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Gender inequality reinforced: the impact of a child's health shock on parents' labor market trajectories

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Abstract

This article employs a couple-level framework to examine how a child's severe illness affects within-family gender inequality in a Northern European context. We study the parental labor market responses to a child's cancer diagnosis by exploiting an event study methodology and individual-level administrative data on hospitalizations and labor market variables for the total population in Finland. We focus on the differences in the effects by gender, breadwinner status, cancer severity and age of children. We find that child cancer has a negative impact on the labor income of both the mother and the father. This effect is considerably larger for women, and therefore leads to an increase in gender inequality on top of the well-documented motherhood penalty related to childbirth. However, mothers who are the main breadwinners in the family experience a smaller reduction in their contribution to household income. Additionally, older age of the child at cancer diagnosis and less severe cancer type potentially protect against gendered responses. These new insights provide evidence on gender roles when a child falls ill and show how child health affects gender inequality in two-parent households.

Keywords: childhood cancer, health shock, parents, labor supply, gender inequality

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1 Introduction

Advances in gender equality have taken place both in the labor market and at home, while women continue to suffer from poorer labor market outcomes and to contribute more to unpaid work within the household (*Bianchi et al.*, 2000; *Sevilla-Sanz et al.*, 2010; *Goldin*, 2014; *Blau and Kahn*, 2017). The literature on the motherhood penalty has shown that childbirth affects the mother's income trajectory more than the father's and increases within-couple gender inequality (*Sani*, 2015; *Kleven et al.*, 2019a; *Musick et al.*, 2020). However, less evidence exists on other situations in which couples re-negotiate their division of labor in the household. In this article, we look at the case of the unanticipated health shock of a child, namely cancer, affecting the way in which parents participate in the labor market and share the responsibility of taking care of a sick child. Our study combines research strands on the motherhood penalty, family spillover effects of health shocks, and gender inequality.

The strong connection between health and socioeconomic status has been well documented in prior research (e.g., *Marmot et al.* 1991; *Bartley* 2016). The association between the two is further complicated by the fact that a serious illness can have an impact beyond the person getting ill (*García-Gómez et al.*, 2013; *Jeon and Pohl*, 2017; *Fadlon and Nielsen*, 2021). These so-called spillover effects can arise for different reasons. The affected may need special care at home from close family members when health conditions limit normal functioning. Furthermore, the health shock of a loved one can cause stress and anxiety and change how family members value time between work and leisure. The spillover effects are expected to be of a gendered nature as women traditionally carry the greatest burden of informal care (*Bracke et al.*, 2008), while the institutional and cultural context is likely to affect the magnitude of the spillover effects as well as their relevance for gender inequality (*Fuwa*, 2004; *Kleven et al.*, 2019a).

Causal evidence on the spillover effects of children's health shocks is still scarce. However, recent studies exploiting Nordic administrative data suggest that children's health shocks have a clearly larger impact on mothers than on fathers, both in terms of employment and psychological well-being *Breivik and Costa-Ramón* (2022); *Eriksen et al.* (2021). Moreover, *Lavelle et al.* (2014) found that having a sick child is associated with worse health outcomes than having a parent or a spouse with the same conditions. As parental responses to a child's ill-health can be considerable, the question arises whether this affects gender inequality within couples. Does an unanticipated child health shock reinforce gendered patterns of behavior?

In this article, we provide new insights into these questions. First, we analyze the impact of childhood cancer on parents' employment and annual labor income and compare how the impacts differ between mothers and fathers. Second, considering the division of labor in the household prior to the child health shock, we study effects according to the breadwinner status of the parent. Third, to understand the effects on within-couple inequality, we follow *Musick et al.* (2020) and analyze the impact on the mothers' share of the total household labor income. Fourth, to shed light on the possible mechanisms behind the results we examine heterogeneity in effects by child age at diagnosis and cancer type. These measures relate to the need of child home care and nurture and thus potentially affect how parents respond to severe child health shocks.

Additionally, drawing from the prior literature on comparative advantage within the household, a couple-level framework is useful in understanding the gendered effects of a child health shock. We expect that the mother's better economic position relative to spouse protects against the negative impacts on labor market outcomes (see e.g., *Raley et al.* 2012). Alternatively, traditional gender norms and parents' gendered perceptions on the quality of care could dominate over economic considerations, supporting the "doing gender" hypothesis (see e.g., *Bittman et al.* 2003). These gender norms could take stronger forms when children get cancer at young age and when the cancer is more life-threatening.

We contribute to the existing research on gender inequality and the motherhood penalty (e.g., *Waldfogel and Mayer* 2000; *Budig and England* 2001; *Kleven et al.* 2019a; *Musick et al.* 2020) by extending the empirical focus from childbirth to the health shock of a child. While parenthood has been acknowledged as a turning point in the gendered division of labor at home, less is known about the disruptions child's health conditions cause to domestic work arrangements. Furthermore, our study is an important addition to the literature on health spillover effects. To our knowledge, this is the first time a couple framework has been used to study health spillover effects with the exception of *Riekhoff and Vaalavuo* (2021).

This article uses Finnish individual-level panel data that includes information on income, education, family, and hospitalizations at an annual level for the whole Finnish population. The data allows us to investigate relatively rare events such as child cancer without concerns about non-participation or attrition severely biasing the estimates. We use the event study framework to assess labor market outcomes before and after the event of a cancer diagnosis. We show that relative to many other health conditions among children, cancers are particularly suitable for causal inference in this framework because they are largely unrelated to parental socioeconomic characteristics.

We provide evidence that expands our understanding on both health and income inequalities in childhood and the gendered dimension of health spillover effects. Our results show that it is the mother who suffers the harshest economic penalty from unexpected health shocks to children. We contribute to the literature on gender inequality by demonstrating that severe health shocks of children aggravate gender inequality related to parenthood. This is particularly the case for those households where the mother's contribution to the household income is low to begin with, for households with small children and for household whose child is diagnosed with a more severe cancer. Our results suggest that care needs related to child's health conditions cause an extra penalty on top of the conventional penalty related to motherhood.

2 Theoretical framework

2.1 Linked lives and household level division of labor

Life course research emphasizes the interdependent nature of decision-making in social relationships. The linked lives principle coined by *Elder* (1987) states that events during an individual's life course should not be analyzed in isolation, but we should take into account that the impacts are shared alongside other people (*Elder*, 1987; *Settersten*, 2015).

The linked lives principle emerges when examining major changes in family life such as childbirth. A growing body of literature has shown that childbirth negatively affects mothers' earnings and employment trajectories and explains a large part of the observed gender inequality in the labor market (*Waldfogel and Mayer*, 2000; *Budig and England*, 2001; *Kleven et al.*, 2019a; *Sieppi and Pehkonen*, 2019; *Musick et al.*, 2020). New evidence from a Nordic setting shows that only in the most recent cohorts also fathers are affected by childbirth (*Nylin et al.*, 2021).

A prominent explanation for the motherhood penalty stems from Gary Becker's (1991) theory on the household level division of labor. This theory assumes that one spouse specializes in paid work outside the home and the other specializes in unpaid housework based on the principle of comparative advantage. Historically, this has meant that fathers that are more educated have acted as the main breadwinners and mothers as the principal caregivers for children. While over time the female share of breadwinning has increased for childless women (20 to 50 percent in Europe according to *Klesment and Van Bavel* 2017), the share is still low for mothers with young children.

Prior research on motherhood/child penalty has demonstrated that the pre-birth constellation of household income may matter for the gender pay gap. Swedish evidence suggests that the income differences between men and women resulting from childbirth grow with the gender pay gap within couple prior to the birth (*Angelov et al.*, 2015). However, comparative advantage is not the only explanation for the increase in within-couple inequality. For example, a recent study by *Andresen and Nix* (2021) suggests that gender norms, discrimination, and perceived gender differences in the quality of childcare are the most prominent reasons for the motherhood penalty. This claim is based on a comparison of labor supply responses between heterosexual parents, same-sex parents and adopting parents using Norwegian administrative data. When controlling for the partners' comparative advantage in the labor market, the responses were substantially smaller for same-sex women than for adopting and biological heterosexual parents.

2.2 Relative earnings and urgent childcare needs

While fathers have increased their time in childcare over time, mothers have not reduced theirs (*Bianchi et al.*, 2000). Women play a central role in care and the amount of care provided by men is often contingent on the women in their family (*Gerstel and Gallagher*, 2001; *Bracke et al.*, 2008). Notwithstanding advances in gender equality, mothers are considered as primary carers. However, as women's stance in the labor market has strengthened, more and more women are primary earners of the family. While there is some evidence of pre-birth situation in resource allocation affecting the magnitude of motherhood penalty, some contrasting results have emerged from related analysis regarding time dedicated to childcare. Evidence from Germany (*Kühhirt*, 2012) and Spain (*Sevilla-Sanz et al.*, 2010) suggests that women's contribution to childcare remain unchanged over the distribution of their relative earnings, whereas evidence from the United States (*Raley et al.*, 2012) suggests that increases in wife's share of earnings in the household shift childcare time from mother to father. However, reaching gender equality in domestic work may require women to outearn their spouse by a gigantic margin (*Siminski and Yetsenga*, 2021).

Besides normal times, women are likely to carry the main responsibility of urgent childcare needs. A rare study on urgent childcare needs found out that when it is necessary to spend time with children, 78 percent of women and 26 percent men take leave from work (*Maume*, 2008). This gendered pattern is strongest when husband works full-time or overtime. Covid-19 pandemic lockdowns also provide valuable insight to gendered responses to urgent childcare needs. The lockdowns preventing families from using childcare services during working hours provoked an additional time constraint for household allocation of working time and childcare. Evidence suggests that majority of the additional childcare fell on mothers (see e.g *Hupkau and Petrongolo* 2020; *Johnston et al.* 2020; *Sevilla and Smith* 2020). The gender difference in childcare sustained even when the mother was the breadwinner (*Andrew et al.*, 2020).

2.3 Spillover effects of health shocks

Since the lives of family members are linked, certain life events, like health shocks, principally affecting one family member could also alter the lives of the loved ones. A growing number of studies have considered the spillover effects of health shocks—usually between spouses. Using administrative data, *Jeon and Pohl* (2017), *Anand et al.* (2022) and *Jolly and Theodoropoulos* (2021) found adverse effects on the labor supply of spouses caused by severe illnesses, while using retrospective survey data, *Riekhoff and Vaalavuo* (2021) found that the association between a health shock and employment trajectory of the individual depends also on the couple characteristics.

Less evidence exists on the spillover effects of children's health shocks. However, when comparing different types of family spillovers for four distinct illnesses, *Lavelle et al.* (2014) suggested that having a child with cancer is associated with the greatest spillover effects. While the survival rates of pediatric cancers have increased throughout the world, these advances have been accompanied with increases in aggressive treatments. Medical treatment in hospital is complemented with informal care provided at home over extensive periods and with care management by parents. Surgeries, chemotherapy and radiation treatment may lead to serious pain for the affected children (*Hickman et al.*, 2021).

Child health shocks will likely produce gendered responses between parents. Survey evidence from the USA from the *Kaiser Family Foundation* (2018) suggests that mothers are more likely to manage children's health and take care of them when they are sick. The increased need to take care of a sick child means time off from paid work. Drawing from the insights from motherhood penalty literature, child health shocks could lead to missing out on professional experience and promotions at work (*Kleven et al.*, 2019b) and employer discrimination (*Correll et al.*, 2007; *Ishizuka*, 2021) translating into longer-term consequences that could be particularly large for highly skilled women due to higher returns on human capital (e.g., *Wilde et al.* (2010); *England et al.* (2016)).

While the labor market costs of parenthood fall predominantly on mothers, evidence is scarce on the impacts of child health shocks on gender inequality. We contribute this literature by asking whether child cancer further reinforce gender inequality and whether pre-shock relative income within couples explain gendered responses to child health shocks. We expect to see stronger negative impacts of a child's cancer on mothers than on fathers following the literature on motherhood penalties and persisting gender roles in domestic work regardless of their breadwinner status, even though theories on the comparative advantage would suggest otherwise.

3 Institutional Background

In addition to individual characteristics, country-level factors regarding gender norms and welfare and labor market institutions affect female employment, gender pay gaps, and the division of housework in the family (*Fuwa*, 2004). In Finland, where women's labor market participation has traditionally been high and the notion of gender equality is important, mothers take considerably longer periods of parental leave. *Nylin et al.* (2021) argue that such behavior after childbirth reinforces the idea of the mother as the main carer and this will have a long-lasting impact on gender equality within the couple.

Finland has a comprehensive welfare system and universal public health care system. Virtually all childhood cancer cases are treated with little direct costs to families. An annual ceiling of 683 euro (in 2021) applies for health care related user fees, after which individuals still pay for short-term in-patient care (22.50 euro per day). There is also a ceiling of 580 euro for drug expenses. Health related travel costs are reimbursed through the National Sickness Insurance. The private sector plays only a negligible role in the treatment of childhood cancers. In general, private health care users can apply for the reimbursement of the costs from the National Sickness Insurance, which covers approximately 30 per cent of the expenses.

The treatment of childhood cancers is centralized in five university hospitals (Helsinki, Tampere, Turku, Oulu, and Kuopio) ensuring standardized treatment protocols. However, *Tolkkinen et al.* (2018) found that childhood cancer mortality in Finland was lower in families with more educated parents as well as in families in the highest quartile of the income distribution. The use of private services could lead to the earlier detection of childhood cancers and thus explain the mortality gradient.

Parents who take time off from work can apply for a special care allowance, paid by the Social Insurance Institution of Finland. Parents whose child experiences a severe illness are eligible for the allowance for a maximum of 60 days. The amount is based on the earnings of the previous year although the reimbursement level decreases when earnings exceed the thresholds of 26,700 and 41,100 euro. A disability allowance is also paid by the Social Insurance Institution when the need for regular care, attention or rehabilitation lasts for more than six months. The rate varies between 93 and 423 euro per month based on the severity of the child's illness. Parents with children of any age can apply for support for informal care which is paid by municipalities. To receive this benefit, a high care burden is required, especially after the child is more than 18 years old. The amount and criteria for the benefit vary between municipalities. All families with children also receive child allowances paid on a universal basis and childcare is inexpensive and free of charge for the poorest families.

4 Data and methods

4.1 Data

We used the Finnish register data of the total population for the years 1995-2019. Using personal identifiers, we linked individual information on family, household, various income measures, labor market status, socioeconomic characteristics, the region of residence, and the causes of death from the registers of Statistics Finland. We also had access to data on public special health care from the Care Register for Health Care (HILMO) provided by the Finnish Institute for Health and Welfare. This data includes information on inpatient stays for years 1987-2019 and the outpatient visits for years 1998-2019 as well as the ICD-10 codes for the primary diagnosis. The data has been linked using pseudonymized identifiers and analyzed in the Statistics Finland remote access system, FIONA. Because the data is routinely collected from administrative sources with nationwide coverage, the only sources of attrition are emigration and mortality.

Using the HILMO data and ICD-10 codes for the diagnosis, we identified children with cancer (all ICD-10 codes in the class C). We focused on children who were diagnosed with cancer for the first time during a hospital stay in 1999-2014 at age 0-19. This ensured that we could observe the parental outcomes four years before and five years after the cancer diagnosis. Because the outpatient data has some deficiencies in cancer diagnoses (namely false positives), we only used inpatient data for identifying child cancer and families affected by it. The data includes the exact date and length of the visit as well as any subsequent visits.

Using personal identifiers, we linked the children with a cancer diagnosis to their biological parents. We included only parents who were cohabiting and living in Finland just before the cancer diagnosis. While the recent literature has brought forward differences in the motherhood penalty between heterosexual and same-sex couples (Andresen and Nix, 2022), we focused on heterosexual couples due to the rare occurrence of childhood cancer. We also excluded families in which two or more children were diagnosed with cancer and parents for whom data was not available for the complete 10-year follow-up. This restriction led to 4% (N=571) in the father sample and 2.5% (N=571) decrease in mother sample.

4.2 Matched analytical sample

We constructed a counterfactual of what would have happened in the absence of child cancer via matching. We provided each of the affected families with one to six matches from unaffected families who resembled the affected families' structure. We matched the treated individuals with up to 6 unique controls (cases without child cancer diagnosis) according to the sex of the child with cancer, birth order (based on order of shared children among parents), the child's first language (in three groups: Finnish, Swedish and other), the father's education level, the mother's education level, the birth year of parents, and the birth year of the child. Apart from the parents' birth year which could digress by one year, all the other background characteristics were matched exactly. We focused on couples and therefore we restricted the matching to be based on children who were identified with two biological parents who lived together at the end of the year preceding the cancer diagnosis. The matching was implemented with the Stata command *calipmatch*.

Matching the individuals based on the birth years and birth order ensured that the family structure was largely similar for the treated and the controls in terms of ages. We identified 2,067 mothers and 2,039 fathers of 2,067 children diagnosed with cancer using the criteria described above. These families were matched with 11,517 mothers, 11,323 fathers and 11,517 children from unaffected families.

Table 1 describes the study sample and compares our treatment and control groups in the period preceding the index diagnosis. The index diagnosis refers to the year of the child's cancer diagnosis for the treated individuals and their 1-6 controls whose children had not experienced cancer. The index diagnosis for the control group can be described as the placebo diagnosis year. Key variables are described in more detail in the following section.

The background characteristics are very similar for the treatment group and the control group once matched. Pre-trends in outcomes are examined

Table 1: Descriptive statistics

	Control group		Treatment group			
Variable	Mean	SD	Mean	SD	Difference	P (difference)
Child characteristics						
Child sex	0.47	0.50	0.47	0.50	0.00	0.86
Index year	2006.2	4.67	2006.3	4.67	0.06	0.47
Child birth year	1997.4	7.97	1997.4	7.98	-0.01	0.92
Child dies within 5 years	0.00	0.03	0.16	0.37	0.16	0.00
Age of child	8.82	6.25	8.86	6.26	0.07	0.51
Father's age	39.75	7.72	40.20	7.99	0.48	0.00
Mother's age	37.46	7.55	37.78	7.71	0.35	0.01
Cancer at age 0-6	0.46	0.50	0.45	0.50	-0.01	0.40
Cancer at age 7-14	0.28	0.45	0.28	0.45	0.00	0.57
Cancer at age 15-19	0.27	0.44	0.27	0.44	0.00	0.71
Birth order	1.79	0.96	1.87	1.14	0.08	0.00
P(First born child)	0.47	0.50	0.45	0.50	-0.01	0.13
Finnish-speaker	0.96	0.20	0.94	0.23	-0.01	0.00
Lives in urban area	0.37	0.48	0.38	0.49	0.01	0.34
Distance to university hospital	73.32	64.21	74.38	64.67	1.06	0.33
Parental education						
Mother's education: Primary	0.54	0.50	0.53	0.50	-0.01	0.39
Mother's education: Secondary	0.21	0.41	0.22	0.41	0.01	0.42
Mother's education: Tertiary	0.25	0.43	0.25	0.43	0.00	0.83
Father's education: Primary	0.66	0.47	0.65	0.48	-0.01	0.44
Mother's education: Secondary	0.12	0.33	0.13	0.33	0.01	0.28
Father's education: Tertiary	0.22	0.41	0.22	0.41	0.00	0.98
Breadwinner status						
Mother earns <40\% of couple's labor income	0.57	0.49	0.57	0.50	0.00	0.76
Equal earners	0.27	0.45	0.28	0.45	0.00	0.66
Mother is the breadwinner	0.16	0.36	0.15	0.36	0.00	0.89
Household characteristics						
Father is employed	0.90	0.29	0.90	0.30	0.00	0.32
Mother is employed	0.77	0.42	0.76	0.43	0.00	0.55
Mother's share of couple's total labor income	0.37	0.29	0.37	0.29	0.00	0.76
HH Labor income	58412	51007	57175	38066	-1327	0.11
HH Taxable income	69369	48842	68432	35968	-986	0.22
Net income transfers received	-10631	28942	-9822	20410	838	0.08
HH disposable income	57597	40489	57568	28360	-31.5	0.96
HH size	4.33	1.16	4.36	1.22	0.03	0.09

Sample means with standard deviations at year preceding the index diagnosis. The sample consists of parents whose child is diagnosed with cancer in Finland between 1999-2014 (N:2,067) at ages 0-19 and 1-6 matched controls (N:11,517).

separately in the empirical results section. The choice of not restricting the sample to include the same number of matches for every case resulted in a minor imbalance in the variables used in the matching.

The time-variant characteristics, such as the household labor income, the mother's labor income share, the household size, or whether the family were living in an urban area were not used in the matching procedure, but the differences in the pre-cancer values of these variables between the treatment and control group were very small.

4.3 Key measures

Our main dependent variable was each parent's annual income from labor (before taxes and social contributions) deflated to the 2019 price level using the Harmonized Index of Consumer Prices. Additionally, we examined labor supply changes using the employment status measured at the end of the calendar year. Secondly, we analyzed the impact on the mother's share of a couple's total labor income to assess the effect on within-couple gender equality. This measure has been previously used as a proxy for the household balance of power as an outcome measure to study the impacts of motherhood (*Musick et al.*, 2020) and as a predictor for divorce (*Bittman et al.*, 2003; *Schwartz and Gonalons-Pons*, 2016).

To examine income trajectories from the perspective of linked lives and comparative advantage within the household, we used the breadwinner status as a moderator of the impact. It refers to a parent's share of the couple's total labor income in the year preceding the cancer diagnosis. This variable was formed by grouping couples into three groups: 1) parent's share of the couple's total labor income was less than 40 percent (secondary earner), 2) parents had an equal income share (40-60 percent of total earnings, i.e., equal earners), and 3) parent's share of the couples' total labor income was more than 60 percent (main breadwinner). This type of discretization of the female partner's income share has been previously used to study breadwinner status heterogeneity in the dissolution of marriage and cohabitation (*Kalmijn et al.*, 2007) or the gendered impacts of spousal residential mobility (*McKinnish*, 2008).

Additionally, we use cancer type, 5-year survival of the child, and child's age as measures for differential burden of care. We divide cancer types to acute lymphoblastic leukemia/lymphoblastic lymphoma (ALL/LBL), central nervous system cancers (CNS), and other cancers. This type of division is commonly used to distinguish more severe childhood cancers (ALL and CNS) from the rest of childhood cancers. For instance, CNS treatments often involve high-dose cranial radiation therapy and CNS cancer survivors may experience substantial cognitive declines (*Mulhern et al.*, 2004). Such long-term impacts could be linked also to shorter impacts that could affect also the well-being of parents and their joint labor market decisions. Furthermore, survival from cancer could be linked to more extreme contrasts than cancer type. This measure potentially reveals whether gendered responses arise from bereavement process (death) or whether gendered responses take place also when child survives. However, both can be associated with high care burden. Age of child at cancer diagnosis is linked to baseline nurturing needs that are exacerbated by cancer diagnosis.

4.4 Research design

To address the endogeneity between health and socioeconomic variables, health shocks have been increasingly employed as a potential source for exogenous variation in health. Among adults, health shocks are often linked to lifestyle factors, but childhood cancer has not been found to be systematically associated with any observed characteristics at the individual or family level (*Cancer Research UK*, 2021). Because childhood cancer is unanticipated, the concerns related to anticipation or reverse causality are minor. Therefore, to identify the causal impact of a health shock on parental outcomes, childhood cancer provides a good empirical case.

Appendix Figures S1 and S2 further provide a rationale for our decision to focus specifically on cancers. They illustrate the differences between families with a child who was hospitalized for the first time for more than 4 days with a specific diagnosis and families with similar family compositions whose children were never hospitalized (after childbirth). We find that childhood cancers are relatively unrelated to household income and parental education. This is not the case for health conditions in general.

The motherhood penalty literature has recently evolved towards using an event study framework focusing on sharp changes in labor outcomes between men and women around the transition to parenthood (e.g., *Kleven et al.* 2019a; *Musick et al.* 2020). The approach typically uses periods before the treatment to construct the counterfactual prediction for periods after the treatment. We depart from such approach by creating an explicit control group from the population of the untreated families. We employed a dynamic difference-in-differences design in an event study framework in which affected families were matched with unaffected families who had a similar family composition and educational background. Our estimated linear model can be written as follows:

$$\mathbf{Y_{i,r}} = \sum_{r \neq -1, r=-4}^{5} \gamma_r I_r + \sum_{r \neq -1, r=-4}^{5} \delta_r I_r C_i + \boldsymbol{X'_{i,t}}\beta + \pi_t + \theta_i + \epsilon_{i,r}. \qquad (1)$$

where the dependent variable $Y_{i,r}$ is the outcome of interest (employment, annual earnings, mother's share of household earnings) of the parent i observed in period r after the child's cancer diagnosis year. I_r represent the indicators relative to the index diagnosis year (actual cancer diagnosis for treated and placebo diagnosis for the matched controls).

The treatment variable is an indicator variable, C_i, which is equal to one for parent i whose child is diagnosed with cancer at period $r = 0$ and zero for a matched parent i whose child is not diagnosed with cancer. The parameter of interest is δ_r which represents the differences in changes in labor market outcomes between the treatment and the control group. To interpret the estimates in relative terms, we scale the absolute impact (in Euros) with the parent's predicted outcome from the group of unaffected ($\hat{Y}_{r0}$) for each relative time period r to form the estimates for the relative effect, $\delta_r^{rel} = \frac{\delta_r}{\hat{Y}_{r0}}$, representing the percentage change in the outcome.

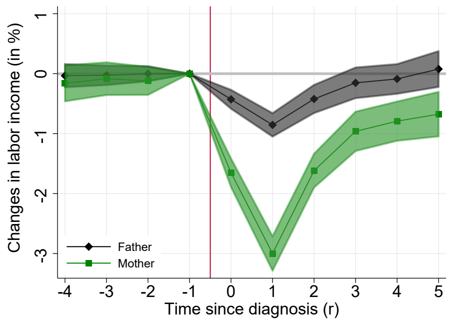
$\boldsymbol{X'_{i,t}}$ represent time-varying control variables for the parent and the child. We only include age of the mother and age of the child fixed effects in $\boldsymbol{X'_{i,t}}$. They will adjust for age-related differences in the labor productivity and the labor supply of parents. Calendar year effects π_t and age fixed effects control for potential time related differences between labor market opportunities between families with different treatment status. θ_i represent individual fixed effects.

5 Results

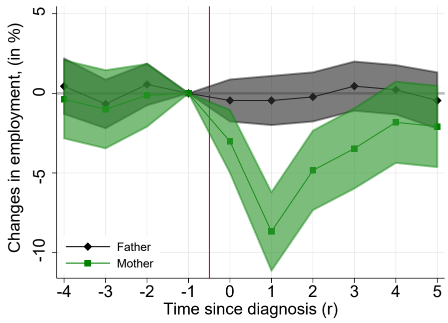
5.1 Impacts at the individual and couple-level

We start by presenting the results regarding the effects at the individual level for mothers and fathers separately. Figure 1 presents our main results in terms of labor income and employment (scaled by the predicted outcomes of the unaffected). It plots the estimated changes in labor income and employment and the corresponding 95% confidence intervals following child cancer normalized at the year preceding the first cancer diagnosis ($r = -1$) using unaffected families as a control group, as specified in Equation (1).

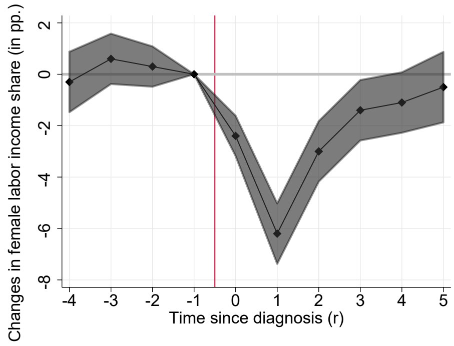
Diverging trends in the time periods preceding the index cancer diagnosis would undermine the common trends assumption and suggest that the control group does not provide a plausible counterfactual for the treated group. However, in our case, there are no underlying trends, such as anticipatory



(A) Labor income



(B) Employment rate



(C) Mother's share of labor income of couples

Figure 1: Impact of child cancer on the labor income and employment of mothers and fathers and mother's relative labor income share between couples. Point estimates (with the shaded areas representing 95 % confidence intervals) refer to changes relative to year preceding the childhood cancer in a fixed effects model specification. The vertical line at time $r = -0.5$ demonstrates the moment of the (placebo) cancer diagnosis. Corresponding regression tables in absolute (Table S1) and relative terms (Table S2) are presented in the Appendix.

behavior, that would undermine the causal interpretation of the estimates. A further look at the outcomes reveals that the employment and labor income between the treatment and control group run in parallel prior to $r = 0$ (Appendix Figure S3).

As illustrated in Figure 1, among mothers, a child's cancer reduces annual labor income by about 17 percent (EUR 3,700) in the diagnosis year and by 30 percent (EUR 6,700) the following year. The reduction then stabilizes to about 7 percent (EUR 1,500) relative to the control group five years after the cancer diagnosis (Panel A). The evolution of the impact on labor income closely follows the changes in employment probability (Panel B).

Fathers are also affected, but much more modestly. Child's cancer reduces annual labor income by about 5 percent (EUR 1,600) in the diagnosis year and by 9 percent (EUR 3,200) the following year. The effects decrease thereafter and become statistically non-significant for the three last years of the follow-up. The point estimates regarding employment probability are considerably smaller and are not statistically significant at 5 percent level. The results confirm our hypothesis on gender differences, while - in contrast to motherhood penalty - also fathers are negatively affected by child's health shock.

How much does child cancer affect the female labor income share within the household? Panel C demonstrates that child cancer has a negative impact on the share of household labor income provided by the mother. At the baseline, the mother's share was 37 percent on average. The year child was diagnosed with cancer, the mother's relative income contribution drops by 2.4 percentage points (6%) and by 6 percentage points (16%) the following year relative to unaffected mothers. While child cancer appears to affect the within-couple dynamics in income contribution in the short term, the results suggest that this impact is temporary in contrast to the penalty related to childbirth.

While our focus is on the within-couple dynamics, examining changes in labor income does not reveal the total financial implications of a child's cancer in the Nordic context. In the Appendix we show that the Finnish social security system cushions families against financial losses when a child falls severely ill. The decreases in the parents annual disposable income (Table S1) and household annual taxable income (Table S3) are considerably smaller once social security transfers are taken into account.

One concern for interpreting the results is potential differences union dissolution patterns between the treatment and control group. It could be assumed that as child cancer causes stress and anxiety for parents, it may also increase union instability. This would lead to an increase in mother's responsibility of childcare and gender inequality in the labor market outcomes because custody arrangements are gendered. However, in Appendix Figure S7 we show that if anything, child's cancer has a minor protective effect on parents' union stability. Therefore, we conclude that the changes in parents' labor income or relative shares of income between parents are not driven by union dissolution.

5.2 Impacts by breadwinner status

Next, we present differences in the impacts of child cancer on mother's labor income share by breadwinner status in Figure 2. The impacts are particularly

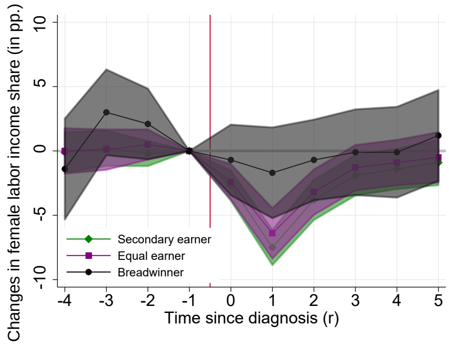


Figure 2: Impacts of child cancer on mother's relative share of total labor income of couples by breadwinner status. For notes see Figure 1 and for corresponding estimates in table format see Appendix Table S3.

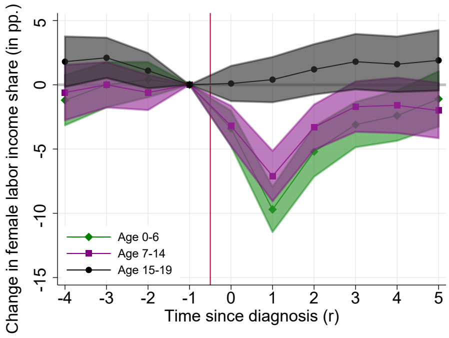
large in the first two years after child cancer diagnosis for mothers who are equal earners or secondary earners. Mothers who earn less than their partner, i.e., almost 60 percent of the treated mothers, suffer the largest drop in household income contribution shares at $r = 0$ (-2.7 pp.) and $r = 1$ (-7.5 pp.) as suggested by the hypothesis on comparative advantage. For mothers in equal earner households (a third of the treated mothers), the impacts are somewhat smaller than for secondary earners (-2.4 pp at $r = 0$ and -6.4 pp. at $r = 1$). Among female breadwinners (15% of the treated mothers), the income contribution shares are smaller throughout the 5-year effect window, but relatively imprecise and do not reach statistical significance.

The results are line with Swedish evidence suggesting that motherhood penalty is the greater the lower the relative income contribution of the mother (*Angelov et al.*, 2015). However, in the households where mothers are breadwinners, men provide low share of household income on average (about 10 percent). Therefore, large absolute impacts for mothers relative to men may not affect the relative income shares greatly. Alternative mechanisms that could determine gendered labor market responses are examined next.

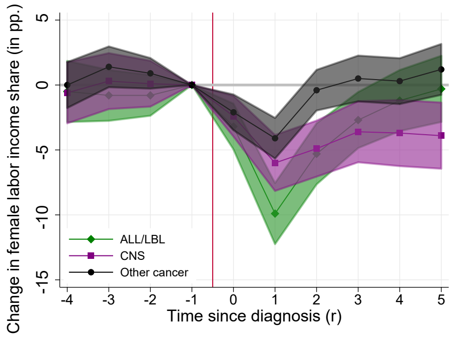
5.3 Alternative mechanisms

In this section, we shift our focus from parent's relative income contribution to potential moderators that are potentially linked to urgent childcare needs and could reinforce behaviour according to traditional gender norms. Young age at cancer and cancer severity are both important factors associated with increased need for nurture. Additionally, we consider 5-year child survival after the cancer diagnosis as an indicator for the severity of cancer. In

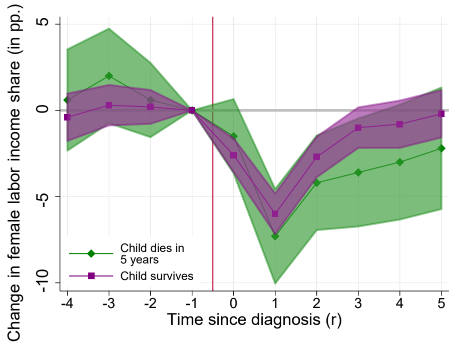
Figure 3 we present results by the age of the child at diagnosis, by cancer type, and by the child's survival in a 5-year follow-up.



(A) Effects by age of child's cancer



(B) Effects by cancer type



(C) Effects by survival

Figure 3: Heterogeneity in impacts on mother's labor income relative to household total labor income. For notes see Figure 1 and for regression estimates in table format see Table S4.

We find considerable heterogeneity in terms of child's age at cancer diagnosis (Figure 3 Panel A). Whereas mothers whose children suffer from cancer in adolescence do not experience the within-couple penalty, the story is different for mothers with younger children. The negative effect is the most pronounced for pre-school children. In this group, the mother's share of labor income decreases first about 3.4 percentage points (10 %) during the year of cancer diagnosis and 9.7 percentage points (29 %) the following year and fades away at the end of the follow-up.

In panel B, the heterogeneity analysis is conducted in terms of the cancer type. Whereas the cancers related to central nervous system (CNS) are related to the highest probability of death (Appendix Table S5) and highest disability benefits in the long-term (Appendix Figure S5), acute lymphoblastic leukemia/lymphoblastic lymphoma (ALL/LBL) are related to the highest treatment intensity especially in years immediately following the cancer diagnosis (Appendix Figure S6). This is reflected in the point estimates. ALL/LBL cause the largest drop in the mother's income contribution in the short term (-10 pp. at $r = 1$) but this gradually decreases to zero by year 5. CNS cancers result in smaller decreases in the short term (-6 pp. at $r = 1$) but the within-couple deficit does not fade away and stabilizes at 4 percentage points by year 5 and stays statistically significant throughout the 5-year effect window. In other types of cancers the short term impacts are smaller (-4 pp. at $r = 1$) and fade away already two years after the cancer diagnosis.

Part of the heterogeneity related to cancer types possibly stems from differences in survival. In panel C, we visualize the differences in the impact according to the survival of the child. While childhood cancer mortality is relatively low (16.5% in 5-year follow-up according to our data) and standard errors are large, we find the effect to be larger when the child dies, especially in the long run.

Taken together, we find that child's cancer affects mother's relative income contribution more when child is young and when cancer is of a severe kind. Naturally, many of the discussed moderators correlate with each other. In Appendix Figure S4 Paneld A we show that child age at cancer is positively linked to the probability of mother being breadwinner and negatively with the probability of child having a severe (ALL or CNS) form of cancer. Efforts to scrutinize the relative importance in more detail face issues related to statistical power. In Appendix, we approach this problem by comparing magnitudes of effects in multiple interaction models (Appendix Figure S4 Panel B) but are unable to provide conclusive arguments favoring either the role of comparative advantage or gender norms in urgent needs driving the results. However, looking at the long-term impacts for the different moderators could entail important information regarding the gendered responses. The only subgroup in which female labor income contribution stays negative at a statistically significant level in $r = 5$ is CNS-cancers. This might suggest that gendered responses in the long-term could arise from extra care burden related to child development delays due to radiation therapy.

5.4 Motherhood penalty reinforced?

Almost half of child cancers occur between ages 0-6. During this age period women's labor market participation is particularly low relative to men. We claim that poor child health and severe health shocks cause an additional penalty for mothers on top of the usual motherhood penalty related to childbearing. We illustrate this in Figure 4 where we compare the predicted labor income trajectories of three groups: i) women with a child with cancer ii) women with a child but no cancer iii) women who undergo fertility treatment in public health care without success in the first 5 years.

The first two groups refer to counterparts in our previous analysis, i.e., women with a child cancer shock and their matched counterparts. The purpose of the last group is to provide a counterfactual for women with children in general. The three groups are matched by the birth year and the education of both women and their partner as well as the municipality of residence and the (expected) birth year of the first child. The expected birth year for women with unsuccessful fertility refers to the first fertility treatment which is recommended after one year of unsuccessful reproduction efforts.

In essence, the figure describes women in families with child cancer with two distinct alternative scenarios: i) the labor market performance without

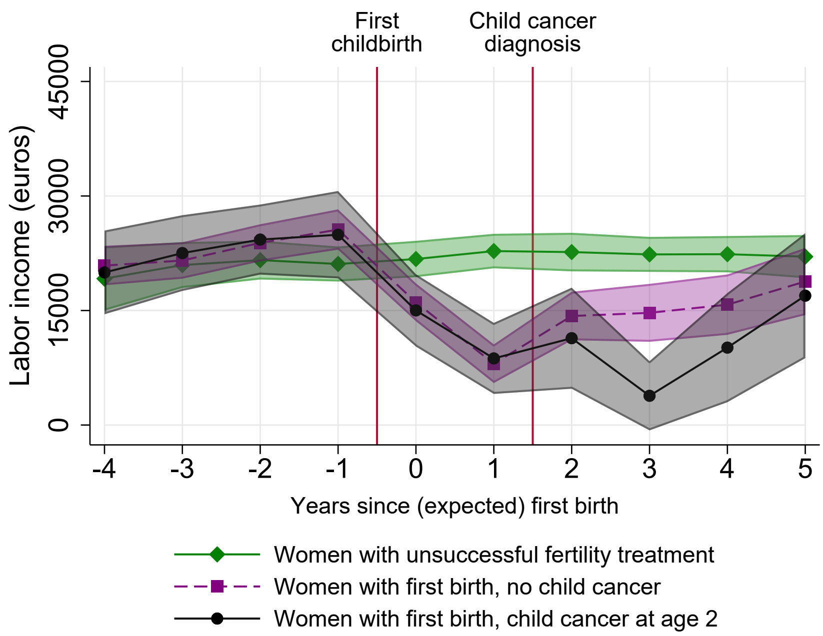


Figure 4: Predicted motherhood penalty illustrated for women with their first birth separately for women whose child are not diagnosed with cancer and for women whose first born is diagnosed with cancer at age 2. The control group for these two groups is a group of women who are diagnosed with ICD-10 code N97 (Female infertility) or Z31 (Encounter for procreative management).

childbirth and ii) the labor market performance with childbirth but no child cancer. We see that the first childbirth produces a labor income deficit of over 50 percent relative to women with unsuccessful fertility treatments a year after the childbirth. Over time the deficit relative to childless women narrows down, but mothers whose first-borns are diagnosed with cancer at age 2 suffer an extra penalty that is at its largest one year after cancer diagnosis or 3 years after childbirth. Over time, the mother's labor market performance recovers from the child's cancer, but is still associated with an annual average deficit of 15 percent over 5 years following the cancer diagnosis.

6 Discussion and conclusions

While remarkable advances have been made in reaching higher levels of gender equality, care responsibilities throughout the life cycle seem to fall on women's shoulders. Despite higher education and stronger attachment to the labor market than before, women have not reduced the time allocated to childcare (*Bianchi et al.*, 2000; *Sevilla-Sanz et al.*, 2010). The motherhood penalty, meaning the drop in a mother's earnings after childbirth, has been well documented in previous research in Western countries, including Finland (e.g., *Juhn and McCue* (2017); *Kleven et al.* (2019a); *Sieppi and Pehkonen* (2019); *Musick et al.* (2020); *Nylin et al.* (2021)).

The differences in earnings trajectories after childbirth between fathers and mothers explain an important part of gender pay gaps and may strengthen the perception of mothers as the main caregivers in the family (*Nylin et al.*, 2021). However, we know much less about other situations in which parents and couples re-negotiate the household division of labor. Therefore, in this article, we examined how a health shock of a child affects the within-couple inequality and parental outcomes, namely the mother's and father's earnings and employment.

While research on health spillover effects has recently been developed (e.g., *García-Gómez et al.* 2013; *Jeon and Pohl* 2017; *Fadlon and Nielsen* 2021), there is scarce evidence on the spillover effects of the severe illness of a child. A recent study has investigated the spillover effects of children's hospitalizations (*Breivik and Costa-Ramón*, 2022), but rather than just looking at individual responses we employed a couple-level framework that recognizes the 'linked lives' between spouses (*Settersten*, 2015) and the potential negative consequences of child cancer on gender inequality within couples.

Consequently, we not only investigated the impact of a child's cancer on the parental labor market outcomes, but we analyzed heterogeneous impacts according to the breadwinner status of the parent as well as the impact on mother's contribution to couple's total labor income. Parents do not make decisions about care and labor market attachment in isolation, but the pre-shock constellation of the household division of labor and comparative advantages are likely to play an important role if we are to believe economic theories on specialization and sociological theories on bargaining power. On the other hand, we were also interested in seeing whether traditional gender roles emerge with the unanticipated illness of a child. A couple-level framework is especially important when we want to understand how the within-couple inequalities are potentially maintained or even reinforced (*Musick et al.*, 2020).

This study benefits from having access to rich individual-level panel data that allows us to investigate manifold repercussions of relatively rare events such as child cancer. Using data for the total population of Finland and children's cancer cases for years 1999-2014, we were able to follow parents four years before and five years after the cancer diagnosis. We matched affected families with comparable unaffected families to estimate both absolute and relative impacts of child cancer on parental labor market outcomes and within-couple relative income.

The socioeconomic gradient in health makes the causal inference between health and labor market outcomes challenging. We approached this obstacle by focusing on a specific group of unexpected health shocks, childhood cancer. Prior research has not identified robust links between lifestyle factors and the incidence of childhood cancer (*Cancer Research UK*, 2021). We were able to show that the differences between families who go through childhood cancer and similar families without a cancer history are very similar to each other prior to the health shock, while this is not necessarily the case for other childhood health conditions (see Appendix Figures S1 and S2). This suggests that childhood cancers are particularly suitable for assessing the spillover effects of health shocks within the family. We argue that the matching method, event study approach, and our focus on childhood cancer allows plausible causal inference.

Our results demonstrate a significant negative impact on all economic outcomes studied, while a gendered impact is clearly visible as mothers bear most of the economic burden. This is in line with the study by *Breivik and Costa-Ramón* (2022). When comparing these results to the study by *Vaalavuo* (2021) on the impact of breast cancer among Finnish working-aged breast cancer survivors, we see that the impact of a child's cancer on mothers could be even larger in the medium term than suffering oneself from cancer. This highlights the importance of studying the so-called spillover effects of health shocks on other family members.

Overall, we found the impact to be larger on labor income than on the probability of employment. While we do not have information on the working hours, the results suggest that the reduction in labor income stems from reduced working hours. Additionally, job changes can potentially explain part of the differences in the estimates for employment and labor income, but these have been shown to be negligible for childhood health shocks in general (*Breivik and Costa-Ramón*, 2022).

The results regarding the breadwinner status support the theory on comparative advantage as mothers who earn less than her spouse experiences a larger relative drop in earnings. However, we also acknowledge that other mechanisms to gendered responses to child health shocks are possible. We show that when cancer takes more severe course or takes place at very young age, the gender inequality effect is more pronounced. We demonstrate that breadwinner status, young age at diagnosis and severity of cancer are all interlinked and the relative importance of these moderators is hard to distinguish due to statistical power issues. Nevertheless, our results show the importance of acknowledging linked lives between spouses and analyzing spouses together rather than as isolated units (*Settersten*, 2015; *Riekhoff and Vaalavuo*, 2021). This strategy is likely to shed light on inequalities both between and within families.

Our study has some limitations. First, we were only able to touch upon the mechanisms behind the effects. While mothers certainly are more negatively affected, we do not know whether this is due to emotional stress and other psychosocial consequences of a child's illness or whether this is due to mothers carrying out care duties and managing care at home. This is definitely a theme that should be considered in future research. Second, while the Finnish administrative data sources allow us to separate samples based on background variables, in the case of a rare event such as child cancer, the statistical power becomes limited in certain subsamples.

However, the results are generally in line with the scarce survey evidence documenting that mothers are much more likely than fathers to stay home when a child is sick. Our results show that parents seem to resort to traditional gender roles when a child falls ill, and the mother is more likely to carry the economic burden. Stronger negative effects on mothers could have long-term consequences for gender equality. According to signaling theory, employers may perceive mothers as less committed to their jobs (*Nylin et al.*, 2021). We illustrate that in addition to the motherhood penalty, other circumstances where more care is needed at home can reinforce gender inequality. Our study adds to the literature on the couple perspective in studying gender inequality related to parenthood. While parenthood is widely acknowledged as a critical point in the diverging career paths of men and women, the role of child health is less documented in this context.

Fathers have increased their share of time spent doing housework and carrying out childcare over time which has raised expectations of reducing wage gaps in the labor market. Further progress is expected as women's earnings potential has seen a secular rise and institutional changes also support parental leave for men. Notwithstanding the progress in gender equality, our evidence illustrates clear gender differences in how parents react to a child's health shock. This result could reflect gender norms or gender differences in the quality of childcare, while economic optimization within families could partly explain the finding because the result regarding female breadwinners shows a smaller negative impact on women's income share. Regardless of the drivers of the gender differences, our evidence suggests that a sudden deterioration in child health or other unexpected childcare arrangements in general form an obstacle to women's careers especially for mothers with young children.

In the future, comparing the effectiveness of the welfare state capacity to cover income losses due to illness in the family across countries would be an interesting endeavor as important differences are likely to emerge. In addition to productivity costs, a child's illness leads to a temporary reliance on social transfers. This means that health shocks are associated with much higher societal costs than just costs in the health care sector. A more comprehensive view of the costs of illness is therefore warranted in debates on health policies and economic evaluation of treatments (see also **?**). Institutional arrangements can also affect gender differences in the responses and overall opportunities and obstacles within couples and between couples of different socioeconomic statuses.

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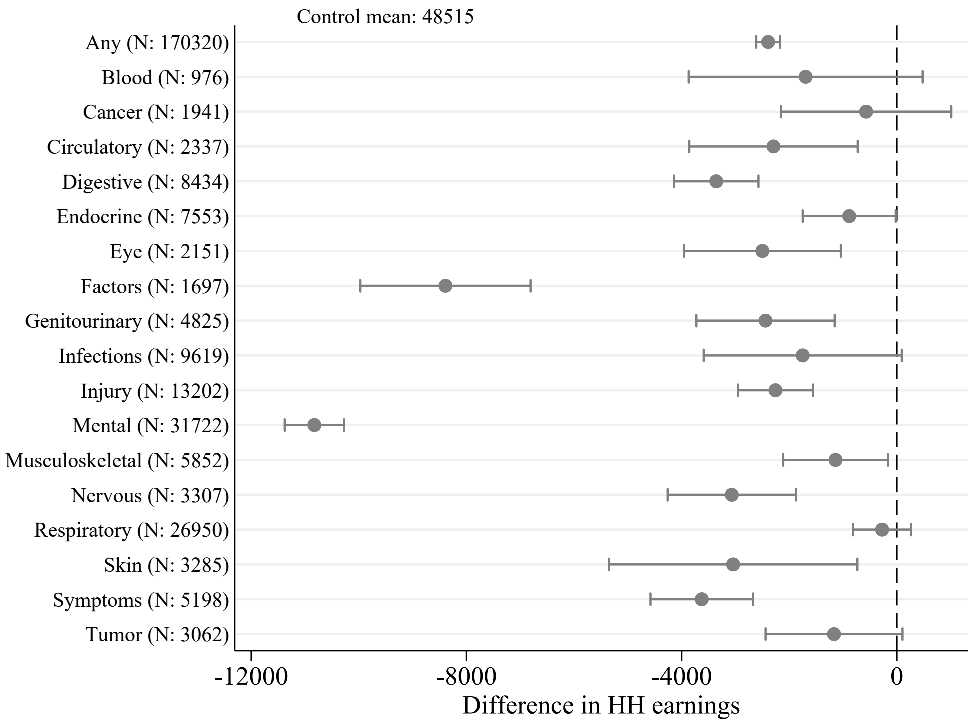
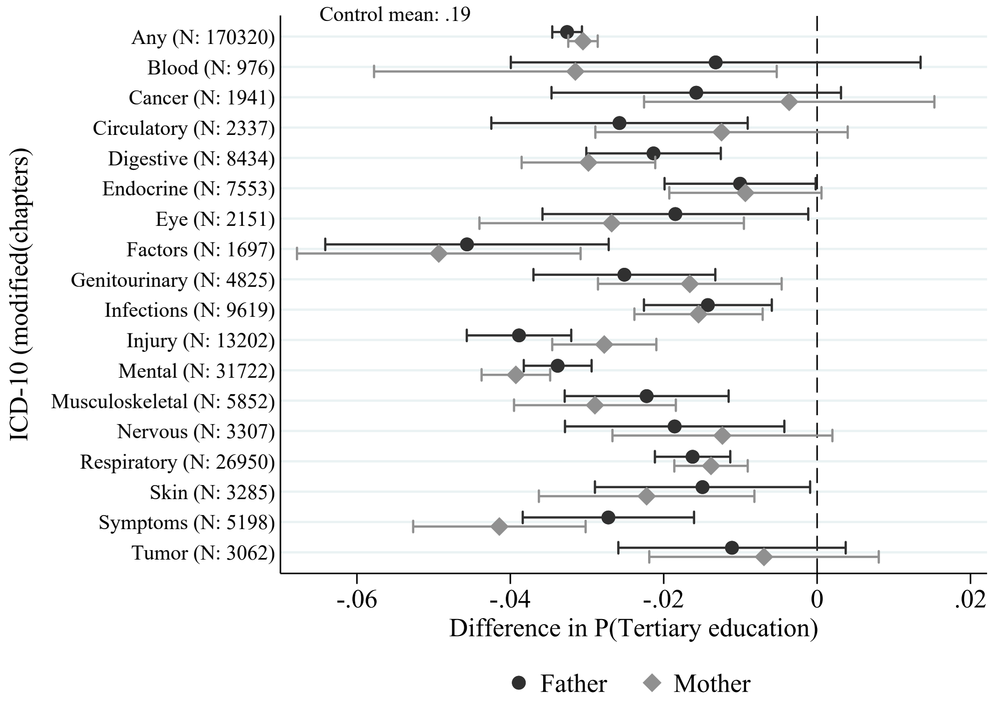
Supplementary material to Vaalavuo et al . *Gender inequality reinforced: the impact of a child's health shock on parents' labor market trajectories*

Figure S1: Household labor income and incidence of childhood health shocks



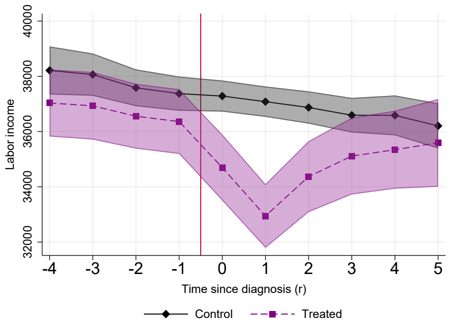
Note: The figure shows the coefficients and 95% CI from on regressions with household labor income at T-1 as dependent variable and treatment indicator as explanatory variable. Treatment indicator takes a value of 1 if the family is in the treatment group (child experiences a health shock), and 0 for the matched control group (child does not experience a health shock). These differences (vs. control group) in pre-cancer household income between the treated and comparison families are represented in different severe childhood health shocks stratified by ICD-10 (modified) chapters. Similarly to *Breivik and Costa-Ramón* (2022), severe health shocks are defined here as having a hospital stay minimum of four days during childhood (ages 0-19). Matching is based on sex and birth order of the child with cancer and birth years of father, mother and the child with cancer. Chapter categories include: Certain infections and parasitic diseases (A00-B99), Tumors/Neoplasms (C00-D48, incl. benign tumors D10-D36 and Cancers (C00-C99)), Diseases of the blood etc. (D50-D89), Endocrine, nutritional and metabolic disease (E00-E90), Mental and behavioral disorders (F00-F99), Diseases of the nervous system (G00-G99), Diseases of the eye and adnexa (H00-H59), Diseases of the ear and mastoid process (H60-H95), Diseases of the circulatory system (I00-I99), Diseases of the respiratory system (J00-J99), Diseases of the skin etc. (L00-L99), Diseases of the musculoskeletal system and connective tissue (M00-M99), Diseases of the genitourinary system (N00-N99), Congenital malformations etc. (Q00-Q99),Symptoms, signs and abnormal clinical and laboratory findings (R00-R99), Injury, poisoning and external causes of morbidity and mortality (S00-V99), Factors influencing health status and contact with health services (Z00-Z99). Pregnancy, childbirth and conditions originating from perinatal period are left out (O00-P96).

Figure S2: Parental tertiary education and incidence of childhood health shocks

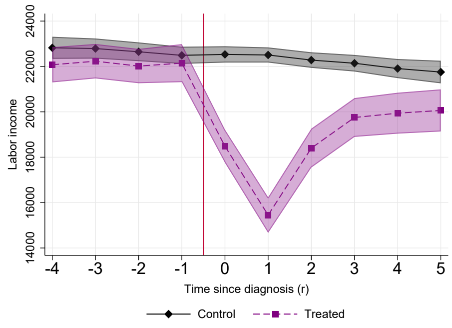


Note: The figure shows the coefficients and 95% CI from on regressions with tertiary education indicator at T-1 as dependent variable and treatment indicator as explanatory variable. Treatment indicator takes a value of 1 if the family is in the treatment group (child experiences a health shock), and 0 for the matched control group (child does not experience a health shock). For further description see Figure S1.

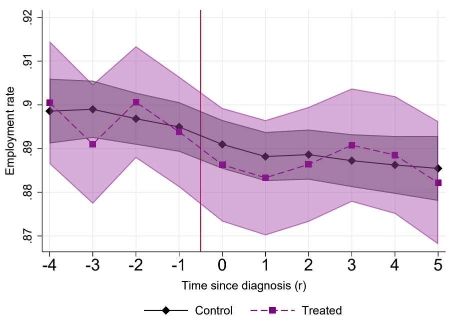
Figure S3: Evolution of labor market outcomes in years surrounding the first child cancer diagnosis



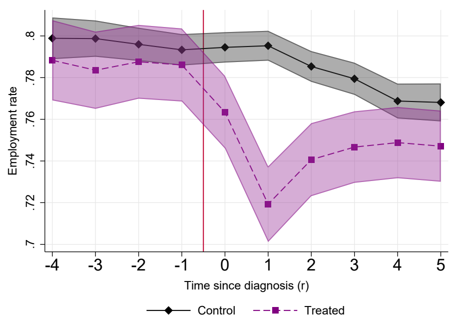
(A) Fathers' labor income



(B) Mothers' labor income



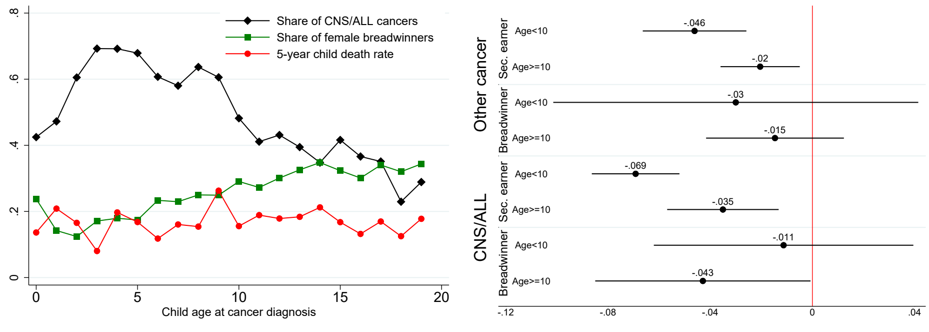
(C) Fathers' employment rate



(D) Mothers' employment rate

Note: Adjusted predictions of labor income and employment for fathers and mothers in years surrounding the first child cancer diagnosis. These adjusted predictions computed from analytic sample using Pooled OLS instead of individual fixed effects but using standard errors clustered at the individual level.

Figure S4: Age at child cancer, mother's breadwinner status, cancer type as moderators



(A) Breadwinner status, cancer type 0-6 and child survival by age at child cancer

(B) Two-year impacts by age group, breadwinner status and cancer type

Note: Links between age at child cancer, mother's breadwinner status, cancer type and 5-year cancer survival in Panel A and Average two-year impact of child cancer on mother's labor income share stratified by age group, breadwinner status and cancer type in Panel B.

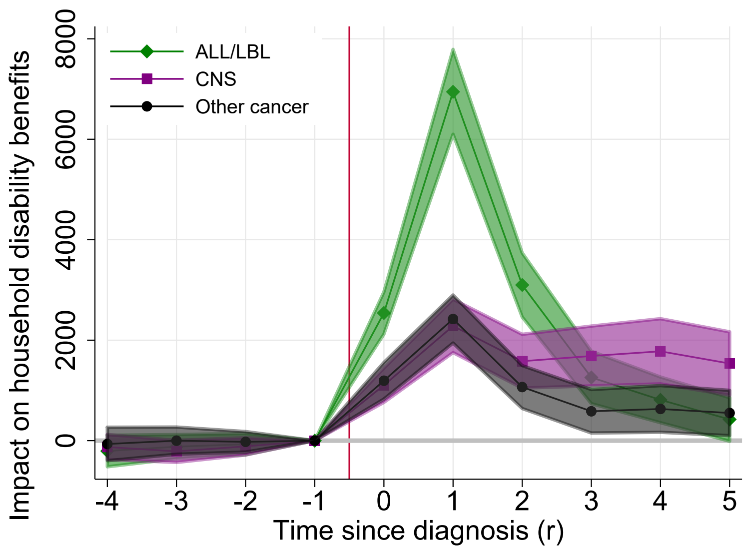
Besides the comparative advantage framework also other mechanisms could have a role determining gendered impacts of child cancer on labor market outcomes. One concern is that breadwinner status is connected to severity of cancer and age of child cancer diagnosis both of which are linked the level of nurture and child care needs provided in the family. We illustrate these interlinkages in Figure S4. From Panel A, we see that most severe child cancers (CNS/ALL), that are related highest disability benefits received by families (Appendix Figure S6) and highest number of hospital days (Appendix Figure S6) take place at young ages at a time when child care needs are already. This coincides with low share of female breadwinners as recent childbirth generally causes a income penalty for mothers but not fathers. However, age at cancer not related to probability of death. So, what is the main driver of reinforced motherhood penalty?

From Panel B of Figure S4, we see that impacts of chilldhood cancer are the greater the younger child is diagnosed with cancer and the more severe it is. When comparing within cancer types and age groups, the point estimates also tend to be smaller for females who are primary earners. This would be in line with prior evidence on motherhood penalty being smaller for women with relatively high education between couples. However, the results should be interpreted with caution as the point estimates are fairly imprecise especially when looking at breadwinning mothers with relative young children (early age at child cancer).

We do not have access to measures that measure the burden of additional care caused by child cancer. To have examine to what extent the type of cancer brings out in responses in parental time towards household work or childcare, we would ideally have access to time diary data. We do not have access to this data but we can derive some conclusions from disability benefit information provided by Statistics Finland Household module. The disability benefits include information on both work disability benefits and disability pension stemming from chronic illness. For children (below age 16) there is a special disability for child that aims to cushion against the costs related to treatment and caring of children with cancer. Assuming that probability of parental disability do not change dramatically from child cancer, we would the changes in disability benefits stem from child disability benefits which in turn give indication of the size and longevity of child disabilities.

Figure S5 reports impacts of child cancer on household's disability benefits. We see that disability benefits rise dramatically immediate after cancer diagnosis especially for ALL/LBL cancers. In the long-term, however,

Figure S5: Impact of child cancer on household disability benefits by cancer type

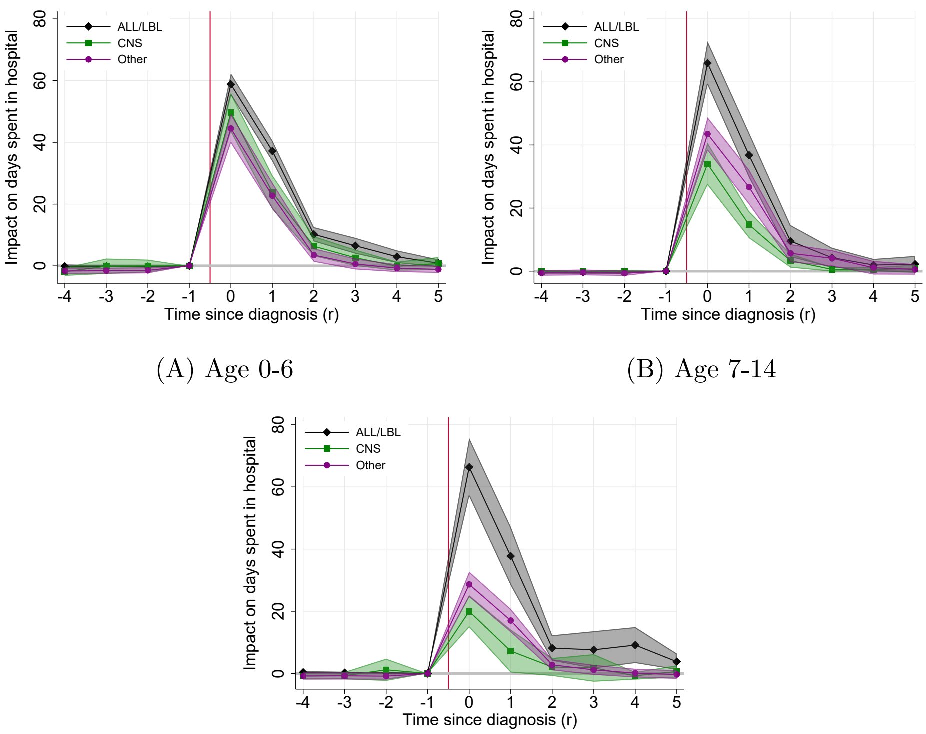


Note: Disability benefits include both work disability benefits and disability pension stemming from chronic illness. For children (below age 16) there is a special disability for child that aims to cushion against the costs related to treatment and caring of children with cancer. Shaded areas represent 95% confidence intervals of point estimates.

the disability benefits diminish considerably and at the end of follow-up the disability benefits are highest for CNS cancers. This result is not surprising because central nervous cancers are associated with longer-term deficits in functioning in affected especially among individuals treated at a young age. Because CNS treatments often involve high-dose cranial radiation therapy, CNS cancer survivors may experience substantial cognitive declines (*Mulhern et al.*, 2004) and difficulties in terms employment and marital outcomes (*Schulte et al.*, 2019). Such long-term impacts on the affected children are likely to affect also the well-being of parents.

Next, we proceed to quantify the intensity of cancer treatment in child cancer. Figure S6 reports impacts of child cancer on children's the annual hospitalization days. We apply the Equation 1 presented in Data and methods section with one exception: we do not impose restriction of balanced sample. Therefore, some of children might drop out from the sample due to

Figure S6: The impact of child cancer on child's hospital days



(A) Age 0-6

(B) Age 7-14

(C) Age 15-19

Note: Shaded areas represent 95% confidence intervals of point estimates.

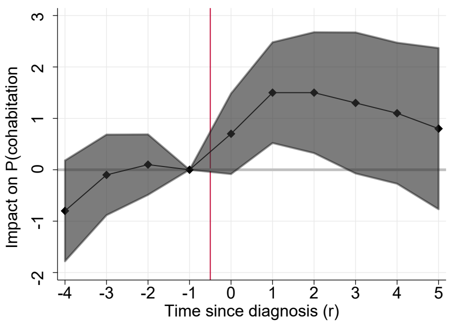
mortality. We matched children as control group. The analysis is stratified by cancer type and age group in order to address potential heterogeneity within cancer types in terms of age at cancer.

We find that in all age groups, ALL/LBL cancers are associated with longest hospital stays. These take place mostly within two years after the first cancer diagnosis. The differences between ALL/LBL and CNS cancer and other cancers are largest in age group 15-19. This could be associated with the fact that ALL/LBL 5-year death rates are particularly high in ages 15-19 whereas the death rates are almost half in other cancers in adolescence.

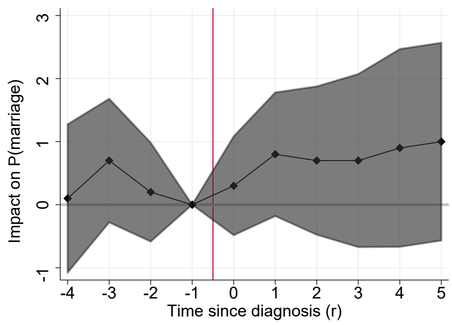
Both survey-based (*Rosenberg et al.*, 2013) and register-based evidence (*Salem et al.*, 2019; *Mader et al.*, 2021) suggest that child cancer causes enormous stress for parents. This in turn could affect the probability of union dissolution. In this section, we test the child cancer increases the union dissolution of parents. Figure S7 visualizes the results of this investigation.

Child's cancer increases the likelihood of parents remaining together especially in short run, while in long run the estimates are not statistically significant (Panel A). For marriage (81% of couples at the baseline) the results are less precise and not statistically significant (Panel B). Looking at the heterogeneous impacts by child survival, we see the that the disparity between the short-term and long-term estimates for cohabitation outcomes appears to be driven by cancers that result to death. In Panels C and D we see indicative evidence that cancer-related child deaths increase the probability of union dissolution in the long-term. While the estimates imprecise for these

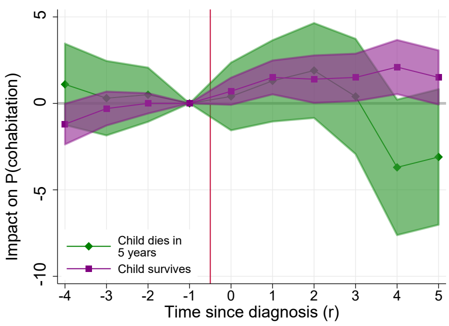
Figure S7: Impacts on the union dissolution



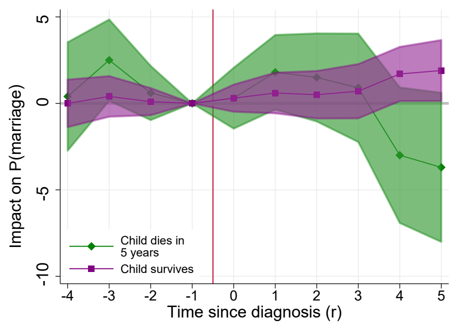
(A) Cohabition



(B) Marriage



(C) Cohabitation by 5-year survival



(D) Marriage by 5-year survival

Note: Shaded areas represent 95% confidence intervals of point estimates.

couples, the results for the families who survive child cancer are clear. For couples, whose child survives cancer, the distress event is more likely to tie parents together than draw them apart in the long-term. In cohabitation, the point estimate is about 1.5 pp and for marriage 1.9pp at time 5.

While the effects are fairly small, are line with the most recent register-based evidence. *Mader et al.* (2020) found slight reduction in risk of parental separation following child cancer using discrete-time hazard regression models. Interestingly, register-based evidence from 20 years ago (**?** *Grant et al.*, 2012) did not find child cancer to have any effects on union dissolution using similar survival models. This could mean that patterns of divorce or separation among parents could have changed over time.

Table S1: Absolute impact of child cancer on parental outcomes

Time to	Labor income		Taxable income		Employment		Disposable income	
diagnosis	Father	Mother	Father	Mother	Father	Mother	Father	Mother
-4	-129	-368	-172	-397	0.004	-0.003	-78	-359
	[377]	[349]	[505]	[330]	[0.008]	[0.01]	[602]	[256]
-3	-103	-191	-314	-238	-0.006	-0.008	-434	-233
	[317]	[317]	[472]	[319]	[0.007]	[0.01]	[415]	[207]
-2	-5	-274	77	40	0.005	-0.001	-48	60
	[244]	[269]	[437]	[299]	[0.006]	[0.008]	[519]	[188]
-1	0	0	0	0	0	0	0	0
	.	.	.	.	.	.	.	.
0	-1594	-3726	-475	-778	-0.004	-0.024	-462	-370
	[301]	[276]	[447]	[268]	[0.006]	[0.008]	[455]	[161]
1	-3167	-6749	-1288	-710	-0.004	-0.069	-361	-365
	[371]	[331]	[453]	[290]	[0.007]	[0.01]	[501]	[191]
2	-1556	-3602	-759	-896	-0.002	-0.038	-332	-608
	[443]	[322]	[562]	[293]	[0.007]	[0.01]	[504]	[192]
3	-559	-2129	484	-917	0.004	-0.027	-386	-689
	[478]	[371]	[692]	[371]	[0.007]	[0.01]	[684]	[236]
4	-321	-1735	-161	-856	0.002	-0.014	2	-288
	[464]	[366]	[647]	[379]	[0.007]	[0.01]	[843]	[425]
5	278	-1468	1533	-928	-0.004	-0.016	1098	-567
	[552]	[412]	[813]	[408]	[0.008]	[0.01]	[960]	[227]
Observations	133616	135840	133616	135840	133616	135840	133616	135840
N	13362	13584	13362	13584	13362	13584	13362	13584
R2	0.107	0.187	0.046	0.111	0.124	0.091	0.016	0.098
DD-estimate	-1086	-3013	0	-685	-0.002	-0.028	73	-337
SE(DD)	367	236	448	228	0.005	0.006	470	172
P(pre-diagnosis)	0.975	0.615	0.831	0.444	0.207	0.868	0.623	0.263
Control group mean	37374	22490	45992	28363	0.895	0.793	33440	24387
Treat. group mean	36362	22147	45067	28434	0.894	0.786	32780	24466
Sample mean	37219	22438	45851	28374	0.895	0.792	33339	24399

Notes: Absolute impact of child cancer on parental outcomes for years relative to child cancer diagnosis. Standard errors (clustered at individual level) are reported below the point estimates in parentheses. Below the event study estimates we report number of observations, number of subjects and R-squared. Furthermore in bottom 6 rows, we report average impact on labor income going from pre-cancer (-4 – -1) to post-cancer (0–5) periods (DD-estimate) and the related standard error. We also report p-value of the hypothesis that all pre-cancer impact estimates are zero and pre-cancer mean of outcomes for the control group, treatment group and the full sample.

Table S2: Impact of child cancer on parental outcomes scaled by control group outcome levels

Time to	Labor income		Taxable income		Employment		Disposable income	
diagnosis	Father	Mother	Father	Mother	Father	Mother	Father	Mother
-4	-0.003	-0.016	-0.004	-0.014	0.004	-0.004	-0.002	-0.014
	[0.015]	[0.011]	[0.012]	[0.009]	[0.013]	[0.018]	[0.01]	[0.010]
-3	-0.003	-0.008	-0.007	-0.008	-0.007	-0.010	-0.013	-0.009
	[0.014]	[0.01]	[0.011]	[0.008]	[0.013]	[0.012]	[0.008]	[0.008]
-2	0.000	-0.012	0.002	0.001	0.006	-0.001	-0.001	0.002
	[0.012]	[0.009]	[0.011]	[0.007]	[0.01]	[0.015]	[0.008]	[0.007]
-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	.	.	.	.	.	.	.	.
0	-0.043	-0.165	-0.010	-0.028	-0.004	-0.030	-0.014	-0.015
	[0.012]	[0.01]	[0.009]	[0.007]	[0.01]	[0.014]	[0.007]	[0.006]
1	-0.085	-0.300	-0.028	-0.025	-0.005	-0.087	-0.011	-0.014
	[0.015]	[0.01]	[0.01]	[0.008]	[0.013]	[0.015]	[0.008]	[0.007]
2	-0.042	-0.162	-0.017	-0.032	-0.002	-0.048	-0.010	-0.024
	[0.014]	[0.012]	[0.01]	[0.008]	[0.013]	[0.015]	[0.008]	[0.007]
3	-0.015	-0.096	0.011	-0.033	0.005	-0.035	-0.012	-0.028
	[0.017]	[0.015]	[0.013]	[0.008]	[0.013]	[0.02]	[0.01]	[0.009]
4	-0.009	-0.079	-0.004	-0.031	0.002	-0.018	0.000	-0.011
	[0.017]	[0.014]	[0.014]	[0.008]	[0.013]	[0.025]	[0.017]	[0.017]
5	0.008	-0.067	0.034	-0.034	-0.005	-0.021	0.033	-0.023
	[0.019]	[0.018]	[0.015]	[0.009]	[0.013]	[0.029]	[0.009]	[0.009]
Observations	133616	135840	133616	135840	133616	135840	133616	135840
N	13362	13584	13362	13584	13362	13584	13362	13584
R2	0.107	0.187	0.046	0.111	0.124	0.091	0.016	0.098
DD-estimate	-0.030	-0.136	0.000	-0.025	-0.002	-0.036	0.002	-0.014
SE(DD)	0.010	0.011	0.010	0.008	0.005	0.008	0.014	0.007

Notes: Relative impact of child cancer on parental outcomes for years relative to child cancer diagnosis. Standard errors (clustered at individual level) are reported below the point estimates in parentheses.

Table S3: Impact of child cancer on household outcomes

Time to diagnosis	Mother's labor income share	P(Cohabiting parents)	P(Parents married)	HH total tax. income
-4	0.007	-0.011	0.004	-51
	[0.007]	[0.008]	[0.008]	[730]
-3	0.009	-0.004	-0.003	-671
	[0.006]	[0.007]	[0.007]	[611]
-2	0.005	-0.005	-0.004	602
	[0.005]	[0.005]	[0.006]	[531]
-1	0.000	0.000	0.000	0
	[.]	[.]	[.]	[.]
0	-0.032	0.010	-0.003	-959
	[0.005]	[0.004]	[0.004]	[638]
1	-0.068	0.012	0.005	-1194
	[0.006]	[0.005]	[0.006]	[578]
2	-0.029	0.011	0.005	-957
	[0.007]	[0.006]	[0.007]	[706]
3	-0.012	0.012	0.007	-860
	[0.007]	[0.007]	[0.008]	[860]
4	-0.011	0.010	0.001	-999
	[0.007]	[0.008]	[0.009]	[837]
5	-0.008	0.009	0.002	613
	[0.007]	[0.008]	[0.009]	[895]
Obs	109000	117060	117060	135840
N	11412	11706	11706	13584
R2	0.065	0.077	0.107	0.026
DD-estimate	-0.032	0.016	0.004	-646
SE (DD-estimate)	0.005	0.006	0.007	608
P(pre-diagnosis)	0.552	0.385	0.490	0.33
Control group mean at r=-1	0.403	0.761	0.599	73112
Treatment group mean at r=-1	0.403	0.758	0.593	71754
Sample mean at r=-1	0.403	0.761	0.598	72906

Notes: Impact of child cancer on household outcomes. Standard errors (clustered at individual level) are reported below the point estimates in parentheses.

Table S4: Heterogeneity in the impact of child cancer on mother's labor income share within household

	Child age at cancer			Breadwinner status			Cancer type			5-year survival	
Time to diagnosis	0-6	7-14	15-19	Sec. earner	Equal earner	Bread -winner	ALL/ LBL	CNS	Other	Surv.	Dies
-4	-0.012	-0.006	0.018	-0.001	0.000	-0.014	-0.010	-0.007	0.00	-0.004	0.006
	[0.010]	[0.011]	[0.010]	[0.008]	[0.009]	[0.020]	[0.013]	[0.012]	[0.009]	[0.007]	[0.015]
-3	0.000	0	0.021	0.002	0.001	0.030	-0.008	0.002	0.0	0.003	0.02
	[0.009]	[0.009]	[0.008]	[0.007]	[0.008]	[0.017]	[0.011]	[0.011]	[0.007]	[0.006]	[0.014]
-2	0.004	-0.006	0.011	-0.002	0.005	0.021	-0.009	0.001	0.01	0.002	0.006
	[0.007]	[0.007]	[0.007]	[0.005]	[0.006]	[0.014]	[0.009]	[0.009]	[0.006]	[0.005]	[0.011]
-1	0.000	0	0	0.000	0.000	0.000	0.000	0.000	0.00	0	0
	[.]	[.]	[.]	[.]	[.]	[.]	[.]	[.]	[.]	[.]	[.]
0	-0.034	-0.032	0.001	-0.027	-0.024	-0.007	-0.034	-0.024	-0.02	-0.026	-0.015
	[0.007]	[0.008]	[0.007]	[0.006]	[0.007]	[0.014]	[0.010]	[0.008]	[0.006]	[0.005]	[0.011]
1	-0.097	-0.071	0.004	-0.075	-0.064	-0.017	-0.108	-0.061	-0.04	-0.06	-0.073
	[0.009]	[0.010]	[0.009]	[0.007]	[0.010]	[0.018]	[0.013]	[0.011]	[0.007]	[0.006]	[0.014]
2	-0.052	-0.033	0.012	-0.038	-0.032	-0.007	-0.056	-0.050	-0.01	-0.027	-0.042
	[0.010]	[0.009]	[0.010]	[0.008]	[0.009]	[0.016]	[0.013]	[0.011]	[0.008]	[0.006]	[0.014]
3	-0.031	-0.017	0.018	-0.019	-0.013	-0.001	-0.033	-0.037	0.01	-0.01	-0.036
	[0.009]	[0.010]	[0.011]	[0.008]	[0.009]	[0.017]	[0.012]	[0.012]	[0.008]	[0.006]	[0.016]
4	-0.024	-0.016	0.016	-0.014	-0.009	-0.001	-0.019	-0.037	0.01	-0.008	-0.03
	[0.010]	[0.011]	[0.011]	[0.008]	[0.009]	[0.018]	[0.013]	[0.013]	[0.008]	[0.007]	[0.017]
5	-0.011	-0.02	0.019	-0.009	-0.005	0.012	-0.007	-0.039	0.01	-0.002	-0.022
	[0.011]	[0.011]	[0.012]	[0.009]	[0.010]	[0.018]	[0.014]	[0.013]	[0.009]	[0.007]	[0.018]
Obs	58622	36253	33899	72353.00	35076.00	19215	32265	32004	62196.00	107799	20975
N	6143	3767	3552	7419.00	3559.00	2023	3380	3334	6502.00	11265	2197
R2	0.095	0.035	0.016	0.12	0.06	0.076	0.084	0.066	0.06	0.064	0.074
DD-estimate	-0.040	-0.029	0.000	-0.030	-0.026	-0.014	-0.037	-0.040	-0.013	-0.023	-0.045
SE (DD)	0.007	0.008	0.008	0.006	0.007	0.015	0.010	0.009	0.006	0.005	0.012
P(pre-diag.)	0.341	0.664	0.078	0.902	0.838	0.008	0.795	0.814	0.178	0.536	0.359
Control mean	0.329	0.424	0.464	0.188	0.488	0.902	0.358	0.393	0.408	0.391	0.397
Treat. mean	0.322	0.447	0.437	0.184	0.484	0.905	0.381	0.393	0.386	0.392	0.368
Sample mean	0.328	0.428	0.460	0.188	0.487	0.903	0.369	0.393	0.405	0.391	0.392

Notes: Impact of child cancer on mother's labor income share. Standard errors (clustered at individual level) are reported below the point estimates in parentheses.

Not all cancers are alike. Table S5 reports 5-year mortality rates in child cancer by cancer types (Acute lymphoblastic leukemia/ lymphoblastic lymphomaleukaemia (ALL/LBL), central nervous system cancers (CNS) and other cancers). We also stratified death rates by mother's education level and age group (ages 0-6 (infancy/preschool), 7-14 (middle childhood) and 15-19 years (adolescence)). The categorization of cancer type is based on the ICD-10 code of the first diagnosis.

In addition to differences in the age distribution, cancer types also differ in severity and mortality risk. Mortality risk is the highest in the age group 7-14 and in the cancers of the central nervous system. In this group of cancers, the survival rates are fairly similar across education groups but in

Table S5: 5-year death probability for children with cancer by mother's education level

	Primary		Secondary		Tertiary		Total	
	N	mean	N	mean	N	mean	N	mean
All cancers	1171	0.179	468	0.152	538	0.135	2067	0.162
Cancers grouped by								
Cancer type								
ALL/LBL	275	0.175	94	0.085	157	0.045	526	0.12
CNS	261	0.26	115	0.243	140	0.243	516	0.252
Other	555	0.141	241	0.137	218	0.128	1014	0.137
Age group								
Age 0-6	497	0.171	151	0.126	284	0.123	932	0.149
Age 7-14	293	0.184	156	0.205	134	0.187	583	0.19
Age 15-19	307	0.186	146	0.123	99	0.101	552	0.154
Cancer type & age group								
ALL/LBL at age 0-6	184	0.13	55	0.091	113	0.035	352	0.094
ALL/LBL at age 7-14	60	0.183	28	0.036	33	0.091	121	0.124
ALL/LBL at age 15-19	31	0.42	11	0.182	11	0	53	0.283
CNS at age 0-6	114	0.316	36	0.25	69	0.304	219	0.301
CNS at age 7-14	80	0.275	45	0.311	43	0.233	168	0.274
CNS at age 15-19	67	0.149	34	0.147	28	0.107	129	0.139
Other cancer at age 0-6	196	0.122	58	0.086	100	0.09	354	0.107
Other cancer at age 7-14	150	0.133	82	0.207	58	0.207	290	0.169
Other cancer at age 15-19	209	0.163	101	0.109	60	0.117	370	0.141

Notes: Probability of death in child cancer by education level of mother and further stratified by age groups of child cancer and cancer type. The rightmost panel reports the 5-year average increases in hospital days following first cancer diagnosis in different age group and cancer type categories contrasted against the control group.

especially in ALL/LBL the educational gradient is pronounced even when stratified by age groups.

Consistent with the findings of *Tolkkinen et al.* (2018), we find an educational gradient at 5-year survival rates of child cancer. The probability of a child death appears to be the highest for children whose mothers have only primary education.