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The menopause "penalty"

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THE MENOPAUSE "PENALTY"

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Abstract

Menopause is a major biological shock to women, marking the end of their reproductive years. Despite its relevance, scant research has studied how menopause impacts social dynamics, labor market outcomes, or health care demand. Using high-quality linked national register administrative data from Norway and Sweden, combined with a stacked difference-in-differences design, we estimate the effect of menopause diagnosis on employment and earnings, reliance on social safety net programs, and demand for medical care. We find that menopause affects a broad swath of women's lives, ranging from a temporary increase in visits to doctors, to a persistent decline in full-time employment and earnings, and an increased receipt of social transfers. The earnings losses amount to 20% relative to the pre-menopause levels. Our results suggest that policies aimed at supporting women who suffer more serious symptoms around the menopausal transition may have wide-ranging benefits.

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1 Introduction

The landscape of female labor force participation is changing worldwide. One striking trend is the growing presence of older women who remain actively engaged in the workforce. While younger women have historically led the rise in female workers, the participation rate of women aged 55 and over is climbing steadily in many developed countries. For example, in the United States the rate for women aged 55-64 rose from 56.6% in 2003 to 59.6% in 2023, and for those over 65, it jumped from 10.6% to 16.0% in the same period (Bureau of Labor Statistics, 2024). Similar trends have been observed in Norway and Sweden, the countries that we study. For Norway, the rate for women aged 55-64 rose from 66.86% in 2011 to 70.12% in 2022, while for Sweden, it rose from 75.99% in 2011 to 81.72% in 2022 (ILO),[1] with the female participation rate for older women matching the rate for males (Laun and Palme, 2018).

These trends, combined with aging population and rising retirement ages, imply that many more women than ever will be working during the menopausal transition and in their post-reproductive years. Menopause is a natural biological process typically occurring between the ages of 45 and 55, and it is marked by the cessation of menstruation, which defines the end of a woman's reproductive life. However, not all women are affected in the same way: there is substantial variation in the duration of the menopause transition, the age at onset of natural menopause, and the number and severity of menopausal symptoms experienced (Talaulikar, 2022).[2] Age at menopause is influenced by multiple factors, both modifiable (such as diet, exercise levels, smoking status, body mass index) and not (e.g. socio-economic background, ethnicity, and concurrent medical/gynaecological health issues) (Schoenaker et al., 2014). Hence, each woman's experience of the menopausal transition is unique.

Two recent reviews (Theis et al., 2023; Verdonk, Bendien and Appelman, 2022) have documented strong negative associations between the presence and the severity of menopause symptoms with job performance, productivity, motivation and commitment to work, as well as overall quality of life; and both reviews point out the scarcity of studies linking menopause, health and work. Crucially, there is a dearth of studies estimating the health and productivity costs of menopause, for individuals, for employers, and for society at large. One of the first attempts is Bryson et al. (2022), who show that the onset of menopause before age 45 (referred to as "early menopause") reduces employment rates by 9 percentage points (around 4 months of employment) for women in their early 50s, with larger effects associated with more severe symptoms.[3] However, there is no such evidence available to date on the labor market, health and social welfare costs of "normal-age" menopause. This study is a first attempt to fill this

[1] See https://www.ceicdata.com/en/sweden/labour-force-participation-rate-by-sex-and-age-annual and https://www.ceicdata.com/en/norway/labour-force-participation-rate-by-sex-and-age-annual

[2] Common symptoms include vasomotor (hot flashes and night sweats), genitourinary, and psychological symptoms (mood swings), and cognition (memory problems) and sleep difficulties.

[3] In a related strand of work, Daysal and Orsini (2015) study the effects of the release of the findings of the Women's Health Initiative Study (WHIS) on uptake of Hormone Replacement Therapy (HRT, the most effective treatment against menopausal symptoms) and on preventive healthcare use.

gap.

In this paper, we use high-quality register administrative data from Norway and Sweden, combined with a difference-in-differences design, to estimate the impact of menopause on employment and earnings, reliance on social safety net programs, demand for medical care, and marriage stability. Our identification strategy exploits the differential timing of menopause diagnosis, precisely determined via detailed diagnostic codes from medical records. We then estimate the effects of menopause via an event study approach akin to that used in the child penalty (Kleven, Landais and Søgaard, 2019; Andresen and Nix, 2022) and health shocks (Fadlon and Nielsen, 2019, 2021) literature: such design allows us to construct counterfactuals for diagnosed women using women who experience the same diagnosis a few years later. Since recent work shows that variation based on treatment timing might cause bias within a traditional two-way fixed effects model in the presence of heterogeneous effects over time (de Chaisemartin and D'Haultfœuille, 2020), we rely on a stacked difference-in-differences approach: this prevents previously treated units from being used as controls in a staggered treatment design (Gormley and Matsa, 2011; Cengiz et al., 2019; Deshpande and Li, 2019; Baker, Larcker and Wang, 2022). We then assess the robustness of our main findings using alternative methods proposed by Borusyak, Jaravel and Spiess (2024) and Callaway and Sant'Anna (2020).

Our analysis leverages long panels of administrative Scandinavian data, which cover the Norwegian and Swedish population and include health care use (contacts with primary care and specialist providers, inpatient and outpatient hospital use, prescriptions), labor market outcomes (earnings, hours worked), and social safety net use (unemployment and disability insurance). We begin by documenting the average effect of menopause on health, labor, and welfare outcomes. Menopause causes a sharp and short-term increase in the number of primary care and specialist doctor visits, but a longer-run increase in drug utilization, driven by medication used to alleviate the physical and mental health symptoms (namely, Hormonal Replacement Therapy and antidepressants). In terms of economic outcomes, there is a persistent decline in employment and earnings, coupled with an increased use of social transfers. The reduction in earnings amounts to 20% relative to the pre-menopause level – a similar magnitude to that found for studies on the child "penalty" in the same contexts (Angelov, Johansson and Lindahl, 2016; Andresen and Nix, 2022). We then document heterogeneity by women's education level and workplaces characteristics: the negative impacts are concentrated in women without a college degree and those employed in workplaces which are larger or with a smaller share of female coworkers aged 45 or older.

This paper contributes to several literatures. First and foremost, our central contribution is to provide evidence on the causal impacts of menopause on women's economic outcomes. Despite the fact that menopause affects half of the world's adults, our current understanding of its consequences for women's economic lives is extremely limited.

Second, we contribute to a broader interdisciplinary literature on the consequences of menopause for women's health. While the medical literature has documented associations between the tim-

ing and symptoms of menopause with women's physical and mental health (see, e.g., Georgakis et al. (2016); Muka et al. (2016)), evidence is scarce on the causal impacts of menopause on women's health and wellbeing – a fact that a 2023 bipartisan Congress bill in the U.S. entitled *The Menopause Research Equity Act* seeks to address, by directing the National Institutes of Health to evaluate its past and present support for menopause research (Clarke, 2023). While this bill illustrates that economics is not alone in its negligence of menopause, it also further underscores the importance of using high-quality administrative data to document the wide-ranging consequences of menopause for women's economic lives, health, and well-being.

Third, in sharp contrast to the dearth of literature on the effects of the *end* of fertility, an extensive literature has documented the career costs of the *onset* of childbearing, across a variety of contexts (Angelov, Johansson and Lindahl, 2016; Kleven et al., 2019; Andresen and Nix, 2022). The long-run child penalty found in the literature for Norway and Sweden is of a similar magnitude to the long-run menopause penalty that we document. A key distinction, however, is that only a subset of women experience the child penalty – women have at least some control over fertility – whereas almost all women (eventually) go through menopause. Additionally, while economists have significantly advanced our understanding of the increased participation of women in the labor market in the last decades (Goldin, 2006), we still know very little about the multiple factors that might push women out of the labor force: and our results suggest that menopause might constitute one critical factor.

Fourth, our paper relates to a broader literature that analyzes the impact of health shocks on labor market outcomes. Consistent with human capital models, the level of health influences the amount and productivity of labor supplied to an economy (Grossman, 1972). The literature has convincingly documented substantial effects of improved health on labor market outcomes (Stephens Jr and Toohey, 2022), and the damaging economic consequences of adverse health shocks (Dobkin et al., 2018; Fadlon and Nielsen, 2021). However, the economic consequences of female-specific health shocks have been largely neglected to date.

Fifth and most broadly, an extensive literature studies the labor market impacts of productivity shocks that affect both men and women (often predominantly men), such as unemployment (see, e.g., Jacobson, LaLonde and Sullivan (1993); Lachowska, Mas and Woodbury (2020)). We contribute to this literature by documenting that menopause – a shock that affects 20 percent of the US workforce[4] – has as large and persistent impacts as displacement in the long-run. Hence, menopause is not only a female-specific health shock, but for many women also a substantial productivity shock. This highlights that women lag behind men, not only in their labor force participation (Goldin, 2006), their pay (Goldin, 2014), and the share who reach top professions (Goldin, 2021), but also in the attention that economists have devoted to female-specific productivity shocks.

[4] https://www.dol.gov/agencies/wb/data/latest-annual-data/working-women.

2 Institutional Background and Treatment Recommendations

Menopause is the point in a woman's life when she stops menstruating and can no longer become pregnant; it commonly occurs around the age of 50. The technical onset of menopause occurs when a woman has gone 12 months without a menstrual period, though symptoms can start earlier, during a period called perimenopause[5] (or menopausal transition), and can last for years. There are a wide range of potential symptoms associated with menopause, including night sweats, joint aches and pains, hot flashes, trouble sleeping, fatigue, palpitations, dizziness, severe headaches and migraines, irritability and mood swings, anxiety and depression, panic, forgetfulness and poor concentration; women can experience one or more of these symptoms, and can suffer mild or severe instances of them (Mishra and Kuh, 2012; Kuh, Wadsworth and Hardy, 1997).

Treatment Recommendations in Norway and Sweden Hormone Replacement Therapy (HRT, also known as Menopausal Hormone Therapy, MHT) remains the most effective treatment for menopausal symptoms (Davis and Baber, 2022). The Norwegian and Swedish Gynecological Associations follow similar treatment recommendations for women with certain symptoms such as hot flashes, night sweats, low mood, and musculoskeletal problems. HRT treatments consist of tablets containing oestrogen only, or a combination of estrogen and progestogen, as well as skin patches, gels and creams. The recommendation is to provide the lowest possible dose that alleviates symptoms.[6]

More specifically, Hormone Replacement Therapy is recommended to women (1) who suffer from hot flashes, night sweats, or other estrogen deficiency symptoms and (2) for women with early menopause (i.e., before 45 years old) or premature ovarian failure until at least the expected age of menopause if there are no contraindications. The recommendation is to start the treatment as early as possible after menopause, and before the age of 60. Such recommendations are based on the positive effects on quality of life, sleep, bone density, fractures, cardiovascular disease, and diabetes. However, the therapy is either not recommended or used with caution for women with some medical conditions.[7]

As we discuss below (subsection 3.2), prescription level data is available for Sweden. Appendix Figure A.1 shows the pattern of HRT initiation among 40 to 60 years old Swedish

[5] https://www.mayoclinic.org/diseases-conditions/perimenopause/symptoms-causes/syc-20354666

[6] For the Norwegian and Swedish recommendations see, respectively https://www.legeforeningen.no/foreningsledd/fagmed/norsk-gynekologisk-forening/veiledere/veileder-i-gynekologi/overgangsalder-menopause/ and https://www.sfog.se/media/337273/mht-sfog-raad-210121.pdf.

[7] HRT is not recommended for women with breast cancer, estrogen-sensitive malignant conditions, vaginal bleeding of unknown cause, venous thromboembolism or coronary heart disease, active liver disease or *porphyria cutanea tarda*. Caution is advised for women with diabetes with possible vascular problems, with a previous or increased risk of venous thromboembolism, gallbladder disease, previous endometrial cancer or some other conditions that may be worsened by used of therapy such as asthma, epilepsy, migraines, lupus, hepatic hemangioma and dementia.

women. This figure shows a remarkable reduction in the initiation rate between 2006 and 2016, with a sudden trend reversal in 2017 – the year a new position statement was issued by the North American Menopause Society.[8]

Healthcare system in Norway and Sweden The healthcare systems are fairly similar in Sweden and Norway. While details vary across the two countries, both systems are almost exclusively publicly funded through taxation, and hospitals are publicly owned and managed. General practice doctors (GPs) act to some degree as gatekeepers to specialist services, and in both countries there are out-of-pocket co-payments for GP consultations, with upper limits (but consultations for children are often free). The number of doctors per 1,000 inhabitants is rather similar in Norway and Sweden: 5.2 vs 4.3; also per capital health spending is similar: $7,771 vs $6,438, respectively, in Norway and Sweden.[9]

The healthcare system in Norway is split into two levels, with local municipalities providing primary care services and larger health regions providing specialist care. Municipalities are responsible for delivering first-line health care services, including GPs, emergency rooms (ERs), infant and child health care centers, school health services, and elderly care. Specialist care is the responsibility of four health regions and includes specialist care, psychiatric health services, and private referral specialists contracted by the health regions. Except in case of emergencies, Norwegian GPs represent the first point of contact between patients and the healthcare system, and are responsible for initial examination, treatment, diagnosis, medication prescription, and sick leave validation. When necessary, the GP refers patients to receive specialist care.[10] GP consultations typically a have co-payment of approximately $20 or 210 Norwegian Kroners (NOK), with total out-of-pocket cost-sharing capped at 2200 NOK per year. As in Norway, the healthcare system in Sweden is decentralized. The main responsibility for financing, organizing and providing health care is delegated to 21 counties.[11] Patients generally incur very low out-of-pocket costs, with some variation across counties. Primary care is often provided through local primary care centers (in Swedish: *vårdcentraler*), where patients see GPs or other health professionals for medical examinations and treatment of most common conditions. If necessary, the primary care providers refer patients to specialists. Patients may also request specialist care without any referral; this may result in a higher cost and longer waiting time (Socialstyrelsen, 2020).[12]

[8] https://journals.lww.com/menopausejournal/abstract/2017/07000/the_2017_hormone_therapy_position_statement_of_the.5.aspx

[9] See Holm, Liss and Norheim (2004) and https://data.oecd.org/health.htm.

[10] Nevertheless, there documented heterogeneity in use across the country (see, for example, Godøy and Huitfeldt, 2020).

[11] The responsibilities of 290 municipalities include financing, organizing and providing health care in ordinary and special housing for elderly people and people with functional impairments, and health care in schools.

[12] Some primary care centers, clinics, and hospitals are privately run, but incorporated into the public health care system and publicly funded. A small subset of private providers also serve patients who have supplemental private health insurance.

3 Empirical Strategy and Data

The data used in this paper is compiled from several Norwegian and Swedish administrative records, including tax records, social security records, employer information, family registers, and health registers. In our main sample of analysis, we consider women born between 1961 and 1968 who have a menopause-related diagnosis between ages 45 and 55; this diagnose could have been performed either by GP or by a specialist physician (a gynecologist). We also extend our analysis to women that have an early diagnosis of menopause between the ages of 40 and 44 (born between 1966 to 1971), to whom the Norwegian and Swedish Gynecological Associations recommend to prescribe hormone replacement therapy.

3.1 Data: Norway

Individual level information comes from several administrative registers maintained by Statistics Norway. These registers cover the entire resident population in Norway between 1967 and 2020, and include demographic information such as date of birth, gender, immigration status and municipality of residency in each year, and socioeconomic data, such as education and earnings. All registers include unique individual identifiers that allow to match individuals across administrative registers and to match each individual to their parents and other relatives.

Information on individuals' education is obtained from administrative registers of the Norwegian school system, which include information on each degree an individual completed since 1970. Labor market outcomes are obtained from the tax and employer registers that are available up to 2020. Employment is defined as having earnings strictly positive earnings in a given year, but we also test the sensitivity of our results using alternative definitions.[13] Information on welfare dependency comes from the Social Security database, which is used to construct an indicator of whether an individual received any welfare benefits each year and the amount received. Welfare benefits include include regular and early retirement pensions, disability benefits, unemployment benefits, sick pay and parental allowance (these are taxable benefits); and tax-free transfers, that include child benefits, housing benefits, study grants, dependent deductions, social assistance, and cash support. We also study separately the impacts on the benefits relevant to the population studied, namely, unemployment benefits, disability income and sick leave.[14]

[13] We also consider employed as defined by earnings above the administratively set basic amount. The basic amount, denominated as G-level, is adjusted each quarter of the year, and are used to determine eligibility in the national social security system. In 2014 one G amounted to approximately $12,000.

[14] Social assistance is temporary income given as a last resort when a person is considered unable to financially support himself/herself. Unemployment benefits are given to active job seekers. Individuals considered active job seekers must have earned at least 1.5G the last year, or 3G over the last three years. The work assessment allowance provides a partial income replacement in periods during which individuals are ill or injured and need assistance from the Norwegian Labor and Welfare Administration to return to work. The allowance is given for a maximum of 3 years. Finally, disability insurance is given when an individual's earnings capacity is permanently reduced due to illness or injury; to be eligible, individuals must be below 67 years of age and it typically is preceded by 12 months of sick leave if the individual is working. All monetary values are deflated to 2015 using

Health data comes from several administrative registers on the use of primary and specialist health care use. GPs and ERs physicians in Norway are obliged to report all services provided and actions taken during each consultation, including the main symptom or diagnosis, exams, referrals and certified sick leaves to this national claims database to receive payment. This dataset is called the Control and Payment of Health Refunds database (acronym "*KUHR*" in Norwegian) and is available between 2006 and 2021. Using these data, we study impacts of menopause on the probability and number of visits to GPs and primary care ERs, the examinations performed and medical assessments during each visit. Additionally, the KUHR includes the list of symptoms and diagnoses following the International Classification of Primary Care (ICPC-2), which allows us to recover the exact timing of menopause-related diagnoses, in particular, those coded as "X11 - Menopausal symptom/complaint" and "X12 - Postmenopausal bleeding".[15]

Specialist care is provided mainly through public hospitals and outpatient care clinics, but it can also be provided by contracted private specialists. Information on the use of such services is obtained from the Norwegian Patient Registry (NPR) and is available between 2008 and 2020. These allow us to study the impacts on hospitalizations (inpatient admissions) and consultations at outpatient clinics.[16] We also identify acute admissions and the medical conditions diagnosed at the admission, following the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). From the Norwegian Patient Registry we gather information on whether women who are diagnosed by specialists with "Menopausal and other perimenopausal disorders" (ICD-10 code N95).

Therefore, we use the information collected from the KHUR and the NPR to determine first date of a menopause diagnosis, which could have been assessed either by a general practitioners, by physician at a primary care emergency room or by a specialist.

3.2 Data: Sweden

Next, we create analogous data for Sweden, with two important differences. First, in Sweden we are able to observe individual-level drug utilization. Second, in Sweden we do *not* observe primary healthcare visits; thus, we only observe menopause-related diagnoses that arise either in the specialist outpatient healthcare system or in inpatient care. We discuss these institutional differences between Norway and Sweden above.

The core of this data is an extract from the Swedish Population Register of all individuals residing in Sweden from 2000 through 2016 (Skatteverket, n.d.). To obtain information about gender, income, and educational attainment, we merge in data from Statistics Sweden's longitudinal database of individuals (LISA) from 1990 through 2019, which contains information

the CPI (https://www.ssb.no/en/statbank/list/kpi).

[15] See https://ehelse.no/kodeverk/icpc-2e–english-version.

[16] An inpatient admission includes both overnight stays and day treatments, such as less invasive surgical procedures.

drawn from various administrative records (Statistics Sweden, 2019). We can link individuals to their spouses using marital records and, from 2011, also to cohabiting partners using information about shared addresses. From here on, we refer to a person's spouse or cohabiting partner as the person's partner.

To construct measures of HRT utilization and health outcomes, we merge in health records from the National Board of Health and Welfare (Socialstyrelsen, 2019), which we refer to as "the Board". For each individual, we observe the universe of prescription drug purchases made in outpatient pharmacies from July 2005 through 2019. For each purchase, we observe the name of the drug and the drug's seven-digit Anatomical Therapeutic Chemical (ATC) classification code. We also observe the universe of inpatient hospital visits and specialist outpatient visits from 2002 through 2019. For each visit, we observe the date of the visit and the diagnosis codes (ICD-10) attached to the visit.

We create a measure of onset of menopause that is similar to the measure used in the data from Norway, namely, the woman's first healthcare visit with a menopause-related diagnosis (note, though, that in Sweden this captures only diagnoses from visits at specialists, not GPs).

We use these data sources to define our key outcome variables for women in our sample and their partners. First, we use our LISA variables to create annual measures of key economic outcomes. The first and central economic outcome is work-related earnings, which is analogous to the Norwegian measure and includes all earnings from employment and self-employment. We also create two outcomes that capture pathways out of employment for individuals who are near, but not at, retirement age: total unemployment insurance (UI) receipts and total disability insurance (DI) receipts. UI receipts include regular UI payments as well public payments of benefits that compensate unemployed individuals for participation in re-training programs. Receipt of DI is the most common pathway out of the labor force for individuals who exit before the normal retirement age in Sweden (Jönsson, Palme and Svensson, 2012). We also construct a final economic variable that captures the total impact of all earnings and social transfers: total disposable income. This is a measure constructed by Statistics Sweden that takes into account all earnings, benefits, and transfers to the individual, and thus gives us the best estimate of the total economic situation.[17]

Second, we use prescription drug records to capture women who initiate HRT treatment. To do this, we create a list of all ATC codes for HRT drugs. We define a woman as initiating HRT treatment on day d if she fills an HRT prescription for the first time in one calendar year (365 days).[18]

Third, we use our health care records to create health outcomes that capture mental and physical wellbeing at the quarterly level, as well as the receipt of certain drugs. Specifically, we

[17]Monetary variables are measured in 100s SEK and deflated to 2012.

[18]The ATC codes of HRT drugs are the following: G03CA03, G03CA57, G03CX01, G03FA01, G03FA12, G03FA15, G03FA17, G03FB05, G03FB06, G03FB09 (Lindh-Åstrand et al., 2015). If a woman satisfies this definition more than once, we use only the first initiation.

create an indicator variable for any drug claims in the category antidepressants.[19] Further, we use our specialist outpatient and inpatient records to create indicator variables for any specialist outpatient visit and the total number of outpatient specialist visits.

We also use LISA to define sociodemographic characteristics, including a categorical variable indicating the individual's municipality (kommun) of residence as of the preceding year and a categorical variable indicating the individual's highest level of completed schooling (i.e., no college, some college, completed college) as of the preceding year.

3.3 Definition of Samples in Norway and Sweden

Throughout our analyses, we use similar samples for Norway and Sweden. Since the different datasets used cover different periods, we clarify here the exact samples used. First, we rely on annual panels for the economic outcomes studied in Norway and Sweden, that is, labor market outcomes and use of social benefits, from 2001 through 2019. We focus on women who are born between 1961 and 1968 and who have a menopause diagnosis when aged 45 through 55, i.e. if that diagnosis occurs in or after the first quarter of 2006 and by the end of 2015 (as we have a 4 year post period and the data ends in 2019; see subsection 3.4 below).

Second, for Norway we use an annual panel dataset for visits to primary and specialist health care services between 2006 and 2021. Our sample covers women born between 1961 and 1968 and who have a menopause diagnosis when aged 45 through 55, i.e. if that diagnosis occurs on or after the first quarter of 2006 and by the end of 2017. For Sweden, outcomes for health care use are measured from outpatient specialist records, which are available between 2001 and 2019. As for Norway, we use women who have a menopause diagnosis when aged 45 through 55 after the first quarter of 2006 (so that we have 8 quarters pre-diagnosis) and by the end of 2017 (as we have an 8 quarters post period).

Finally, we rely on the prescription records available in Sweden from third quarter of 2005 through 2019. Thus, for these outcomes we focus on women whose diagnosis occurs on or after Q3 2007 (so that we have 8 quarters pre-diagnosis) and Q4 2017 (as we have an 8 quarters post period).

3.4 Strategy

Almost all women who live long enough experience menopause. However, not all are medically diagnosed with menopause-related symptoms, so our main sample will not include all women that go through menopause. Instead, our main analytic sample includes all women who have a medical menopause-related diagnosis, with the first such diagnosis occurring between the ages of 45 and 55.[20] While the exact timing of menopause is impossible to predict, cer-

[19] Appendix A lists the exact ATC codes for all of our outcomes.

[20] While the most common cause of menopause is due to women aging out of fertility, menopause can also be induced as a consequence of surgical procedures that involve removal of both ovaries or medical interventions that

tain socio-demographic characteristics, health-related behaviors and genetic characteristics are correlated with age of menopause. Therefore, we build on an event study approach to identify the impacts of menopause akin to that used in the child penalty (Kleven, Landais and Søgaard, 2019; Andresen and Nix, 2022) and health shocks literatures (Fadlon and Nielsen, 2019, 2021), which allows us to construct counterfactuals for affected women using women that experience the same diagnosis but a few years later (Murabito et al., 2005).[21]

However, recent work shows that using variation in treatment timing can cause bias when using a traditional two-way fixed effects (TWFE) analysis, because the "already treated" groups are used as control group (de Chaisemartin and D'Haultfœuille, 2020; Borusyak, Jaravel and Spiess, 2024). This is not problematic if the treatment effect is constant over time, but if treatment effects change over time, then the early treated groups are not following the same trend as the later treated group. A stacked difference-in-differences or stacked event study overcomes such problems because it is equivalent to a setting where the events happen contemporaneously, thus it prevents the use of past treated units as effective comparison units (Gormley and Matsa, 2011; Cengiz et al., 2019; Deshpande and Li, 2019; Baker, Larcker and Wang, 2022). We then assess the robustness of our main findings using alternative methods proposed by Borusyak, Jaravel and Spiess (2024) and Callaway and Sant'Anna (2020).

Specifically, we define b as a potential age for the menopause (which we refer to as *base-age*). Then, for each woman, we define a panel of five years before the base age and four years after the base age. If the base age is the actual menopause age (or year), that panel is the treated-panel, while preceding base age panels are control-panels. Base ages after the menopause age are not included.

Each panel is a "sub-experiment," and the relative time in each "sub-experiment" is not relative to the shock of menopause, but relative to the base age which may or may not be the age (year) of menopause. We then stack the treated-panels and control-panels, where each observation is at the woman-by-base age-by-relative time level. This stacked difference-in-differences specification averages all of the time-varying effects into a single averaged effect, that is, we stack the event-specific data sets in relative time and calculate the average effect across all events using a single set of treatment indicators.

Thus, our basic estimating equation for the difference-in-differences models is:

$$y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta} \tag{1}$$

where y_{ibta} is an outcome for woman i in base age b, in year t, at age a. The coefficient of interest is β_1, and $Post_{ibt}$ takes value one if the woman's age is greater than the base age b, and 0 otherwise; $Treated_{ib}$ takes value one if woman i experience menopause in base age b,

cause cessation of ovarian function (for example, radiation therapy or chemotherapy).

[21] Cigarette smoking is the most established and consistently observed risk factor for younger age at menopause, with estimates of impact on the order of about 1 year (Harlow and Signorello, 2000; Kinney, Kline and Levin, 2006)

and zero otherwise. We include women-base age fixed effects (δ_{ib}), calendar year fixed effects (γ_t), and age fixed effects (η_a). Note that, in addition to the change in the data structure, the only difference in the estimation equation between the standard TWFE approach and a stacked regression alternative is defining the main variables within each event-specific dataset, so that unit- and time-fixed effects are saturated with indicators for dataset identifiers (e.g., δ_{ib}). The error term is ε_{ibta}.

We also estimate event study models that allow us to use years leading up to a diagnosis to test for any differential pre-trends and examine time-varying treatment effects. The estimating equation is:

$$\begin{aligned} y_{ibta} &= \alpha_0 + \sum_{\tau=-5}^{4} \alpha^{\tau} \Big(\mathbf{1}[t-b=\tau] \cdot Treated_{ib} \Big) + \sum_{\tau=-5}^{4} \zeta^{\tau} (\mathbf{1}[t-b=\tau]) \\ &+ \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta} \end{aligned} \tag{2}$$

where $\mathbf{1}[t-b=\tau]$ is an indicator for the time relative to the base age b, and all other variables are defined as above. The coefficients of interests are α^{τ}, which trace out the effect of menopause before and after menopause onset. Relative time -1 is omitted, so all estimate are relative to that period.

The difference-in-differences design identifies the causal effect of menopause diagnosis under the assumption that the trends in outcomes would be the same in the treated-panels as in the control-panels if women did not experience menopause (in the base-age of the treated-panel). Although this assumption cannot be tested directly, we conduct a variety of checks to support the validity of this assumption, using the fact that the time-to-event specification allows us to use the leading terms to assess potential preexisting trends in the outcomes studied.

The standard errors are clustered by woman-base year of diagnosis to account for woman-specific serial correlation in the timing of the diagnosis. That is, we cluster the standard errors at the unit of treatment assignment (Deshpande and Li, 2019).

For health outcomes studied in Swedish data – which we observe at a more granular level than the annual labor market outcomes – we construct analogous stacked panels at the quarterly level.

3.5 Basic Descriptive Statistics

We start by providing descriptive characteristics of the women in our sample from Norway, for whom we are able to identify menopause diagnoses from both GPs and specialists. Recall that the health data from where our treatment variable is identified are available from 2006 to 2021. Because women who are born in 1961 turn 45 in 2006, our main sample follows a group of women that are observed between 2006 and 2021 within the age range 45-55 at the onset of menopause. Figure 1 plots the distribution of age at the first menopause related diagnosis for women in Norway. On average they receive the first diagnosis at 50.15 years old (standard

deviation 3.65). This is similar for Norwegian women born during 1936–1939, the mean age is 50.31 years.[22]

While almost all women will eventually experience menopause, not all are medically diagnosed as such, so our main sample will not include all women who go through menopause. Of the 285,507 women born in Norway between 1961 and 1968, 105,109 received a diagnosis of menopause between the years of 2006 and 2021 and between the ages of 45 and 55. The majority of these diagnoses were assigned by a primary care physician (in 64.4% of the cases).

We next compare the women in our Norwegian analytic sample with other women in their cohorts. In Table 1, we present summary statistics taken at age 40, and thus before the usual ages of menopause for women with and without a menopause diagnosis (born between 1961 and 1968). Overall, given the time frame of the health registers (that start in 2006) we can construct summary statistics for 142,112 women. Of these, 42,305 (30%) receive a menopause diagnosis between ages 45 and 55 years old by a general practitioner or a specialist; 4,931 (3.4%) are diagnosed between 40 and 44 years old; and the remaining 65% either do not receive any diagnosis or receive it after age 55.

Table 1 shows that women in our main sample, who receive a menopause diagnosis between ages 45 and 55 years old, (column 1) are in general similar to women who do not receive any diagnosis (column 3), but have 0.7 less annual visits to GPs. On the other hand, women who have an early menopause diagnosis (column 2) use more health services and they are worse off in several socioeconomic dimensions than women without a diagnosis (column 3). In particular, women with an early menopause diagnosis have almost 50% more annual GP visits than women with a diagnosis between 45 and 55 years old; they have more visits with mental health-related symptoms or diagnoses; and each medical visit includes more expensive and time consuming medical evaluations, which translate into higher reimbursement cost per visit (129.8NOK/$12 vs. 106.8NOK/$10). Women with early menopause are less likely to have a college degree, their average annual earnings are lower by 41,000NOK/$3,800 (which is equivalent to a full month of work), and they take on average 2.5 more days of sick leave than women without a menopause diagnosis.

Since in the Swedish data it is not possible to identify visits to primary health care providers, so that the menopause diagnosis is obtained from outpatient specialist visits or hospital visits, we use the Norwegian data to compare women who are first diagnosed by a GP versus women first diagnosed by a specialist (see Appendix Table A.1). Women diagnosed by a GP have more contacts with primary care, are less educated, and have higher costs per visit, but they are similar to women diagnosed by a specialist in terms of income, hours worked, labor market participation and sick leave use.

Appendix Table A.2 shows that Swedish women who receive a diagnoses of menopause

[22] Gottschalk et al. (2020) report an average onset age of 52.73 years old using data from two self-administered questionnaires from women born during 1960–1964 who participated in the Norwegian breast cancer screening program (BreastScreen Norway) during the years 2006–2014.

from a specialist are on average similar to Norwegian women in terms of education and income.

4 Results

We now present our main findings. To do so, we rely first on the Norwegian administrative records, where it is possible to identify all primary and specialist care diagnoses. We then turn to the Swedish administrative records with a dual purpose. First, to test if the findings from Norway extrapolate to another setting, albeit among women who receive the diagnosis from a specialist; second, we are able to identify from the Swedish register the universe of prescriptions made by physicians (GPs and specialists), which provide us with drug-based measures of treatment of menopausal symptoms, as well as other conditions.

4.1 Main Sample: Menopause Ages 45 to 55 Years Old

Use of Health Care Services Panel A of Table 2 presents the estimates for β_1 from model 1 for several measures of health care utilization. β_1 measures the impact of the first diagnosis of menopause on outcomes during the subsequent four years. Column 1 shows that a diagnosis raises the number of GP annual visits by 0.16, which is equivalent to an effect size of 2.3% relative to the number of visits in the year prior to the diagnosis. Prior to the diagnosis, women visited their GPs on average 6.7 times per year, which is equivalent to a visit every 6 to 7 weeks. Column 2 of Table 2 shows that there are no effects on primary care emergency visits, while column 3 shows a small impact on the number of mental health-related visits. As expected, the increase in the number of primary care visits leads to an increase the overall value of reimbursements, by 50NOK/$4, which is economically small (column 5), but no changes in the cost per visit (column 6). Finally, a menopause diagnosis causes an increase in the extensive and intensive margins of specialist visits: there is a 1.9 ppt (5.7%) increase in the likelihood of at least one annual specialist visit, relative to a mean of 32.5% in the year prior to the diagnosis, and an increase of 0.05 (5.8%) in the number of specialist visits.

To trace the temporal pattern of these effects, we present in Figure 2 the estimates for the α^{τ}s from the dynamic DD event study model (equation 2). These figures all include the pre- and post-diagnosis outcomes allowing for a visual inspection of the validity of the parallel trends assumption. Panel A of Figure 2 shows that the increase in the number of GP annual visits in Table 2 (Panel A) is driven by an extra visit in the year of the diagnosis ($t = 0$). There are no changes in the use of primary care emergency room services (Panel B of Figure 2). During the year of menopause, annual reimbursements and the cost per visit also increase (Panels C and D of Figure 2), suggesting that the physicians engage in more extensive examinations during the year of diagnosis. Finally, all panels in the figure show that the estimates for α^{τ}s prior to the diagnosis of menopause are very close to zero, consistent with parallel pre-trends in the outcomes studied. This supports our main identifying assumption as it suggests that women

diagnosed at different ages would have had similar trends in outcomes in the absence of a menopause diagnosis.

In sum, the results in Table 2 and Figure 2 suggest that a menopause diagnosis is associated with a temporary change in the use of healthcare services in Norway, but no sustained impacts up to 4 years after the diagnosis.

Labor Market and Welfare Outcomes In Panel A of Table 3 we turn to the impacts of menopause on labor market outcomes. Despite the small effects on health care demand documented in Table 2 and Figure 2, the estimates in Table 3 show economically meaningful labor market effects of menopause. Earnings fall by 7% over the four years after menopause diagnosis. This earnings decline is driven by a combination of extensive and intensive margin effects: there is a 0.5 percentage point decrease in the likelihood of working and 0.5% decrease in the hours worked among women are employed. Panels (A) to (C) of Figure 3 plot the estimates from the associated event studies. They indicate that the labor market effects grow over time and show a persistent separation from the labor force in the post-diagnoses years. The reduction in earnings reaches 20% four years after the medical diagnosis, a magnitude that is similar to the child penalty in Norway, documented by Andresen and Nix (2022).

Turning to the use of the social safety net, column (5) of Table 3 (Panel A) shows no impacts on the number of days on sick leave, while column (6) shows an increase in the amount of social benefits received (about 1.2% relative to the pre-diagnosis level). Panel (D) of Figure 3 reveals that the time-varying effects for social transfers are similar in magnitude, but in the opposite direction, to that of the labor market outcomes. Thus, increased social transfers make up for the earnings decline in these women's lives. Next, in Appendix Table A.3 we explore several common pathways out of employment for individuals who are near, but not at, retirement age in Norway:[23] unemployment insurance (UI) and disability insurance (DI). The increase in social transfers is driven by an increase in disability insurance benefits, but not in unemployment benefits. Over the 4 years after menopause diagnosis, the likelihood of being on DI increases by 4% and the amount of DI benefits increases by approximately 6% of the baseline mean. The impacts on DI – the most common pathway out of the labor force for individuals who exit before the normal retirement age in Norway (and Sweden) (Jönsson, Palme and Svensson, 2012) – are especially noteworthy. They suggest that one important driver of the economic effects of menopause are that menopause-related symptoms cause women to adjust their labor market participation in a way that is consistent with an accelerated but gradual path towards retirement.

The results in Figure 2 and Figure 3 raise an interesting question. How can we reconcile the large and persistent labor market impacts of menopause with the apparent absence of persistent impacts on the use of healthcare services? To understand these patterns, we turn Swedish administrative records,where we are able to trace healthcare services also using drug data.

[23] These benefit programs operate similarly in Sweden.

4.2 Use of Health Services and Well-Being

Before turning to the drug data from Sweden, we start by comparing the impacts of menopause in Norway and Sweden using outcomes that we observe in both countries. To do so, we construct consistent samples in both countries, by including all women who get the menopause diagnosis at either an outpatient specialist visit or inpatient visit (in the main Norwegian analysis, we also use diagnosis at GPs, which we do not observe in the data from Sweden).[24]

We first present results on the impact of menopause on annual economic outcomes, in Figure 4. The Figure shows that there are large and persistent economic effects of menopause. First, Panels (a) and (b) show that work-related earnings fall substantially in both countries. Panels (c) and (d) also indicate that the impact on social transfers is similar in the two countries. Specifically, panel (c) shows that, in Norway, the use of social transfers increases after menopause. Next, panel (d) shows that in Sweden, disposable income – which is the sum of earnings and social transfers – declines less than earnings decline upon menopause.

Second, because we observe diagnoses made by both GPs and specialists in Norway, we can compare the estimates within Norway for women diagnosed by specialists only (as in our Sweden sample) to our estimates for women diagnosed by either a GP or specialist (main analysis above). As discussed in subsection 3.5, women diagnosed by a GP have more contacts with primary care, are less educated, and have higher costs per visit at age 40 (i.e., prior to the diagnosis; see see Appendix Table A.1). This suggests that women whose first diagnosis is performed by a specialist may have more severe symptoms. This is consistent with a comparison of the estimates in panels A and B of Table 2 and Table 3, respectively. Specifically, panels A and B of Table 2 show that while women diagnosed by a specialist experience no changes in visits to their GP, there is an increase in the cost per visit (column (6) of Panel B), and a relatively larger increase in the number of visits to specialists (columns (7) and (8) of Panel B). Further, in terms of labor market outcomes, Panels A and B of Table 3 reveal larger impacts on earnings, labor force participation, and the use of sick leave days and benefits among women diagnosed by specialists.

Use of Health Services and Prescriptions in Sweden We now return to the question that we briefly discussed above: Reconciling the large and persistent labor market impacts in Figure 3 – one of the central results of this paper – with the temporary effects on the use of healthcare services in Figure 2. One potential mechanism behind these results is that menopause-related symptoms are persistent – as the labor market effects – even though we do not see a persistent impact on the measures of healthcare consumption that we observe in the Norwegian data. This is particularly plausible in the context of menopause, as the *initiation* of HRT drugs occurs through a connection with the healthcare system (which would show up in our administrative records from Norway), whereas continuation of drug therapy would not necessitate a

[24] We use exactly the same cohorts. Thus, to construct the "comparison sample" in our data from Norway, we simply remove the women from our Norway sample who receive their menopause diagnosis in primary care.

new healthcare visit.

To shed light on this potential mechanism, we turn to our Swedish administrative records, where we observe individual-level drug as well as health care utilization. These results are presented in Figure 5 and Table 4 (note these results are at the quarter level, instead of the annual level, as we observe drug and health records at a much more granular level in Sweden). The time profile for the use use of outpatient services (Figure 5 – Panel A) is strikingly similar to the one found in Norway upon a menopause diagnosis. In Panels B to D of Figure 5, we show that upon a diagnosis, women not only take HRT to treat the physical symptoms of menopause, but more antidepressant drugs to treat the psychological symptoms.

Thus, when we are able to observe continuous drug utilization after menopause, the results clearly suggest that menopause-related symptoms, too, are large and persistent. These effects appear both when we look at drugs that treat the physical impacts of menopause (HRT drugs) and when we study drugs that treat the key mental health outcome that is treated with drug therapy in this age group of women.

5 Other Results

5.1 Household Dynamics

We now turn to investigating if a menopause diagnosis affects household dynamics, namely, by affecting divorce rates or the health and labor market characteristics of the husband. For these analyses, we rely on the Norwegian data, as we return to our broader sample that includes women who are diagnosed by their GPs. Table 5 shows a small reduction in the divorce rate of 1.3% (0.2 percentage points relative to divorce rate of 0.149 in the year leading up to the diagnosis). To examine if partners respond to the reduction in earnings of post-menopause women, we examine the labor market outcomes of the woman's husband following a menopause diagnosis. Columns (2) to (5) shows negligible labor market effects for the spouse, but still suggesting a reduction in labor market attachment (0.6% reduction on earnings and 0.1% reduction in employment) and no impact on husbands' health care use.

5.2 Early Menopause Sample: Menopause Before 45 Years Old

Appendix Table A.4 presents estimates for the sample of women who are first diagnosed with menopause before 45 years old (i.e., early menopause). Because of the time coverage of the health registers starts in 2006, this analysis uses women born between 1966 and 1971. Panel A shows, in general, no statistially significant impacts on the use of primary health care services (columns 1 to 5), while there is an increase of 2.1 percentage points in the likelihood of visits to specialist services (relative to a mean of 0.317). Panel B of the table show no statistically significant impacts on the labor market outcomes.

In Figure A.3 and Figure A.4 we present the event studies estimates. Figure A.3 shows that, as for women diagnosed between 40 and 45 years old, there is an increase in GP on the year of the diagnosis (Panel A), which has an associated more thorough medical assessments as revealed by higher cost per visit (Panels C and D). Turning to the labor market outcomes and use of social programs, Figure A.4 shows no impacts in the two years immediately after a diagnosis on the likelihood of full time work (Panel A), hours work (Panel B) or earnings (Panel C); however, three and four years after the diagnosis there is reduction in the extensive and intensive margins of labor supply, which results in a reduction in earnings of almost 20%.

The comparison of the labor market effects for women diagnosed with menopause at the usual ages of 45-55 versus before age 45 is interesting. Since early menopause occurs for a younger group of women, the end of their reproductive years could come as more of shock. On the other hand, the medical recommendation is to provide these women with hormone replacement therapy, which could mitigate the effects of menopause (see section 2). The smaller impacts we observe among early menopausal women may be driven by a combination of age at diagnosis and treatment.

5.3 Sensitivity Analyses

We now probe the robustness of our results to sample choice, empirical approach, and inference. First, we start by expanding the sample to include women born between 1956 and 1971, diagnosed between 45 and 55 years old. The estimates are presented in Table A.5 and are similar to our baseline results presented in Table 2 and Table 3. These results suggest that our main results are not driven by specific cohorts.

Second, in Panels A and B of Figure A.5 we estimate the effect of menopause using the efficient imputation estimator proposed by Borusyak, Jaravel and Spiess (2024) and Callaway and Sant'Anna (2020), respectively.[25]

Finally, in our baseline estimates, the standard errors are clustered at the woman-by-base age level (the level of treatment assignment) to account for serial correlation in the timing of diagnosis and outcomes. In Table A.6 we present estimates with standard errors clustered at the woman level instead of woman-by-base age level. Our results are not sensitive to the unit of clustering.

6 Heterogeneity and Mechanisms

To shed light on potential mechanisms, we now turn to testing if some groups of women are more affected by a menopause diagnosis than others. To do so, we re-estimate equation (1) allowing β_1 to vary along several dimensions. Specifically, we investigate how estimates vary

[25] We note that the estimator proposed by Borusyak, Jaravel and Spiess (2024) is more efficient than those in Callaway and Sant'Anna (2020) and de Chaisemartin and D'Haultfœuille (2020) under heteroskedasticity.

by the woman's level of education, by access to health-related information (see, for example, Aizer and Stroud, 2010; Chen, Persson and Polyakova, 2022; Finkelstein et al., 2022), and by workplace characteristics, which have been shown to affect the impact of family leave policies.[26] We then study the extent to which access to healthcare and menopause treatments (HRT) can ameliorate the impacts of menopause.

6.1 Heterogeneity

Education and Information We start by allowing the estimates in model (1) to vary by whether women have a college degree at age 40. In terms of health outcomes, Panel A of Table 6 shows that women with a college degree increase the use of GP services more than women without a college degree. We note that GP visits are elective and they are mostly demand-initiated. Columns (7) and (8) of the table show that the higher demand for primary care services among higher educated women translates into an increase in the probability, but not the quantity, of referrals to specialist services by the GP.

In Panel B of Table 6, we allow for differential effects of menopause for women with differential access to health-related information. We capture health-related expertise by flagging women who have a medical degree themselves or who have at least one direct relative (parent or sibling) with a medical degree. Interestingly, women with access to such health-related expertise do not change their use of primary health care services upon menopause diagnosis (columns 1-6), while women without access to health-related expertise increase their primary care utilization. There is no differential rate of referrals to specialist services.

Turning to labor market outcomes, Panel A of Table 7 shows that the negative labor market impacts are driven by women without a college degree. On the other hand, Panel B shows amplified negative labor market effects among women with medical expertise (either self or within the family), potentially suggesting that health-related expertise may help in navigating the DI system.

Workplace Characteristics and Peers In Table 8 and Table 9 we turn to the role of workplace characteristics and peers.[27] In particular, we consider the characteristics of the establishments of working women in the year of the menopause diagnosis. We allow the impacts to vary by sector of work (private and public sectors) in Panel A; by whether the woman is in a workplace with more workers than the median workplace (that is, 16 workers) in Panel B; by whether the woman is in a workplace with a high fraction of female co-workers (median workplace has 71% female workers) in Panel C; and by whether the woman is in a workplace with a high fraction of female co-workers of menopause age (median workplace has 37% female workers aged 45 or older) in Panel D.

[26] For example, Ginja, Karimi and Xiao (2023) show significant responses in smaller workplaces to a three months expansion of the duration parental leave in 1989 in Sweden.

[27] We use the terms establishments or workplaces interchangeably.

The estimates in Table 8 reveal little heterogeneity in health outcomes based on a woman's workplace characteristics at the time of menopause diagnosis. However, Table 9 shows interesting patterns for the labor market outcomes. Panel A of Table 9 shows that working in the public sector halves the negative impacts on earnings, the employment rate, and hours worked (60% of women work in the public sector at the time of the diagnosis;[28] see Table A.7). We note that the public sector, which is mostly comprised of the education and health sector, is financed by annual budgets, which leaves less margin for adjustments. Nevertheless, our impacts are aggregated over the four years subsequent to the diagnosis, which allows for at least some adjustments such as more flexible work arrangements.

In Panel B, the impact of a menopause diagnosis varies by workplace size.[29] The negative impacts on the employment and hours worked are driven by large workplaces; see columns (3) and (4). In large workplaces it might be easier to find appropriate substitutes for the diagnosed worker that is taking longer sick leaves (see column 5). Panels C and D allow the impacts to vary by demographic characteristics of peers; the estimates show that working in a firm with a high fraction of female peers eliminates the negative effect on the probability of full time employment.

6.2 Role of Access to Healthcare and Hormone Replacement Therapy

Next, we examine whether the impacts of menopause vary with the characteristics of the diagnosing GP. As menopause is inherent to women, we start by allowing impacts to vary by the gender of the GP. In Panel A of Tables 10 and 11, we consider a subsample of women who were part of the same GP list for two full years prior to their (first) menopause diagnosis, and who thus likely have an established relationship with their GP. The estimates show no differential effects on health or labor market outcomes by the gender of the GP.[30]

As mentioned in section 2, the most effective treatment for serious adverse symptoms of menopause is Hormone Replacement Therapy. Thus, we turn now to shedding light on the protective effects of HRT. We proceed in two steps. First, we start by using information on the prescription rate, which is available at the year-by-county (*fylke*) level in Norway,[31] and we allow the estimates for the diagnosis of menopause to vary by whether the woman is diagnosed with menopause in a county-year with HRT prescription rate above the national prescription rate. Panel B of Table 10 shows that high prescription areas are also associated more intense use of health services, translated into more primary and specialist visits (columns (1), (3), (7) and (8)), but also more costly medical examinations per visit (column (6)). Panel B of Table 11 shows that in high prescription areas there are smaller impacts on earnings and employment

[28]The share of women working in the public sector is similar in the other Nordic countries, namely, Sweden, Denmark and Finland; see https://doi.org/10.1787/22214399.

[29]We drop workplaces with one or two workers, which are associated typically with self-employment.

[30]These estimates should be interpreted with caution because individuals are allowed to change GPs at most twice per year.

[31]The information is available since 2004. See Appendix Figure A.2.

(see columns (1) and (2)). This may suggest some protective role of HRT. Nevertheless, one should be cautious when comparing high versus low prescription county-years, because of potential reverse causality as the prescription rate might be correlated with the health of the local population. In ongoing work we explore the protective roles of HRT using our much more granular individual-level administrative data from Sweden.

7 Conclusions

The dramatic increase in female labor force participation and the changing economic roles of women have been described as among the greatest advances in society in the last century (Goldin, 2014). The large-scale entry of women into the formal economy amounts to a momentous transformation of the labor market, and today women over the age of 50 drive employment growth in a range of countries (Goldin and Katz, 2018).

Yet, evidence is virtually nonexistent about the economic impacts of a major midlife health event in women's lives: the menopausal transition. Menopause marks the end of a woman's reproductive years, and in the years leading up to menopause as many as 85% of women begin to experience physical and mental menopause-related health symptoms – symptoms that often last for several years (National Institutes of Health). Today, 45 million women in the U.S. are between ages 45 and 55, when symptoms usually begin, and women near the menopausal transition are estimated to account for 20 percent of the U.S. workforce.[32] Coincidentally, around menopause age, women earnings drop faster than men's (see Appendix Figure A.6). In short, the period surrounding menopause is a long-lasting biological transition, which affects an overwhelming majority of all women and a fifth of the U.S. workforce; yet little is known about its causal impacts on women's economic lives, careers, health outcomes, and families.

This paper begins to fill this gap by providing causal evidence on the effect of menopause on women's careers, health, and marital well-being. Using administrative data from Norway and Sweden and leveraging stacked difference-in-difference designs and event studies, we document that menopause impacts multiple dimensions of women's lives. It causes a sharp, but short-lived increase in the number of primary care and specialist doctor visits, but a permanent increase in drug utilization – driven by medications used to alleviate the physical and mental health symptoms of menopause (namely, Hormonal Replacement Therapy and antidepressants). In terms of economic outcomes, we find large and persistent declines in employment and earnings, coupled with an increased use of social transfers. The negative impacts on the labor market and increased use of social transfers are concentrated in women without a college degree as well as women working in workplaces which are larger or with a smaller share of female coworkers aged 45 or older. These results point to the importance of policies supporting women who suffer more severe menopausal symptoms.

[32] https://www.nia.nih.gov/news/research-explores-impact-menopause-womens-health-and-aging.

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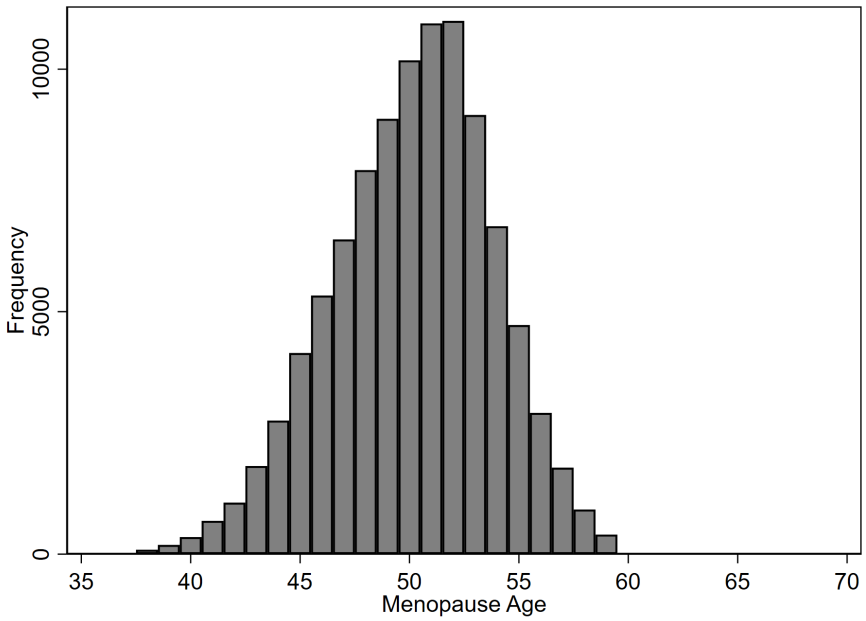
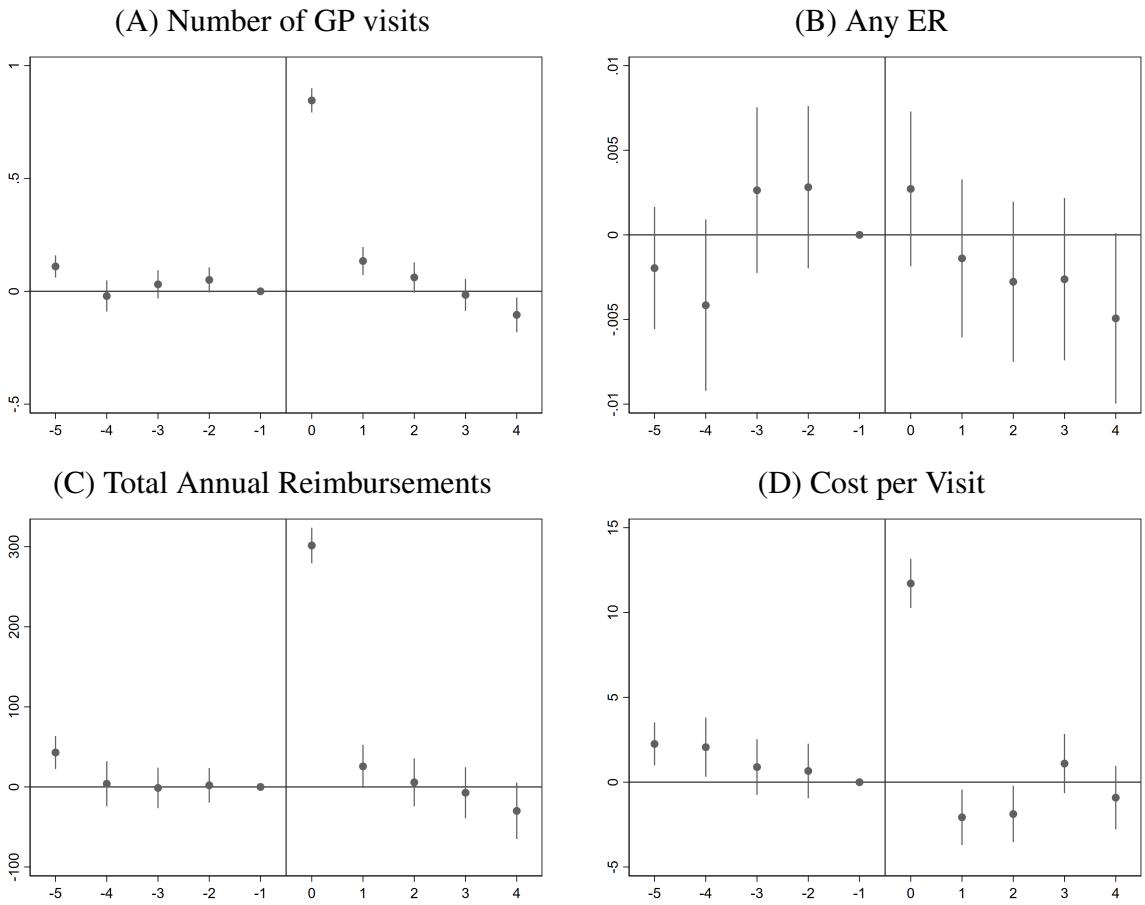
8 Figures and Tables

Figure 1: Distribution of Age At First Diagnosis in Norway



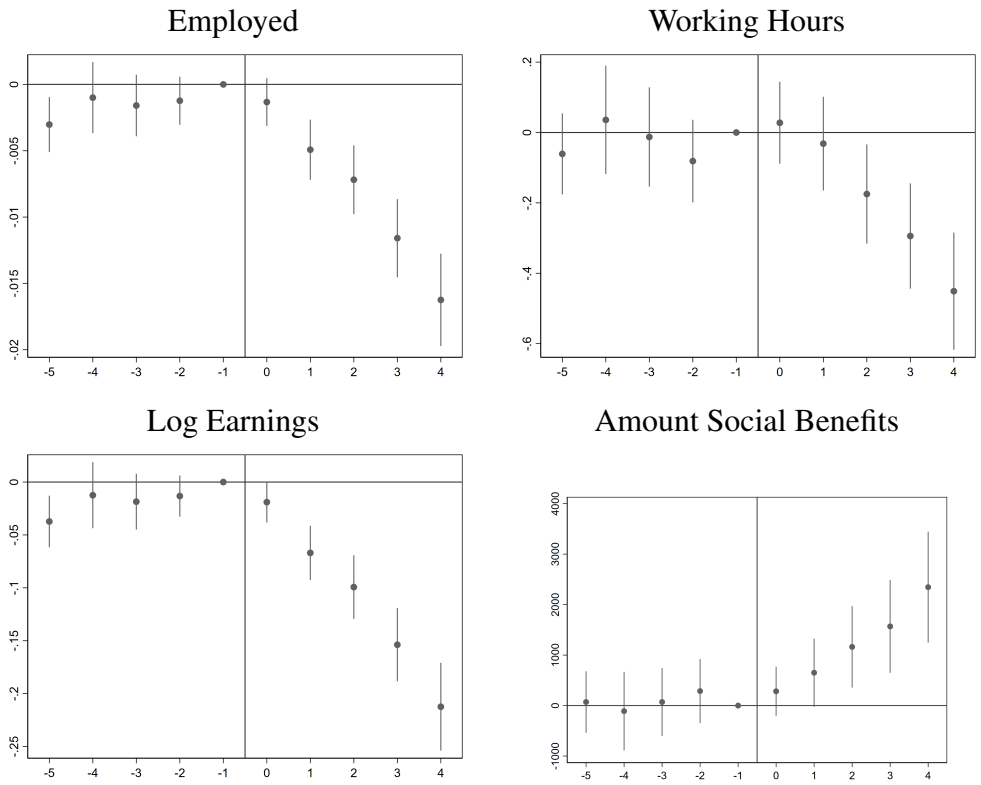
Note: This figure plots the distribution of age at the first menopause related diagnosis for all women born between 1961 and 1968 in Norway, between 2006 and 2021. Data source Norwegian register administrative data.

Figure 2: Event Study: Health Outcomes for Women with First Symptom Between 45-55 in Norway



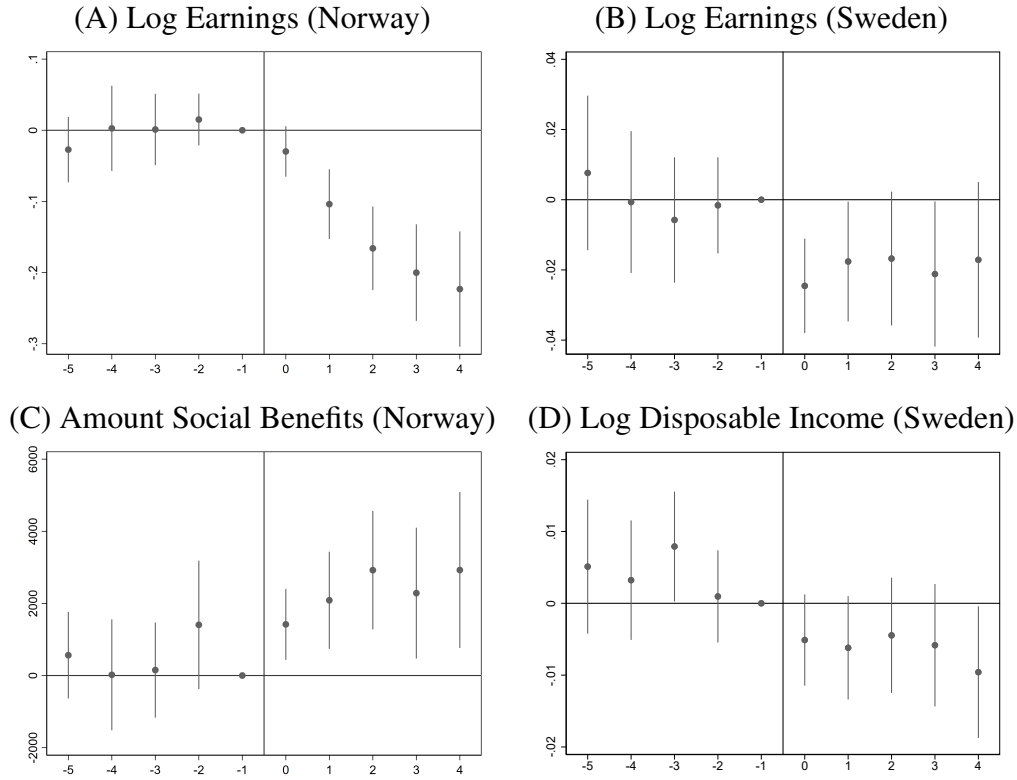
Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Norwegian register administrative data.

Figure 3: Event Study: Labor Market Outcomes and Take-Up of Social Transfers for Women with First Symptom Between 45-55 in Norway



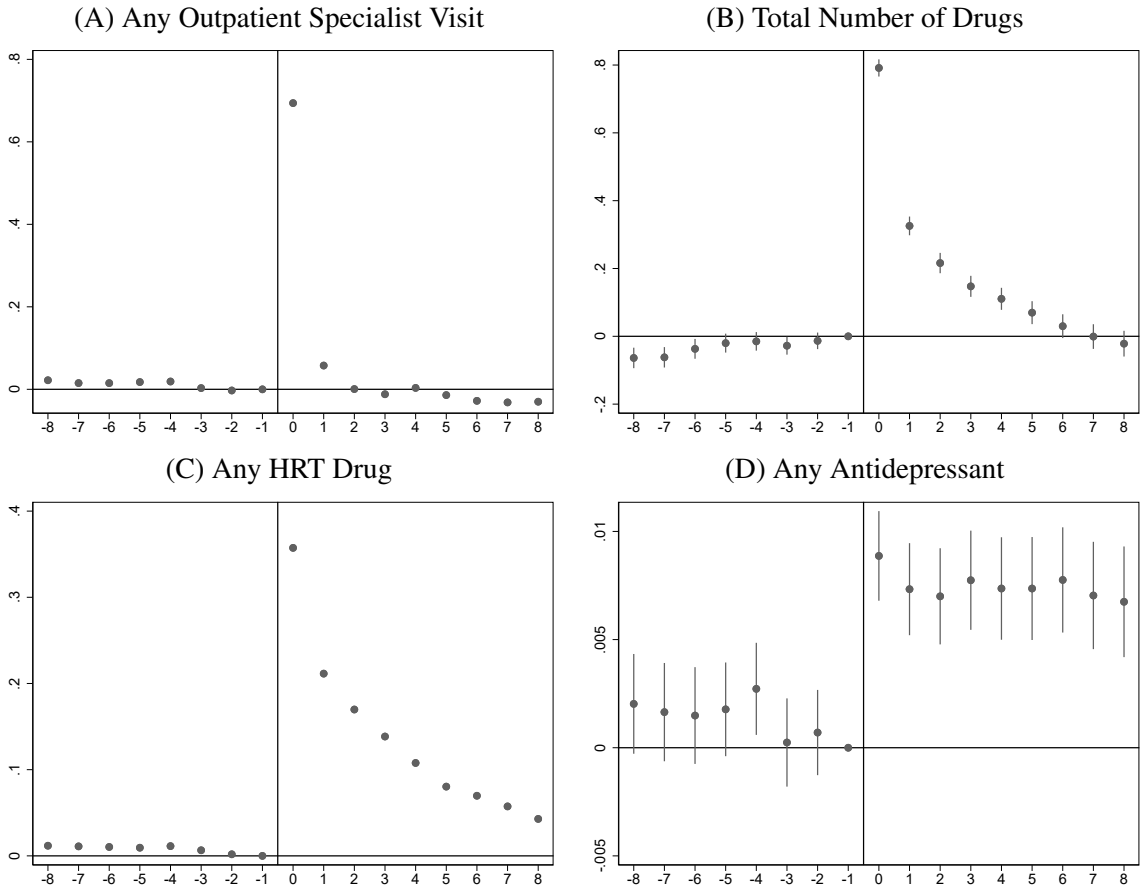
Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Norwegian register administrative data.

Figure 4: Event Study: Labor Market Outcomes for Women with First Symptom Between 45-55 in Norway and Sweden



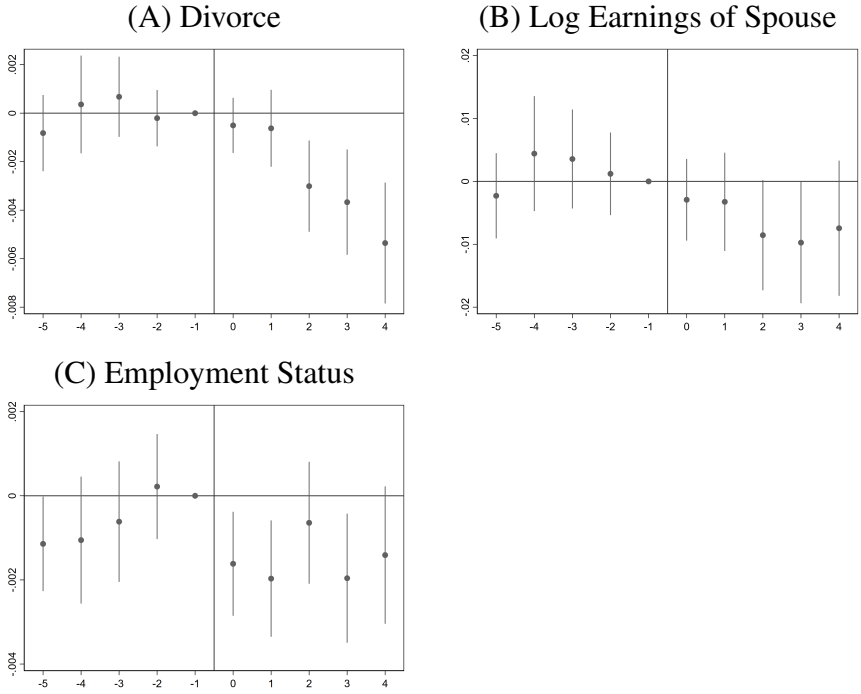
Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Norwegian and Swedish register administrative data.

Figure 5: Event Study: Health Outcomes for Women with First Symptom Between 45-55 in Sweden



Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Swedish register administrative data.

Figure 6: Event Study: Household Outcomes for Women with First Symptom Between 45-55 in Norway



Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Norwegian register administrative data.

Table 1: Selection Investigation: Characteristics at Age 40 for Women With and Without a Menopause Diagnosis in Norway

	(1) Main Sample (Menopause 45 - 55)	(2) Menopause before 45	(3) No Menopause	(4) Total
Any GP or ER Visits	0.810	0.882	0.760	0.779
Any ER Visits	0.222	0.269	0.211	0.217
Annual GP Visits	5.362	7.125	4.654	4.950
Annual GP Visits, Excl Mental Health	4.282	5.493	3.683	3.924
Annual Mental Health Visits	1.080	1.632	0.970	1.026
Medical Reimbursements (NOK)	1055.8	1425.8	886.4	955.6
Reimbursements per Visit (NOK)	117.3	129.8	106.8	110.7
Less than College	0.588	0.682	0.591	0.593
Earnings (NOK)	375731.1	325691.8	366740.7	367967.3
Full Time Emp (35+ hrs)	0.347	0.313	0.331	0.335
Sick Leave Days	21.22	23.11	18.71	19.61
Married	0.525	0.522	0.516	0.519
N	42305	4931	94876	142112

NOTE: This table includes the characteristics at age 40 for all women with and without a menopause diagnosis born between 1961 and 1968. Data at the women level. Data source Norwegian register administrative data.

Table 2: Difference-in-Differences: Health Outcomes for Women with First Symptom Between 45-55 in Norway

	(1) Annual GP Visits	(2) Any ER Visits	(3) Annual GP Visits Excl Mental Health	(4) Annual MH Visits	(5) Medical Reimbursements (NOK)	(6) Reimb. per Visit (NOK)	(7) Specialist Visits	(8) Any Specialist Visits
Panel A: Treatment includes Diagnoses by GPs and Specialists								
DiD	0.155***	-0.001	0.130***	0.025**	50.228***	0.648	0.049***	0.019***
	(0.020)	(0.001)	(0.018)	(0.012)	(9.644)	(0.424)	(0.010)	(0.001)
Control Mean	6.752	0.208	5.455	1.296	1479.240	152.949	0.851	0.325
N	4282885	4282885	4282885	4282885	4282885	4282885	4282885	4282885
Panel B: Treatment includes Diagnoses by Specialists								
DiD	0.023	-0.001	0.021	0.003	44.734**	2.289***	0.105***	0.048***
	(0.037)	(0.002)	(0.034)	(0.022)	(19.279)	(0.873)	(0.021)	(0.002)
Control Mean	6.649	0.201	5.447	1.202	1609.257	168.324	1.172	0.451
N	1266065	1266065	1266065	1266065	1266065	1266065	1266065	1266065

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Difference-in-Differences: Labor Market Outcomes for Women with First Symptom Between 45-55 in Norway

	(1) Log Earnings (+1)	(2) Employed (Earnings > 0)	(3) Weekly Hrs Worked	(4) Full Time Emp (35+ hrs)	(5) Sick Leave Days	(6) Social Benefits
Panel A: Treatment includes Diagnoses by GPs and Specialists						
DiD	-0.067***	-0.005***	-0.101**	-0.004***	-0.145	867.627***
	(0.012)	(0.001)	(0.045)	(0.001)	(0.185)	(309.128)
Control Mean	11.087	0.871	20.562	0.384	20.394	69428.322
N	4000240	4000240	3710845	3710845	4000240	4000240
Panel B: Treatment includes Diagnoses by Specialists						
DiD	-0.105***	-0.008***	-0.077	-0.004	-0.950***	1524.474**
	(0.023)	(0.002)	(0.087)	(0.003)	(0.357)	(624.088)
Control Mean	11.098	0.870	20.586	0.385	20.626	68933
N	1094130	1094130	1015254	1015254	1094130	1094130

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4: Difference-in-Differences: Labor Market Outcomes, Welfare Use and Health for Women with First Symptom Between 45-55 in Sweden

	(1)	(2)	(3)	(4)
	Panel A: Labor Market Outcomes and Welfare Use			
	Work Income	Disposable Income	UI (Broad)	DI
DID	-0.015	-0.007*	2.539*	5.797***
	(0.008)	(0.003)	(1.045)	(1.119)
Control Mean	6.972	7.771	55.594	106.605
N	4101660	4101660	4101660	4101660
	Panel B: Health Outcomes			
	Any Outpatient	Drugs	Any HRT	Antidepressant
DiD	0.068***	0.224***	0.133***	0.006***
	(0.001)	(0.011)	(0.001)	(0.001)
Control Mean	0.262	2.562	0.074	0.117
N	32241554	31830698	31830698	31830698

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Swedish register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Difference-in-Differences: Household Outcomes for Women with First Symptom Between 45-55 in Norway

	(1)	(2)	(3)	(4)	(5)
		Spouse Outcomes			
	Divorced	Log Income	Employed	Annual GP Visits	Any Specialist Visits
DiD	-0.002**	-0.006**	-0.001*	0.011	-0.004
	(0.001)	(0.003)	(0.000)	(0.022)	(0.011)
Control Mean	0.149	13.303	0.985	4.675	0.505
N	6097360	3825447	3836341	2253810	2253810

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Difference-in-Differences: Health Outcomes for Women with First Symptom Between 45-55 in Norway, by Education level and Relative with a Medical Degree

	(1) Annual GP Visits	(2) Any ER Visits	(3) Annual GP Visits Excl Mental Health	(4) Annual MH Visits	(5) Medical Reimbursements (NOK)	(6) Reimb. per Visit (NOK)	(7) Specialist Visits	(8) Any Specialist Visits
Panel A: By Education Level								
DiD	0.124***	-0.004***	0.104***	0.020	52.177***	0.558	0.054***	0.017***
	(0.027)	(0.001)	(0.024)	(0.016)	(11.944)	(0.506)	(0.011)	(0.002)
DiD×College (β_3)	0.068*	0.008***	0.058*	0.010	-9.575	0.207	-0.013	0.006**
	(0.039)	(0.002)	(0.035)	(0.022)	(19.854)	(0.884)	(0.022)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.030	0.000	0.068	0.008	0.300	0.038	0.000
N	4250265	4250265	4250265	4250265	4250265	4250265	4250265	4250265
Panel B: Relative with a Medical Degree								
DiD	0.170***	-0.000	0.151***	0.019	53.933***	0.668	0.054***	0.019***
	(0.022)	(0.001)	(0.020)	(0.013)	(10.315)	(0.445)	(0.010)	(0.001)
DiD×Relative MD (β_3)	-0.108**	-0.004	-0.147***	0.040	-29.936	-0.193	-0.032	0.001
	(0.054)	(0.003)	(0.048)	(0.027)	(28.526)	(1.309)	(0.035)	(0.004)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.209	0.123	0.935	0.017	0.368	0.701	0.520	0.000
N	4282618	4282618	4282618	4282618	4282618	4282618	4282618	4282618

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 7: Difference-in-Differences: Labor Market Outcomes for Women with First Symptom Between 45-55 in Norway, by Education level and Relative with a Medical Degree

	(1) Log Earnings (+1)	(2) Employed (Earnings > 0)	(3) Weekly Hrs Worked	(4) Full Time Emp (35+ hrs)	(5) Sick Leave Days
			Panel A: By Education Level		
DiD (β_1)	-0.097***	-0.007***	-0.278***	-0.008***	-0.324
	(0.016)	(0.001)	(0.055)	(0.002)	(0.236)
DiD×College (β_3)	0.110***	0.008***	0.558***	0.013***	0.591*
	(0.023)	(0.002)	(0.092)	(0.003)	(0.354)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.456	0.485	0.000	0.027	0.337
N	3965320	3965320	3678448	3678448	3965320
			Panel B: Relative with a Medical Degree		
DiD (β_1)	0.012	0.002*	-0.044	-0.004**	0.104
	(0.012)	(0.001)	(0.048)	(0.002)	(0.200)
DiD×Relative MD (β_3)	-0.517***	-0.044***	-0.369***	0.001	-1.632***
	(0.044)	(0.004)	(0.131)	(0.004)	(0.469)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.000	0.001	0.465	0.000
N	4000150	4000150	3710761	3710761	4000150

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 8: Difference-in-Differences: Health Outcomes for Women with First Symptom Between 45-55 in Norway, by Workplace Characteristics

	(1) Annual GP Visits	(2) Any ER Visits	(3) GP Visits Excl MH	(4) Annual MH Visits	(5) Reimbursements (NOK)	(6) Reimbursements per Visit (NOK)	(7) Specialist Visits	(8) Any Specialist Visits
Panel A: By Sector of Work								
DiD (β_1)	0.231***	-0.003*	0.150***	0.081***	60.001***	0.899	0.060***	0.023***
	(0.030)	(0.002)	(0.027)	(0.015)	(14.168)	(0.702)	(0.015)	(0.002)
DiD×Public (β_3)	-0.014	0.004*	0.018	-0.032	33.800*	1.795**	0.002	-0.002
	(0.039)	(0.002)	(0.036)	(0.020)	(18.863)	(0.907)	(0.020)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.687	0.000	0.000	0.000	0.000	0.000	0.000
N	3512826	3512826	3512826	3512826	3512826	3512826	3512826	3512826
Panel B: Workplace Size								
DiD (β_1)	0.231***	-0.003	0.157***	0.074***	64.147***	1.275	0.040**	0.019***
	(0.040)	(0.002)	(0.036)	(0.019)	(17.394)	(0.904)	(0.018)	(0.003)
DiD× Large WP (β_3)	0.010	0.002	0.010	-0.000	27.377	0.992	0.030	0.003
	(0.046)	(0.003)	(0.043)	(0.023)	(21.107)	(1.061)	(0.022)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.587	0.000	0.000	0.000	0.000	0.000	0.000
N	3059618	3059618	3059618	3059618	3059618	3059618	3059618	3059618
Panel C: Fraction of Female Co-Workers								
DiD (β_1)	0.215***	-0.002	0.146***	0.069***	72.430***	1.302*	0.077***	0.023***
	(0.029)	(0.002)	(0.026)	(0.015)	(15.746)	(0.721)	(0.015)	(0.002)
DiD×High (β_3)	0.040	0.001	0.032	0.008	21.465	1.359	-0.032	-0.003
	(0.041)	(0.002)	(0.038)	(0.021)	(20.175)	(0.965)	(0.021)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.559	0.000	0.000	0.000	0.000	0.002	0.000
N	3059618	3059618	3059618	3059618	3059618	3059618	3059618	3059618
Panel D: Fraction of Female Workers 45+								
DiD (β_1)	0.252***	-0.003	0.180***	0.072***	89.095***	1.765**	0.077***	0.024***
	(0.029)	(0.002)	(0.027)	(0.016)	(15.611)	(0.730)	(0.015)	(0.002)
DiD×High (β_3)	-0.028	0.002	-0.031	0.003	-9.812	0.428	-0.030	-0.006*
	(0.041)	(0.002)	(0.038)	(0.021)	(20.248)	(0.968)	(0.021)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.883	0.000	0.000	0.000	0.001	0.002	0.000
N	3059618	3059618	3059618	3059618	3059618	3059618	3059618	3059618

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 9: Difference-in-Differences: Labor Market Outcomes for Women with First Symptom Between 45-55 in Norway, by Workplace Characteristics

	Log Earnings (+1)	Employed (Earnings > 0)	Weekly Hrs Worked	Full Time Emp (35+ hrs)	Sick Leave Days
			Panel A: By Sector of Work		
DiD (β_1)	-0.159***	-0.011***	-0.092	-0.011***	0.374
	(0.016)	(0.001)	(0.080)	(0.003)	(0.301)
DiD×Public (β_3)	0.094***	0.005***	0.037	0.013***	0.053
	(0.020)	(0.002)	(0.101)	(0.003)	(0.393)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.000	0.384	0.234	0.115
N	3224690	3224690	2992849	2992849	3224690
			Panel B: Firm Size		
DiD (β_1)	-0.178***	-0.013***	0.412***	0.013***	0.709*
	(0.020)	(0.001)	(0.104)	(0.003)	(0.409)
DiD× Large WP (β_3)	0.046**	0.004**	-0.590***	-0.020***	-0.225
	(0.023)	(0.002)	(0.120)	(0.004)	(0.471)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.000	0.003	0.002	0.061
N	2717110	2717110	2521217	2521217	2717110
			Panel C: Fraction of Female Workers		
DiD (β_1)	-0.131***	-0.008***	-0.007	-0.010***	0.713**
	(0.013)	(0.001)	(0.075)	(0.003)	(0.297)
DiD×High (β_3)	-0.028	-0.004**	-0.009	0.019***	-0.339
	(0.020)	(0.001)	(0.104)	(0.004)	(0.419)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.000	0.832	0.001	0.235
N	2717110	2717110	2521217	2521217	2717110
			Panel D: Fraction of Female Workers 45+		
DiD (β_1)	-0.158***	-0.010***	-0.076	-0.008***	0.525*
	(0.014)	(0.001)	(0.076)	(0.003)	(0.304)
DiD×High (β_3)	0.024	0.000	0.121	0.014***	0.045
	(0.020)	(0.001)	(0.104)	(0.004)	(0.419)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.000	0.531	0.031	0.065
N	2717110	2717110	2521217	2521217	2717110

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 10: Difference-in-Differences: Health Outcomes for Women with First Symptom Between 45-55 in Norway, by Gender of GP and Prescription Rate of Area of Residence

	(1) Annual GP Visits	(2) Any ER Visits	(3) Annual GP Visits Excl Mental Health	(4) Annual MH Visits	(5) Medical Reimbursements (NOK)	(6) Reimbursements per Visit (NOK)	(7) Specialist Visits	(8) Any Specialist Visits
Panel A: Gender of GP								
DiD (β_1)	0.128***	-0.000	0.110***	0.018	45.010***	0.328	0.052***	0.021***
	(0.029)	(0.002)	(0.026)	(0.017)	(14.242)	(0.601)	(0.014)	(0.002)
DiD×Female GP (β_3)	0.035	-0.001	0.023	0.012	2.781	0.298	-0.020	-0.007**
	(0.043)	(0.002)	(0.039)	(0.024)	(21.141)	(0.937)	(0.022)	(0.003)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.378	0.000	0.090	0.002	0.384	0.055	0.000
N	3685593	3685593	3685593	3685593	3685593	3685593	3685593	3685593
Panel B: Prescription Rate in the County of Residence								
DiD (β_1)	0.129***	-0.002	0.105***	0.024**	44.802***	0.268	0.039***	0.015***
	(0.021)	(0.001)	(0.019)	(0.012)	(10.365)	(0.454)	(0.011)	(0.001)
DiD×High (β_3)	0.073**	0.004*	0.075**	-0.002	13.404	1.575**	0.039**	0.019***
	(0.035)	(0.002)	(0.032)	(0.020)	(16.126)	(0.801)	(0.016)	(0.002)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.000	0.355	0.000	0.257	0.000	0.017	0.000	0.000
N	4276592	4276592	4276592	4276592	4276592	4276592	4276592	4276592

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 11: Difference-in-Differences: Labor Market Outcomes for Women with First Symptom Between 45-55 in Norway, by Gender of GP and Prescription Rate of Area of Residence

	(1) Log Earnings (+1)	(2) Employed (Earnings > 0)	(3) Weekly Hrs Worked	(4) Full Time Emp (35+ hrs)	(5) Sick Leave Days
			Panel A: Gender of GP		
DiD (β_1)	-0.021	-0.001	0.018	-0.001	-0.023
	(0.016)	(0.001)	(0.063)	(0.002)	(0.261)
DiD×Female GP (β_3)	-0.007	-0.000	-0.111	-0.003	0.054
	(0.025)	(0.002)	(0.100)	(0.003)	(0.410)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.136	0.300	0.234	0.135	0.922
N	3394410	3394410	3152032.000	3152032.000	3394410
			Panel B: Prescription Rate in the County of Residence		
DiD (β_1)	-0.080***	-0.006***	-0.079*	-0.003**	-0.283
	(0.013)	(0.001)	(0.048)	(0.002)	(0.200)
DiD×High (β_3)	0.035*	0.003**	-0.116	-0.002	0.582
	(0.021)	(0.002)	(0.081)	(0.003)	(0.399)
p-value: $H_0 : \beta_1 + \beta_3 = 0$	0.025	0.109	0.013	0.026	0.423
N	3506471	3506471	3506471	3506471	3506471

NOTE: Each DiD cell is β_1 and interaction term is β_3 from a separate regression: $y_{ibta} = \beta_0 + \beta_1 Post_{ibt} \times Treated_{ib} + \beta_2 Post_{ibt} + \beta_3 Post_{ibt} \times Treated_{ib} \times HeteroTerm_i + \delta_{ib} + \gamma_t + \eta_a + \varepsilon_{ibta}$. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

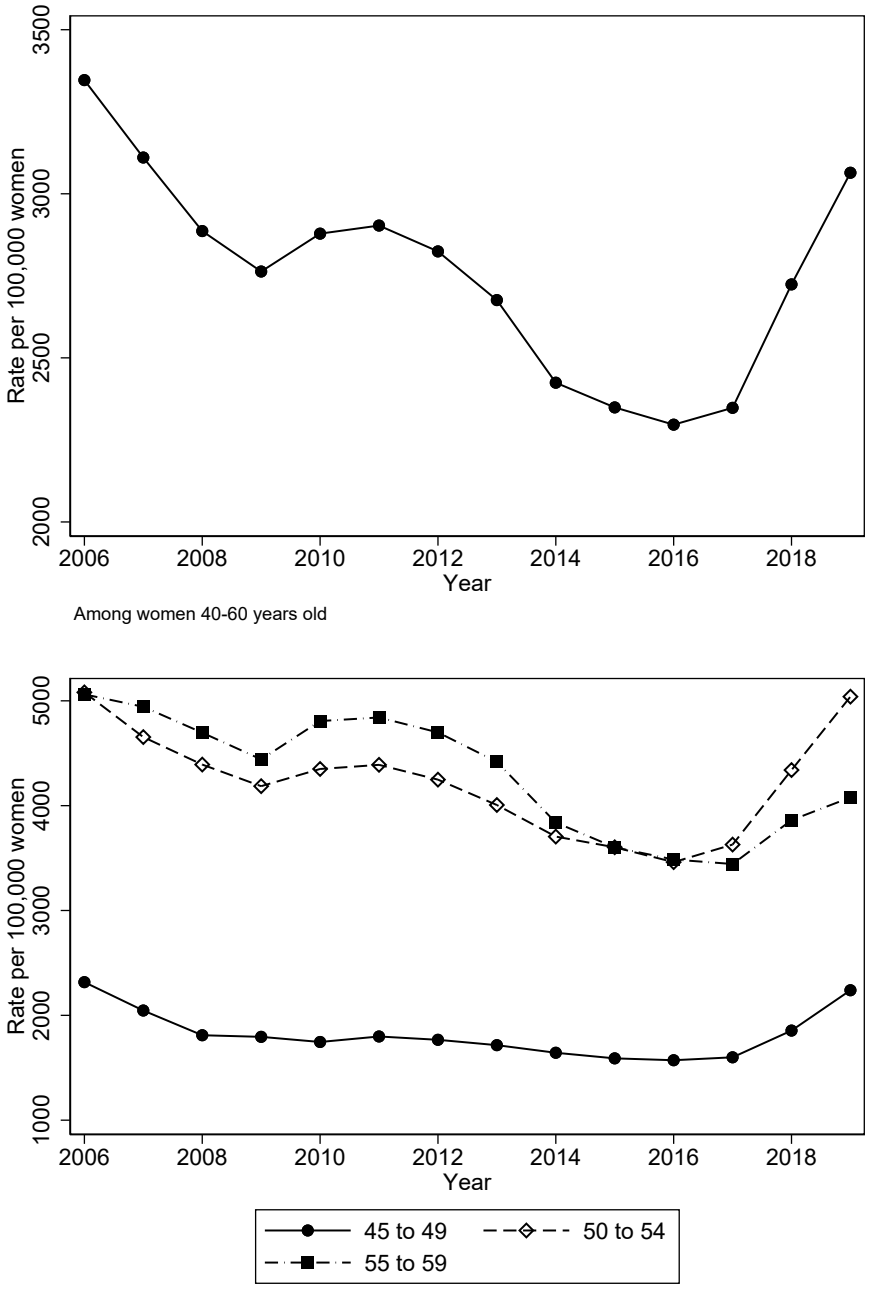
The Menopause "Penalty"

Gabriella Conti, Rita Ginja, Petra Persson & Barton Willage

ONLINE APPENDIX

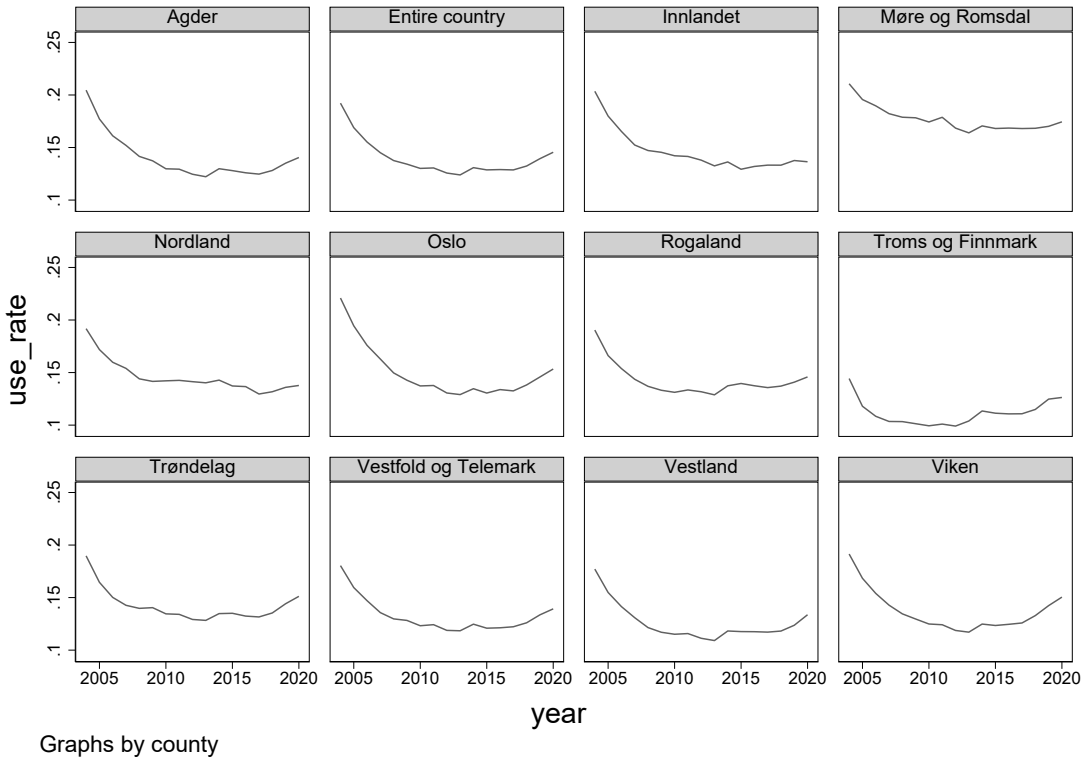
A Additional Figures and Tables

Figure A.1: Hormone Replacement Therapy Initiation Rate by Year and Age in Sweden



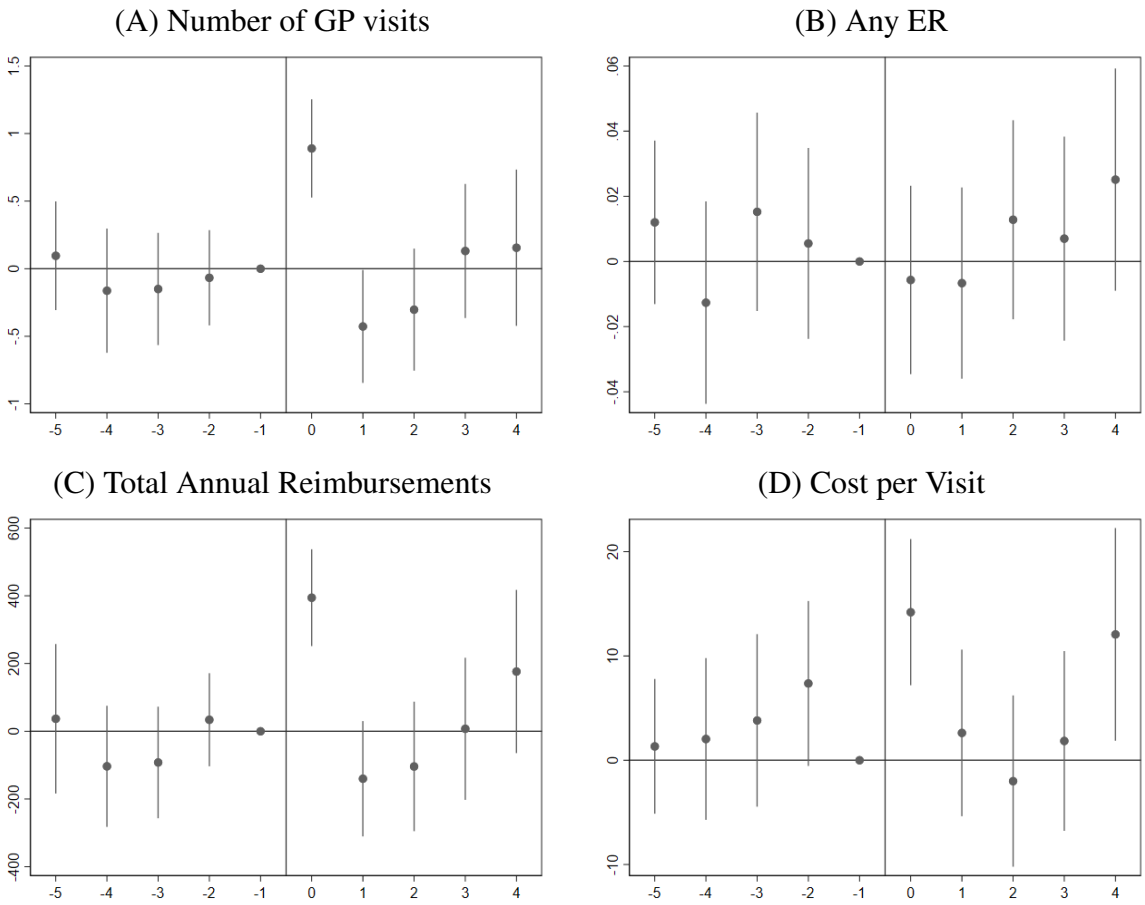
Note: Figure plots the rate of HRT initiation by year among all Swedish women 40-60 years old. Data source Swedish register administrative data.

Figure A.2: Proportion of Women 45-59 Taking HRT in Norway



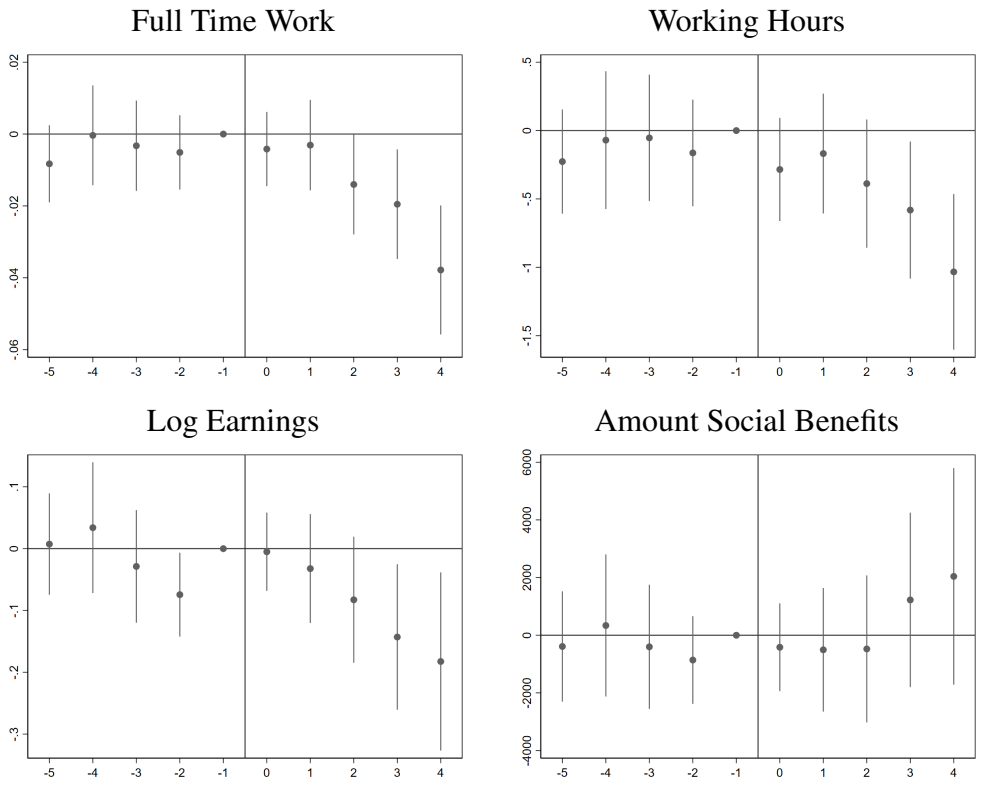
Note: This figure plots the share of women 45-59 years old taking HRT medication in Norway. Data: Prescription Records (available by county and age groups). Data source Norwegian register administrative data.

Figure A.3: Event Studies: Health Outcomes for Women with First Symptom Between 40-44 in Norway



Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1966-1971. Data source Norwegian register administrative data.

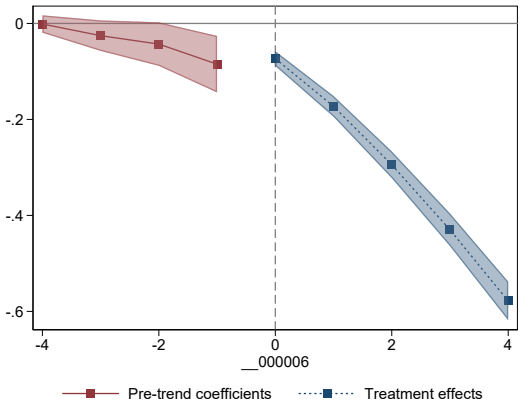
Figure A.4: Event Studies: Labor Market Outcomes and Take-up of Social Programs for Women with First Symptom Between 40-44 in Norway



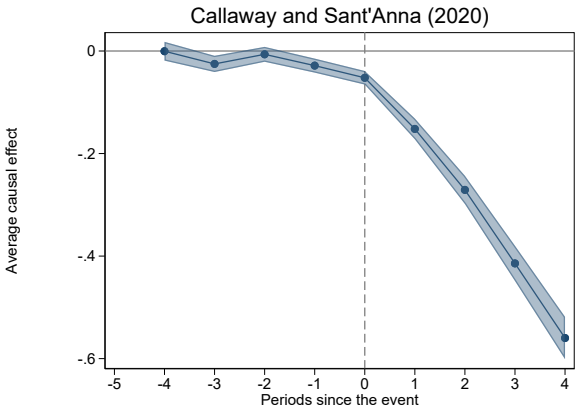
Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1966-1971. Data source Norwegian register administrative data.

Figure A.5: Sensitivity Analyses: Labor Income in Norway for Women with First Symptom Between 45-55 in Norway

(A) Borusyak et al., 2024

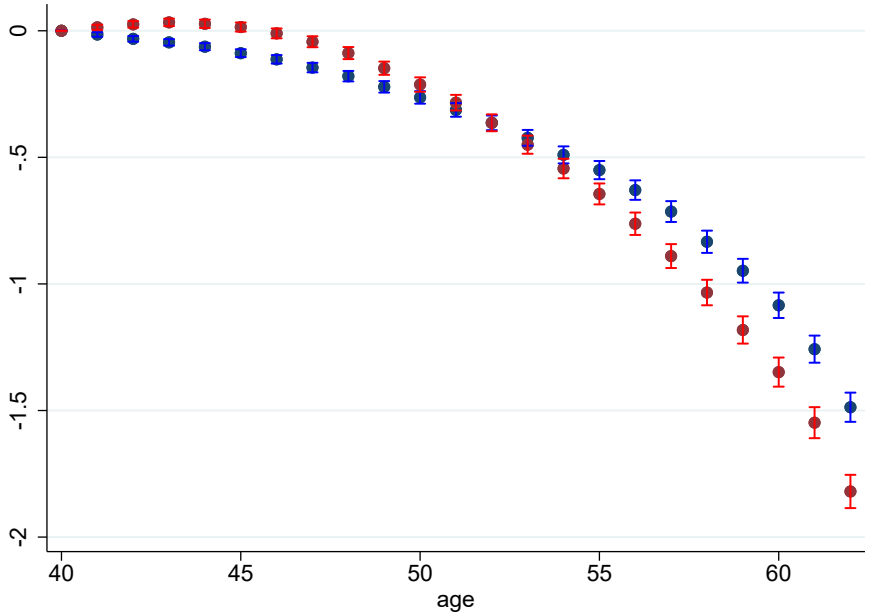


(B) Callaway and Sant'Anna (2020)



Note: Each graph presents estimates for α^{τ} from a separate regression of model 2. The whiskers are 95% confidence intervals. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data source Norwegian register administrative data.

Figure A.6: Age Profile of Earnings in Norway



Note: This figure plots the age coefficients from a regression of log labor earnings on age and year fixed effects separately for men and women (the red dot are for females; blue for males). Data source Norwegian register administrative data.

Table A.1: Characteristics at Age 40 for Women with First Menopause Diagnosis by GP or a Specialist in Norway

	(1) GP	(2) Specialist	(3) (1)-(2)	(4) p-value
Any GP or ER Visits	0.839	0.804	0.035	0.000
Any ER Visits	0.222	0.225	-0.002	0.608
Annual GP Visits	5.800	5.389	0.410	0.000
Annual GP Visits, Excl Mental Health	4.606	4.360	0.245	0.000
Annual Mental Health Visits	1.194	1.029	0.165	0.000
Medical Reimbursements (NOK)	1071.400	1185.900	-114.459	0.000
Reimbursements per Visit (NOK)	115.100	130.600	-15.501	0.000
Less than College	0.601	0.574	0.027	0.000
Annual Earnings (NOK)	372265.800	374118.300	-1852.506	0.522
Full Time Emp (35+ hrs)	0.348	0.343	0.005	0.341
Sick Leave Days	21.600	21.180	0.423	0.542
Married	0.522	0.540	-0.017	0.001

NOTE: This table includes the characteristics at age 40 for women with the first menopause diagnosis by GP or a specialist. Birth cohorts 1961-1968. Data source Norwegian register administrative data.

Table A.2: Summary Statistics at Age 40 of Menopause Diagnosis Sample (Sweden)

	(1)
No College	0.572
	(0.495)
	(0.379)
Work Income	2266.9
	(1949.7)
Disposable Income	2449.3
	(2144.0)
Any UI Receipt	72.22
	(246.1)
Any DI Receipt	80.85
	(297.1)
Any Outpatient Specialist Visit	0.454
	(0.498)
Total Number of Drugs	6.193
	(12.81)
Any Antidepressant	0.145
	(0.353)
N	30421

NOTE: Table presents summary statistics of the sample of Swedish women in birth cohorts 1961-1968 diagnosed with menopause diagnosis by a specialist between the ages of 45 and 55. All outcomes except "HRT Initiation After Diagnosis" are measured at age forty. Standard errors are in parentheses. Data source Swedish register administrative data.

Table A.3: Difference-in-Differences: Welfare Outcomes for Women with First Symptom Between 45-55 in Norway

	(1) All Benefits	(2) Any DI Benefits	(3) DI Benefits	(4) Any UI Benefits	(5) UI Benefits
	Panel A: Norway (Treatment includes Diagnoses by GPs and Specialists)				
DiD	862.950***	0.003***	752.944***	-0.001	-2.801
	(309.747)	(0.001)	(204.545)	(0.001)	(78.232)
Control Mean	69428.322	0.073	13465.743	0.043	3159.719
N	3991134	3991134	3991134	3991134	3991134
	Panel B: Norway (Treatment includes Diagnoses by Specialists)				
DiD	1498.500**	0.005***	1136.308***	-0.002	-163.876
	(625.292)	(0.002)	(400.498)	(0.001)	(141.579)
Control Mean	68933.000	0.077	13960.192	0.039	2951.593
N	1091505	1091505	1091505	1091505	1091505

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Control Mean is obtain the year prior to the diagnosis of menopause. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1961-1968. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.4: Difference-in-Differences: Women with First Symptom Between 40-44 in Norway

	(1)	(2)	(3)	(4)	(5)	(6)
	Panel A: Health Outcomes					
	Annual GP Visits	Any ER Visits	Annual MH Visits	Reimbursements (NOK)	Reimbursements Visit (NOK)	Any Specialist Visits
DiD	0.174	0.000	0.125	72.810	3.624*	0.021***
	(0.135)	(0.006)	(0.084)	(65.718)	(1.994)	(0.007)
Control Mean	7.675	0.262	1.590	1810.275	161.641	0.317
N	65610	65610	65610	65610	65610	65610
	Panel B: Labor Market Outcomes					
	Log Earnings (+1)	Employed (Earnings >0)	Weekly Hrs Worked	Full Time Emp (35+ hrs)	Sick Leave Days	
DiD	-0.056	-0.004	-0.211	-0.006	0.512	
	(0.040)	(0.003)	(0.143)	(0.004)	(0.552)	
Control Mean	10.451	0.831	17.960	0.334	23.359	
N	452950	452950	262230	262230	456400	

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Standard errors clustered at woman-by-base age in parentheses. Birth cohorts 1956-1971. Data at the women-by-base age-by year level. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.5: Difference-in-Differences: Women Diagnosed Between Ages 45-55 in Norway

	(1)	(2)	(3)	(4)	(5)
	Panel A: Health Outcomes				
	Annual GP Visits	Annual MH Visits	Reimbursements (NOK)	Reimbursements per Visit (NOK)	Any Specialist Visits
DiD	0.198***	0.021	54.331***	0.593	0.024***
	(0.025)	(0.015)	(12.070)	(0.456)	(0.002)
Control Mean	6.722	1.294	1464.658	152.260	0.326
N	3388070	3388070	3388070	3388070	3388070
	Panel B: Labor Market Outcomes				
	Log Earnings (+1)	Employed (Earnings >0)	Weekly Hrs Worked	Full Time Emp (35+ hrs)	Sick Leave Days
DiD	-0.079***	-0.006***	-0.169***	-0.006***	0.028
	(0.009)	(0.001)	(0.032)	(0.001)	(0.124)
Control Mean	11.108	0.872	20.616	0.384	20.201
N	12868780	12868780	9439980	9439980	13597620

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Standard errors clustered at woman-by-base age in parentheses. Data at the women-by-base age-by year level. Birth cohorts 1956-1971. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.6: Difference-in-Differences: Women Diagnosed Between Ages 45-55 in Norway, Changing Clustering of Standard Errors

	(1)	(2)	(3)	(4)	(5)
	Panel A: Health Outcomes				
	Annual GP Visits	Annual MH Visits	Medical Reimbursements (NOK)	Reimbursements per Visit (NOK)	Any Specialist Visits
DiD	0.155***	0.025**	50.228***	0.648*	0.019***
	(0.018)	(0.010)	(8.345)	(0.382)	(0.001)
Control Mean	6.702	1.292	1464.367	152.766	0.326
N	4282885	4282885	4282885	4282885	4282885
	Panel B: Labor Market Outcomes				
	Log Earnings (+1)	Employed (Earnings $>$ 0)	Weekly Hrs Worked	Full Time Emp (35+ hrs)	Sick Leave Days
DiD	-0.067***	-0.005***	-0.101***	-0.004***	-0.145
	(0.010)	(0.001)	(0.037)	(0.001)	(0.152)
Control Mean	11.137	0.873	20.753	0.388	19.963
N	4000240	4000240	3710845.000	3710845.000	4000240

NOTE: Each cell is β_1 from a separate regression of model 1. Controls included in the model, but excluded from the table are fixed effects for "woman-base age", year and age. Standard errors clustered at the woman-level in parentheses. Data at the women-by-base age-by year level. Birth cohorts 1961-1968. Data source Norwegian register administrative data. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table A.7: Characteristics of Workplaces of Women at the time of Diagnosis in Norway

	(1) Mean	(2) Median	(3) SD
Proportion of Women Working in the Public Sector	0.596	1.000	0.491
Characteristics of Workplaces			
Number of workers	38.266	16.000	146.312
Fraction of Female Workers	0.672	0.714	0.280
Number of Female Workers	19.347	8.000	66.208
Fraction of Female Workers 45+	0.403	0.367	0.248
Number of Female Workers 45+	10.012	4.000	32.727
Fraction of Women among the Top Decile of Salaries	0.026	0.000	0.035

NOTE: Characteristics of workplaces of women in our main sample at the time of menopause diagnosis. Sample of women diagnosed between ages 45-55, birth cohorts 1961-1968. Data source Norwegian register administrative data.