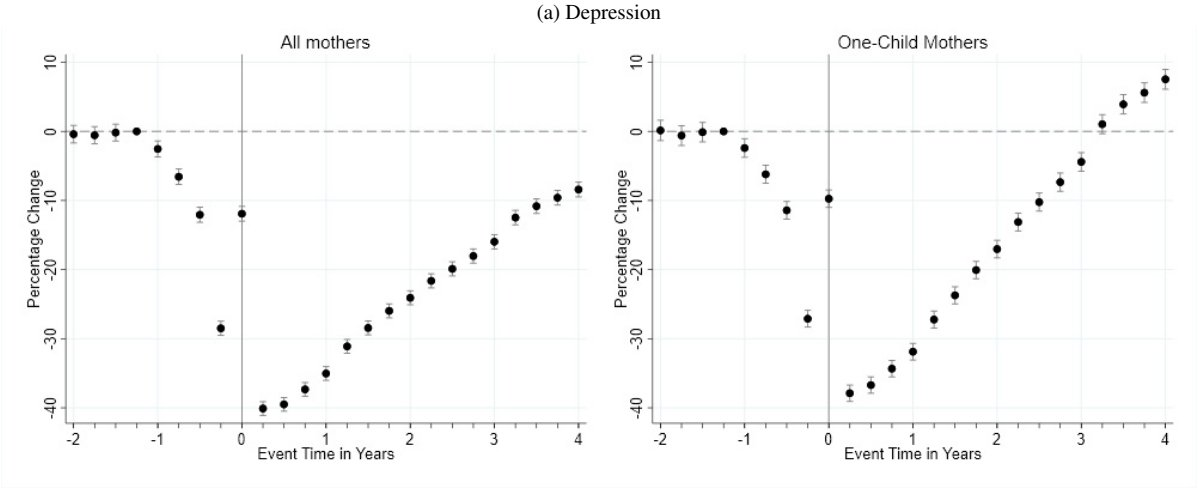
Notes: This figure shows health dynamics around the transition into motherhood, with the grey solid line at $t = 0$ indicating the first live birth. Each figure shows the event time coefficients and the 95% confidence interval with robust standard errors estimated from equation 1 for different health outcomes and samples. Coefficients are depicted in percentage changes compared to the counterfactual outcome without children, as defined in Section 3. In the left panel, the sample consists of all women with at least one live birth. The right panel covers the subset of "one-child mothers", meaning women for whom we observe no subsequent birth.

Mental Illness Diagnoses

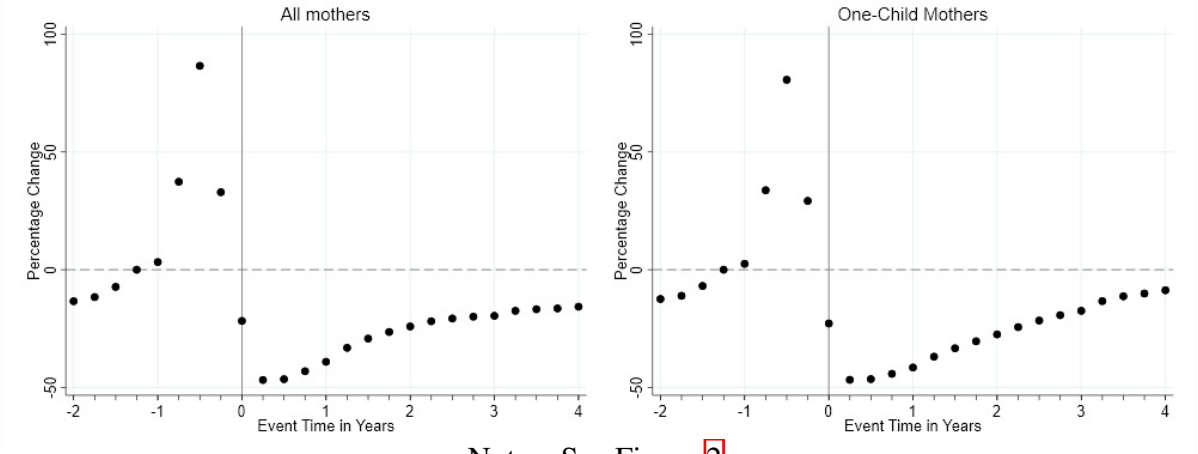
In a next step, we look at diagnoses of depression and other mental disorders in Figure 3. The additional value of using diagnoses on top of prescriptions is that they explicitly mention a specific illness and also identify cases not treated with medication or psychotherapy. Diagnoses are recorded by physicians or psychotherapists, either upon detecting an underlying illness or to state a reason for psychotherapy or medication prescriptions. The latter may imply that fewer prescriptions during pregnancy may mechanically reduce diagnoses in the data.

Figure 3: Event Study – Mental Disorders

(a) Depression



(b) Other Mental Disorders



Notes: See Figure 2.

Diagnoses of depression follow a similar pattern as antidepressants and psychotherapy, but do not reveal a pre-trend (Figure 3a). For all mothers, the rate of diagnosed depression amounts to 4.6% in the baseline quarter, the quarter before conception (Table A.2), and decreases by 27% until the end of pregnancy. In the quarter of childbirth, there is a temporary increase, probably

driven by women experiencing postpartum depression. Four years after childbirth, the diagnosis rate remains below pre-conception levels for all mothers, while "one-child mothers" have a 8% higher probability of being diagnosed with depression compared to the counterfactual without a child.

After childbirth, the absolute rate of diagnosed depression also never exceeds 7% (in the last observed quarter, for "one-child mothers", Figure A.3a). Even though this is a substantial proportion of new mothers with depression, it is lower than what is found, for instance, in a meta-analysis by Shorey et al. (2018) based on studies using clinical interviews or self-assessments.

Given the potential reluctance of physicians to document depression and the quantitative importance of other diagnoses, we complement the picture with other mental disorders (such as anxiety, somatoform, and adjustment disorders). Compared to depression, these conditions may have different symptoms (e.g. a more physical manifestation in somatoform disorder) and often represent milder illness (e.g. a reaction to the stress of a new life situation).

Diagnoses of other mental disorders evolve differently from depression (Figure 3b). They follow a slightly upward-sloping pre-trend and are relatively frequent right before and during pregnancy.[13] Around the second trimester of pregnancy, diagnoses peak at a prevalence rate of 16% (Figure A.3b), indicating an 87% increase compared to the pre-pregnancy level.[14] This increase could be driven by pregnancy-related stress, more intensive medical care, or physicians coding adjustment disorder as something caused by exceptional life events rather than depression. The latter might explain some of the opposite trends in depression and mental disorder diagnoses before and during pregnancy.

[13] Note that pre-trend deviations might be driven by spontaneous abortions and psychological distress accompanying infertility treatments (Jacob et al., 2019).

[14] Previous studies on prenatal anxiety disorders provide mixed evidence. Using survey data, Vesga-López et al. (2008) show that pregnant women have a lower risk of anxiety disorders compared to non-pregnant women of the same age. A meta-analysis by Viswasam et al. (2019), in contrast, documents a higher prevalence of specific anxiety disorders such as panic and obsessive-compulsive disorders among pregnant women compared to the general female population.

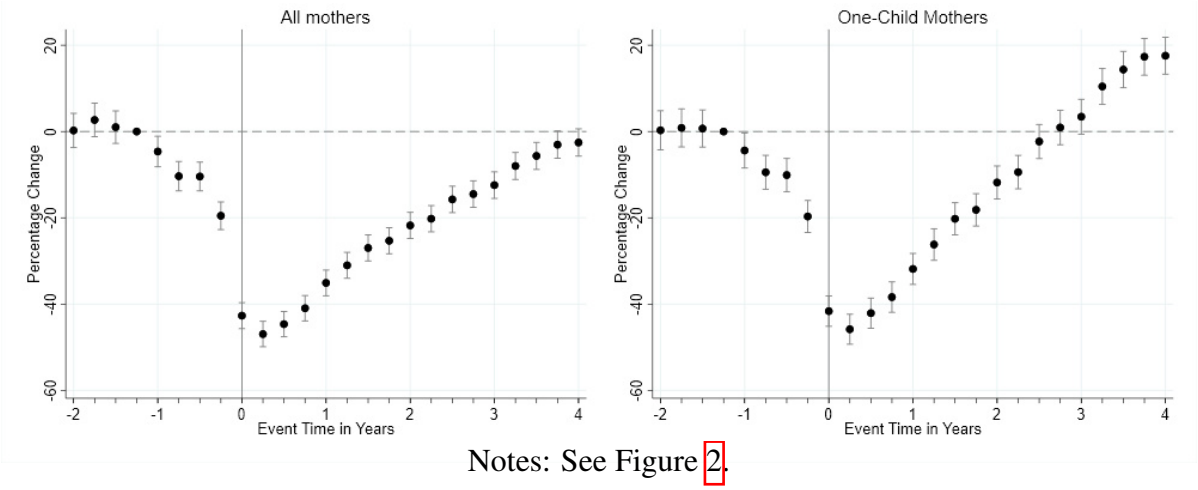
Diagnoses of other mental disorders drop sharply before birth, reaching their lowest prevalence in the quarter immediately following birth, but increase each subsequent quarter. At the end of our observation period, rates of diagnosed other mental disorders for "one-child mothers" are similar compared to two years prior to birth, conditional on age and calendar time. It is striking to observe that in case of a diagnosis of mental disorder (depression and other mental disorders taken together), mothers have a higher probability of prescription of antidepressants compared to the counterfactual case of not being a mother.[15] We attribute this finding to the burden that comes with motherhood. Due to time constraints and additional responsibilities, mothers may have fewer resources and less resilience to cope with mental disorders than before pregnancy, and therefore opt for antidepressants.

For sleep disorder, we observe a pattern similar to that of depression (Figure 4). It should be emphasized that this is a rare diagnosis, occurring in only 0.5% of women in the baseline quarter. Note that sleep disorder refers to sleep-related mental illnesses and not simply to less sleep, as often experienced during pregnancy (Reichner, 2015) or due to children's needs. In Figure 4, we see no pre-trend, but a decrease in the prevalence of sleep disorder in pregnancy. After childbirth, diagnoses increase linearly. Four years after childbirth, "one-child mothers" have a 18% higher risk of being diagnosed with a sleep disorder compared to a situation without a child.

[15] From regression coefficients we calculated that the prevalence of diagnosis for depression or other mental disorders is 0.9 percentage points lower in quarter 16 in a situation with a child compared to the counterfactual of not having a child. At the same time, however, the prevalence of antidepressant take-up is one percentage point higher involving a child compared to not having a child. Thus, motherhood increases the risk of being prescribed antidepressants more than receiving a diagnosis.

Figure 4: Event Study – Sleep Disorder

(a) Sleep Disorder



Notes: See Figure 2.

Overall, our analysis of GePaRD data reveals a period of favorable mental health surrounding childbirth, characterized by only a few corresponding prescriptions and diagnoses, except for prenatal other mental disorders. However, it is important to acknowledge that precautions, time constraints, or reservations to record diagnoses remain plausible driving mechanisms, which cannot be dispelled with claims data alone. Second, all five outcomes of mental health increase each subsequent postpartum quarter, starting from low levels at childbirth. This increase is the highest for prescriptions of antidepressants, with a significant rise above pre-conception levels. For "one-child mothers", all measures exceed pre-conception levels at some point, except for other mental disorders and psychotherapy. We explore these findings further by adding survey data to our analysis.

Self-Assessed Mental Well-Being

To gain additional insights into the dynamics of perceived mental health and well-being, we pool SOEP and Pairfam data on emotional states (within four weeks before the interview). By doing that, we add more nuanced measures of perceived mental health information to secured diagnoses of mental illnesses. In addition, our outcomes are not susceptible to diagnosis-related concerns or behavioral adjustments regarding medication. The sample however has

fewer observations and a reduced number of survey periods, with SOEP and Pairfam accounting for only 1% of the GePaRD sample.[16] We therefore restrict the time scale in our figures to years or half-years and do not control for calendar time. Because individuals self-report their mood, the analysis may also be prone to survey bias.

For feeling happy, there appears to be a slight positive pre-trend before pregnancy, followed by a substantial rise with the first childbirth and a sequential decline thereafter (Figure 5a). For "one-child mothers", happiness feelings return to pre-pregnancy levels by the time the child is two years old, and fall below respective levels one year later. The coefficients are less pronounced for the sample of all mothers, as subsequent pregnancies act as confounders. Findings for "one-child mothers" remain unaffected by subsequent births, yet the sample might be selective.[17]

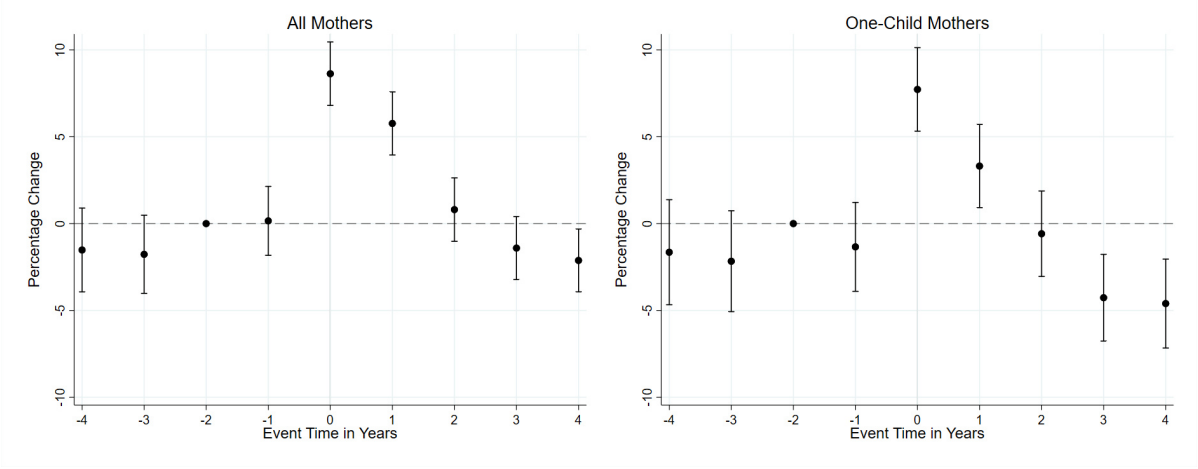
Results on anger mirror those on feeling happy after birth, as shown in Figure 5b. The intensity of anger exceeds pre-pregnancy levels in the third and fourth year after the first childbirth, for all mothers as well as "one-child mothers." In Appendix Figure A.9a, we further illustrate a tendency for women to report feeling sad less often in the year of childbirth and immediately afterward. For anxiety (Figure A.9b in the Appendix), there is no evidence of a lasting motherhood effect; only in the year around birth, anxiety exhibits a one-time increase. This aligns with a peak in other mental disorders during pregnancy, as reported in Figure 3b.

[16] In the survey data, we have usually one observation per year, while we have four observations each year in GePaRD.

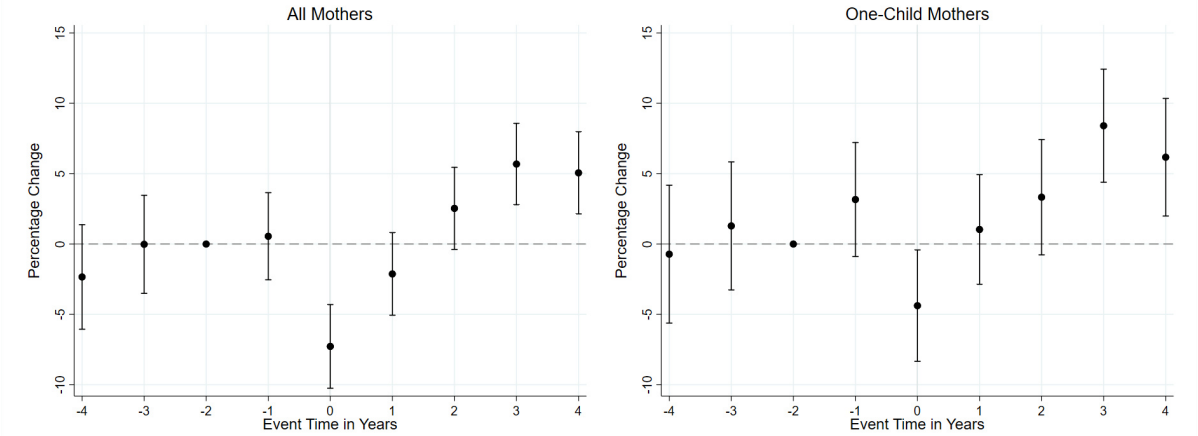
[17] These results are more negative than the findings on "feeling happy and cheerful" by Metzger and Gracia (2023) for the UK, where feeling happy stays above pre-pregnancy values.

Figure 5: Event Study – Survey Questions on Emotions: Feeling Happy and Angry

(a) Feeling Happy



(b) Feeling Angry



Notes: Each graph shows point estimates and 95% confidence intervals from an event-time regression using robust standard errors and additional fixed effects of mothers' age. The data comes from SOEP and Pairfam. See Table A.4 for details on each outcome variable and Table A.6 for values at the omitted baseline period. In the left panel, the sample consists of all women with at least one live birth. In the right panel, we exclude mothers for whom we observe a subsequent birth. Event time $\tau = 0$ indicates the first birth of a woman.

Other studies that investigate mental health with the SOEP use the Mental Component Summary Scale (MCS) and models with more parametric assumptions than our event study. Our event study based on the MCS (Appendix Figure A.10) has large standard errors. Consistent with Giesselmann et al. (2018) and Asselmann et al. (2022), self-assessed mental health, as measured by the MCS, is better around childbirth and deteriorates thereafter. The medium- to

long-term decline below baseline levels, as identified in these studies, can neither be supported nor ruled out by our event study.[18] Since the analysis of MCS does not include additional Pairfam data and is limited to fewer survey years, the resulting sample is smaller compared to our event study on feeling happy and angry.

In conclusion, the self-reported survey evidence supports our finding that women enter a period of high well-being beginning with, and to some extent even before, pregnancy. It supports the interpretation that the decline in antidepressant use, psychotherapy, and diagnoses of depression and sleep disorder observed in the claims data is not solely attributable to caution and time constraints. The persistent deterioration of mental health within four years after entering motherhood is also evident in the self-reported measures of feeling happy or sad. For mothers who did not experience another birth during our observation period, prescriptions of antidepressants, diagnoses of depression, anger, and sadness significantly exceed pre-pregnancy levels (and those two years before birth). Consistently, feeling happy declines below pre-pregnancy levels.

4.2 Physical Health

Next, we present findings on physical health. Our selection of relevant diagnoses and prescriptions was guided by the recognition that their (re)emergence or need for treatment can be linked not only to predisposition or adverse events but also to stress and lifestyle choices. This applies in particular to obesity, headaches, back pain, and painkiller use. Respiratory diseases and the use of antibiotics are primarily related to infections transmitted from children to their mothers. The frequent reappearance of infections or the need for medication may however also be related to exhaustion and stress, which suppresses resistance (e.g. Seiler et al., 2020). In the following section, we look at each outcome separately.

[18] This is also because the baseline half-year seems to be an outlier in the MCS event study (see Figure A.10).

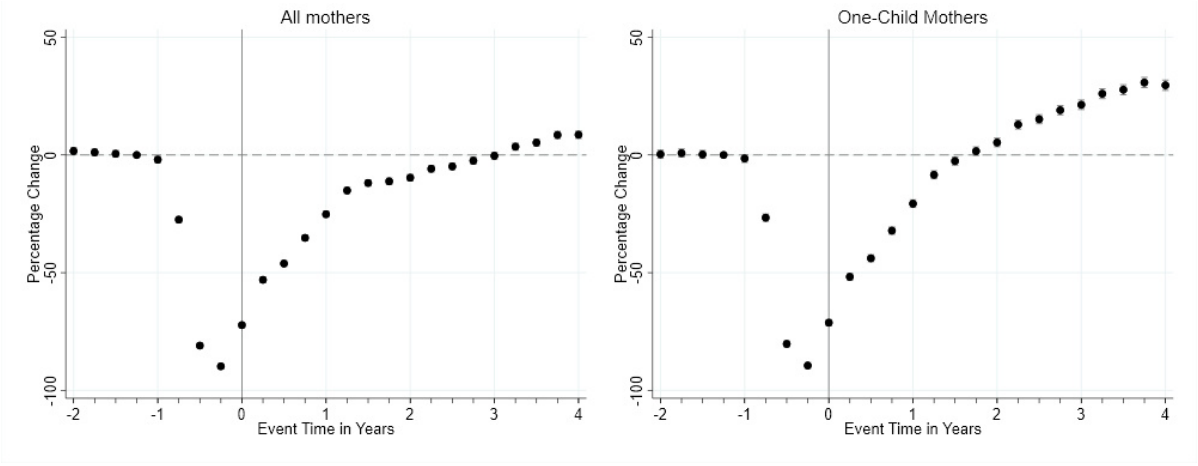
Painkillers and Antibiotics

Figure 6a shows the prescription dynamics of painkillers surrounding the transition into motherhood. From a prescription rate of 3.3% at baseline (Table A.2), we detect a large decline during pregnancy similar to antidepressants, but no pre-trend before conception. After childbirth, mothers continuously resort to painkillers. Unconfounded by subsequent births, the postnatal prescription of painkillers for "one-child mothers" increases by up to 30% compared to the counterfactual case of not having a child.

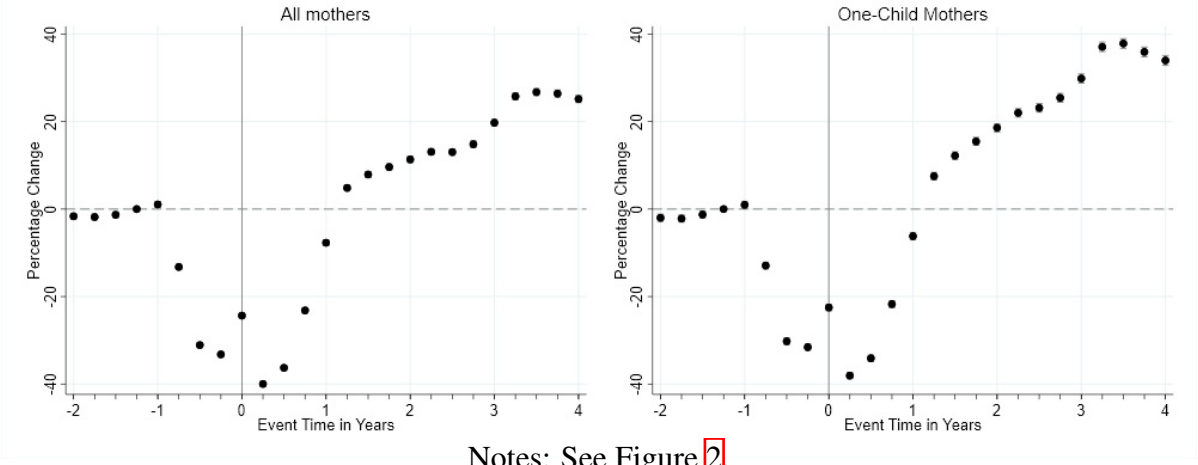
The prescription of antibiotics – as outlined in Figure 6b – also decreases during pregnancy, but to a lesser extent than painkillers or antidepressants. Entering motherhood increases the use of antibiotics after the child turns one year old, with an additional increase when the child is three years old and a slight decrease afterward. This often reflects the treatment of respiratory diseases that children contract at the daycare center and then pass on to their mothers, as discussed below. Overall, entering motherhood has a long-term impact on the prescription of antidepressants, painkillers, and antibiotics.

Figure 6: Event Study – Painkillers and Antibiotics

(a) Painkillers



(b) Antibiotics



Notes: See Figure 2.

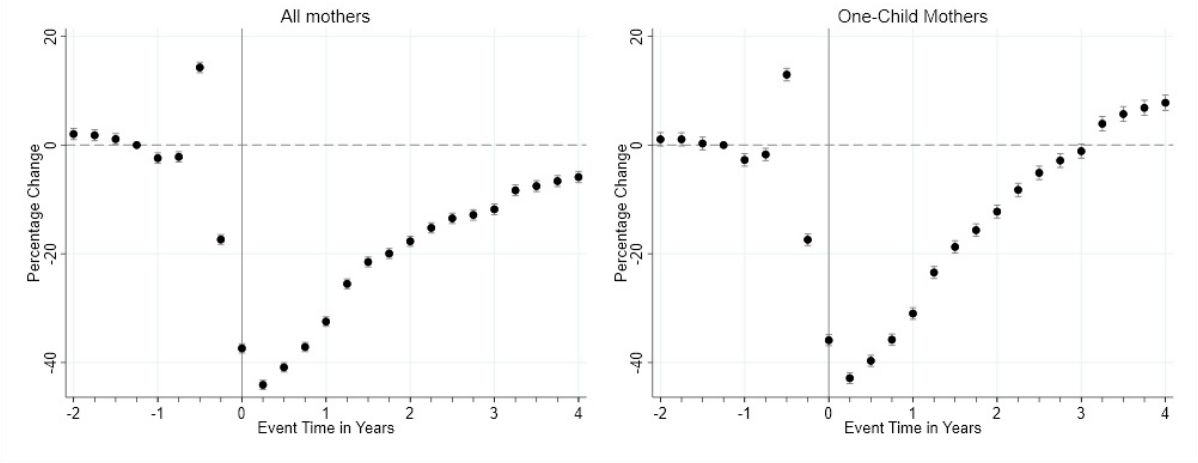
Pain and Respiratory Diseases

Relevant and common diagnoses correlated to painkillers include headaches and back pain, with baseline rates of 7% and 11%, respectively (Table A.2). For headaches, we observe a higher prevalence around the second trimester of pregnancy (Figure 7a), aligned with a reduction around the third trimester as expected from findings in the medical literature (Negro et al., 2017). As a subcategory of headaches, migraines tend to recur a few months after the end of pregnancy, as reflected in our results and supported by Hoshiyama et al. (2012). The rate of women diagnosed with headaches increases each quarter during the first four years of motherhood; by the end of the observation period, the rate is 8% higher for "one-child mothers" compared to the counterfactual case. This pattern mirrors the observed dynamics in mental health diagnoses, particularly those among "one-child mothers." The risk for back

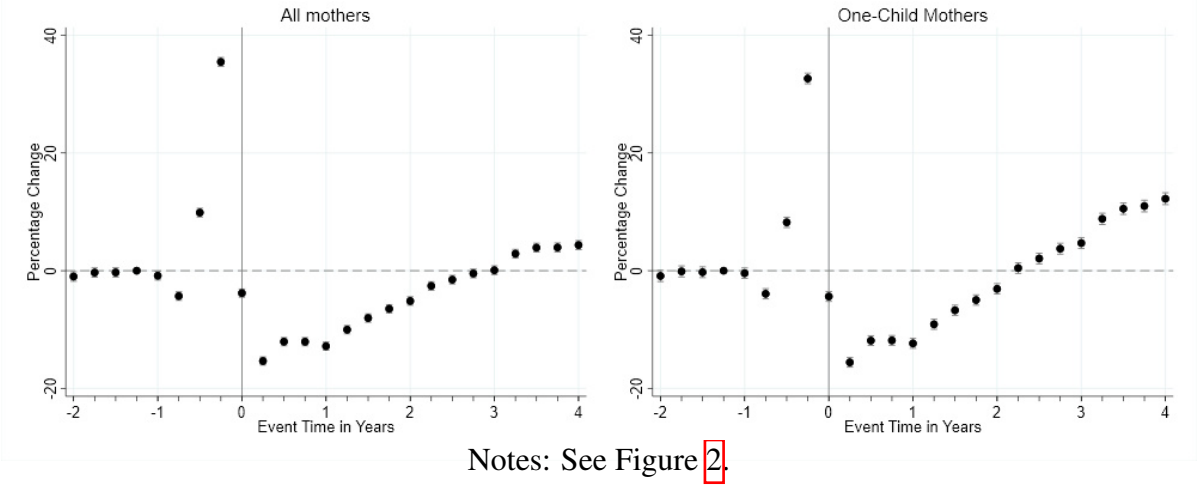
pain increases during pregnancy (Figure 7b), caused for instance by the increased spinal load (Mogren and Pohjanen, 2005). Back pain decreases after childbirth but exceeds pre-pregnancy levels at the end of the observation period by 12% for "one-child mothers." The increase for one-child mothers is particularly striking, as these estimates are not upward biased due to back pain in future pregnancies. Our results show that although the prevalence of back pain decreases right after birth, becoming a mother increases the risk of back pain in the long run.[19]

Figure 7: Event Study – Pain

(a) Headaches



(b) Back Pain



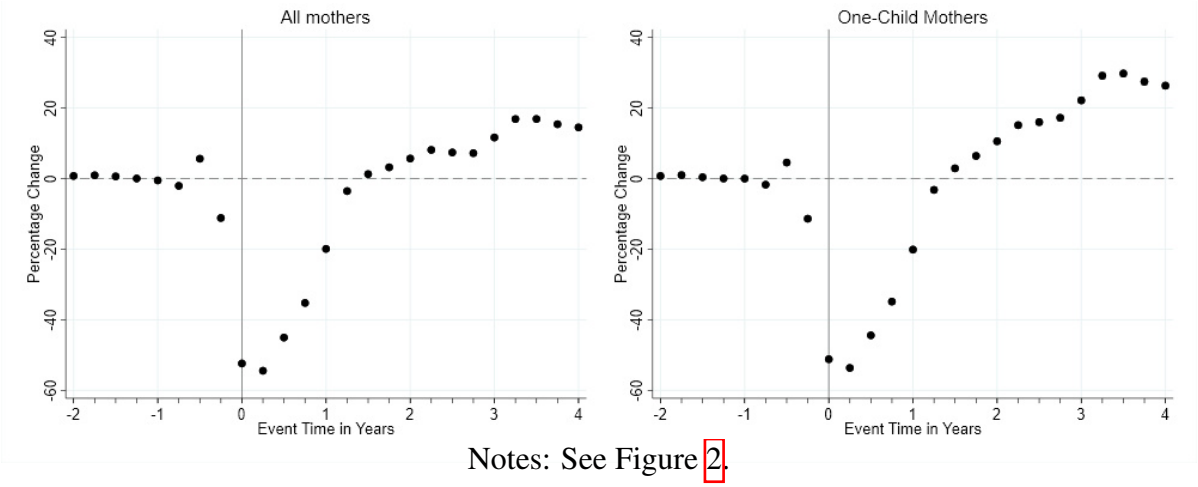
Notes: See Figure 2.

The prevalence of respiratory diseases reaches pre-pregnancy levels relatively soon after the first childbirth compared to other outcomes (Figure 8). Similar to antibiotics, we detect a sharp increase in respiratory diseases around the child's first birthday and after the child's third birthday. At these ages, many children enter institutional childcare. With access to

[19] In 2023, back pain and related disorders accounted for almost a fifth of all days absent from work, after respiratory diseases and before mental disorders (Hildebrandt-Heene et al., 2023).

childcare, Barschkett (2024) also finds a temporary increase in respiratory diseases among children, and Barschkett and Bosque-Mercader (2023) and Dehos et al. (2024) document a corresponding increase among mothers. Four years after entering motherhood, the rate of diagnosed respiratory diseases is much higher than in the counterfactual case of not having a child (26% for "one-child mothers"), but still below the increase in antibiotic prescriptions. We cannot separate whether this increase is entirely due to more intense contact with infectious children or also due to weaker body defenses. In short, motherhood has an undesirable long-term impact on the incidence of headaches, back pain, respiratory diseases, and related medical treatments.

Figure 8: Event Study – Respiratory Diseases



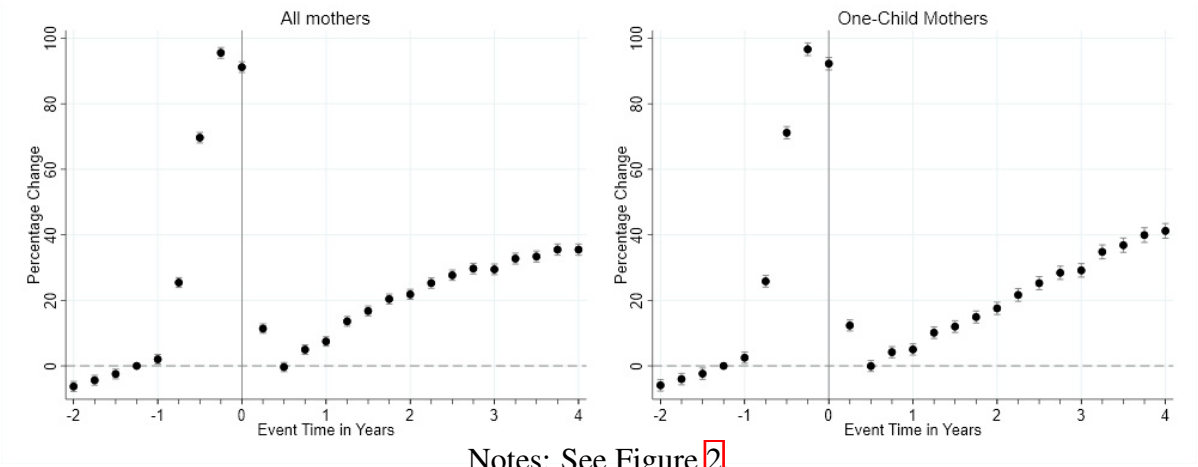
Notes: See Figure 2.

Obesity

Obesity poses a major health risk, and a high BMI in the years following childbirth is a predictor of long-term overweight (Rooney et al., 2005). Previous literature indicates that stress from parenting, including feelings of isolation, attachment issues, and depressive symptoms correlate with postpartum weight retention (Whitaker et al., 2014). Since obesity diagnoses are only recorded when weight is relevant, such as before surgery or a planned weight loss treatment, we observe a lower rate in our data compared to its actual incidence in the population.

Preceded by a positive pre-trend, diagnoses of obesity become approximately 97% more likely during pregnancy, as illustrated in Figure 9. Four years after giving birth, mothers have a 41% ("one-child mothers") higher risk of being diagnosed with obesity compared to pre-pregnancy levels conditional on time and age.

Figure 9: Event Study – Obesity

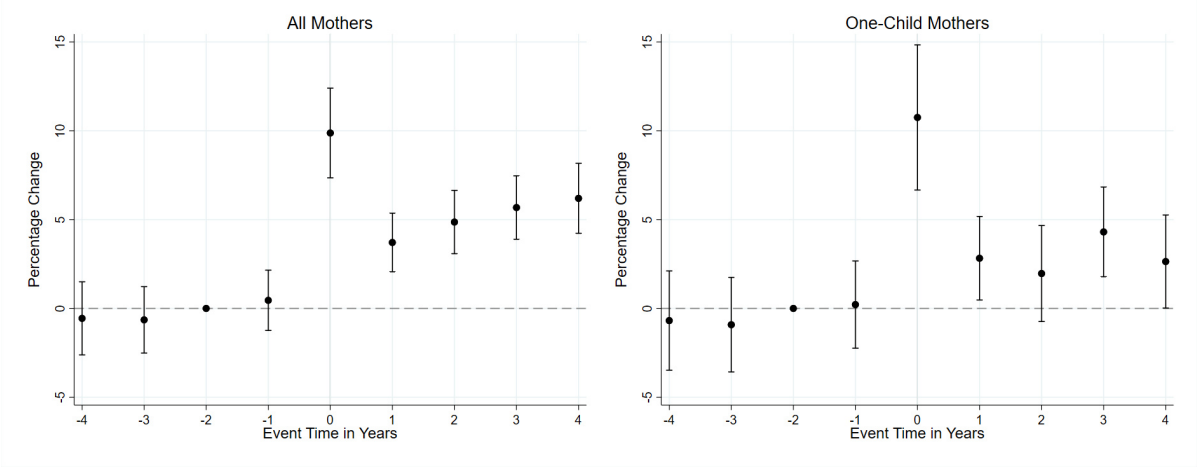


Notes: See Figure 2.

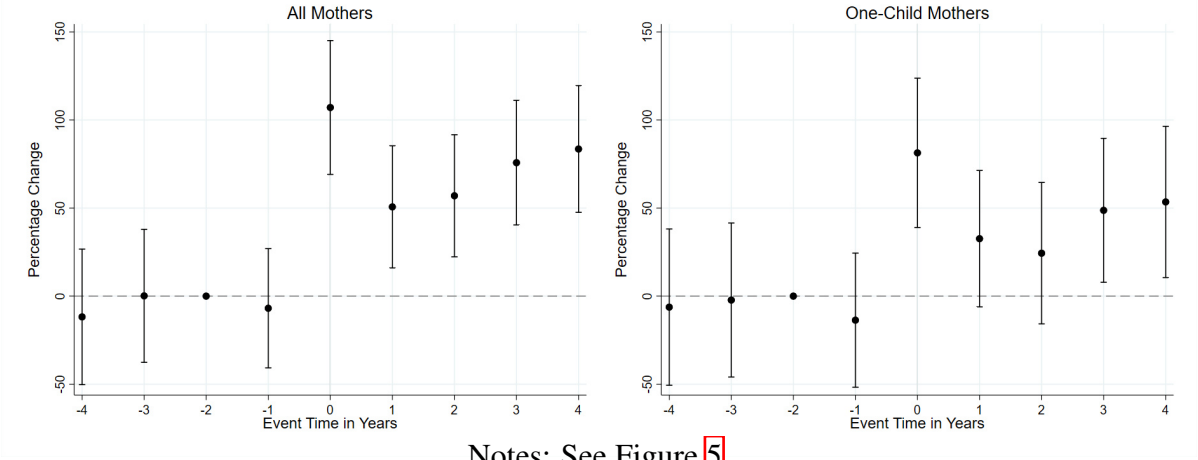
Considering the measurement issue of obesity in claims data, we enhance our analysis with BMI information from SOEP and Pairfam, as outlined in Figure 10a. In the year after childbirth, we observe a 4% higher BMI compared to the counterfactual case of not becoming a mother. Due to the small sample size, confidence intervals tend to be large. For "one-child mothers", we detect a small significant increase in BMI that persists until the end of the observation period. In Figure 10b, we further define an obesity dummy if the reported BMI is greater than 30. The results for "one-child mothers" show an increased obesity risk in the years following motherhood, with a incidence more than 50% higher in the fourth year compared to a pre-pregnancy rate of 9% (Table A.6). While some caution is warranted in light of pre-trends, our analysis of claims and survey data suggests an increased risk of obesity through motherhood.

Figure 10: Event Study – Survey Evidence on BMI and Obesity

(a) BMI



(b) Obesity



Notes: See Figure 5.

5 Mechanisms

In this section, we explore different mechanisms that might underlie our findings. Our previous analysis indicates that on average mothers experience a phase of good mental and physical health throughout the period of conception and pregnancy (with some exceptions, such as back pain). With complementary survey data, we provide further evidence that this improvement is not only mechanically driven by precautionary behavioral adjustments. Upon entry into motherhood, health and mood steadily deteriorate over the next 16 quarters. Especially

for "one-child mothers", several outcomes are worse than before pregnancy. In the following subsection, we first examine mechanical effects through the cessation of breastfeeding and potential adjustments in the number of doctor visits. Subsequently, we explore potential channels, such as sleep and time use, as well as health-protective behaviors.

Breastfeeding

During pregnancy as well as lactation, prescriptions might be lower due to concerns about risks for the child. Based on SOEP data, we outline the proportion of mothers who breastfeed in Figure A.12. Respective precautions are likely to be relevant for the 69% of women who breastfeed one quarter after childbirth and for the 48% who do so two quarters after childbirth. This implies that medication might not reflect the true (mental) health status of mothers in this period. Many mothers may hesitate to take antidepressants or painkillers to protect their child, even if they are facing depression or pain. Two years postpartum, virtually all women have stopped breastfeeding. This coincides with the point in time when the rate of antidepressant prescriptions among "one-child mothers" reaches pre-conception levels. The continuing increase in prescriptions for antidepressants, painkillers, and antibiotics can therefore not be related to more mothers stopping breastfeeding, at least for "one-child mothers."

Physician Visits

Pregnancy and family planning may mechanically increase diagnoses due to increased interactions with the healthcare system. This could drive the steep pre-birth increase in diagnoses of obesity and other mental disorders, such as somatoform disorder. Quarterly physician visits indeed show a positive pre-trend and a notable increase during pregnancy (Appendix Figure A.13a).[20] But the number of diagnoses per visit (including standard pregnancy-related diagnoses) also rises the year before childbirth (Figure A.13b in the Appendix). In the postpartum period, the number of physician visits per quarter increases to a lesser extent than most di-

[20]The pre-trend could be driven by planned pregnancies following assisted reproductive treatments (Rauprich et al., 2011) or by earlier pregnancies with spontaneous abortions (see e.g. Bütikofer et al., 2024).

agnoses and prescriptions. At the same time, there is a more pronounced rise in the number of diagnoses per visit. We therefore conclude that the increasing rates of prescriptions and diagnoses are unlikely to be explained by mothers going to the doctor more often (e.g. for sick notes once they resume employment).

Sleep

Sleep deprivation and poor sleep quality are common after childbirth and contribute to fatigue, postpartum depression, and overweight (Spaeth et al., 2013). Nevertheless, the medium- to long-term effects of motherhood on sleep remain relatively understudied (see Richter et al., 2019, and the literature therein). Figure A.14 shows a substantial drop in mothers' sleep duration after childbirth. Despite a slight recovery after the first year, event-time coefficients consistently remain 8% to 9% below baseline until the end of the observation period. These results align with an analysis by Richter et al. (2019) based on fixed effects models. In addition, Richter et al. (2019) show that sleep satisfaction follows the same pattern and does not recover within six years after entering motherhood. Persistent reductions in sleep duration, along with interruptions due to the child's needs, are likely to exacerbate issues such as headaches, mood, the frequency of respiratory diseases, and obesity, but may also contribute to the development of sleep disorder, as measured in Figure A.4, or depression (e.g. Kendall-Tackett, 2023).

Childcare and Market Work

The transition to motherhood comes with huge changes in time use. In the first half-year after childbirth, mothers indicate spending about 16 hours per day on childcare, 12 hours when the child is two years old, and still about 11 hours when the child is four years old (Figure A.15). By the time the child turns two, almost 40% of the children are in institutional childcare (Figure A.15b). At that time, "one-child mothers" dedicate on average 11.3 hours a day to childcare, along with 3.5 hours of market work and 2.5 hours of housework, resembling

a remarkable total workload.[21] This may eventually contribute to worse mood and mental and physical health. At the beginning of motherhood, women may be highly motivated and possess sufficient energy for extensive caregiving, which may diminish over time, explaining the upward trend in many outcomes.

Self-Care and Physical Activities

Motherhood comes with a reported 50% long-term reduction in time spent on physical activities and in time spent on other leisure activities and hobbies (Figure A.16).[22] Related to this, mothers report higher consumption rates of sugar-sweetened beverages, saturated fat, and total calories compared to childless women (Berge et al., 2011). Interestingly, mothers do not seem to return to more sport or leisure activities as the baby grows older, even though childcare duties lessen (as shown in Figure A.15). Reduced physical and leisure activities can in the long term increase the risk of obesity, back pain, and headaches, and influence the propensity for (or the recurrence of) mental illness.

Life Satisfaction and Psychosocial Distress

A qualitative strand of literature, as summarized by Giesselmann et al. (2018), argues that social expectations and the ideal of intensive mothering, with the pressure to devote oneself entirely to the child, lead to tension. Together with the social norm of working mothers, there might be conflicting demands and feelings of guilt that increase psychological distress, depression, and anxiety.

[21] Hours of housework and market work calculated from SOEP, with market work referring to weekdays.

[22] Bellows-Riecken and Rhodes (2008) outline that parents, especially mothers, are less involved in physical activity and exercising than childless individuals.

This situation, alongside other aspects of life, may be reflected in a measure of overall life satisfaction. Appendix Figure A.11 shows high levels around and after childbirth. For "one-child mothers", life satisfaction declines subsequently, reaching pre-pregnancy levels when the child is 18 months old, and falling 7% below pre-pregnancy levels (accounting for maternal age and time) when the child turns four.[23][24] On the one hand, declining life satisfaction may predispose mothers to health issues. On the other hand, life satisfaction may itself be affected by (mental) illnesses.

To summarize potential mechanisms underlying the health patterns around entering motherhood, breastfeeding cannot affect the upward trend beyond the second postpartum year, nor do behavioral effects regarding physician visits play an important role. Our results support the argument that permanent reductions in sleep, sport, and other leisure activities, together with extensive childcare responsibilities and potential psychosocial distress, may be key factors contributing to worsening health, as reflected in increased use of medication, back pain, and obesity.

6 Effect Heterogeneity

Heterogeneity by Education

In this section we examine whether observed health dynamics differ by education. Lower education correlates with limited financial resources, which makes parenting more difficult. Women with higher education tend to have intellectually and time-wise more demanding jobs and may also be more stressed by recent mothering ideologies (Hart et al., 2023; Metzger and Gracia, 2023). In Appendix Figures A.17 to A.22, we divide the sample by the highest

[23] When focusing on "one-child mothers", our conclusion on long-term effects tends to be more negative than studies by Myrskylä and Margolis (2014) and Baetschmann et al. (2016).

[24] van Scheppingen et al. (2018) detect a decline in maternal self-esteem and relationship quality in Norway from the sixth month after childbirth onwards.

obtained degree into low, medium, and high education levels, including all individuals with available information.[25] Both panels refer to "one-child mothers", with left panels showing the unconditional means of the outcome variables and right panels respective event studies conditional on age and calendar years.

The left panel of Figure A.17 shows that pre-pregnancy prescription of antidepressants is highest among women with low education and lowest for women with high education. However, the three groups follow a similar trend, and – as the right panel indicates – the relative effect of entering motherhood on antidepressant use does not differ by education.

For psychotherapy, the highest uptake is observed among highly educated individuals and the lowest among people with low education. Differences across groups persist over time. For high- and medium-educated mothers, the take-up of psychotherapy in the event-study findings (right panel) remains below pre-pregnancy levels, while low-educated mothers engage in psychotherapy more often after becoming a mother.

The unconditional means for diagnosed depression (Figure A.18a) closely resemble those for antidepressant use. As also observed for psychotherapy, low-educated mothers experience a slightly stronger long-term increase following motherhood compared to other groups (right panel). Other diagnosed mental disorders do not involve effect heterogeneity (Figure A.18b).[26]

Our findings on physical health reveal that low-educated mothers are most likely to receive painkillers and antibiotics, both before and after pregnancy (Figure A.19). The relative effect of motherhood on painkillers proves the same for all groups, but varies for antibiotics, with some catch-up for medium-educated and highly educated mothers whose children may be more likely to enroll in public childcare at an earlier age. This pattern aligns with diagnoses of headaches and back pain, although with the noteworthy observation that medium-skilled

[25] We define "low-educated" as individuals without a vocational degree or completed academic track, "medium-educated" as people with an apprenticeship or comparable degree or with a completed academic track, and "high-educated" as people with university degrees.

[26] Results for sleep disorder exhibit similar patterns, but are not shown. Due to the rarity of respective diagnoses, confidence intervals tend to be large.

mothers exhibit the highest pre-birth incidence. For respiratory diseases, pre-birth levels are the highest among low-skilled people, but relative increases following motherhood are the strongest among highly skilled mothers, as also observed for antibiotics. For obesity we also see strong differences in levels, but no differential effects of motherhood.

In summary, pre-birth levels of prescription and diagnosis rates differ substantially by education. In particular, low-educated mothers are more prone to receive prescriptions and diagnoses, while highly educated mothers are more likely to visit a psychotherapist. However, heterogeneity in the relative effects of entering motherhood is small.

East-West Heterogeneity

We also examine heterogeneities between East and West Germany, as differences in employment rates and social norms persist in the period under consideration (e.g. Boelmann et al., 2021). Figures A.23 to A.28 show slightly higher pre-pregnancy diagnoses and prescription rates for West German compared to East German women, possibly due to the latter having a lower average age at first childbirth. The effects of motherhood are very similar across most outcomes, but for physical health measures like painkillers, headaches, back pain, and obesity, the relative effect tends to be slightly higher in East Germany. Respiratory diseases and antibiotics show different patterns, probably reflecting early childcare enrollment of many East German children at age one, while many West German children do not start until they turn three. It is worth noting that motherhood has an increasing long-term effect on depression of about 10% in West Germany and no long-term effect in East Germany, despite higher depression rates in West Germany already at baseline.

7 Conclusion

Based on claims and survey data, we provide a comprehensive picture of stress-related health outcomes around the transition to motherhood. Prescriptions serve as an important health measure, since they signal a health condition a physician deems serious enough to recommend or approve a medical intervention. Diagnoses add more specific information about the nature of the condition, including cases that do not require treatment. We supplement our results

from claims data with survey information from SOEP and Pairfam, which offer subjective assessments of mood, mental health, and life satisfaction. The joint use of these three measures provides a more comprehensive picture than studies relying on a single measure and enables us to examine interconnections like a decrease in the importance of psychotherapy relative to antidepressants after entering motherhood, or a decrease in antidepressants along with improved mood during pregnancy.

The time immediately after childbirth is characterized by relatively few diagnoses for depression, other mental disorders, and sleep disorder and their respective treatments, suggesting a period of good mental health. Survey evidence supports our finding that, on average, women enter a period of good mental health during pregnancy. After childbirth, mental health measures included in our claims data become more unfavorable in each subsequent quarter. Four years into motherhood, the prescription of antidepressants exceeds the pre-pregnancy level by 44% for observations not confounded by a subsequent birth, while the probability of depression is 8% higher compared to pregnancy and the probability of sleep disorder is 18% higher. The probability of other mental disorders is 9% lower. The role of antidepressants relative to psychotherapy increases. Survey questions on feeling happy and sad, which cover the full range of emotions and not just mental illness as claims data, provide strikingly similar findings, despite a small sample size.

Physical illnesses and prescriptions that are potentially stress- and lifestyle-related reveal a similar pattern. While painkillers and antibiotics are rarely prescribed during and shortly after pregnancy, motherhood increases the prescriptions by 30% and 34% respectively in the long term. Related diagnoses also exhibit an increase, but again to a lesser extent compared to prescriptions. Finally, both claims and survey data show an increase in obesity rates. Taken together, the adverse long-term effects of motherhood on mental well-being and increased medication are not limited to mental health, but manifest similarly in physical illness and medication usage.

Complementary analyses of mechanisms support the argument that a sustained reduction in sleep, sport, and other leisure activities, together with extensive involvement in childcare and possible psychosocial distress, may be important channels explaining the worsening in health. We further find that lactation cannot affect our results beyond the second year after birth and that behavioral effects related to doctor visits do not play an important role. The causal identification of the aforementioned mediators, such as sleep or sport, lies beyond the scope of this study.

Heterogeneity in the relative effects of entering motherhood by education groups is small. Overall health dynamics are also similar for East and West German mothers, with slightly higher relative effects for physical outcomes in East Germany and a long-term increase in depression beyond pre-pregnancy levels only for West German mothers. As such, the documented patterns are not only relevant for small social groups, but applicable to large parts of the population.

In sum, this paper supports the impression conveyed through (social) media and popular readings that many women live with exhaustion, commonly referred to as "maternal burnout." Our insights are relevant, as health problems during this critical period can have a lasting impact on long-term health. Moreover, health constitutes an important factor of life satisfaction and is closely associated with earnings as well as a child's well-being.

It is important to emphasize that maternal health and mood around childbirth are particularly good. The subsequent worsening thus starts from a favorable state. Concerning policies, maintaining the good health status that many women enjoy before entering motherhood and alleviating respective burdens should be paramount. Measures such as the provision of childcare, parental leave schemes with potential incentives for fathers, easy access to mental health counseling, mother-child clinics, or health insurance-sponsored household helpers could help achieve this goal.

References

Ahammer, A., Glogowsky, U., Halla, M., and Hener, T. (2023). The Parenthood Penalty in Mental Health: Evidence from Austria and Denmark. *IZA Discussion Paper*, 16459.

Aizer, A., Stroud, L., and Buka, S. (2016). Maternal Stress and Child Outcomes: Evidence from Siblings. *Journal of Human Resources*, 51(3):523–555.

Andresen, M. E. and Nix, E. (2022). What Causes the Child Penalty? Evidence from Adopting and Same-Sex Couples. *Journal of Labor Economics*, 40(4):971–1004.

Angelov, N., Johansson, P., and Lindahl, E. (2020). Sick of family responsibilities? *Empirical Economics*, 58(2):777–814.

Asselmann, E., Garthus-Niegel, S., Knappe, S., and Martini, J. (2022). Physical and mental health changes in the five years before and five years after childbirth: A population-based panel study in first-time mothers and fathers from Germany. *Journal of Affective Disorders*, 301:138–144.

Baetschmann, G., Staub, K. E., and Studer, R. (2016). Does the stork deliver happiness? Parenthood and life satisfaction. *Journal of Economic Behavior & Organization*, 130:242–260.

Baker, M., Stabile, M., and Deri, C. (2004). What Do Self-Reported, Objective, Measures of Health Measure? *Journal of Human Resources*, XXXIX(4):1067–1093.

Barschkett, M. (2024). The Early Bird Gets the Germs? The Impact of Early Daycare Attendance on Children's Health. Available at SSRN: https://ssrn.com/abstract=4760456.

Barschkett, M. and Bosque-Mercader, L. (2023). Building Health across Generations: Unraveling the Impact of Early Childcare on Maternal Health. *DIW Berlin Discussion Paper*, 2059.

Becker, M., Weinberger, T., Chandy, A., and Schmukler, S. (2016). Depression During Pregnancy and Postpartum. *Current Psychiatry Reports*, 18(3):32.

Bellows-Riecken, K. H. and Rhodes, R. E. (2008). A birth of inactivity? A review of physical activity and parenthood. *Preventive Medicine*, 46(2):99–110.

Berge, J. M., Larson, N., Bauer, K. W., and Neumark-Sztainer, D. (2011). Are parents of young children practicing healthy nutrition and physical activity behaviors? *Pediatrics*, 127(5):881–887.

Beuchert, L. V., Humlum, M. K., and Vejlin, R. (2016). The length of maternity leave and family health. *Labour Economics*, 43:55–71.

Biasi, B., Dahl, M., and Moser, P. (2021). Career Effects of Mental Health. *NBER Working Paper*, 29031.

Boelmann, B., Raute, A., and Schönberg, U. (2021). Wind of Change? Cultural Determinants of Maternal Labor Supply. *CESifo Working Paper*, 9094.

Brüderl, J., Drobnič, S., Hank, K., Neyer, F. J., Walper, S., Wolf, C., Alt, P., Bauer, I., Böhm, S., Borschel, E., Bozoyan, C., Christmann, P., Edinger, R., Eigenbrodt, F., Garrett, M., Geissler, S., Gonzalez Avilés, T., Gröpler, N., Gummer, T., Hajek, K., Herzig, M., Lorenz, R., Lutz, K., Peter, T., Preetz, R., Reim, J., Sawatzki, B., Schmiedeberg, C., Schütze, P., Schumann, N., Thönnissen, C., Timmermann, K., and Wetzel, M. (2023). The German Family Panel (pairfam). GESIS, Cologne. ZA5678 Data file Version 14.1.0.

Bütikofer, A., Coy, D., Doyle, O., and Ginja, R. (2024). The Consequences of Miscarriage on Parental Investments. *CESifo Working Paper*, 11003.

Bütikofer, A., Cronin, C. J., and Skira, M. M. (2020). Employment effects of healthcare policy: Evidence from the 2007 FDA black box warning on antidepressants. *Journal of Health Economics*, 73:102348.

Currie, J. and Zwiers, E. (2023). Medication of Postpartum Depression and Maternal Outcomes. *Journal of Human Resources*, 1021-11986R1.

Dehos, F. T., Paul, M., Schäfer, W., and Süß, K. (2024). The Impact of Family Policies on Maternal Health. *[Unpublished Manuscript]*.

Fontenay, S. and Tojerow, I. (2020). Work Disability after Motherhood and How Paternity Leave Can Help. *IZA Discussion Paper*, 13756.

Giesselmann, M., Hagen, M., and Schunck, R. (2018). Motherhood and mental well-being in Germany: Linking a longitudinal life course design and the gender perspective on motherhood. *Advances in Life Course Research*, 37:31–41.

Halla, M., Mayr, H., Pruckner, G. J., and García-Gómez, P. (2020). Cutting fertility? Effects of cesarean deliveries on subsequent fertility and maternal labor supply. *Journal of Health Economics*, 72:102325.

Hart, R. K., Baranowska-Rataj, A., Dang, T., Øystein Kravdal, , and Syse, A. (2023). Mental Health Penalties of Childbearing in a Family Friendly Welfare State. *SocArXiv*.

Haug, U. and Schink, T. (2021). German Pharmacoepidemiological Research Database (GePaRD). In Sturkenboom, M. and Schink, T., editors, *Databases for Pharmacoepidemiological Research*, pages 119–124. Springer International Publishing, Cham.

Hildebrandt-Heene, S., Dehl, T., Zich, K., and Nolting, H.-D. (2023). *Analyse der Arbeitsunfähigkeiten: Gesundheitsrisiko Personalmangel: Arbeitswelt unter Druck*, volume 44 of *Beiträge zur Gesundheitsökonomie und Versorgungsforschung*. medhochzwei Verlag GmbH, Heidelberg.

Hoshiyama, E., Tatsumoto, M., Iwanami, H., Saisu, A., Watanabe, H., Inaba, N., and Hirata, K. (2012). Postpartum migraines: a long-term prospective study. *Internal medicine (Tokyo, Japan)*, 51(22):3119–3123.

Huinink, J., Brüderl, J., Nauck, B., Walper, S., Castiglioni, L., and Feldhaus, M. (2011). Panel analysis of intimate relationships and family dynamics (pairfam): Conceptual framework and design. *Zeitschrift für Familienforschung*, 23(1):77–101.

Jacob, L., Gerhard, C., Kostev, K., and Kalder, M. (2019). Association between induced abortion, spontaneous abortion, and infertility respectively and the risk of psychiatric disorders in 57,770 women followed in gynecological practices in Germany. *Journal of Affective Disorders*, 251:107–113.

Kendall-Tackett, K. (2023). *Depression in new mothers: Causes, consequences and treatment alternatives*. Taylor & Francis.

Kleven, H., Landais, C., and Søgaard, J. E. (2019). Children and Gender Inequality: Evidence from Denmark. *American Economic Journal: Applied Economics*, 11(4):181–209.

Kravdal, Ø., Grundy, E., and Skirbekk, V. (2017). Fertility history and use of antidepressant medication in late mid-life: a register-based analysis of Norwegian women and men. *Aging & Mental Health*, 21(5):477–486.

Liu, Y., Kaaya, S., Chai, J., McCoy, D. C., Surkan, P. J., Black, M. M., Sutter-Dallay, A.-L., Verdoux, H., and Smith-Fawzi, M. C. (2017). Maternal depressive symptoms and early childhood cognitive development: a meta-analysis. *Psychological Medicine*, 47(4):680–689.

Mckenzie, S. K. and Carter, K. (2013). Does transition into parenthood lead to changes in mental health? Findings from three waves of a population based panel study. *Journal of Epidemiology & Community Health*, 67(4):339–345.

Menta, G., Lepinteur, A., Clark, A. E., Ghislandi, S., and D'Ambrosio, C. (2023). Maternal genetic risk for depression and child human capital. *Journal of Health Economics*, 87:102718.

Metzger, S. and Gracia, P. (2023). Gender differences in mental health following the transition into parenthood: Longitudinal evidence from the UK. *Advances in Life Course Research*, 56:100550.

Mogren, I. M. and Pohjanen, A. I. (2005). Low Back Pain and Pelvic Pain During Pregnancy: Prevalence and Risk Factors. *Spine*, 30(8).

Muzik, M. and Hamilton, S. E. (2016). Use of Antidepressants During Pregnancy?: What to Consider when Weighing Treatment with Antidepressants Against Untreated Depression. *Maternal and Child Health Journal*, 20(11):2268–2279.

Myrskylä, M. and Margolis, R. (2014). Happiness: before and after the kids. *Demography*, 51:1843–1866.

Negro, A., Delaruelle, Z., Ivanova, T. A., Khan, S., Ornello, R., Raffaelli, B., Terrin, A., Reuter, U., Mitsikostas, D. D., and on behalf of the European Headache Federation School of Advanced Studies (2017). Headache and pregnancy: a systematic review. *The Journal of Headache and Pain*, 18(1):106.

Persson, P. and Rossin-Slater, M. (2019). When Dad Can Stay Home: Fathers' Workplace Flexibility and Maternal Health. *NBER Working Paper*, 25902.

Puschmann, A.-K., Drießlein, D., Beck, H., Arampatzis, A., Moreno Catalá, M., Schiltenwolf, M., Mayer, F., and Wippert, P.-M. (2020). Stress and Self-Efficacy as Long-Term Predictors for Chronic Low Back Pain: A Prospective Longitudinal Study. *Journal of Pain Research*, 13:613–621.

Rauprich, O., Berns, E., and Vollmann, J. (2011). Information provision and decision-making in assisted reproduction treatment: results from a survey in Germany. *Human Reproduction*, 26(9):2382–2391.

Reichner, C. A. (2015). Insomnia and sleep deficiency in pregnancy. *Obstetric Medicine*, 8(4):168–171.

Richter, D., Krämer, M. D., Tang, N. K. Y., Montgomery-Downs, H. E., and Lemola, S. (2019). Long-term effects of pregnancy and childbirth on sleep satisfaction and duration of first-time and experienced mothers and fathers. *Sleep*, 42(4):zsz015.

Rieder, J. (2022). Familienversicherung in der GKV: Voraussetzungen - Finanztip. https://www.finanztip.de/gkv/familienversicherung/. Last checked on Dec-13, 2022.

Rooney, B. L., Schauberger, C. W., and Mathiason, M. A. (2005). Impact of perinatal weight change on long-term obesity and obesity-related illnesses. *Obstetrics and Gynecology*, 106(6):1349–1356.

Roth, J., Sant'Anna, P. H., Bilinski, A., and Poe, J. (2023). What's trending in difference-in-differences? A synthesis of the recent econometrics literature. *Journal of Econometrics*, 235(2):2218–2244.

Rouche, A., Bätzing, J., Rose, M., Erhart, M., Holstiege, J., and Akmatov, M. K. (2019). Der Affected Mental and Physical Systems Index (AMPSI): Ein neuer Index zur Erfassung funktioneller psychischer und somatischer Beschwerden anhand vertragsärztlicher Abrechnungsdaten. *Versorgungsatlas-Bericht*, 19(08).

Sandner, M., Cornelissen, T., Jungmann, T., and Herrmann, P. (2018). Evaluating the effects of a targeted home visiting program on maternal and child health outcomes. *Journal of Health Economics*, 58:269–283.

Saxbe, D., Rossin-Slater, M., and Goldenberg, D. (2018). The transition to parenthood as a critical window for adult health. *The American psychologist*, 73(9):1190–1200.

Schink, T., Wentzell, N., Dathe, K., Onken, M., and Haug, U. (2020). Estimating the Beginning of Pregnancy in German Claims Data: Development of an Algorithm With a Focus on the Expected Delivery Date. *Frontiers in public health*, 8:350.

Scholle, O., Asendorf, M., Buck, C., Grill, S., Jones, C., Kollhorst, B., Riedel, O., Schüz, B., and Haug, U. (2022). Regional Variations in Outpatient Antibiotic Prescribing in Germany: A Small Area Analysis Based on Claims Data. *Antibiotics*, 11(7).

Schramm, S. H., Moebus, S., Lehmann, N., Galli, U., Obermann, M., Bock, E., Yoon, M.-S., Diener, H.-C., and Katsarava, Z. (2015). The association between stress and headache: A longitudinal population-based study. *Cephalalgia*, 35(10):853–863. PMID: 25480807.

Schröder, H., Brückner, G., Schlüssel, K., Breitkreuz, J., Schlotmann, A., and Günster, C. (2020). Monitor: Gesundheitliche Beeinträchtigungen - Vorerkrankungen mit erhöhtem Risiko für schwere Verläufe von COVID-19: Verbreitung in der Bevölkerung Deutschlands und seinen Regionen.

Seiler, A., Fagundes, C. P., and Christian, L. M. (2020). The Impact of Everyday Stressors on the Immune System and Health. In Choukèr, A., editor, *Stress Challenges and Immunity in Space: From Mechanisms to Monitoring and Preventive Strategies*, pages 71–92. Springer International Publishing, Cham.

Shorey, S., Chee, C. Y. I., Ng, E. D., Chan, Y. H., Tam, W. W. S., and Chong, Y. S. (2018). Prevalence and incidence of postpartum depression among healthy mothers: A systematic review and meta-analysis. *Journal of Psychiatric Research*, 104:235–248.

Spaeth, A. M., Dinges, D. F., and Goel, N. (2013). Effects of Experimental Sleep Restriction on Weight Gain, Caloric Intake, and Meal Timing in Healthy Adults. *Sleep*, 36(7):981–990.

Steffen, A., Nübel, J., Jacobi, F., Bätzing, J., and Holstiege, J. (2020). Mental and somatic comorbidity of depression: a comprehensive cross-sectional analysis of 202 diagnosis groups using German nationwide ambulatory claims data. *BMC psychiatry*, 20(1):142.

Stowe, Z. N. and Nemeroff, C. B. (1995). Women at risk for postpartum-onset major depression. *American Journal of Obstetrics and Gynecology*, 173(2):639–645.

Umberson, D., Liu, H., Mirowsky, J., and Reczek, C. (2011). Parenthood and trajectories of change in body weight over the life course. *Social Science & Medicine*, 73(9):1323–1331.

van Scheppingen, M. A., Denissen, J. J. A., Chung, J. M., Tambs, K., and Bleidorn, W. (2018). Self-esteem and relationship satisfaction during the transition to motherhood. *Journal of personality and social psychology*, 114(6):973–991.

Vesga-López, O., Blanco, C., Keyes, K., Olfson, M., Grant, B. F., and Hasin, D. S. (2008). Psychiatric Disorders in Pregnant and Postpartum Women in the United States. *Archives of General Psychiatry*, 65(7):805–815.

Viswasam, K., Eslick, G. D., and Starcevic, V. (2019). Prevalence, onset and course of anxiety disorders during pregnancy: A systematic review and meta analysis. *Journal of Affective Disorders*, 255:27–40.

Wagner, G. G., Frick, J. R., and Schupp, J. (2007). The German socio-economic panel study (SOEP)-Scope, evolution and enhancements. *Journal of Contextual Economics–Schmollers Jahrbuch*, 127(1):139–169.

Wentzell, N., Schink, T., Haug, U., Ulrich, S., Niemeyer, M., and Mikolajczyk, R. (2018). Optimizing an algorithm for the identification and classification of pregnancy outcomes in German claims data. *Pharmacoepidemiology and drug safety*, 27(9):1005–1010.

Whitaker, K., Young-Hyman, D., Vernon, M., and Wilcox, S. (2014). Maternal Stress Predicts Postpartum Weight Retention. *Maternal and child health journal*, 18(9):2209–2217.

Appendix

A.1 Data

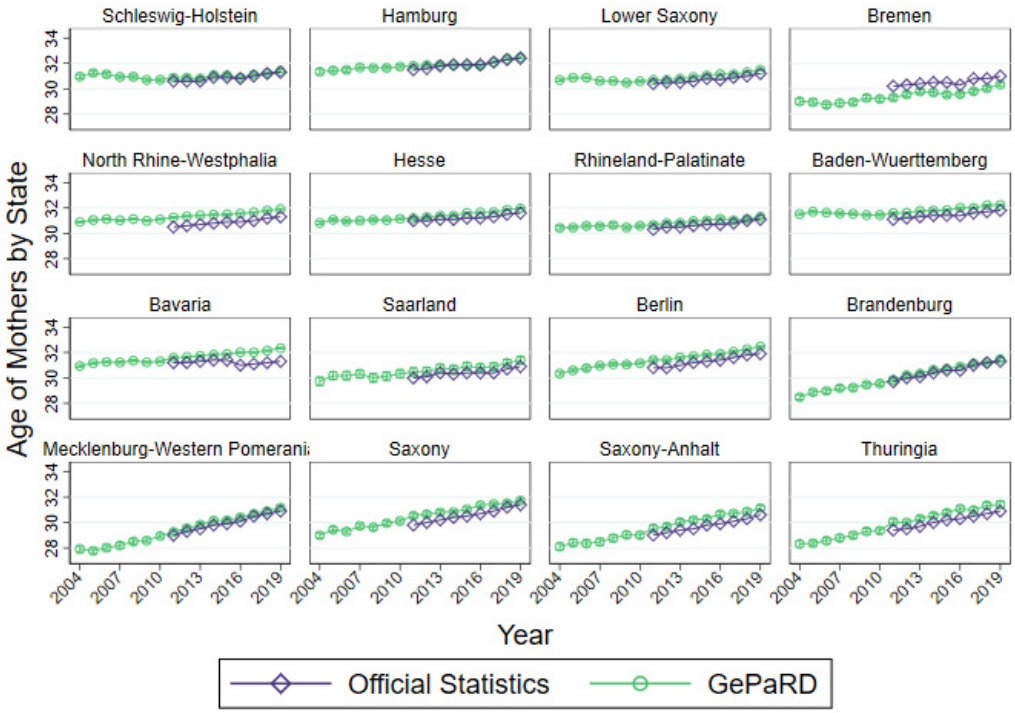
Table A.1: List of Outcome Variables and ICD-10 Codes

Outcomes	ICD-10
Depression	F32, F330, F331, F332, F333, F338, F339, F341, F381, F53, O993, R452, R453
Other Mental Disorders	F40, F41, F430, F432, F438, F439, F444, F445, F446, F45, F54, F59, F606, F680, R457, R52
Sleep Disorder	F510, F511, F512, F515, F518, F519, G47
Back Pain	M50, M51, M53, M54
Headaches	G43, G440, G441, G442, G443, G448, R51
Obesity	E65, E66, E67, E68
Respiratory Disease	J00, J01, J02, J03, J06, J09, J10, J11, J12, J13, J14, J15, J16, J18, J20, J300, J31, J32, J40, J41, J42, J44

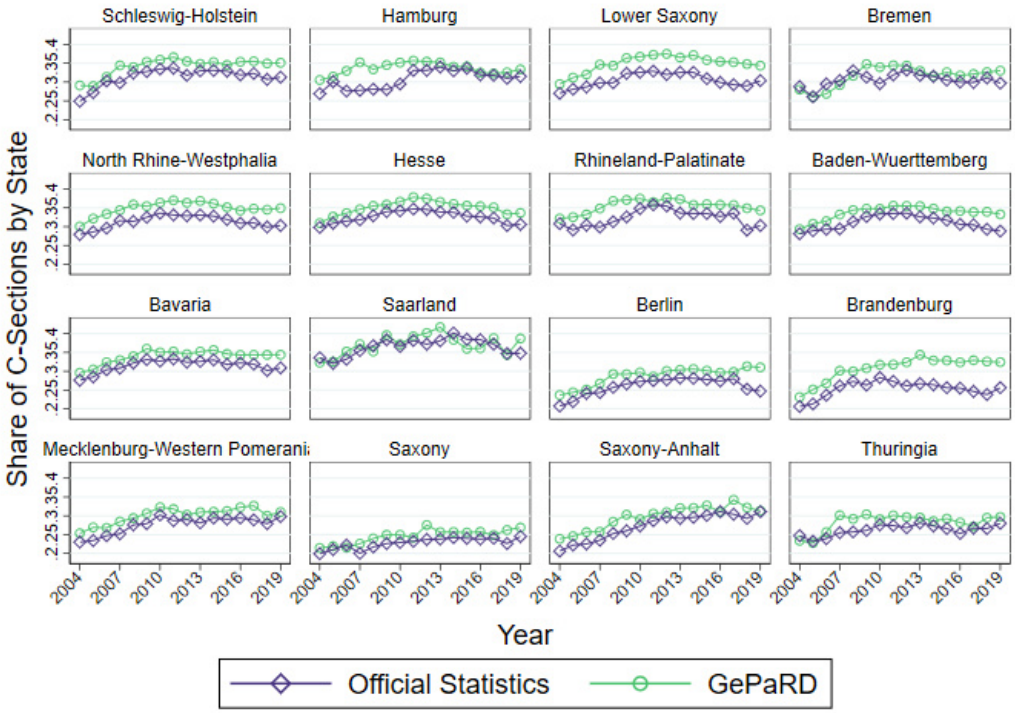
Mapping of ICD codes is based on Beuchert et al. (2016); Persson and Rossin-Slater (2019); Rouche et al. (2019); Sandner et al. (2018) and Steffen et al. (2020).

Figure A.1: Birth Outcomes for GePaRD and Official Birth Records

(a) Maternal Age at Childbirth



(b) C-Sections



Source: Own illustration based on GePaRD and destatis (2022). Data for GePaRD includes all deliveries of a mother.

Table A.3: Basic Demographics

	All Mothers		One-Child Mothers	
	Mean	SD	Mean	SD
Other Nationality	0.096	0.295	0.103	0.304
German	0.819	0.385	0.808	0.394
Nationality Missing	0.085	0.279	0.089	0.284
Age at Childbirth	30.696	5.219	31.464	5.357
Lower Education	0.040	0.197	0.040	0.197
Middle Education	0.431	0.495	0.421	0.494
Higher Education	0.200	0.400	0.180	0.384
Education Missing	0.329	0.470	0.358	0.479
West German	0.810	0.392	0.804	0.397
East German	0.187	0.390	0.194	0.395
Place of Residence Missing	0.002	0.048	0.003	0.052
Premature Birth	0.071	0.256	0.075	0.263
Cesarean Section	0.349	0.477	0.367	0.482
Working Before Pregnancy (Proxy)	0.812	0.391	0.804	0.397
No Further Child Observed ("One-Child Mother")	0.667	0.471	1	0
N	1468892		979900	

Source: GePaRD. The table includes information on mothers with at least one live birth.

Table A.2: Pre-Pregnancy Summary Statistics: GePaRD

	All Mothers		One-Child Mothers	
	Mean	SD	Mean	SD
Prescription of Antidepressants	0.020	0.139	0.022	0.147
Psychotherapy	0.029	0.167	0.031	0.172
Other Mental Disorders	0.081	0.272	0.087	0.281
Depression	0.046	0.209	0.051	0.219
Sleep Disorder	0.005	0.071	0.006	0.076
Prescription of Antibiotics	0.132	0.338	0.133	0.339
Prescription of Painkillers	0.033	0.179	0.035	0.183
Headaches	0.067	0.249	0.069	0.254
Back Pain	0.106	0.307	0.111	0.314
Respiratory Diseases	0.177	0.382	0.179	0.383
Obesity	0.031	0.172	0.033	0.180
Physician Visits	2.212	2.107	2.221	2.128
Diagnoses per Visit	1.430	1.460	1.439	1.478
N	1122167		751193	

Source: GePaRD. This table shows different maternal outcomes five quarters before childbirth of the first child. The outcomes therefore correspond to the baseline period in the event-study graphs. The left-hand panels refer to all first-time mothers and the right-hand columns to mothers for whom we do not observe a further birth in our data.

Table A.4: Sample Overview – SOEP and Pairfam

		Sources	
	N	**SOEP**	**Pairfam**
Feeling Within Last 4 Weeks...			
Happy (1-4 Scale)	14076	2007-2019	W2-W11
Sad (1-4 Scale)	14079	2007-2019	W2-W11
Angry (1-5 Scale)	11752	2007-2019	W3-W5
Anxious (1-5 Scale)	11175	2007-2019	W4-W5
Life Satisfaction at Present (0-10 Scale)	15881	2004-2019	
BMI	10268	2004, 6, 8, 10, 12, 14, 16, 18	W1, 3, 5, 7, 9, 11
Obesity (if BMI>30)	10268	2004, 6, 8, 10, 12, 14, 16, 18	W1, 3, 5, 7, 9, 11
Breastfeeding	4626	2007-2019	
Childcare by Mother (h)	7234	2005, 7, 9, 11, 12, 13, 15, 17, 19	
Institutional Childcare	15333	2004-2019	
Average Sleep per Day (h)	9080	2008-15, 17, 19	
Physical Activities: Sport, Fitness, Gymnastics (h)	3006	2013, 15, 17, 19	
Other Leisure Activities and Hobbies (h)	7216	2005, 7, 9, 11, 12,13, 15, 17, 19	

Notes: This table shows the overall sample size for each outcome, along with the corresponding waves that are available in SOEP and Pairfam data.

Table A.5: Basic Demographics – SOEP and Pairfam

	All Mothers		**One-Child Mothers**	
	Mean	SD	Mean	SD
Other Nationality	0.109	0.312	0.107	0.309
German	0.891	0.312	0.893	0.309
Age at Childbirth	29.023	5.326	29.422	5.867
Lower Education	0.114	0.317	0.140	0.347
Middle Education	0.565	0.496	0.574	0.494
Higher Education	0.267	0.443	0.230	0.421
Education Missing	0.054	0.227	0.056	0.230
West Germany	0.733	0.442	0.699	0.459
East Germany	0.231	0.422	0.265	0.441
Place of Residence Missing	0.036	0.185	0.036	0.187
Working Before Pregnancy (Proxy)	0.855	0.352	0.849	0.358
No Further Child Observed ("One-Child Mother")	0.515	0.500	1.000	0.000
N	14076		7247	

Note: This table shows demographic summary statistics for the sample of mothers who are included in the analysis of being happy within the last four weeks (Table A.4). We cover mothers within four years before and four years after the birth of the first child.

Table A.6: Pre-Pregnancy Summary Statistics: SOEP and Pairfam

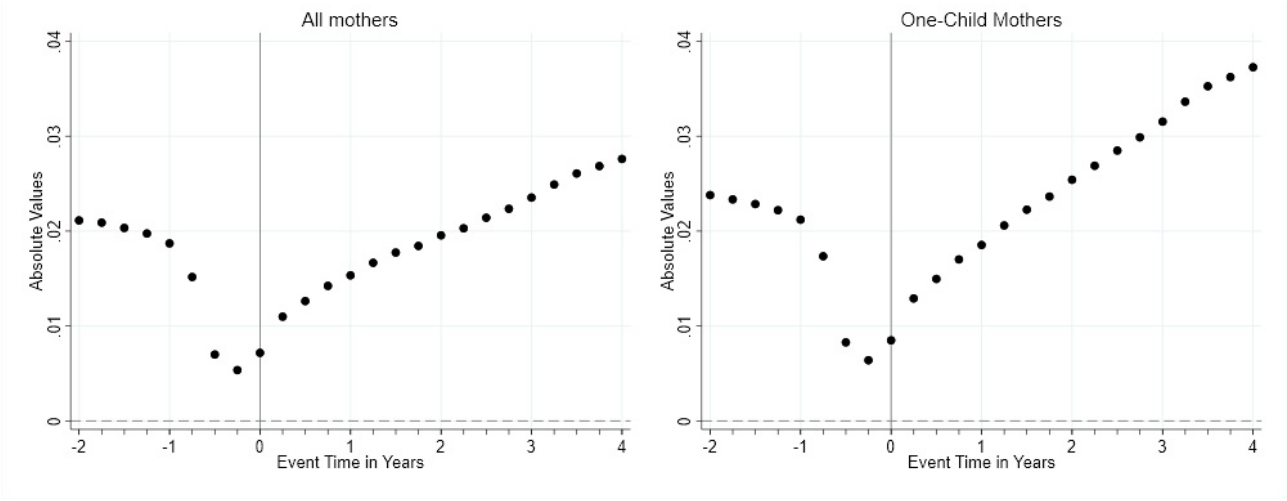
	All Mothers			**One-Child Mothers**			**Baseline Period** Before Birth (b.b.)
	Mean	**SD**	**N**	**Mean**	**SD**	**N**	
Feeling Within Last 4 Weeks...							
Happy (1-4 Scale)	3.04	0.73	1037	3.03	0.74	629	2^{nd} year b.b.
Sad (1-4 Scale)	1.73	0.81	589	1.75	0.80	363	2^{nd} year b.b.
Angry (1-5 Scale)	2.95	1.01	510	3.03	1.00	305	2^{nd} year b.b.
Anxious (1-5 Scale)	2.09	1.02	487	2.18	1.04	295	2^{nd} year b.b.
Life Satisfaction at Present (0-10 Scale)	7.50	1.49	597	7.49	1.48	361	3^{rd} half-year b.b.
BMI	23.35	4.52	453	23.65	5.09	268	2^{nd} year b.b.
Obesity (if BMI>30)	0.08	0.26	453	0.09	0.29	268	2^{nd} year b.b.
Breastfeeding	0.00	0.00	546	0.00	0.00	317	5^{th} quarter b.b.
Childcare by Mother (h)	0.09	0.66	259	0.11	0.74	152	3^{rd} half-year b.b.
Institutional Childcare	0.00	0.00	607	0.00	0.00	368	3^{rd} half-year b.b.
Average Sleep per Day (h)	8.59	0.98	298	8.55	1.04	168	3^{rd} half-year b.b.
Physical Activities: Sport, Fitness, Gymnastics (h)	0.84	0.76	114	0.88	0.85	75	3^{rd} half-year b.b.
Other Leisure Activities and Hobbies (h)	2.80	2.06	268	2.93	2.14	155	3^{rd} half-year b.b.

Notes: This table shows different maternal outcomes before the birth of the first child. The outcomes therefore correspond to the baseline period in the event-study graphs.

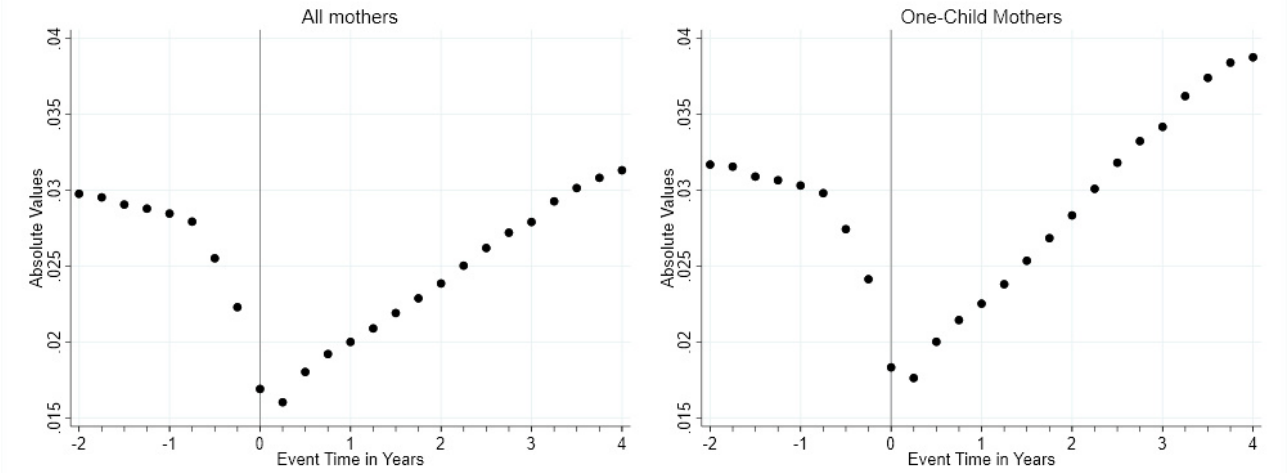
A.2 Unconditional Means

Figure A.2: Unconditional Means – Mental Health Treatments

(a) Antidepressants



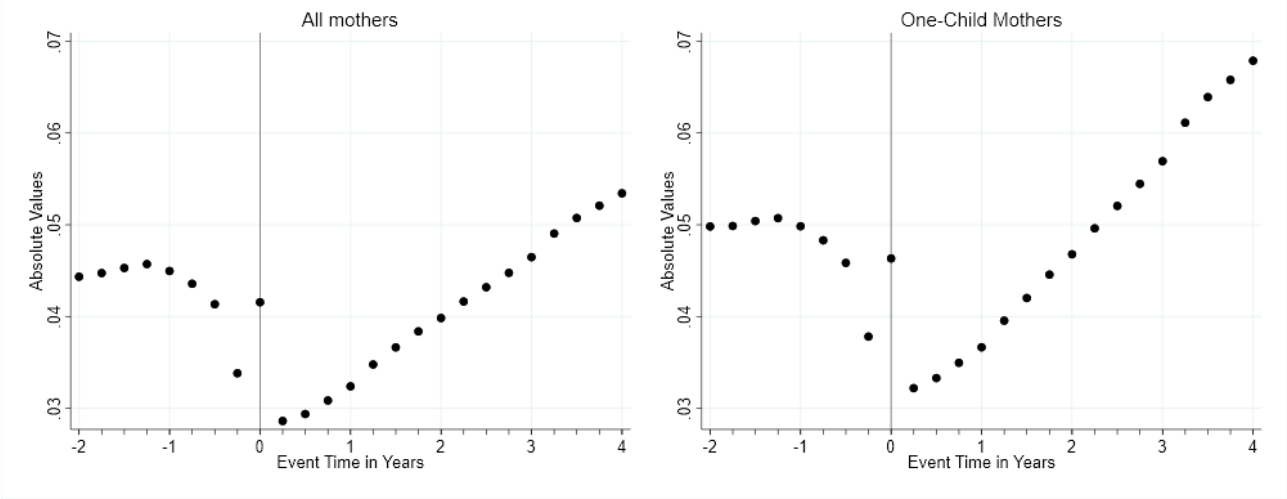
(b) Psychotherapy



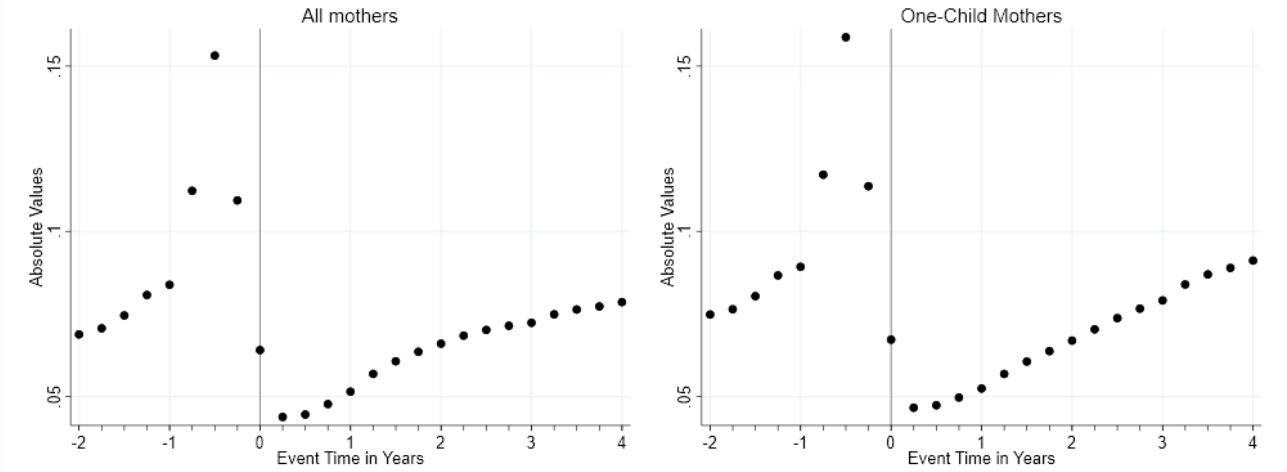
Notes: The points show the average value of the outcome variable for each quarter around the birth of the first child. No control variables. In the left panel, the sample consists of all women with at least one live birth. In the right panel, we exclude mothers for whom we observe a subsequent birth. The grey dashed line at $t = 0$ denotes the first live birth of each woman.

Figure A.3: Unconditional Means – Mental Disorders

(a) Depression

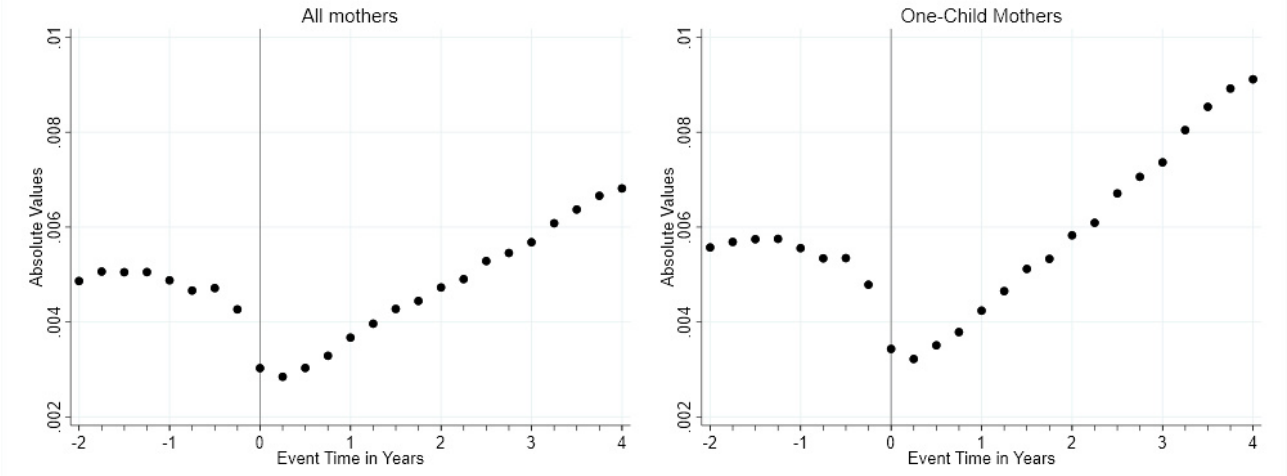


(b) Other Mental Disorders



Notes: See Figure A.2.

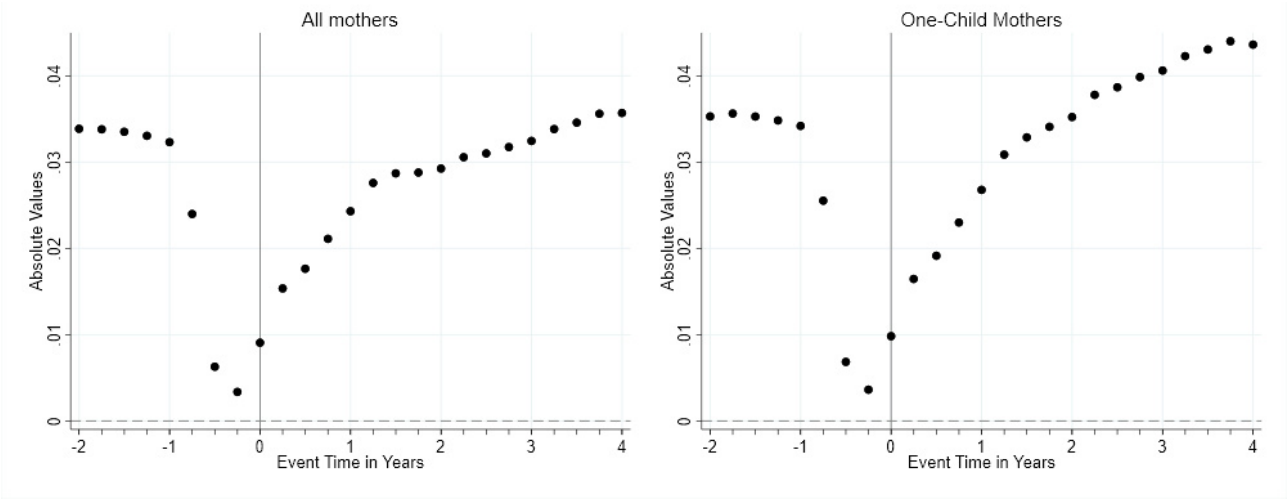
Figure A.4: Unconditional Means – Sleep Disorder



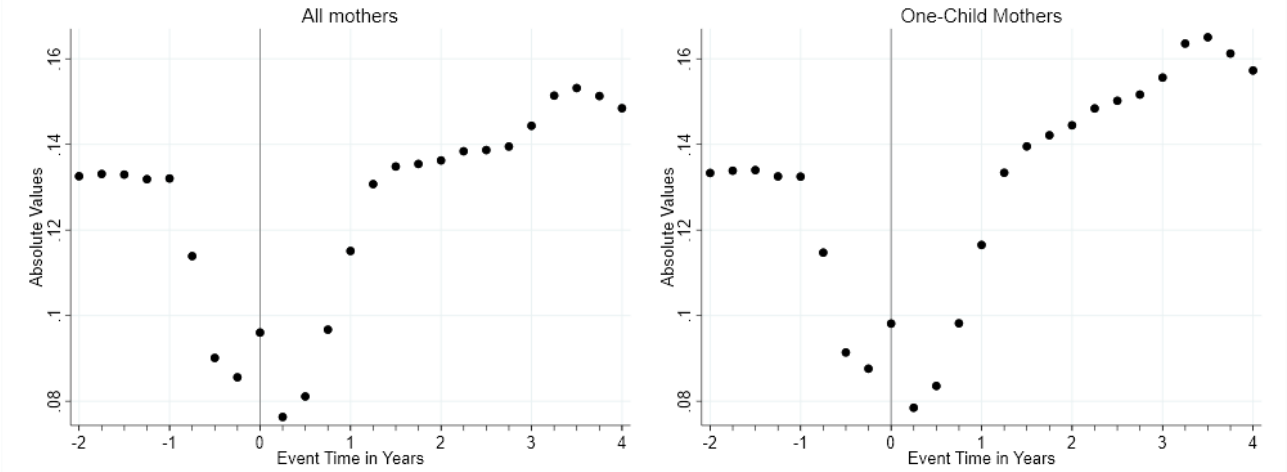
Notes: See Figure A.2.

Figure A.5: Unconditional Means – Painkillers and Antibiotics

(a) Painkillers



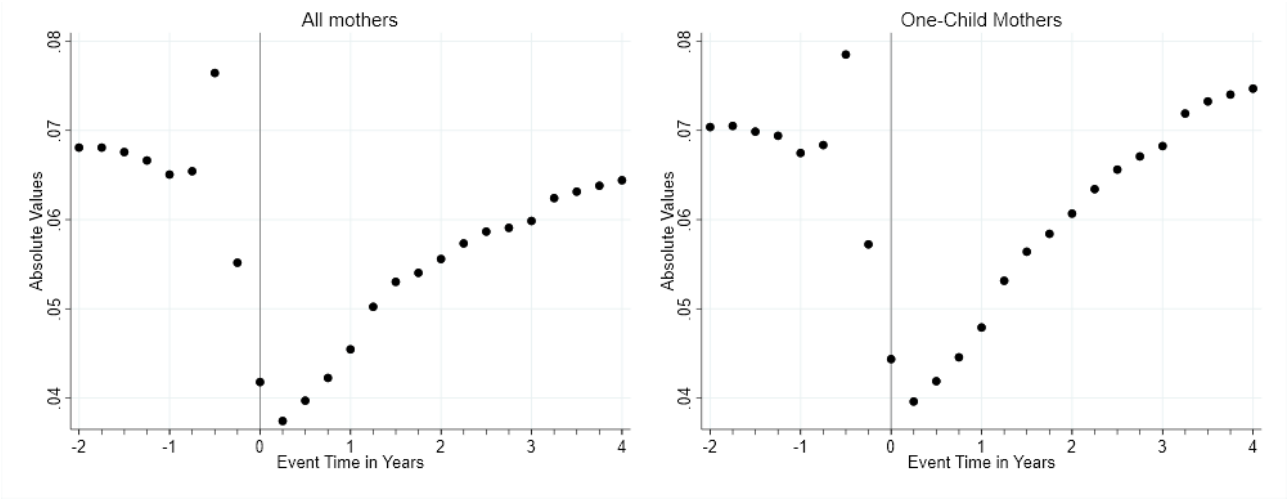
(b) Antibiotics



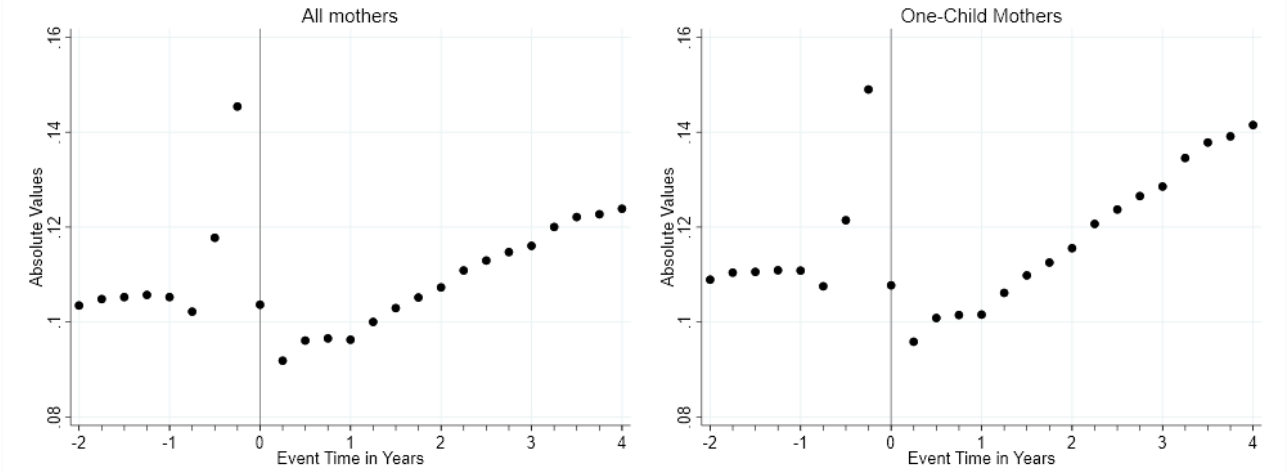
Notes: See Figure A.2.

Figure A.6: Unconditional Means – Pain

(a) Headaches

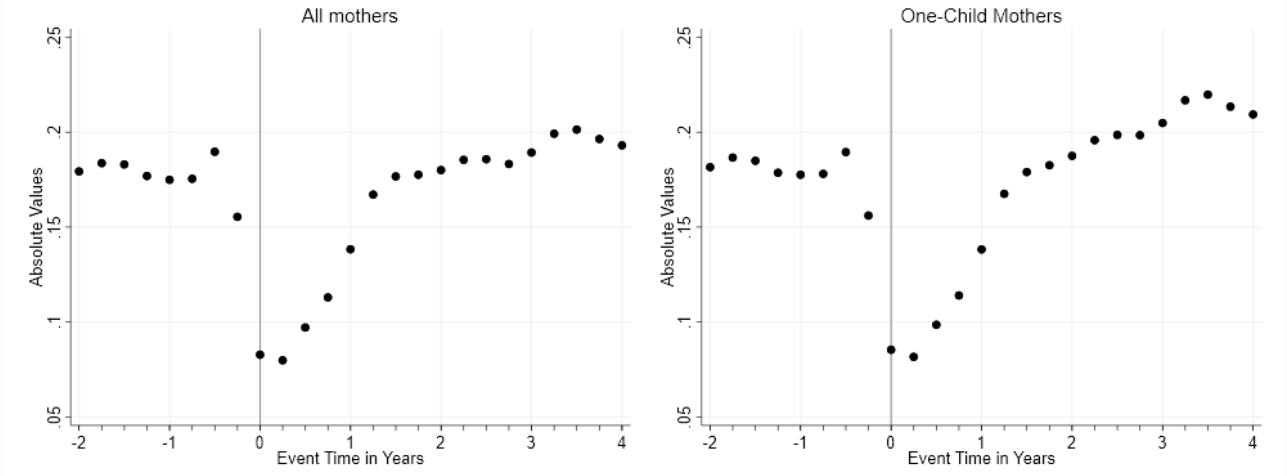


(b) Back Pain



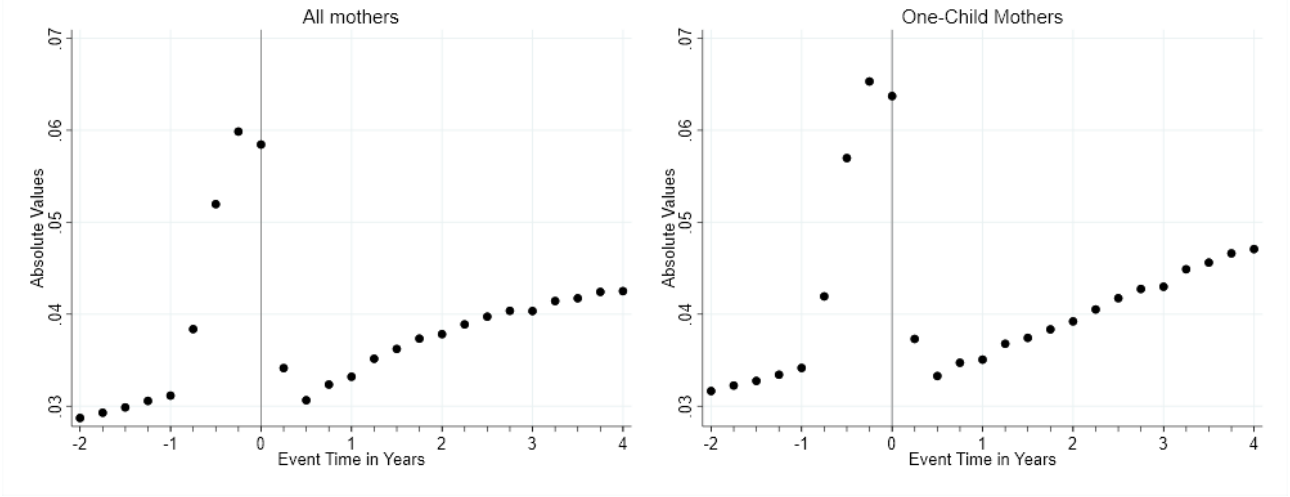
Notes: See Figure A.2.

Figure A.7: Unconditional Means – Respiratory Diseases



Notes: See Figure A.2.

Figure A.8: Unconditional Means – Obesity

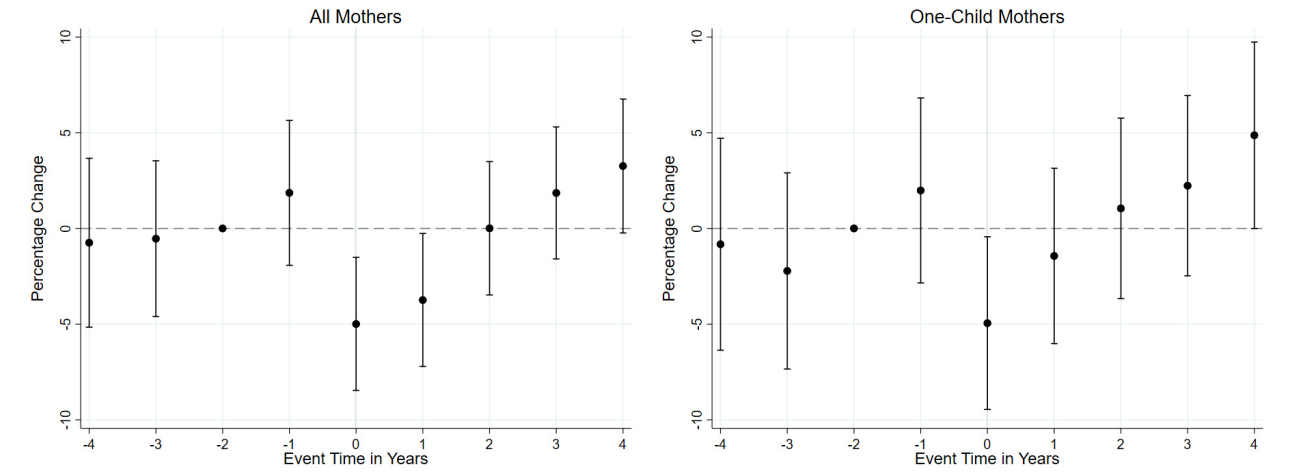


Notes: See Figure A.2.

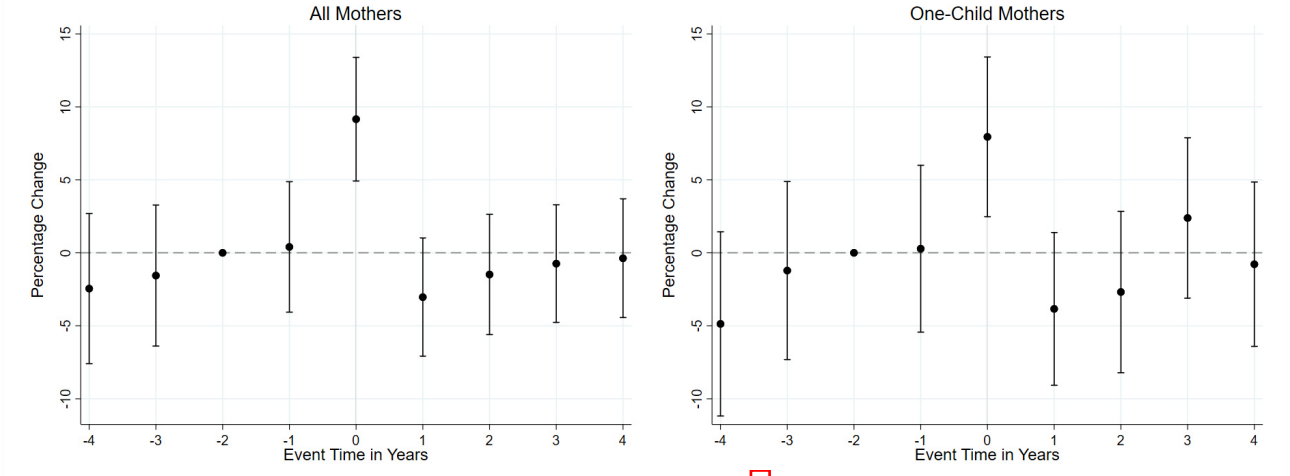
A.3 Event Study – Additional Outcomes

Figure A.9: Event Study – Survey Questions on Emotions: Sadness and Anxiety

(a) Feeling Sad

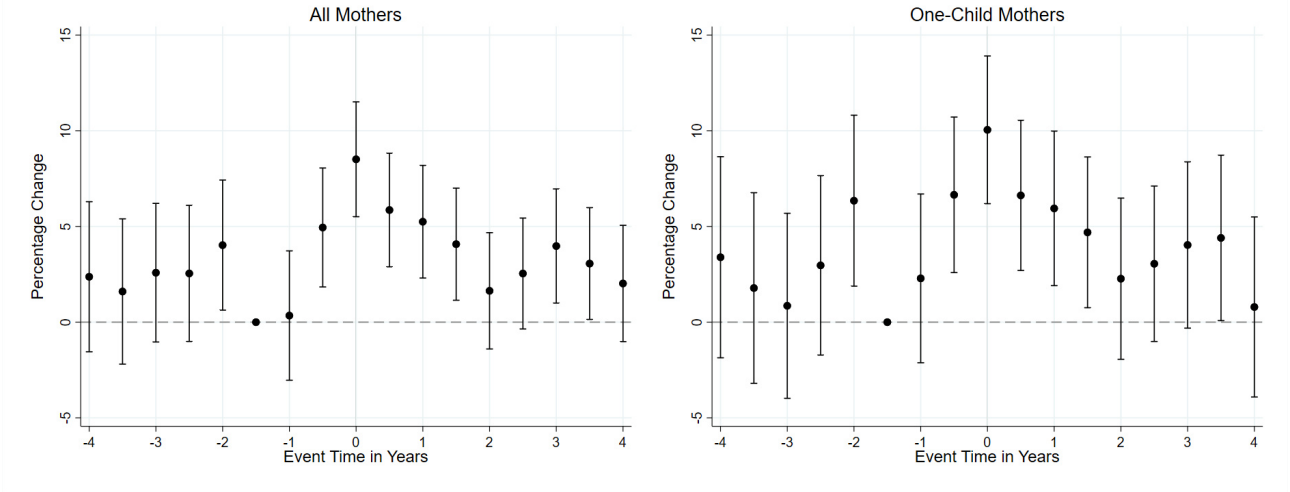


(b) Feeling Anxious



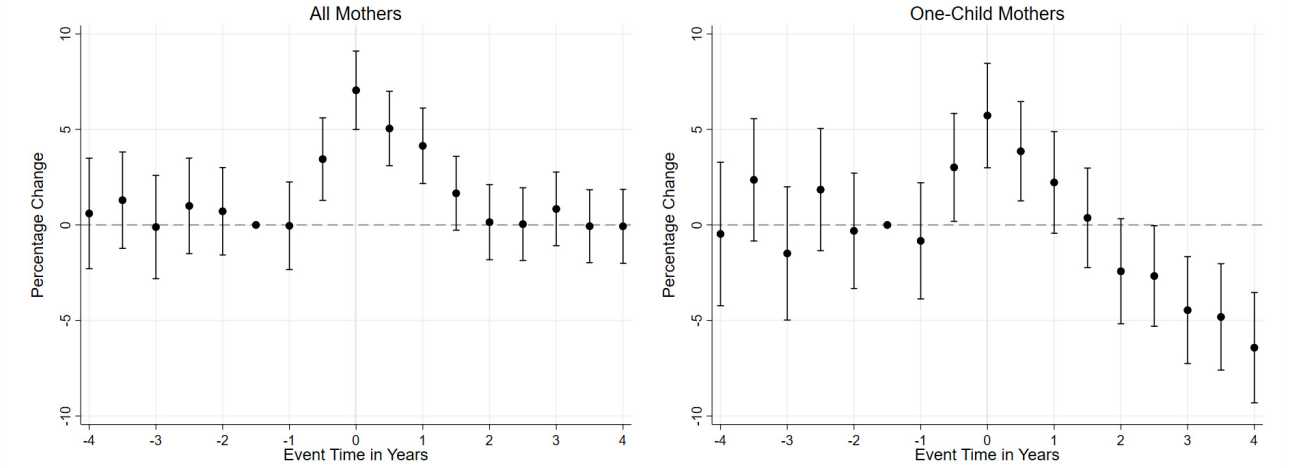
Notes: See Figure 5.

Figure A.10: Event Study – Mental Component Scale from Survey Questions



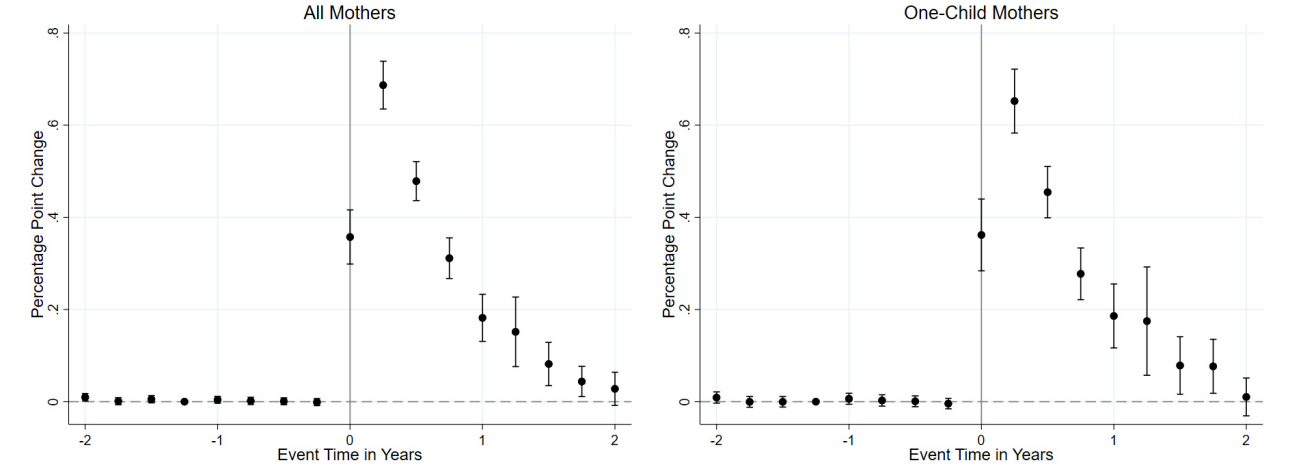
Notes: See Figure 5.

Figure A.11: Event Study – Survey Questions on Life Satisfaction



Notes: See Figure 5.

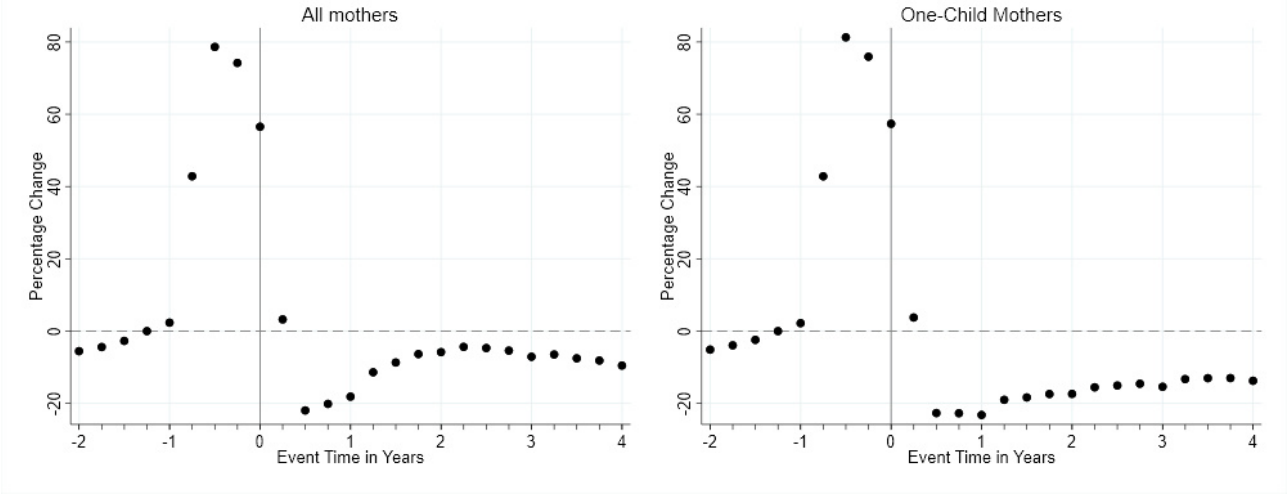
Figure A.12: Event Study – Survey Evidence on Currently Breastfeeding



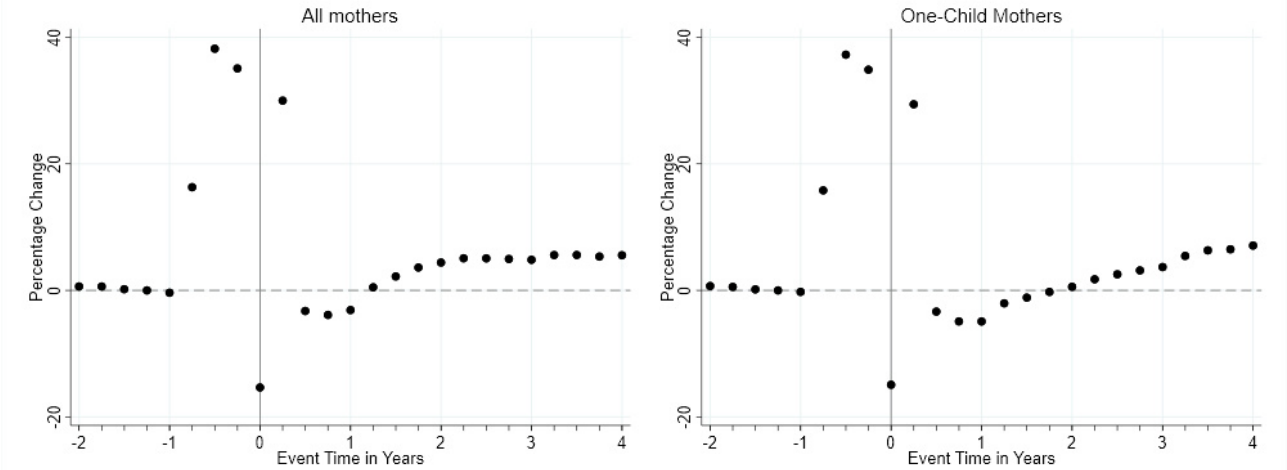
Notes: See Figure 5.

Figure A.13: Event Study – Physician Visits and Diagnoses

(a) Physician Visits

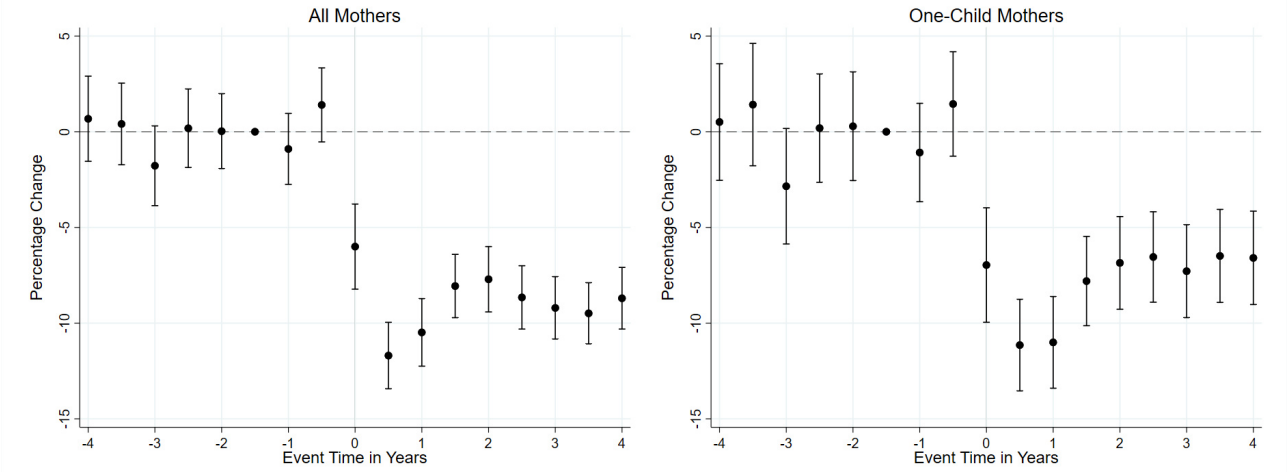


(b) Diagnoses per Visit



Notes: See Figure 2.

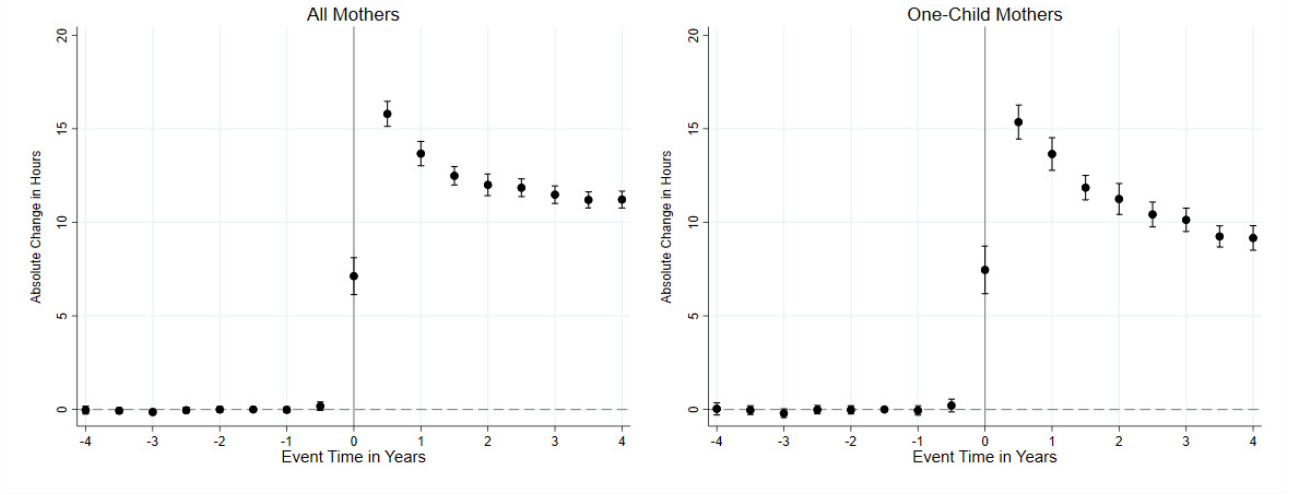
Figure A.14: Event Study – Survey Evidence on Average Hours of Sleep per Day



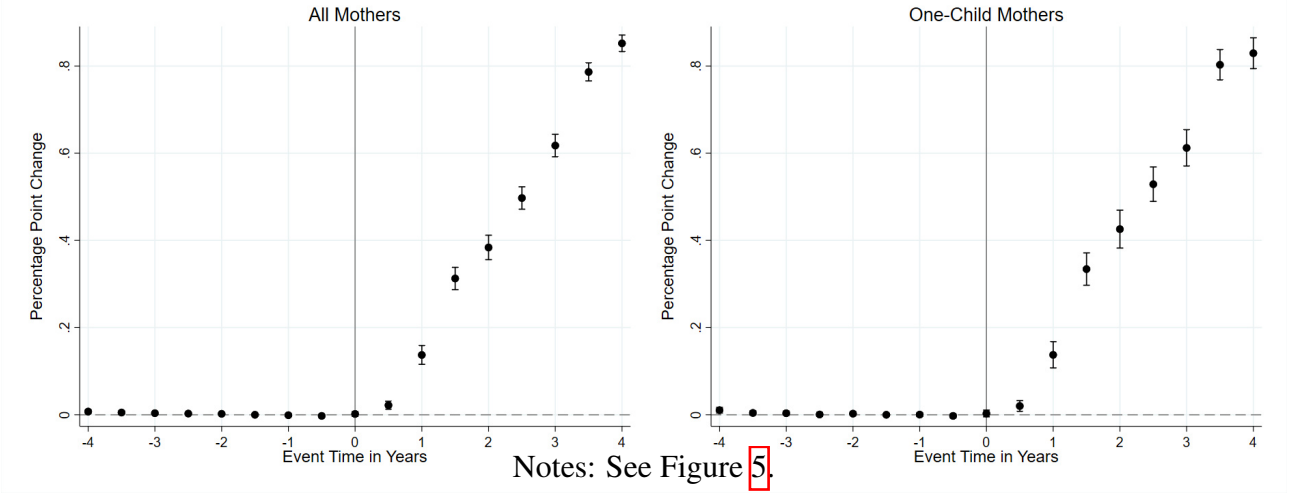
Notes: See Figure 5.

Figure A.15: Event Study – Survey Evidence on Childcare

(a) Childcare Provided by Mother



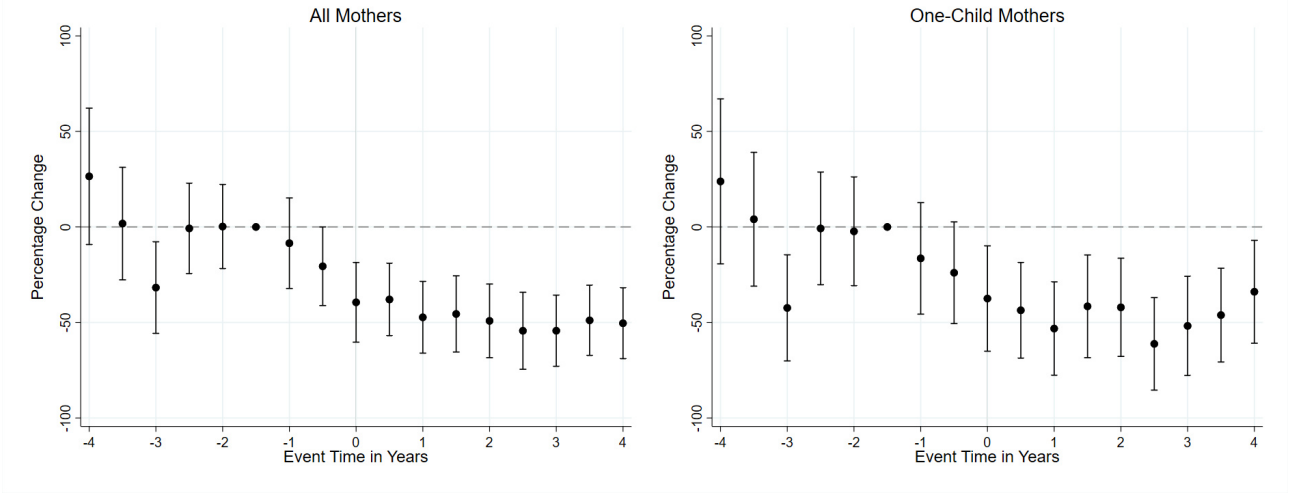
(b) Institutional Childcare Attendance



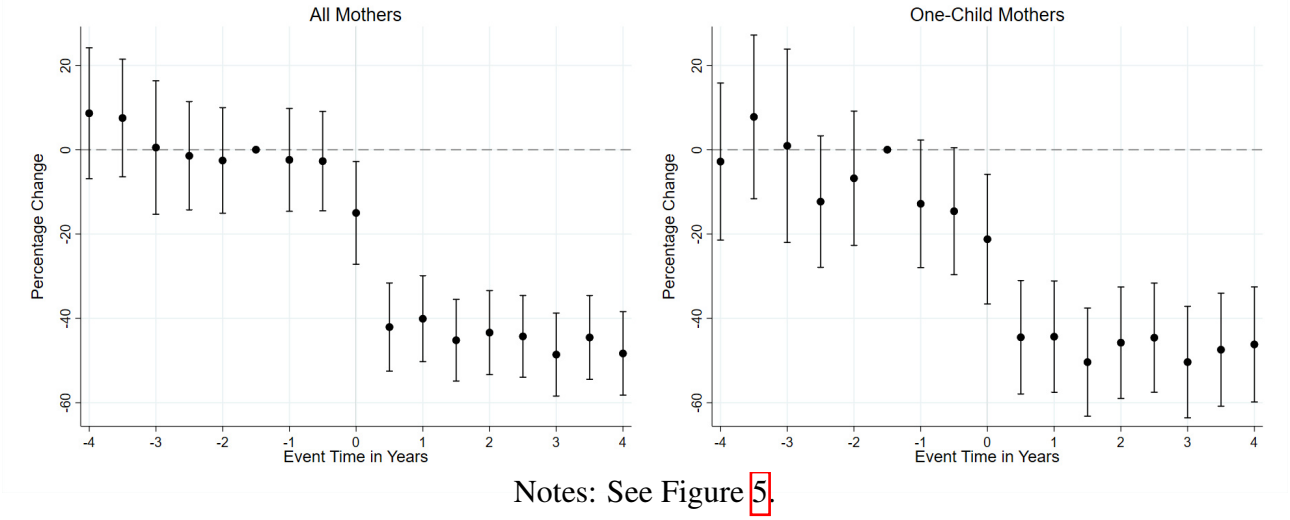
Notes: See Figure 5.

Figure A.16: Event Study – Survey Evidence on Activities

(a) Physical Activities (Sport, Fitness, Gymnastics)



(b) Other Leisure Activities and Hobbies

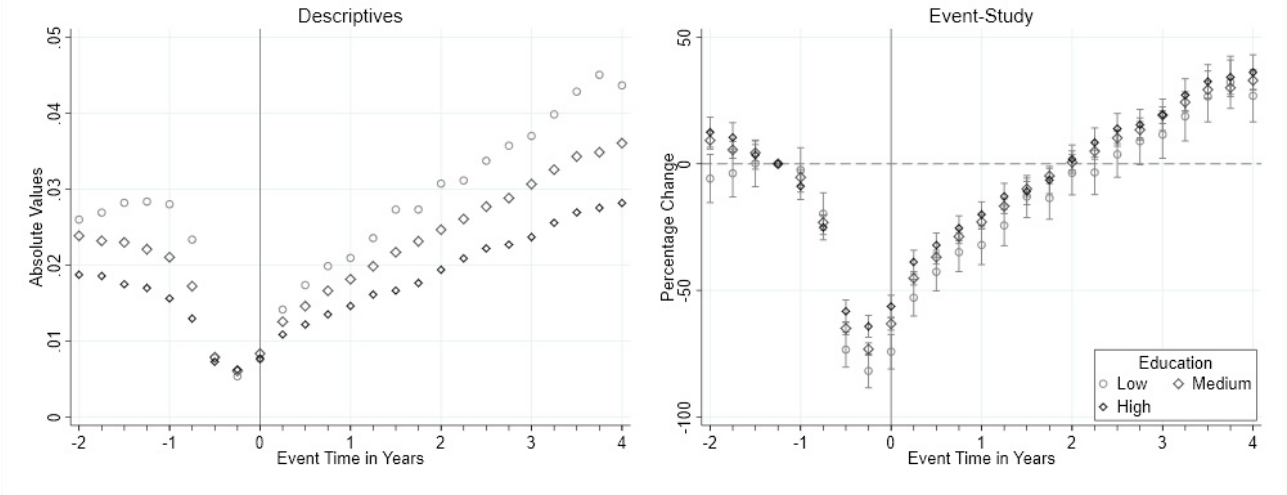


Notes: See Figure 5.

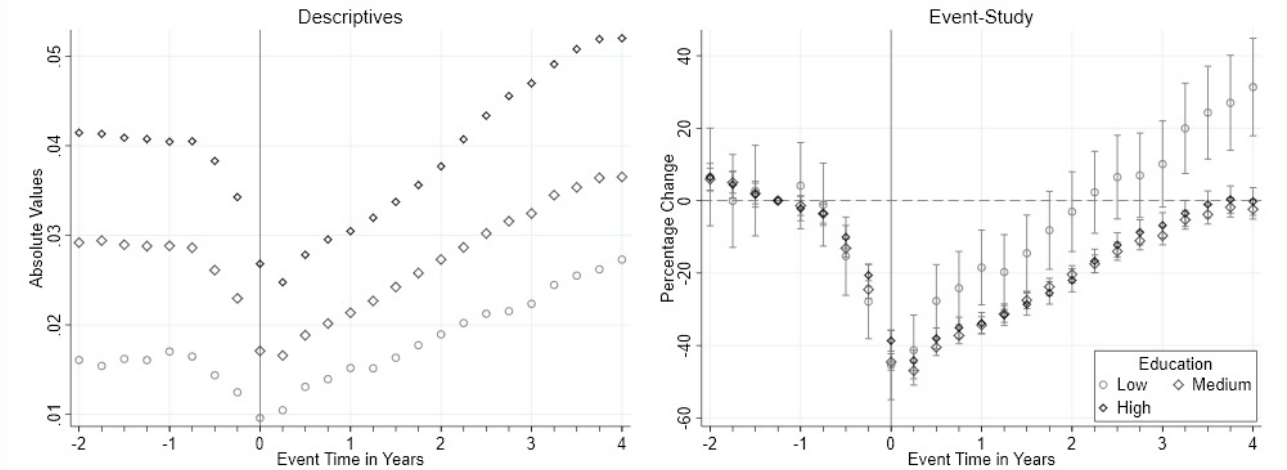
A.4 Effect Heterogeneity

Figure A.17: Heterogeneity by Education – Mental Health Treatments

(a) Antidepressants



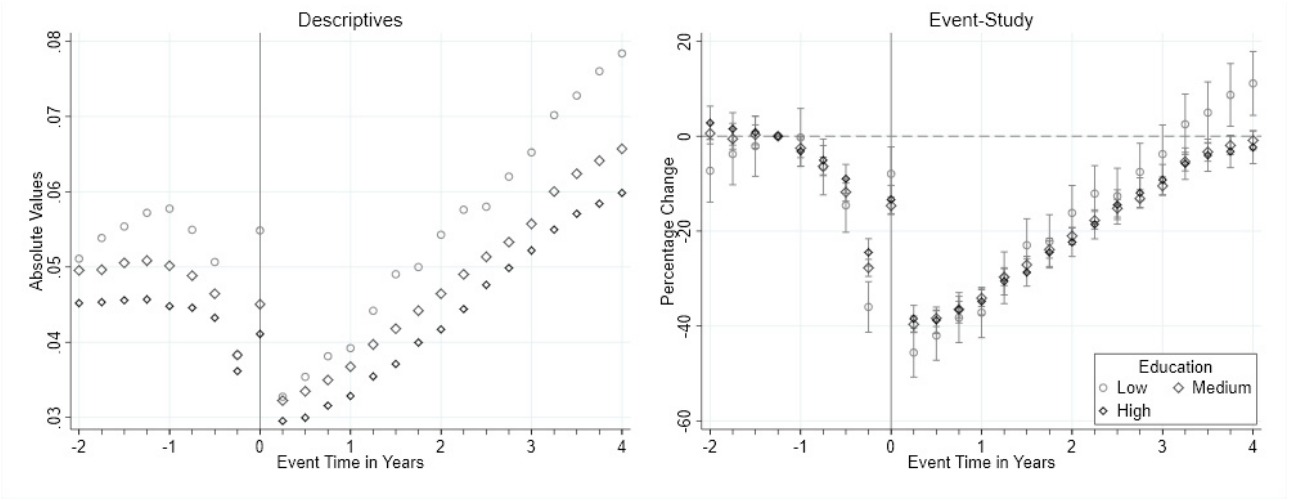
(b) Psychotherapy



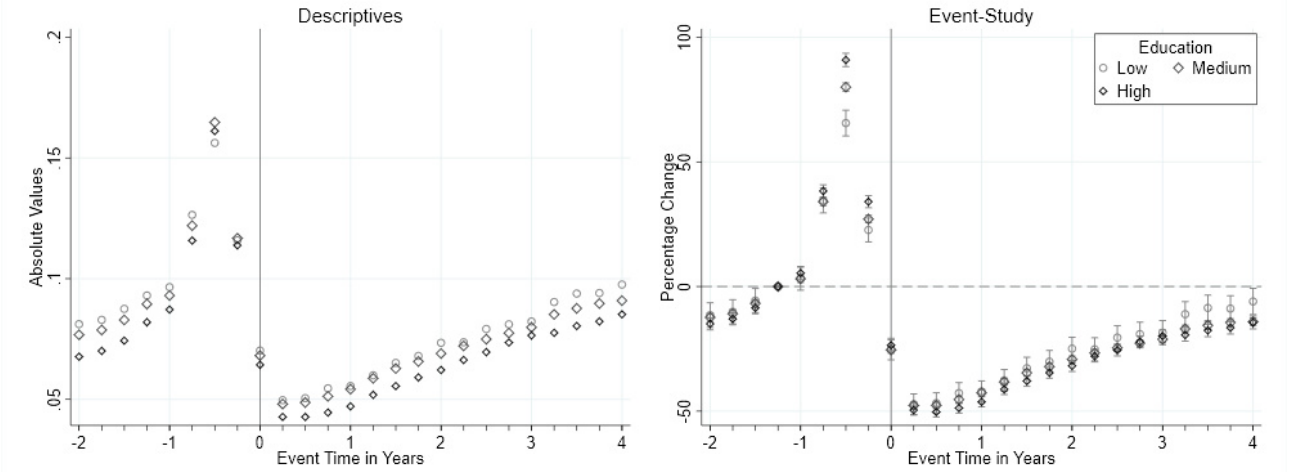
Notes: For both graphs, we exclude mothers for whom we observe a subsequent birth. **Both graphs use the subsample of "one-child mothers."** The left-hand graph shows the average value of the outcome variable for each quarter around the birth of the first child separately by education. No control variables. The right-hand panel shows event-study coefficients separately by education (controlling for maternal age and calendar time).

Figure A.18: Heterogeneity by Education – Mental Disorders

(a) Depression



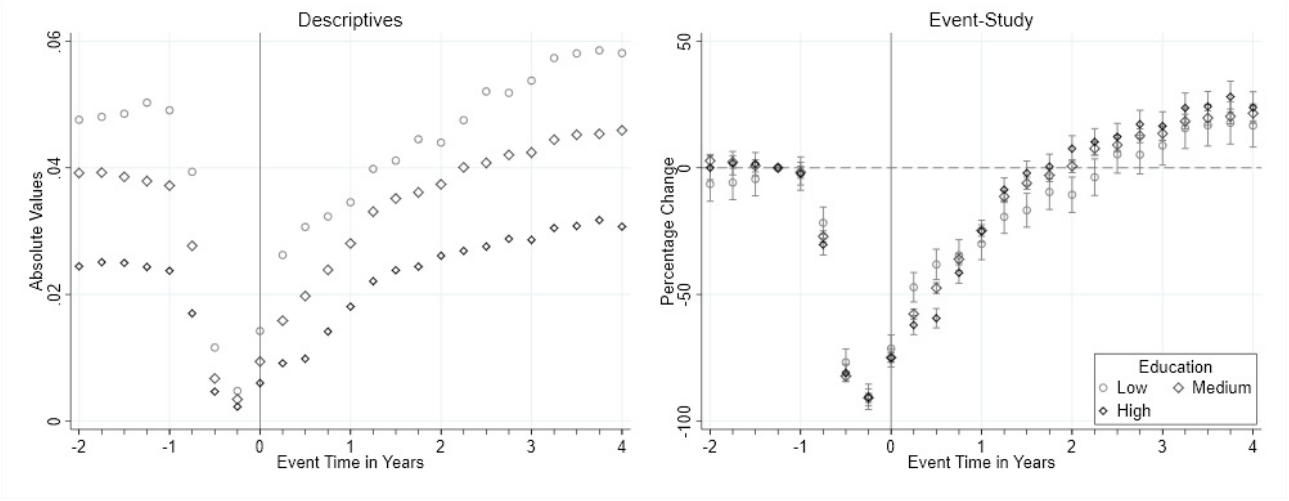
(b) Other Mental Disorders



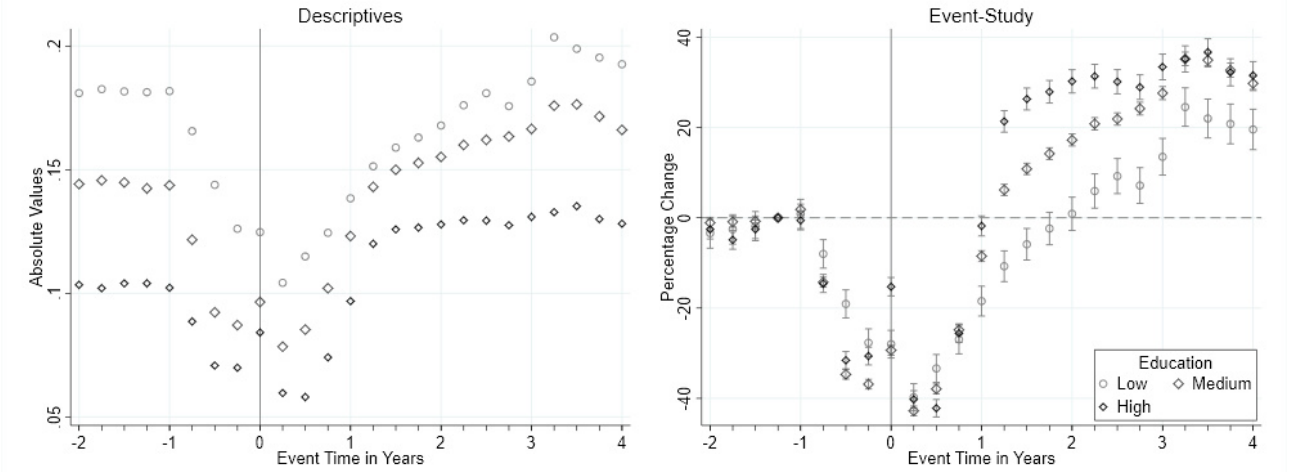
Notes: See Figure A.17.

Figure A.19: Heterogeneity by Education – Painkillers and Antibiotics

(a) Painkillers



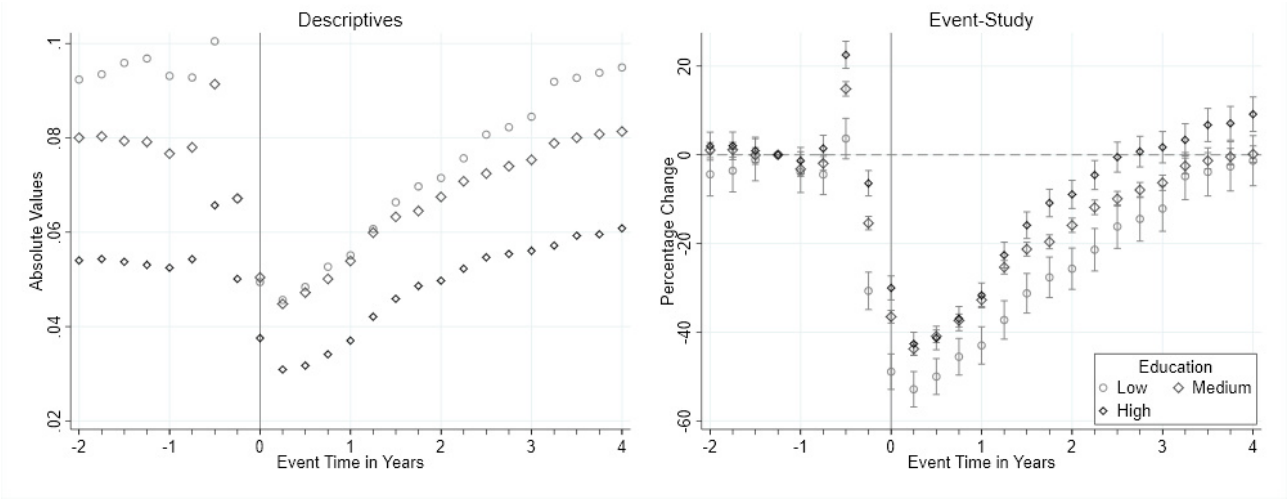
(b) Antibiotics



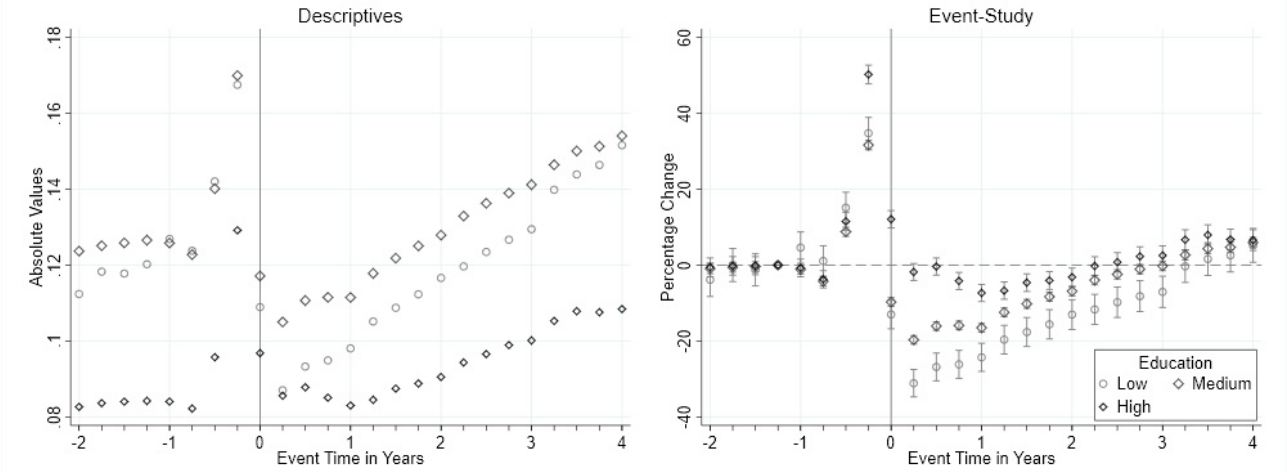
Notes: See Figure A.17.

Figure A.20: Heterogeneity by Education – Pain

(a) Headaches

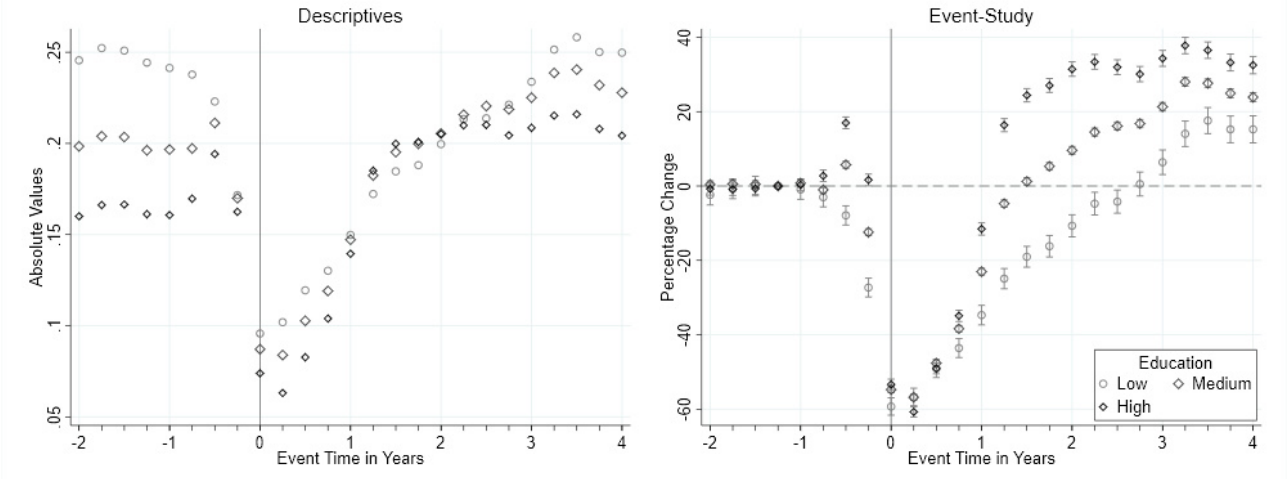


(b) Back Pain



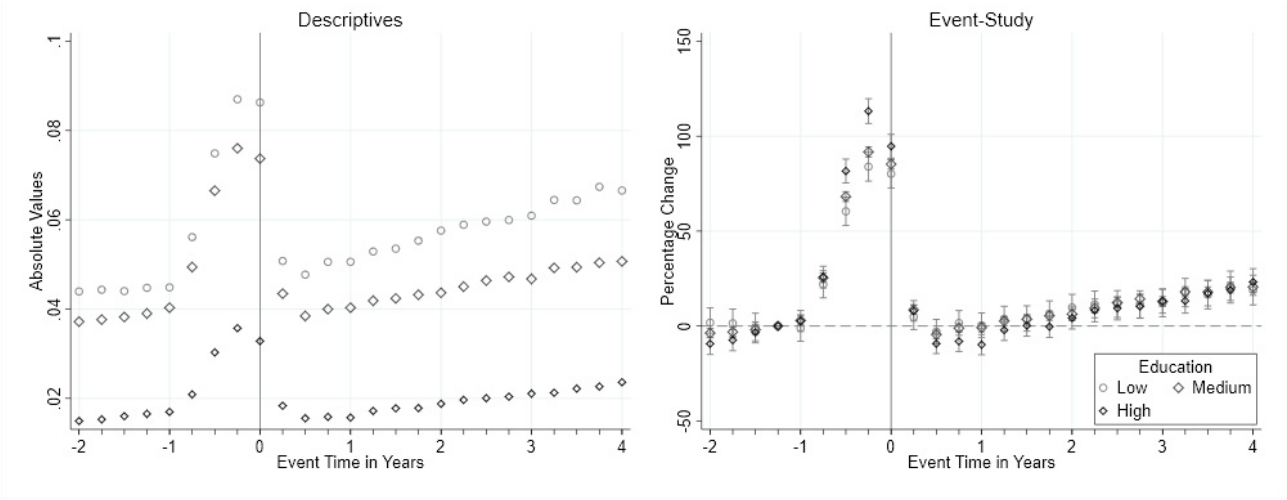
Notes: See Figure A.17.

Figure A.21: Heterogeneity by Education – Respiratory Diseases



Notes: See Figure A.17.

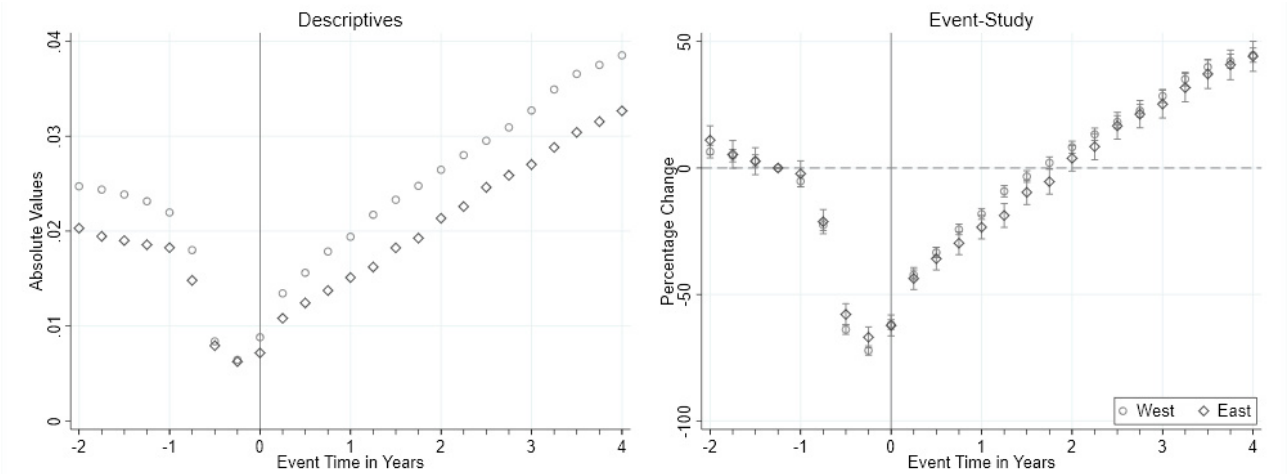
Figure A.22: Heterogeneity by Education – Obesity



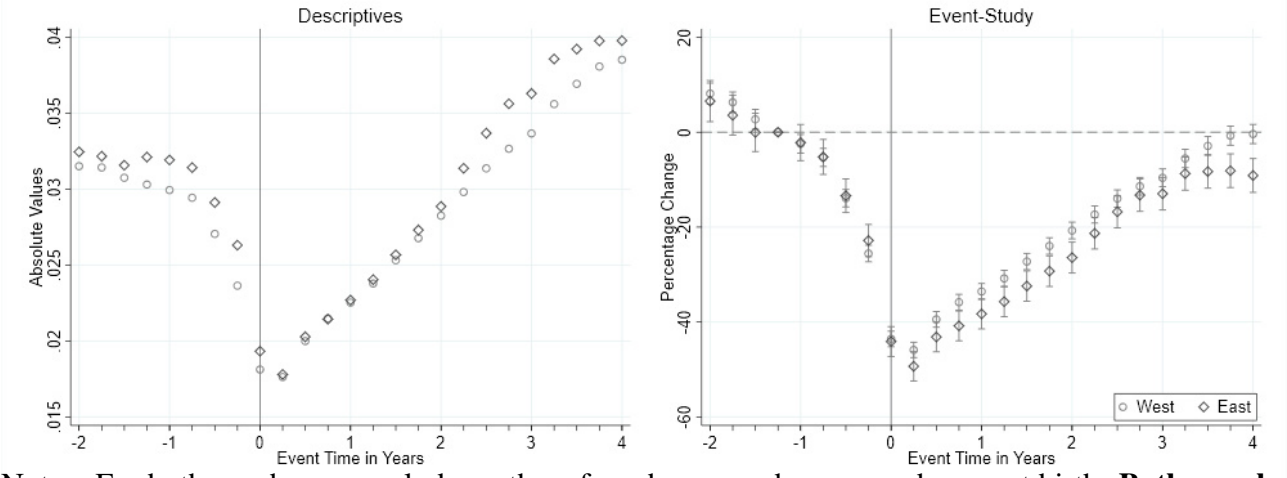
Notes: See Figure A.17.

Figure A.23: East-West Heterogeneity – Mental Health Treatments

(a) Antidepressants



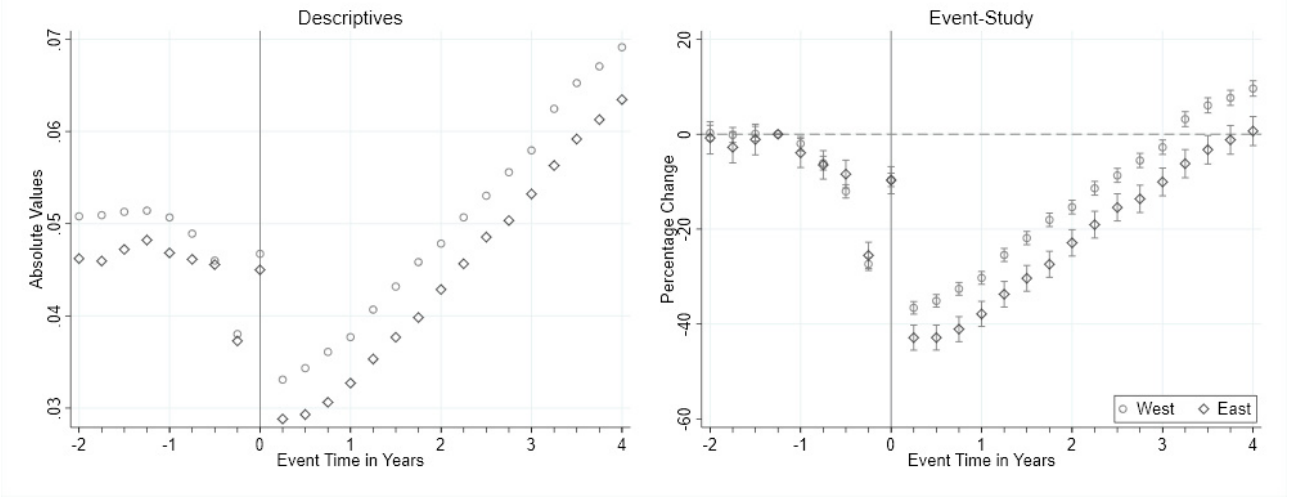
(b) Psychotherapy



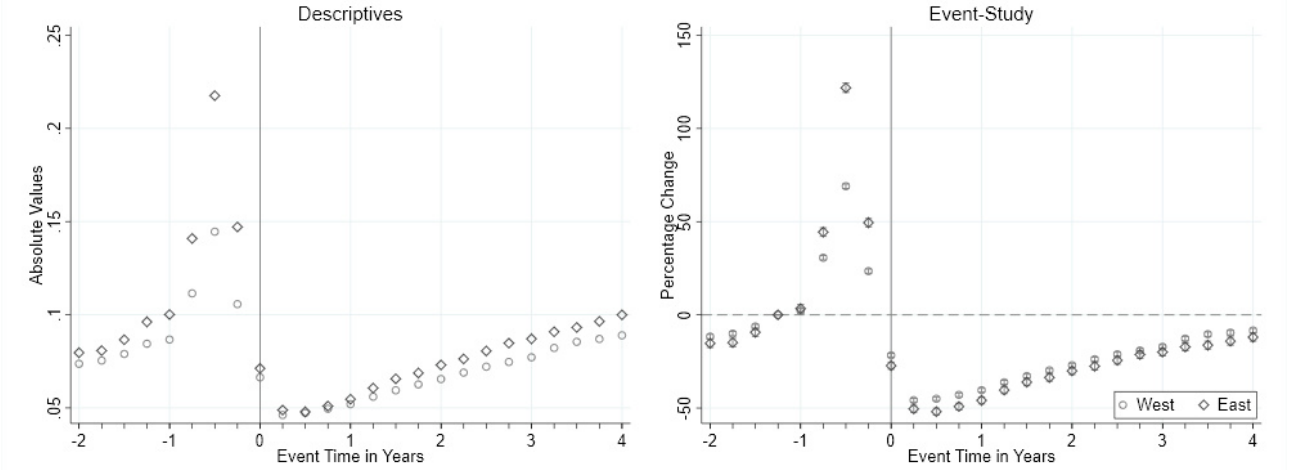
Notes: For both graphs, we exclude mothers for whom we observe a subsequent birth. **Both graphs use the subsample of "one-child mothers."** The left-hand graph shows the average value of the outcome variable for each quarter around the birth of the first child separately by East / West without control variables. The right-hand panel shows event-study coefficients separately by East / West (controlling for maternal age and calendar time).

Figure A.24: East-West Heterogeneity – Mental Disorders

(a) Depression



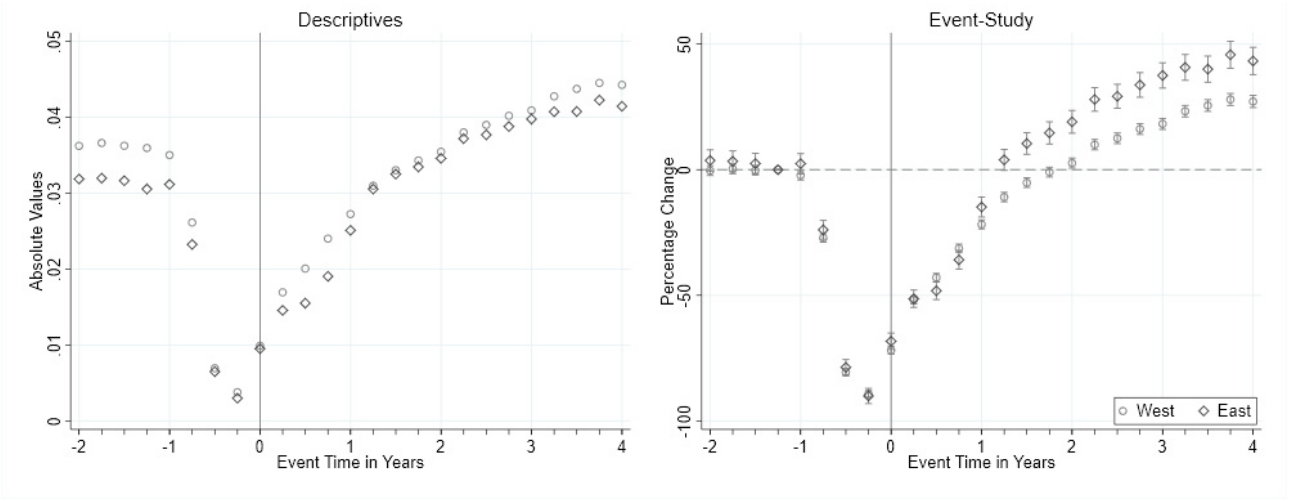
(b) Other Mental Disorders



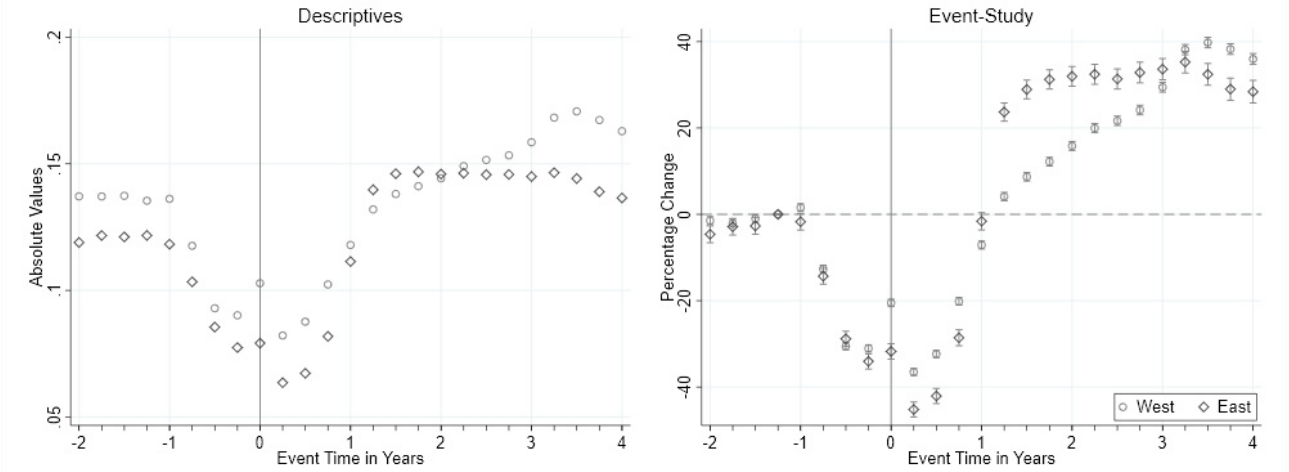
Notes: See Figure A.23.

Figure A.25: East-West Heterogeneity – Painkillers and Antibiotics

(a) Painkillers



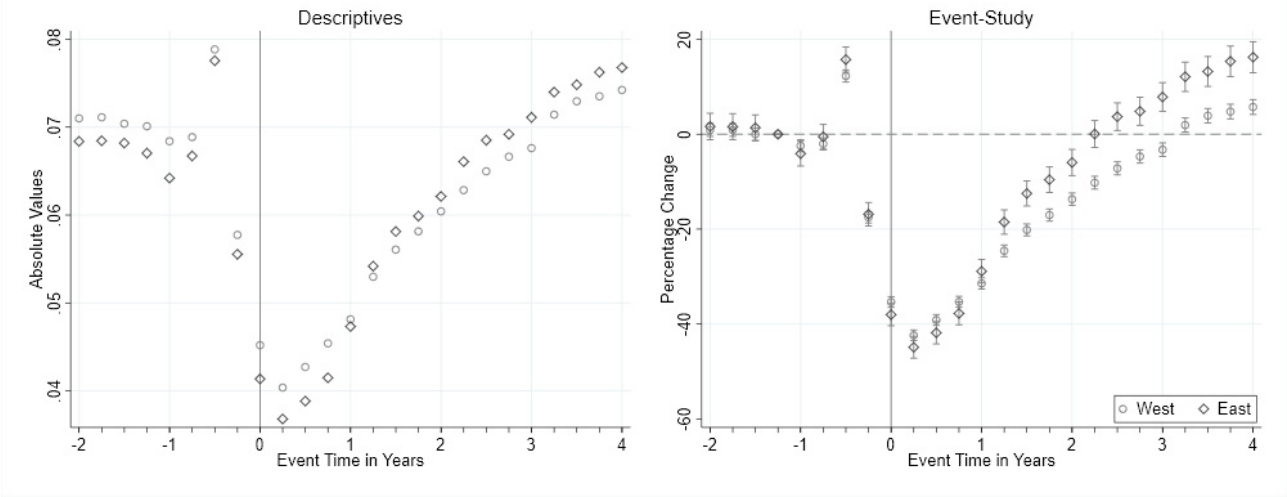
(b) Antibiotics



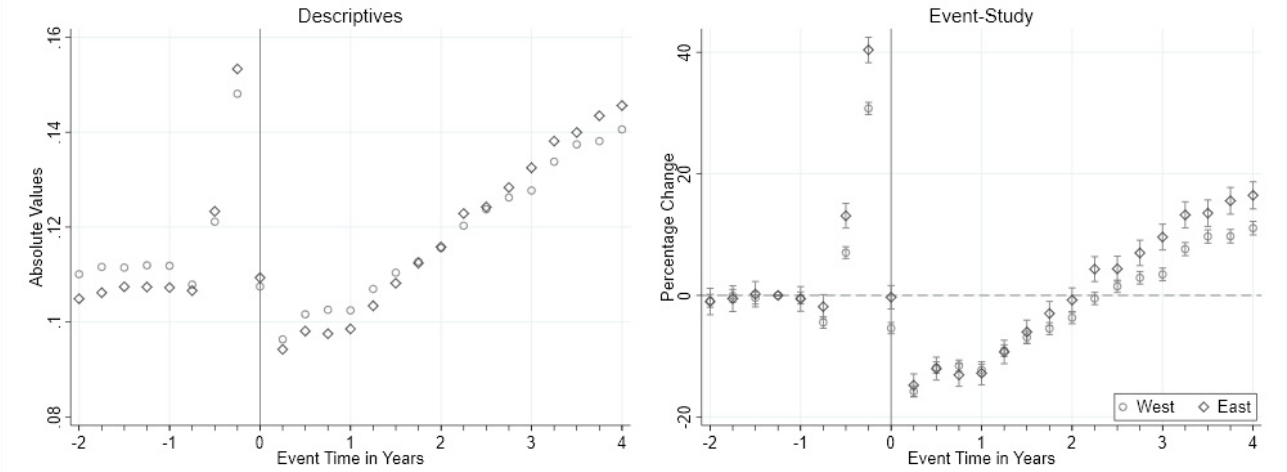
Notes: See Figure A.23.

Figure A.26: East-West Heterogeneity – Pain

(a) Headaches

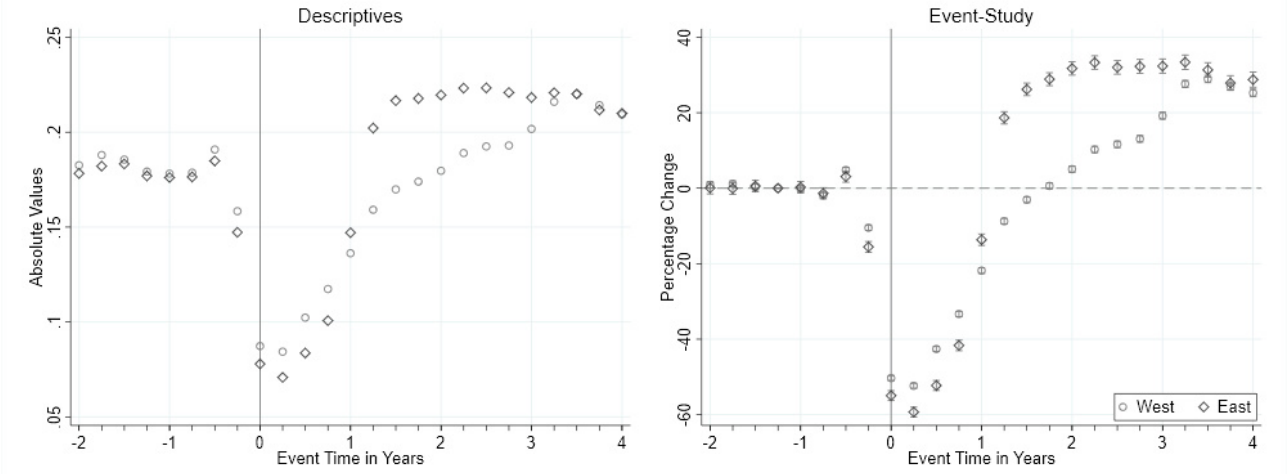


(b) Back Pain



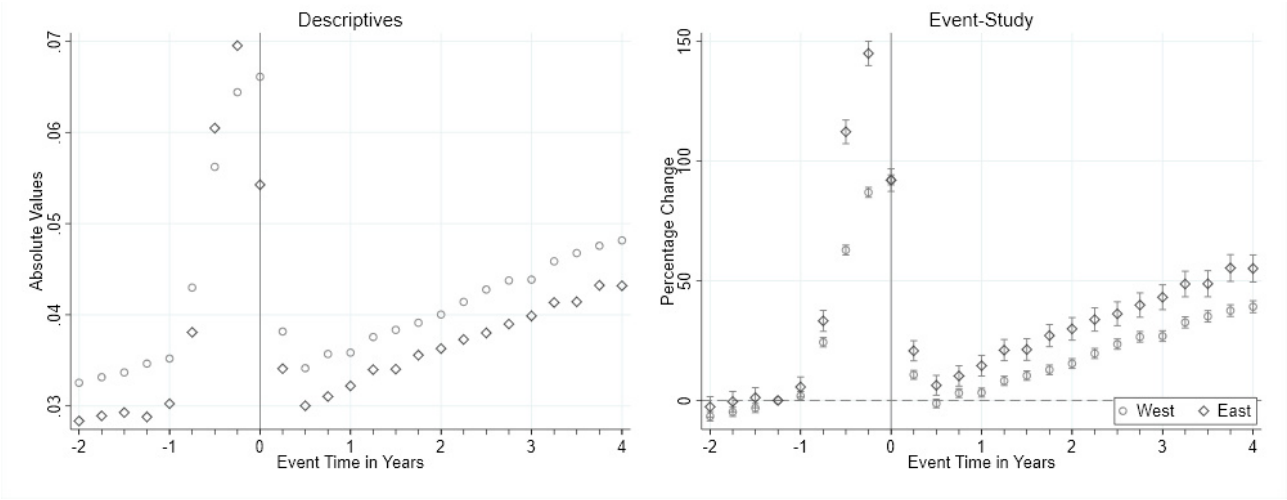
Notes: See Figure A.23.

Figure A.27: East-West Heterogeneity – Respiratory Diseases



Notes: See Figure A.23.

Figure A.28: East-West Heterogeneity – Obesity



Notes: See Figure A.23.