Impacts of Child Health on Families: Evidence from Childhood Cancers*

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Abstract

How do parents contend with threats to the health and survival of their children? We combine the universe of cancer diagnoses among Danish children with register data for affected and matched unaffected families. Parental income declines substantially for 3-4 years following diagnosis, an effect driven by reductions in working hours. Fathers' incomes recover fully, but mothers' incomes remain 5% lower 12 years after diagnosis. Both parents' mental health suffers. Fertility increases, particularly among families in which the child died. These results demonstrate that even in high-income settings, severe shocks to child health can have long-lasting consequences for family outcomes.

JEL Codes: I10, J13, J22
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1 Introduction

Families have always contended with the possibility of negative shocks to the health and survival of their children. Historically, rates of mortality in infancy and early childhood were astronomical – globally, 1 in every 4 children died before the age of 5 in 1950. Indeed, until the mid-twentieth century, child mortality was high even in countries with high *per capita* incomes today.[1] Technological breakthroughs and increases in general resource availability have made this threat more rare in high-income countries, yet still large numbers of families are affected by severe health shocks to children every year. In the United States, for example, in 2018 6.5% of children under the age of 12 were admitted to the hospital at least once (Center for Disease Control and Prevention, 2018).[2]

How do the decision-making and outcomes of families respond to such shocks in both the short and long term? The answer could have fundamental implications for our understanding of life-cycle decision-making, including labor supply, fertility, and health. Yet rigorous evidence on this question remains elusive, for at least two reasons.[3] The first is the endogeneity of child health, which is co-determined with a host of household characteristics and behaviors, including, importantly, family socioeconomic status (Case et al., 2002; Currie and Hyson, 1999; Currie and Stabile, 2003). Most determinants of child health likely directly affect family outcomes, rendering the identification of causal impacts difficult. The second issue is data constraints. In particular, pairing detailed information on child health – including the precise timing of shocks – with panel data on families' economic outcomes extending long enough to track long-run adjustments, which may be a critical part of the overall story, is a tall order.

Our work aims to overcome these challenges by studying the impacts of a large health shock – childhood cancer – on parents' income and safety net transfers, labor market decisions, health, and well-being in Denmark. We link data on the universe of childhood cancer diagnoses in Denmark to population register data on the characteristics and outcomes of families of affected children, as well as the same data from matched families of unaffected children.[4]

Childhood cancer has several important features that make it well suited for the purpose of estimating the impacts of severe shocks to child health on family outcomes. First, cancers are an important determinant of population health in nearly all contexts, including among high-income countries. Cancer is the second leading cause of death in OECD countries, accounting for more than 25 percent of all deaths (OECD, 2019). While cancer is often studied in the context of aging, it can also have devastating effects across the age distribution. Cancer is the leading cause of

[1] For example, 1 in 27 children in the United States did not survive to age five in 1950 (Gapminder, 2020).

[2] This is similarly true in the Danish context, where our study is based: in 2018, 2.8 percent of children aged one to fourteen were hospitalized in Denmark (authors' calculations using data from Statistics Denmark, available at `https://www.statbank.dk/`).

[3] There is a rich, older literature on the effects of child mortality on fertility choices (see, e.g., Ben-Porath (1976); Rosenzweig and Schultz (1983); Schultz (1978); Wolpin (1984)), which this study builds on, but little rigorous work on the effects of large health shocks or mortality on parents' health and economic outcomes. This older literature also largely ignores potential endogeneity concerns.

[4] Appendix A.1-A.2 provide an overview of diagnosis and treatment of childhood cancers in Denmark along with a discussion of social insurance and mental health services available to families of sick children.

disease-related death among children in high-income countries (Grabas et al., 2020); for example, in the United States 1 in 285 children will be diagnosed with cancer before the age of 20 (Ward et al., 2014). The impacts of cancer diagnosis and treatment on the health and well-being of children are likely profound – studies in pediatrics and public health seek to quantify some of these impacts, usually based on samples of childhood cancer survivors (see, e.g., Armstrong et al. (2016, 2009)). But there is little rigorous evidence on the potentially substantial impacts of childhood cancer diagnosis on the short- and long-run economic outcomes of mothers and fathers.

Second, unlike some cancers, which are strongly hereditary, the occurrence of most childhood cancers is very difficult to predict, in that it is not associated with cancer prevalence in past generations, nor with genetic or physical traits of infants and young children, nor with socioeconomic characteristics of households (Birch, 1999; Lichtenstein et al., 2000). This means that for most families, a child's cancer diagnosis is an unanticipated event – that is, truly a shock. This also implies that this shock is not confined to a particular socioeconomic or demographic group – families across income and demographic categories are, to a large extent, equally likely to experience it.

Third, childhood cancer is a large and potentially life-changing event for families. Depending on the severity of the cancer and the health impacts of treatment, children may require intensive care and resources, thus affecting parents' choices regarding income generation, labor market participation, saving, debt, and the like. This particular shock may thus plausibly affect both short- and long-term economic well-being for families.

Finally, childhood cancer in high-income countries results in remission in approximately four out of every five cases (Lam et al., 2019), meaning that for most affected households, the direct impacts of the child's diagnosis and treatment are temporary in nature. However, economic effects may well persist; for example, temporary shifts in labor supply and income might have long-run consequences for wages and career growth, if parents spend substantial time out of the labor force or work in reduced capacity. This is important for understanding whether temporary fluctuations in child health, which likely constitute the vast majority of such shocks, can nevertheless have long-lasting consequences for families' economic well-being.

We use population data to identify close matches of each affected household from unaffected "controls" based on households' socioeconomic characteristics and demographic structure. Matching techniques offer promise in environments with a large pool of potential controls, such as the present context with register data on the entirety of the Danish population over time. We leverage this large pool of potential controls to find children who are *ex ante* statistically identical (based on a set of individual and parental characteristics) to children who are eventually diagnosed with cancer. We then use an event study framework to estimate the impacts of childhood cancer diagnosis, leveraging the plausible exogeneity of the occurrence and timing of diagnosis. This, along with the repeated observations of outcomes, allows for the identification of treatment effects and the evaluation of pre-trends across affected and unaffected households.

We study impacts of childhood cancer diagnosis on the economic outcomes and mental health of mothers and fathers separately. Time use surveys across the world document that women

are disproportionately responsible for child care and other household production tasks.[5] Given this imbalance, it stands to reason that mothers and fathers might make very different economic decisions when their children are affected by a negative health shock. These decisions, even if they are transitory, may have long-run implications for earnings and career advancement for mothers versus fathers, and may consequently contribute to the well documented gender pay gap. Indeed, in line with this reasoning, recent evidence documents that the career costs of having children are starkly different for women and men (Kleven et al., 2019; Lundborg et al., 2017). Similar patterns might thus ensue as responses to shocks to children's health, as well.

We find that both mothers' and fathers' market incomes decrease markedly immediately following a cancer diagnosis for their child. This decline is more pronounced for mothers, whose income drops by twenty percent in the year following diagnosis; father's income drops by less than ten percent in the same period. For mothers, the drop in income is due to a large fraction of affected mothers shifting from full- to part-time employment, and also in smaller part to a decline in labor force participation. Fathers also shift from full- to part-time work, but do not drop out of the labor force in response to the shock. Both parents' incomes rebound 3-4 years after initial diagnosis, but only father's income fully recovers – mother's income reaches a new steady state that is approximately five percent lower than controls.

Safety net transfers track the inverse of parents' market income – they spike following diagnosis, peaking at nearly ten times their pre-diagnosis levels, and return to *ex ante* levels 4-5 years after diagnosis. The generosity of public support thus buffers the peak market income losses, such that total parental income does not decline substantially immediately after cancer diagnosis. However, the eventual weaning of public resources, combined with sustained losses of market income for mothers, lowers long-run family income by about 2.5 percent relative to controls.

We then turn to an important proxy for mental health, care contact with mental health professionals. We find an almost doubling of the share with any mental health care usage in the 1-2 years following diagnosis for both mothers and fathers. Elevated mental health care demand persists for nearly a decade following diagnosis, equalizing with control levels thereafter. We also examine mothers' fertility responses. Results show that mothers' total fertility increases by about five percent about a decade after a cancer diagnosis among their children.

Finally, we study one key dimension of heterogeneity in impacts – by child survival. Conditional on following treatment protocols effectively (which is essentially uniformly the case in the Danish context), the risk of mortality due to childhood cancer is idiosyncratic. This allows us to reasonably interpret differences as likely due to differential child survival as opposed to differential selection into survival. In general we find that impacts on the above outcomes are all more pronounced for the unfortunate subset of families that experienced child mortality as a result of cancer. In this sub-sample (twenty percent of the total sample) parental market income declines by 20 percent, contact with mental health care professionals increases by more than 500 percent at its peak, and

[5] This is true even in the most highly developed country contexts (Fuwa, 2004), even when both parents work full-time (Lichard et al., 2021; Windebank, 2001), and even when both parents share egalitarian views about the sharing of household responsibilities (Hudde et al., 2021).

fertility increases by 25 percent, indicating a strong replacement fertility motive (the latter result in line with prior work in this subject area, which is mostly from low-income contexts (Rosenzweig and Schultz, 1983; Schultz, 1978; Wolpin, 1984)).

The primary contribution of this study is toward answering the question of how parents respond to changes in child health and survival. Our biggest takeaway is that shocks to child health have long-term economic consequences for families, even in a country like Denmark, with its high *per capita* income and strong welfare system. Our results suggest substantial declines in parental labor supply immediately following a child's cancer diagnosis. This is especially true if the cancer is aggressive enough to result in mortality. Importantly, we find that mothers experience permanent labor market penalties while fathers' labor market outcomes fully recover in the long-run.

Our work is closest to three recent papers.[6] Breivik and Costa-Ramón (2021) examine the short-run economic effects of child hospitalizations. There are two main differentiating features of our study relative to theirs. First, our study is able to examine long-run adjustments for more than a decade after diagnosis. This is important because the presence and size of economic impacts in the short-run (2-3 years) may not predict long-run impacts particularly well. Second, because hospitalizations are associated with a variety of important household characteristics that also affect economic outcomes, Breivik and Costa-Ramón (2021) exploit differences in the timing of the shock relative to the age of the child, arguing that the shock likely has larger impacts on families for exposures at younger ages. This restriction, while it improves internal validity, inevitably limits the external validity of estimates. We complement this work via our focus on childhood cancers, whose incidence is uncorrelated with family backgrounds, health histories, or genetics. Gunnsteinsson and Steingrimsdottir (2021) examine the effects of children with disabilities, and Eriksen et al. (2021) study the impacts of a child's diagnosis with type-I diabetes. There are two key differences between these papers and ours. The first is the temporal nature of the shock. Disability is most often a long-term condition; it thus likely changes parents' life-cycle decision-making for all future periods. This may lead to a very different pattern of response than the more "temporary" nature of childhood cancer diagnosis, which most commonly either results in remission after treatment or in the untimely death of the child (Ward et al., 2014). The second is the timing of the shock (most applicable to Gunnsteinsson and Steingrimsdottir (2021)). Disability is often diagnosed at the time of birth; thus event studies must use this as the time of potential departure between affected and unaffected families. While it is still of course possible to measure impacts credibly in this way, the timing of the health shock is conflated with the timing of birth, which itself has substantial effects

[6]Several papers in economics document that poor child health is associated with reduced parental labor supply (see, e.g., Burton et al. (2017); Powers (2003); Salkever (1982)). These studies, however, do not fully address the concern of endogeneity of child health. There is also a public health literature specifically studying the impacts of childhood cancer on a similar set of outcomes as we consider here. Much of this work tracks the (often self-reported) outcomes of families of childhood cancer survivors, and does not adequately emphasize the need for counterfactual outcomes (this evidence is nicely reviewed in Roser et al. (2019)). A small subset of these studies do consider matched controls, but do not evaluate pre-trends and match on a very limited set of characteristics, nor do they examine impacts over time (Mader et al., 2021, 2020a,b). We add to this work by leveraging a more rigorous matching design, including testing for differential pre-diagnosis trends, and considering a broad set of socioeconomic outcomes over a long period of time.

on parents' economic decisions. Childhood cancers almost always manifest symptoms several years after birth, allowing us to separate these two important events – childbirth and diagnosis of a severe illness – in the lives of families (Lichtenstein et al., 2000).

We also contribute to the understanding of the link between socioeconomic status (SES) and health (Adler et al., 1994). SES and child health are strongly positively associated in both low- and high-income contexts (Case et al., 2002; Currie, 2009; Currie and Hyson, 1999; Currie and Stabile, 2003; McGovern et al., 2017). Most of the work in this space in economics has focused on the direction of causality running from household income and resources to children's health (see, e.g., Currie (2009); Gertler (2004); Hoynes et al. (2015)). There is a dearth of rigorous evidence for causality running in the opposite direction – that is, on the question of whether child health affects parents' short- and long-run economic outcomes, which would further help explain the observed association between the two.[7] Our work aims to fill this evidence gap.

2 Data and Empirical Strategy

2.1 Data

We combine several administrative registers from Statistics Denmark to collect a wide range of objective measures of child health and parental outcomes for the entire population of Denmark. We focus on children born between 1986 and 2005 and use unique person-level identifiers to link parents and children. As outcomes, we study parental labor market performance, welfare use, measures of mental health, and family structure.

Cancer Diagnosis and Survival

We identify childhood cancers using the *National Patient Register*, a dataset on all inpatient admissions, outpatient visits, and emergency room visits to hospitals. Cancer diagnoses are identified using diagnosis codes based on the World Health Organization's International Classification of Disease (ICD). We classify a child as a cancer patient if they receive a cancer diagnosis before the age of sixteen. We furthermore use data from the *Cause of Death Register* to obtain information on child survival.

Labor Market Outcomes

The income measures come from the *Income Statistics Register* which gathers information from people's tax records. We use a taxable income aggregate over all jobs as a measure of *total income*. The measure in the *Income Statistics Register* includes transfers due to lost labor market earnings (see discussion in A.2). We construct the variable *market income* by subtracting relevant transfers from *total income*. Data on parents' reliance on welfare programs come from the municipalities (the *Income Transfer Register*), and contains information on the kind of benefit parents receive as well

[7] Related work – e.g., Dobkin et al. (2018); Fadlon and Nielsen (2021); Finkelstein and McKnight (2008); Gupta et al. (2018) – has demonstrated the impacts of shocks to the health of prime-age and elderly adults on economic outcomes.

as the amount received each month. The outcome variable *transfers* is constructed to capture all transfers that are due to child's illness and disability. Finally, information on employment comes from the *Register-Based Labour Force Statistics*. This register records the employment status of the entire Danish population (observed on January 1st) as of November of the preceding year. We construct an indicator equal to one if an individual is employed and zero otherwise. Our data includes number of hours worked beginning in 2008. The data up until 2008 only includes a variable that registers full time employment, defined as a person working more than 32 hours per week on average. We therefore define full-employment to indicate working more than 32 hours per week on average.

Parents' Mental Health

To investigate the effects on parental mental health, we use the *Health Insurance Register*, which provides information on reimbursements to private-practice physicians (both general practitioners and specialists) for all patient-related services covered by the national health insurance. We construct an indicator equal to one if the parent has used any services provided by psychologists or mental health related services provided by general practitioners.

Family Structure and Background

We use data from the *Birth Register* and the *National Population Register* to identify children's parents and to study the effect on family structure. We study the impact on mother's total fertility and the probability of relationship dissolution. In this part of the analysis we focus on mothers who had a registered partner in the year before diagnosis, and define an indicator equal to one if she is separated from this registered partner. This includes mothers who stay single and those with a new registered partner. Finally, information on parents' education comes from the *Education register*.

Appendix Table A1 compares the characteristics of (parents of) children diagnosed with cancer before age sixteen with the entire population of (parents of) children born in the same years and who do not have a cancer diagnosis. Children diagnosed with cancer are more likely to be male, were born earlier, and are of slightly lower birth order than children who do not have cancer, but otherwise look similar in terms of many parental characteristics at the time of birth: age, marital status, schooling, government transfers received, and likelihood of having mental health contact. While there are statistically significant differences in parental income and full-time employment, these differences are small in magnitude (approximately 2% of the mean of income in the non-cancer population, and 2-3 percentage points for employment). All monetary values are reported in 1,000 Danish Kroner (DKK) deflated to 2015 prices using the consumer price index. In that year the exchange rate was approximately DKK 7 per US $1.

2.2 Empirical Strategy

In order to investigate how families react to a large child health shock, we identify parents whose children are diagnosed with cancer (hereafter referred to as a "child cancer household") and match them to observably similar households. Specifically, for every child cancer household in our dataset,

we search for all other households fitting the following criteria: (a) have a child of the same gender and birth order and born in the same year as the child diagnosed with cancer (b) have parents that are identical to the cancer household parents in terms of mother's age and father's age at the time of birth (measured in 5-year age bins), marital status at the time of birth, and mother's and father's educational attainment at the time of birth (a dummy for more than a high school education).

We begin with 3071 unique households with 3090 children born between 1986-2005 that had at least one childhood cancer diagnosis between 1986-2015. We drop 37 households that had more than one child with a cancer diagnosis. We drop another 35 observations due to the inability to find exact matches based on the above criteria, leaving us with a total of 3018 matched cancer households. The median number of matched control households per cancer household is 139.

Each household i belongs to one of 2976 unique groups indexed by j, defined by the unique combination of all variables involved in the matching: child gender, birth year, and birth order, as well as mother's age category, father's age category, parental marital status, mother's education, and father's education at the time of birth.[8] In addition, each group is associated with a unique diagnosis year (the year of the child's first cancer diagnosis), which means that child cancer households with the same characteristics but different diagnosis years form distinct groups. Therefore, a control household can show up in multiple groups if they have the same characteristics as multiple cancer households with different diagnosis years. Each group j has at least one cancer and one control household. All households (both cancer and control) in a group are assigned the diagnosis year of the cancer household(s) in the group.

Appendix Table A2 shows that the characteristics of child cancer households in the year before the first cancer diagnosis are almost identical to their matched controls' characteristics in that same year. One exception is government transfers, which are significantly higher for cancer households, likely due to our delayed detection of child cancer in some instances (the first childhood cancer diagnosis in our data may not be the first time a child began suffering from health problems). As we discuss later, this late detection does not appear to be a serious issue given that we demonstrate flat pre-trends in treatment-control differences in all other outcomes.

We let the indicator variable $C_i = 1$ for cancer households and 0 for matched control households. Outcome variables Y_{ijt} are measured in each calendar year t. We define dummy variables D^k_{jt} for $k = -12$ to 11, where $D^k_{jt} = 1$ if calendar year t is k years since group j's diagnosis year. We estimate the following regression:

$$Y_{ijt} = \sum_{k=-12}^{11} \left(\beta_k C_i \times D^k_{jt} + \gamma_k D^k_{jt} \right) + \alpha X_i + \mu_j + \delta_t + \epsilon_{ijt}. \tag{1}$$

This specification controls for group fixed effects (μ_j), calendar year fixed effects (δ_t), and household-level controls (X_i). These include mother's and father's (precise) age fixed effects, along with maternal and paternal educational attainment (in continuous months), measured at the time of the

[8] The parental age categorical variables include a category for missing age.

child's birth. Standard errors are clustered at the group level. We estimate a weighted regression, where cancer households each receive a weight of one, while each control household in group j receives a weight equal to the number of cancer households in group j divided by the number of control households in group j.

We are interested in the 24 coefficients β_k, which provide the difference in outcome Y_{ijt} between cancer households and control households in each year starting from 12 years before to 11 years after the diagnosis year. In the results section, we will plot these coefficients graphically in order to demonstrate how the differences between cancer and control households evolve over time. If, as we are assuming, a childhood cancer diagnosis is exogenous to outcomes conditional on the observable characteristics used for matching and included in the regression, we would expect to see no differences prior to the diagnosis ($\beta_k = 0$ for $k < 0$), which is indeed what we find.

3 Results

3.1 Labor Market Outcomes

We begin by asking how a child cancer diagnosis affects the labor market outcomes of the mother and father. In Figure 1, we plot the β_k coefficients from specification (1). Panel A displays the results for mother's market income while panel B shows the results for father's market income (total income excluding transfers). In both figures, differences between cancer and non-cancer households are close to zero in the 12 years before the cancer diagnosis, suggesting that the matching procedure succeeded in identifying suitable comparable controls for the cancer households.

Starting in the year of the cancer diagnosis, however, mother's income in cancer households drops substantially below that of control households (panel A). In the year of the cancer diagnosis (year 0 on the x-axis), the gap between cancer and non-cancer households is approximately 15% of average mother's income in the year before diagnosis. In the first year after diagnosis, this drops even further, to more than 20% of average income. Cancer households' income does begin to recover after this, but by the 12th year after diagnosis, mother's income in cancer households is still lower than that of non-cancer households', and this difference is about 3% of average household income in the year before diagnosis.

In Panel B, father's income demonstrates a much smaller drop after the cancer diagnosis.[9] At the trough (in the first year after the diagnosis), the gap between cancer and non-cancer households is equal to around 7% of average father's income in the year before diagnosis. Recovery is fairly quick: by the third year after the diagnosis, the gap between cancer and non-cancer households is no longer significantly different from zero.

Panels C and D of Figure 1 show that these drops in income are likely to be driven by parents switching out of full-time employment. Both mothers' and fathers' full-time employment drops

[9] Although the axes represent differences relative to pre-diagnosis means, and even though fathers have higher income than mothers on average, we note that the magnitude of the drop in level terms is also larger for mothers than fathers.

substantially in the year of diagnosis. For both mothers and fathers, the difference between cancer and non-cancer full-time employment rates eventually decreases but remains negative for the entire 12 year period.

The graphs in Figure 1 illustrate the responses of parental market income, excluding any government transfers received by the households. Given Denmark's generous welfare system, however, we are also interested in the extent to which the shocks to market income are buffered by government transfers. In Panel A of Figure 2, we show a sharp increase in total government transfers received by the household in the year of child's cancer diagnosis. By the first year after the diagnosis, transfers are more than 9 times the average in the year before diagnosis.[10]

When we examine total household income, inclusive of transfers (in Panel B), we see that these transfers substantially buffer the large dips in market income detected in Figure 1: there is only a small, statistically insignificant decline in the year of diagnosis. Interestingly, however, we find that the decline in total income increases over time: 8 years after the diagnosis, the cancer households earn significantly less than non-cancer households. The magnitude of this gap is approximately 2.5% of total average income in the year before diagnosis and narrows only slightly in the remaining 4 years displayed in the graph.

In the first two columns of Appendix Table A3 we report simplified versions of these event study regressions and show that the decline in total parental income is driven primarily by a decline in mother's rather than father's income. While some of this is likely driven by the shift out of full-time employment (documented in Figure 1), we also show that part of this decline can be attributed to mothers dropping out of the labor force completely (column 3). In the 6-11 years after the child's cancer diagnosis, the difference between treated and control mothers' labor force participation is -1.3 percentage points. There is no significant effect on father's labor force participation (column 4).

It is not only mothers who adjust their labor force participation in response to a child's cancer diagnosis: we also find changes in grandparents' labor force participation. Specifically, columns 5 and 6 of Appendix Table A3 show that both grandmothers and grandfathers drop out of the labor force after a grandchild receives a cancer diagnosis, perhaps to help with childcare responsibilities.[11] The effect is slightly larger and appears earlier for grandfathers, who have higher participation rates on average. In the 6-11 years after the cancer diagnosis, grandmothers' labor force participation is 1.5 percentage points lower in cancer households compared to non-cancer households, while grandfathers' labor force participation is 2.2 percentage points lower. Both effects are slightly larger than the effects on maternal labor force participation.

[10] There is a small gradual uptick in transfers starting from four years prior to the cancer diagnosis, which is likely because our methods of determining the year of cancer diagnosis are imperfect and may be detecting some cancers late. The small magnitude of this uptick, however, suggests we are likely correctly identifying diagnosis year for the vast majority of cancer episodes in the sample.

[11] The grandmothers' (grandfathers') labor force participation variable averages labor force participation of the maternal and paternal grandmothers (grandfathers).

3.2 Mental Health

We next examine how parental mental health is affected by having a child diagnosed with cancer. In Figure 3, we repeat our analysis using an indicator for having a mental-health-related contact with the healthcare system as our outcome variable. Panel A examines mother's mental health, while panel B examines father's mental health. Both graphs show a large jump in the likelihood of a mental health visit in the year of and the first few years after the child's cancer diagnosis. For mothers, the effect peaks in the first year after diagnosis (with a magnitude almost two times the average in the year before diagnosis). For fathers, the initial jump in the year of diagnosis is larger, though the peak, which occurs in the second year after diagnosis, is of similar magnitude (in relative terms). Because the axes represent differences relative to pre-diagnosis averages, we note that mothers are more likely to have mental health visits on average and that their increases are larger in level terms.

Recovery is somewhat slow: there still are significant differences between cancer and non-cancer households around 7-8 years after the diagnosis. By the end of our analysis period, however, differences between cancer and non-cancer households are no longer statistically significant. In Appendix Table A3, we show that there are effects on both psychologist and general practitioner visits, though the effects on psychologist visits are more persistent.

3.3 Fertility and Separations

Finally, we examine how mother's fertility responds to a child's cancer diagnosis. Figure 4 shows a gradual but steady increase in the fertility gap between cancer and non-cancer households. Cancer households increase their fertility more than non-cancer households after a child cancer diagnosis.

The last column of Table A3 focuses on parental separations and shows that in the first five years after diagnosis, mothers in cancer households are 0.9 percentage points less likely to separate from their partners (this coefficient is significant at the 10% level). These results are in contrast with the former literature documenting an increase in divorces and separations in households with health shocks among children. Gunnsteinsson and Steingrimsdottir (2021) find that parents who have a child with severe disability are four percentage points less likely to be together 11-15 years after the birth of the child, than comparable parents who gave birth to a healthy child. Others find even larger effects: Kvist et al. (2013) find that parents who have children with attention-deficit-hyperactivity disorder (ADHD) have a 75 % higher probability of being separated ten years after the birth of the child, Reichman et al. (2004) find that poor child health reduces the probability of parents living together by ten percentage points, and Swaminathan et al. (2006) show that having a child with very low birth weight decreases the probability that the parents are married two years after the birth of the child by five to ten percentage points.

3.4 Heterogeneity

In our sample, approximately 20% of the children who are diagnosed with cancer die within 5 years of their diagnosis. We might expect to see different responses in households where the child dies and where the child survives. We therefore repeat our analysis separately for these two groups, which Appendix Table A4 reveals are overall quite similar with a few statistically significant differences: children who survive were diagnosed at an older age, are of higher birth order, were born later, are 4 percentage points less likely to have parents that were married at the time of birth, have fathers who are 5 percentage points more likely to be be employed full time, and have mothers who are 2 percentage points more likely to have had a mental health contact in the year before diagnosis.

Figure 5 presents the results. Panel A focuses on total parental market income, panel B on parental full time employment status, panel C on parental mental health, and panel D on mother's fertility.[12] Households where the child dies within 5 years are represented by the red crosses, while households where the child survives are represented by the blue dots. All figures suggest substantial treatment heterogeneity by child survival, with families where children do not survive exhibiting much larger and more persistent responses. For example, the initial drop in parental market income is substantially larger for households where the child does not survive, amounting to 20% of the average in the year before diagnosis at the trough, compared to 10% for households where the child survives. In addition, households where the child survives come much closer to a full recovery after 12 years. We similarly observe larger drops and a slower recovery in the full-time employment status among parents of children who die.

The increase in the likelihood of having mental health visits after a cancer diagnosis is also substantially larger for households that experience a child's death. For these households, the likelihood of having a mental health visit peaks in the second year after diagnosis at a value more than 5 times the average in the year before diagnosis, while the peak for the other group is less than 1. In both groups, however, we detect no significant differences between the cancer households and their matched controls by the end of the analysis period.

Finally, the increase in fertility documented in Figure 4 appears to be completely driven by households where the child diagnosed with cancer does not survive. There is essentially no fertility response among households where the child survives, but a large gradual increase in households where the child dies. This is consistent with the finding of differences in parental separation effects across the two groups, illustrated in Figure A1. Though standard errors are large for both groups, there is a small decline in coefficients for children who die within five years, compared to a flat pattern of coefficients for those who survive. The magnitude of the negative separation effect is small, however, which suggests that this is only a minor part of the fertility effect heterogeneity.

[12] We measure parental full-time employment by an indicator if both parents work full-time.

4 Conclusion

This study analyzes the consequences of severe child health shocks – in the form of childhood cancers – on parents' decision making and long-run outcomes. We find that even in a high-income context with a robust public safety net such as Denmark, these impacts can be quite pronounced and long-lasting. Immediate impacts on income are large, particularly for mothers, on the order of 20 percent of pre-diagnosis income. These impacts on income persist for mothers for more than a decade, generating a steady-state income that is 3-4 percent lower than control levels. Effects are most pronounced for the 20 percent of families in which the cancer results in the child's death. Our results suggest that public policy should consider long-term transfers to households in which children have experienced severe health shocks, particularly those which result in child mortality.

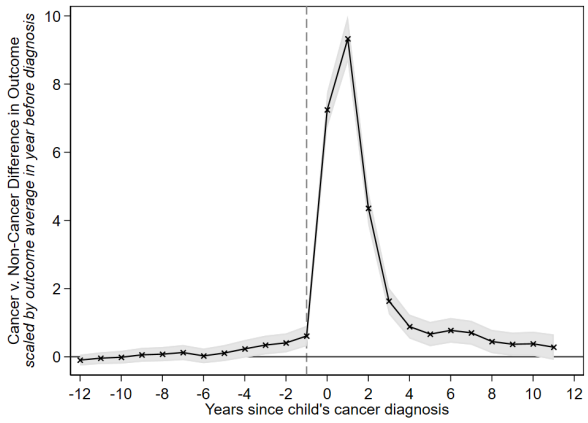
Figures

Figure 1: Parental Labor Market Responses to Child Cancer Diagnosis

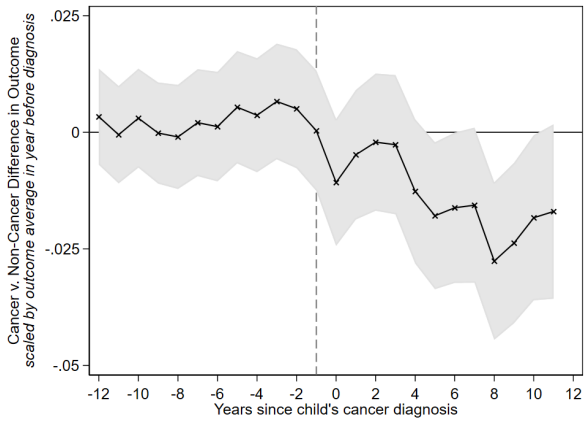
Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households, scaled by the outcome average in the year before diagnosis.

Figure 2: Government Transfer and Total Income Responses to Child Cancer Diagnosis

A. Government Transfers



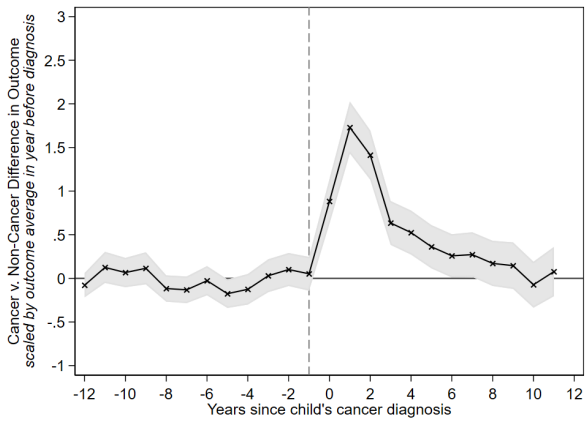
B. Total Parental Income



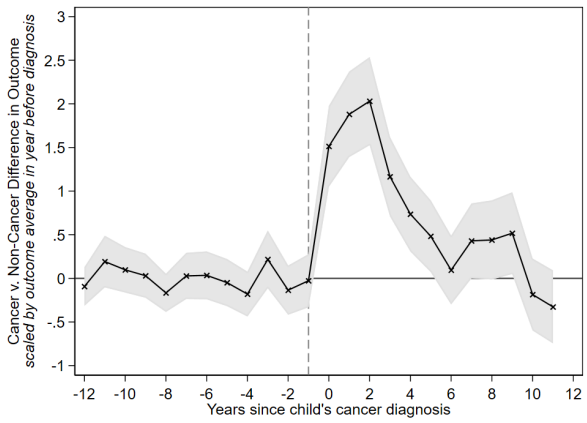
Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households, scaled by the outcome average in the year before diagnosis.

Figure 3: Parental Mental Health Responses to Child Cancer Diagnosis

A. Mother's Mental Health Contact

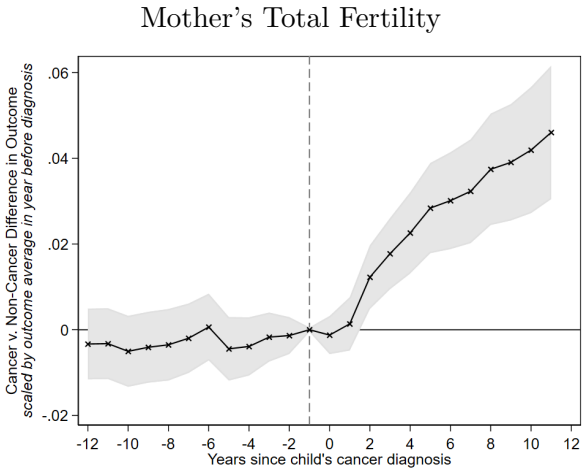


B. Father's Mental Health Contact



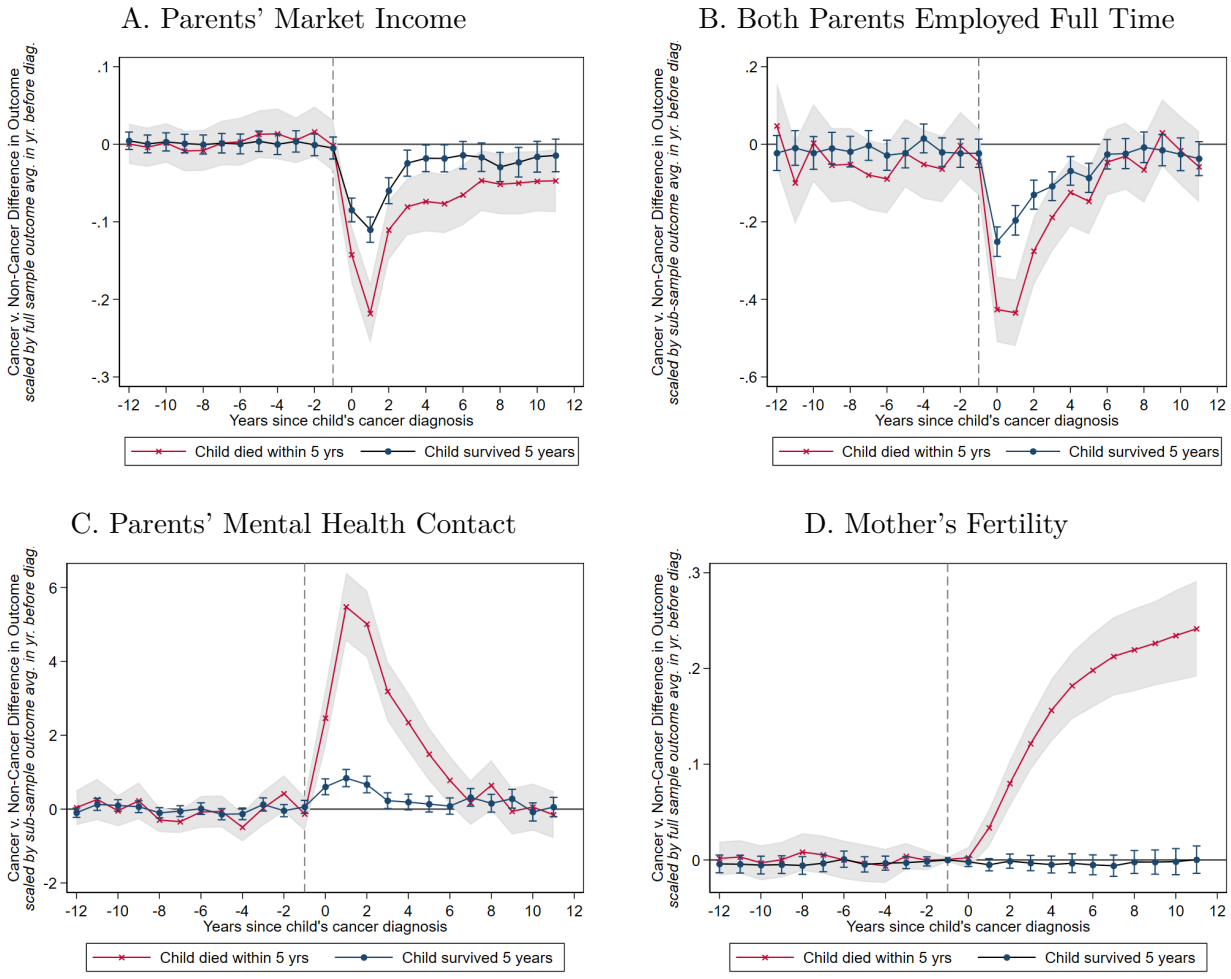
Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households, scaled by the outcome average in the year before diagnosis.

Figure 4: Fertility Responses to Child Cancer Diagnosis



Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households, scaled by the outcome average in the year before diagnosis.

Figure 5: Heterogeneity in Responses to Child Cancer Diagnosis, by Child Survival



Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households, scaled by the sub-sample outcome average in the year before diagnosis.

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A Online Appendix

A.1 Diagnosis and Treatment of Childhood Cancers in Denmark

Childhood cancers are an important public concern in Denmark. Approximately 200 children are diagnosed with childhood cancer every year and childhood cancers remain the leading cause of disease-related death among 1 to 17 year-olds (Grabas et al., 2020). There are well established guidelines that outline diagnosis and treatment pathways for the most common types of childhood cancers, including leukemias, tumors of the central nervous system, and lymphomas (Sundhedsstyrelsen, 2016). Health care services, including all stages in the diagnosis and treatment of childhood cancers, are free of charge for all residents (Danish Ministry of Health and Prevention, 2008).

Children's health care is organized in primary and secondary systems with general practitioners acting as gatekeeper for specialist treatment (Mathiesen et al., 2016). General practitioners are responsible for regular consultations as well in the provision of preventive health examinations at the age of 5 weeks, 5 months, and annually until the age of 5 years.[13] Diagnosis of childhood cancers begins with the general practitioner's physical examination. If the general practitioner is concerned about a potential childhood cancer, the patient is referred to a hospital-based pediatric department for further checks, including clinical examination, blood tests, and imaging. Depending on the results, the children are further referred to a pediatric oncology unit in specific university hospitals where they receive surgical biopsies, laboratory and pathological studies, and imaging tests (e.g., computed tomographic scans, magnetic resonance imaging scans). Existing guidelines indicate that the time from the general practitioner's referral until arrival at the pediatric oncology unit should be 24 hours.[14]

Children who are diagnosed with cancer receive care in pediatric oncology units by a dedicated, multi-disciplinary team that not only includes oncologists, radiologists, surgeons, and pathologists but also nutritionists and psychologists. Denmark follows international protocols when determining the appropriate treatment options. The specific treatment regimen provided to each patient depends on many factors, including cancer characteristics (e.g., type, site, stage, and histology) as well as characteristics of the child (e.g., age, general health status). Common treatments include surgery, chemotherapy, radiation therapy, and immunotherapy. Most children receive a combination of two or three therapies (Hewitt et al., 2013). Survival rates in Denmark are similar to those of other high-income countries, with four out of five children having successful remission (Schrøder et al., 2016).[15] The lengthy treatment process coupled with latent health effects often require substantial parental involvement in the monitoring and management of the child's treatment and side effects. In the next section, we briefly describe the resources available in assisting parents of children with

[13] More than 90% of children attend the first three preventive examinations (Mathiesen et al., 2016).

[14] According to the guidelines, CT scans should be conducted within 24 hours of the general practitioner's referral. Similarly, MRI scans should be conducted within 3 days of referral. In 2014, the median number of days from date of diagnosis to initiation of therapy was 7 days, and 80% of children started treatment within 14 days of diagnosis (Schrøder et al., 2016).

[15] Survivors sometimes experience persistent health issues ranging from balance problems to impaired hearing and vision to sleep and hormonal problems (Hewitt et al., 2013).

cancer.

A.2 Social Insurance and Mental Health Services for Families of Sick Children

In Denmark, parents of sick children receive financial compensation through two benefit schemes. The first scheme (parental leave) targets families where children under the age of 18 are admitted to the hospital for a period of at least 12 days. Parents are eligible to receive compensation if they meet the criteria for being included in the Danish parental leave program. The benefits are provided for a max of 52 weeks and were 4,460 DKK per week (approximately 683 USD) in 2021.

A second benefit scheme concerns compensation for earning losses in families where children under the age of 18 suffer significant long-term limitations in activities of daily living. This benefit scheme covers parents who reduce their labor supply due to the necessity of caring for the child at home (without excluding the need for hospital care). The benefits can be received by both parents simultaneously. The compensation levels are determined relative to the loss of parental income with a cap that was 32,617 DKK (approximately 4,990 USD) per month in 2021. Parents can keep receiving compensation for as long as they meet the eligibility criteria.

In addition to the compensation for lost income, parents can receive support for day-to-day activities (e.g., cleaning, care for healthy siblings) through additional municipality-based programs. Importantly, pediatric oncology departments have in-house social workers who inform families of the different benefit schemes and help them with the administrative procedures for accessing the relevant welfare programs.

Finally, since 1992, closest family members of individuals who suffer from a severe somatic disease (including cancer) are eligible for referral to a specialist for subsidized psychological counseling. According to Serena (2021), in 2020, one counselling session with a psychologist cost 860 DKK (approximately 132 USD). The Danish public health insurance covers 60 percent of the cost of up to 12 counseling sessions for families of children with cancer. The remaining 40 percent can be covered through private health insurance or must be paid out-of-pocket.

A.3 Tables and Figures

Table A1: Summary Statistics for Cancer and Non-Cancer Households, Full Population

	(1) Cancer	(2) Non-Cancer	(3) Difference
Child Characteristics			
Female	0.46	0.49	-0.026***
	(0.50)	(0.50)	(0.0090)
Birth Order	1.54	1.58	-0.041***
	(0.73)	(0.76)	(0.013)
Birth Year	1994.8	1995.7	-0.86***
	(5.50)	(5.66)	(0.099)
Parental Characteristics in Year of Birth			
Age of Mother	29.6	29.6	-0.055
	(4.94)	(4.96)	(0.089)
Age of Father	32.3	32.4	-0.094
	(5.80)	(5.63)	(0.11)
Parents Married	0.50	0.51	-0.0046
	(0.50)	(0.50)	(0.0090)
Years of Schooling (Mother)	12.4	12.5	-0.047
	(2.30)	(2.39)	(0.041)
Years of Schooling (Father)	12.7	12.7	-0.040
	(2.50)	(2.49)	(0.045)
Market Income (Mother)	245.7	250.9	-5.20***
	(98.4)	(100.3)	(1.77)
Market Income (Father)	346.5	353.4	-6.88**
	(173.4)	(185.1)	(3.12)
Full-Time Employment (Mother)	0.43	0.46	-0.031***
	(0.49)	(0.50)	(0.012)
Full-Time Employment (Father)	0.57	0.60	-0.027**
	(0.50)	(0.49)	(0.011)
Combined Total Income	592.3	604.2	-11.9***
	(228.3)	(240.9)	(4.11)
Government Transfers (Income)	20.8	20.2	0.54
	(57.9)	(60.6)	(1.04)
Mental Health Contact (Mother)	0.017	0.017	0.00013
	(0.13)	(0.13)	(0.0028)
Mental Health Contact (Father)	0.0091	0.0083	0.00082
	(0.095)	(0.091)	(0.0021)
Observations	3090	1153553	1156643

Notes: * p< 0.1 ** p< 0.05 *** p< 0.01. Standard deviations (in columns 1 and 2) and standard errors (in column 3) in parentheses. Sample includes all children born between 1986-2005.All monetary values are in 1,000 DKK, deflated by CPI to year 2015.

Table A2: Summary Statistics for Cancer and Non-Cancer Households, Matched Sample

	(1) Cancer	(2) Non-Cancer	(3) Difference
Child Characteristics			
Female	0.46	0.46	0
	(0.50)	(0.50)	(0.013)
Birth Order	1.91	1.91	0
	(0.90)	(0.90)	(0.023)
Birth Year	1994.9	1994.9	0
	(5.51)	(5.51)	(0.14)
Parental Characteristics in Year of Birth			
Age of Mother	29.5	29.5	-0.016
	(4.84)	(4.66)	(0.12)
Age of Father	32.1	32.1	-0.018
	(5.46)	(5.31)	(0.15)
Parents Married	0.50	0.50	0
	(0.50)	(0.50)	(0.013)
Years of Schooling (Mother)	12.4	12.4	-0.014
	(2.31)	(1.97)	(0.056)
Years of Schooling (Father)	12.7	12.7	0.0050
	(2.47)	(2.09)	(0.059)
Parental Characteristics in Year before Cancer Diagnosis			
Market Income (Mother)	297.6	301.3	-3.73
	(128.4)	(61.5)	(2.61)
Market Income (Father)	406.7	405.3	1.37
	(236.2)	(93.8)	(4.67)
Full-Time Employment (Mother)	0.57	0.56	0.0061
	(0.49)	(0.20)	(0.012)
Full-Time Employment (Father)	0.73	0.73	0.0021
	(0.44)	(0.15)	(0.010)
Combined Total Income	706.3	704.3	1.91
	(305.4)	(148.4)	(6.22)
Government Transfers (Income)	26.9	21.0	5.91***
	(77.2)	(28.2)	(1.51)
Mental Health Contact (Mother)	0.049	0.047	0.0021
	(0.21)	(0.054)	(0.0042)
Mental Health Contact (Father)	0.020	0.020	-0.00053
	(0.14)	(0.035)	(0.0027)
Observations	2976	2976	5952

Notes: * p< 0.1 ** p< 0.05 *** p< 0.01. Standard deviations (in columns 1 and 2) and standard errors (in column 3) in parentheses. Sample includes all cancer children and matched controls in our final sample. Each observation represents a group-level average, where groups are defined by the unique combination of all variables involved in the matching: child gender, birth year, and birth order, as well as mother's age category, father's age category, parental marital status, mother's education, and father's education at the time of birth.All monetary values are in 1,000 DKK, deflated by CPI to year 2015.

Table A3: Regression Estimates of Responses to Child Cancer Diagnosis

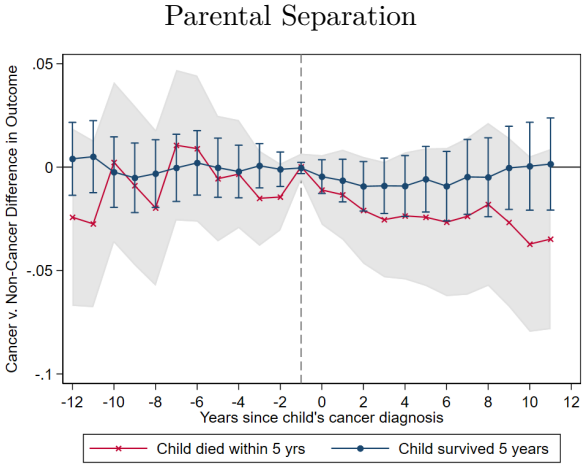
	(1) Mother's Total Income	(2) Father's Total Income	(3) Mother's LFP	(4) Father's LFP	(5) Grandmothers' LFP	(6) Grandfathers' LFP	(7) Mother's Psychologist Contact	(8) Father's Psychologist Contact	(9) Mother's Psych GP Contact	(10) Father's Psych GP Contact	(11) Parental Separation
Cancer vs. Non-Cancer Difference											
7-12 yrs before diagnosis	-2.42	1.37	-0.00017	-0.0015	0.0020	-0.0073	0.00087	-0.00036	-0.0020	0.00055	-0.0018
	(1.58)	(3.01)	(0.0048)	(0.0037)	(0.0063)	(0.0063)	(0.0012)	(0.00062)	(0.0014)	(0.0010)	(0.0063)
1-6 yrs before diagnosis	-1.94	3.16	0.00048	-0.00048	0.0016	-0.0068	0.0013	-0.00037	-0.0026	-0.00069	-0.00080
	(1.65)	(3.25)	(0.0044)	(0.0034)	(0.0060)	(0.0066)	(0.0012)	(0.00058)	(0.0017)	(0.0012)	(0.0037)
0-5 yrs after diagnosis	-5.06***	-1.61	-0.013***	0.00013	-0.0060	-0.014**	0.034***	0.018***	0.011***	0.0077***	-0.0093*
	(1.91)	(3.79)	(0.0047)	(0.0038)	(0.0055)	(0.0068)	(0.0024)	(0.0016)	(0.0025)	(0.0017)	(0.0048)
6-11 yrs after diagnosis	-5.79**	-4.63	-0.012**	-0.0040	-0.014***	-0.020***	0.0060***	0.0028***	0.0029	0.00056	-0.0075
	(2.28)	(4.50)	(0.0056)	(0.0048)	(0.0051)	(0.0073)	(0.0018)	(0.0010)	(0.0028)	(0.0018)	(0.0082)
N	13345875	13313771	13247683	13177301	12572024	11682708	11847168	11847168	11847168	11847168	12021144
mean of dep. var.	296.2	400.1	0.85	0.92	0.38	0.47	0.022	0.0080	0.042	0.020	0.20

Table A4: Summary Statistics for Cancer Households, by Child Survival

	(1) Survived	(2) Died	(3) Difference
Child Characteristics			
Age at Diagnosis	7.44	6.46	0.98***
	(5.06)	(4.84)	(0.24)
Female	0.46	0.47	-0.012
	(0.50)	(0.50)	(0.024)
Birth Order	1.92	1.85	0.070*
	(0.91)	(0.85)	(0.042)
Birth Year	1995.0	1994.1	0.96***
	(5.50)	(5.54)	(0.27)
Parental Characteristics in Year of Birth			
Age of Mother	29.6	29.3	0.21
	(4.81)	(4.91)	(0.24)
Age of Father	32.1	32.1	0.019
	(5.42)	(5.52)	(0.28)
Parents Married	0.49	0.54	-0.044*
	(0.50)	(0.50)	(0.024)
Years of Schooling (Mother)	12.4	12.4	0.041
	(2.33)	(2.19)	(0.11)
Years of Schooling (Father)	12.7	12.7	-0.067
	(2.46)	(2.57)	(0.12)
Parental Characteristics in Year before Cancer Diagnosis			
Market Income (Mother)	299.1	289.8	9.35
	(129.1)	(127.0)	(6.21)
Market Income (Father)	408.0	401.1	6.89
	(239.0)	(230.2)	(11.3)
Full-Time Employment (Mother)	0.57	0.58	-0.013
	(0.50)	(0.49)	(0.031)
Full-Time Employment (Father)	0.74	0.69	0.051*
	(0.44)	(0.46)	(0.027)
Combined Total Income	709.0	692.2	16.7
	(308.7)	(298.8)	(14.7)
Government Transfers (Income)	27.1	25.3	1.76
	(78.9)	(67.2)	(3.38)
Mental Health Contact (Mother)	0.051	0.033	0.018*
	(0.22)	(0.18)	(0.0096)
Mental Health Contact (Father)	0.020	0.016	0.0046
	(0.14)	(0.12)	(0.0065)
Observations	2513	505	3018

Notes: * p< 0.1 ** p< 0.05 *** p< 0.01. Standard deviations (in columns 1 and 2) and standard errors (in column 3) in parentheses. Sample includes all cancer children in our final sample.Regressions restrict to children of mothers with a registered partner in the year before diagnosis.All monetary values are in 1,000 DKK, deflated by CPI to year 2015.

Figure A1: Heterogeneity in Parental Separation Response to Child Cancer Diagnosis, by Child Survival



Notes: Graphs plot estimates and 95% confidence intervals for the β_k coefficients from specification (1), which represent the difference between cancer and non-cancer households.