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Access to Treatment and Educational Inequalities in Cancer Survival*

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Abstract

The public health care systems in the Nordic countries provide high quality care almost free of charge to all citizens. However, social inequalities in health persist. Previous research has, for example, documented substantial educational inequalities in cancer survival. We investigate to what extent this may be driven by differential access to and utilization of high quality treatment options. Quasi-experimental evidence based on the establishment of regional cancer wards indicates that i) highly educated individuals utilized centralized specialized treatment to a greater extent than less educated patients and ii) the use of such treatment improved these patients' survival.

Keywords: Education, Health, Inequality

JEL Classification: I10, I20

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1 Introduction

Educational inequalities in mortality rates have been documented across a wide range of countries. Differences in lifestyle and health behaviors are major factors driving the positive association between education and health, but the quality of treatment for various diseases could also play a role. Treatment quality is expected to depend on income when health services must be bought in the open market, such as in the United States. This is less obvious in egalitarian welfare states such as the Nordic countries, where public health care systems aim to offer equal access to high quality health care, regardless of socioeconomic status and geographic location. This is particularly true for cancer diagnosis, treatment, and care, where private options are virtually nonexistent. Against this background, it is surprising that educational inequalities in cancer mortality are of a similar magnitude in the United States and in the Nordic countries (cp. Kinsey et al. 2008, Elstad et al. 2012).

A difference in economic resources is not the only possible mechanism behind the relationship between education and health. Grossman (1972) emphasizes that education may affect health directly, acting as a 'technology parameter' in a health production function (Cutler and Lleras-Muney 2012). Highly educated individuals may make more efficient use of available health inputs for various reasons. People with higher education could, for example, have a better understanding of the relationship between health inputs (behavior and treatment) and health outcomes (Kenkel 1991). Glied and Lleras-Muney (2008) find that better educated individuals have a greater survival advantage from diseases for which there has been rapid health-related technological progress. This indicates that people with higher education are the first to take advantage of technological advances that improve health.

A related hypothesis is that highly educated people may be better at finding their way through the health bureaucracy, claiming their rights, acquiring relevant information, and communicating their symptoms. Several studies show that patient-provider communication varies with patients' socioeconomic status, with the level of education being of particular importance (e.g., Smith et al. 2009, Marks et al. 2010, Grytten et al. 2011). Bago d'Uva and Jones (2009) document that highly educated individuals use specialist care more frequently in many European countries, irrespective of actual needs.

In this paper, we investigate how access to and utilization of highly specialized treatment affects survival after cancer, and how this is related to educational attainment. We use individual level data covering all primary cancer diagnoses in Norway from 1980 to 2000. During this period, patients were allocated to local hospitals based on their residential addresses, and they were only transferred to other hospitals if specialized treatment was deemed necessary. Typically, patients would be transferred to the national hospitals located in Oslo for specialized treatment (Kravdal 2006).[1] However, patient-doctor interactions could also play a role since referral practices and treatment protocols are not fully codified. In our analysis, being treated in the health region where the national hospitals are located is a proxy for specialized treatment. To analyze how specialized treatment affects survival probabilities, we make use of the fact that regional cancer wards opened at different points in time in cities with universities outside the Oslo area.

Several studies document that there are fewer complications and improved survival chances at more specialized centers (for example, Black and Johnston 1990, Kelly and Hellinger 1986). Hospital volume and surgeon competency have been shown to be particularly important (Porter et al. 1998, Wibe et al. 2005). In our context, the care provided in the newly opened regional cancer wards could therefore have been of lower quality than the care provided at the well-established national hospitals, especially in the period shortly after their establishment. The opening of the new wards can therefore be interpreted as representing a decrease in access to specialized treatment for patients residing in these regions. The opening of the regional wards and the subsequent build-up of local knowledge and expertise meant that transferring patient groups with common cancer forms between health regions was no longer warranted. The decentralization process was therefore accompanied by stricter regulations concerning which cases should be treated centrally versus locally. As such, the opening of regional wards meant that there was less scope for differences in access to and the use of specialized treatment at the national hospitals that were not directly related to disease characteristics.

We use the time variation in the establishment of the regional cancer wards as a quasi-experiment providing exogenous variation in access to specialized treatment. In a differences-in-differences framework, we thus exploit the sudden fall in the transfer rate to the national hospitals in Oslo in two out of three health regions (Central and Northern) to investigate how specialized treatment affects survival. The Western health region serves as the control group, as its transfer

[1] This is largely due to the availability of surgical equipment and expertise, but also because of the absence of comprehensive oncology teams in regions outside the Oslo area.

rate to Oslo was stable during the period under investigation. By applying a differences-in-differences-in-differences set-up, we also investigate the extent to which educational inequalities in cancer survival were affected by the opening of the regional cancer wards.

After controlling for the general time trend, we find that survival rates declined in regions where cancer wards were opened. The effect was particularly pronounced for patients living close to a newly established ward, and for patients with university level education. This entails a reduction in educational inequalities in cancer survival. Prior to the decentralization, patients with a university level education were much more likely to be transferred to the national hospitals than patients without such education. A plausible explanation for the drop in the transfer probability differentials is that stricter transfer regulations made it more difficult to use a possible information or competency advantage to gain access to specialized treatment. Our results thereby suggest that educational inequalities may depend upon health sector organization. Our study also shows that part of the educational gradient in cancer survival may be explained by different inputs (regional versus specialized care) having different productivity, and differential use of these inputs by educational attainment. The observed educational gradient thus reflects more than just differences in unobserved patient characteristics.

Our paper is related to the rapidly growing literature on the causal effects of education on health, typically using compulsory schooling laws as a source of identification. The results of these studies are, however, mixed. Lleras-Muney (2005), who was the first to make use of such laws in the US context, finds a strong reduction in mortality for each year of additional schooling.[2] This is in contrast to Clark and Royer (2013) and Meghir et al. (2012), who fail to find beneficial effects on health of compulsory schooling reforms in the United Kingdom and Sweden.[3] Our paper fits with this literature by empirically substantiating a plausible channel for the development of health disparities by education.

[2]Later research has shown that this result is sensitive to the inclusion of state specific trends (Mazumder 2008).

[3]Cutler and Lleras-Muney (2012) and Mazumder (2012) review this literature. Also the content of education might matter for health outcomes. Leuven, Oosterbeek and Wolf (2013) estimate the impact of attending medical school in the Netherlands. Using admission lotteries for identification they find only modest impacts on health outcomes.

2 Institutional Setting

The public health care system in Norway offers treatment, including highly specialized cancer care, universally and almost free of charge (Molven and Ferkis 2011). Moreover, it is based on the idea of decentralized authority, with clear obligations for the different actors involved. During our study period (1980-2000), the municipalities (around 435 in total) had full responsibility for all primary and emergency health care for their residents, whereas more specialized health care (including cancer care) was the responsibility of the counties (19 in total).[4] Through bilateral agreements, the counties collaborated to provide care within five health regions. In addition, two national hospitals in the Oslo area had a tertiary responsibility for providing state-of-the-art cancer treatment, and challenging cases were thus transferred from counties and/or regions to these institutions run by the central government. Thus, during our study period, there were three levels of hospitals in Norway: Local hospitals (administrated by individual counties), typically covering one or more municipalities; regional hospitals (administrated by collaborating counties within the respective health regions); and national hospitals (administrated by the central government). Patients were allocated to local and regional hospitals based on their residential addresses.[5]

As of today, as shown in Figure 1, the municipalities are organized in four health regions (South-Eastern; Western; Central; Northern).[6] The national hospitals, Rikshospitalet University Hospital and the Norwegian Radium Hospital, are located in Oslo, the capital of Norway, in the South-Eastern health region.[7] In the following, we refer to this region as the Oslo region.

The speed and quality of access to cancer care depends on referrals from publicly employed general practitioners (GPs) working at the municipality level. Some smaller municipalities have few, or even share GPs, whereas larger municipalities have several GPs. Although primary health care may be comprised of many different GPs, the municipalities have common guidelines for diagnostic

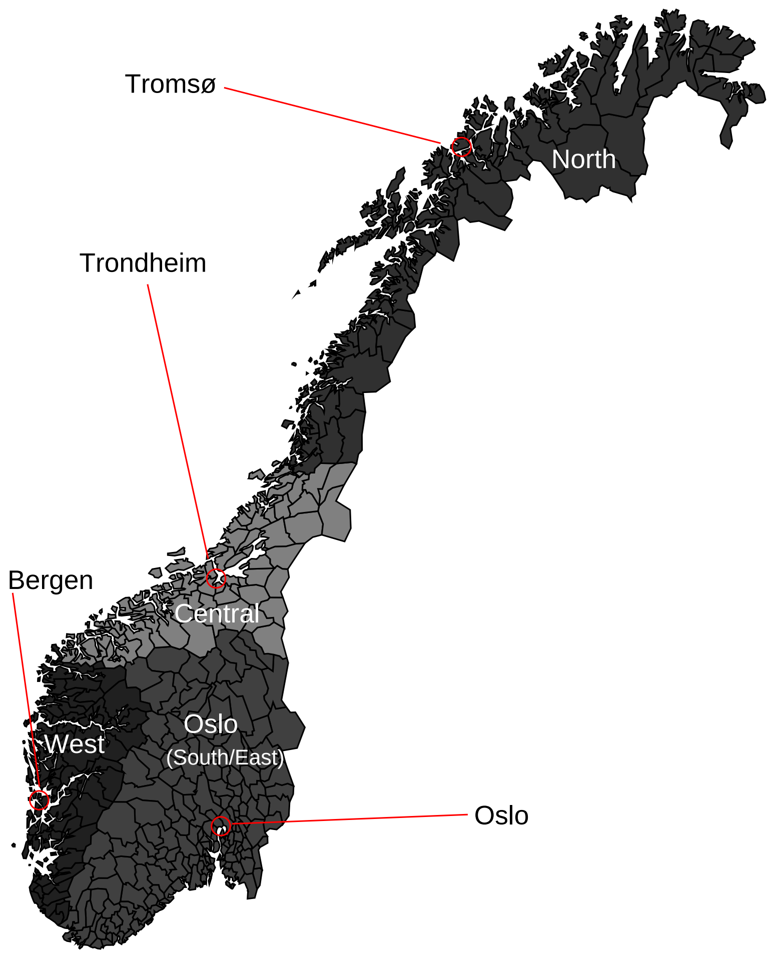
[4]Hospital ownership was transferred from the counties to the central government in 2002.

[5]Our register data allow us to follow patients up until the end of 2008. This means that we can study five-year survival rates for patients diagnosed with cancer in 2003 at the latest. We have therefore chosen to exclude data for the period after the system of free hospital choice within care levels was introduced in 2001. Our main results are not altered in any substantial way if we include also data through 2003.

[6]Five health regions existed up until 2002, after which two of them (Southern and Eastern) merged. Our data follow the most recent health region structure.

[7]Today, they both belong to the Oslo University Hospital, along with other teaching hospitals in the Oslo area.

Figure 1: Norwegian municipalities and health regions



Note: The map shows the four health regions (marked by different shades of grey) and municipality borders based on the municipality structure of 2000 (n=435). The map also shows the cities of Oslo (where the two national hospitals are located), Bergen (regional hospital with cancer ward since 1972), Trondheim (regional hospital with cancer ward since 1987) and Tromsø (regional hospital with cancer ward since 1985).

work-up and referrals of persons who may have cancer.

The decision to either treat patients at the local hospitals (to which they belong), or transfer them to more specialized care depended on an overall assessment of patients' age, cancer form and spread, likely outcomes, and the availability of specialized treatment, including surgical, radiation and chemotherapeutic options within the local hospital catchment area. The patient's interaction with the GP as well as with doctors at the local hospital is also likely to have played a role for referrals and treatments, as there is room for judgement calls depending on cancer type, likely outcomes, patient age etc.

As radiation treatment requires a series of treatments at designated hospitals, it is the treatment form most strongly related to place of residence. Closeness to a radiation unit strongly predicts its use (NOU 1997: 20). Until the early 1970s, Oslo was the only health region that offered adjuvant radiation and chemotherapy.[8] Hence, prior to the establishment of regional cancer wards in 1972, 1985, and 1987 in the Western, Northern, and Central regions, respectively, patients were required to travel to the Oslo region to obtain this type of treatment.

Prior to the opening of the regional oncological wards, the standard practice at local hospitals was to consult oncological surgeons at the Radium Hospital in Oslo prior to diagnosis and treatment, as well as during the course of treatment. The Radium Hospital was the primary oncological hospital in Norway prior to the 1980s, and referrals were made almost exclusively to this hospital.[9]

Referral patterns changed after the opening of the regional oncological wards, so that patients were primarily sent to these regional wards for diagnosis and, when necessary, treatment. In cases where further treatment was deemed necessary, referrals to the Radium Hospital were primarily initiated by these regional oncological wards, typically after telephone consultations between the two. After the opening of the regional wards, transfers of large patient groups with

[8]Surgical treatment, which has been available in Norway for more than 150 years, is the primary treatment for most cancer forms. Patients may also be treated with radiation (available in Oslo since the 1950s) and/or chemotherapy (available since the early 1970s). According to a Norwegian Government White Paper from 1997 (NOU 1997: 20, Omsorg og kunnskap!) around 85% of cured Norwegian patients received surgery. During the period we study, radiation therapy was involved in around 40% of the cases, whereas chemotherapeutic drugs were estimated to have been involved in around 14% of treatments (http://www.helsetilsynet.no/upload/Publikasjoner/andrepublikasjoner/kapasitet_ventetid_straalebehandling_1999.pdf). The use of radiation was limited until the late 1950s, but it gradually became more prevalent in the 1960s and 1970s. Today, multimodal treatment regimens, i.e., various combinations of surgery, radiation, and chemotherapy, predominate.

[9]Searches in newspaper archives indicate that doctors from the Northern health region received training in Oslo prior to the opening of the regional wards.

common cancer forms *between* regions was thus no longer warranted.[10] By the year 2000, comprehensive oncological teams comprising pathologists, radiologists, oncologists, oncological surgeons, and other relevant health personnel were present in all four health regions, and the regional hospitals in Bergen, Tromsø and Trondheim were all incorporated in university settings.[11]

3 Data and Descriptive Statistics

Our analyses are based on individual level data from the Cancer Registry of Norway matched with data on patients' level of education from administrative registers from Statistics Norway. We distinguish between patients who have university level education (*higher education*)[12] and patients without a university level education (*lower education*).

The Cancer Registry contains detailed information about the date of diagnosis, the patient's age at diagnosis, gender, tumor location (International Classification of Diseases, 10th revision (ICD-10)), stage at diagnosis (local, regional, distant or unknown), residential municipality on the date of diagnosis, and the health region the patient was treated and/or examined in.

We limit our sample to individuals residing outside the Oslo region who were between 30 and 75 years old when first diagnosed with cancer.[13] This results in 99,988 individuals in total, 10% of whom have a higher education. In our

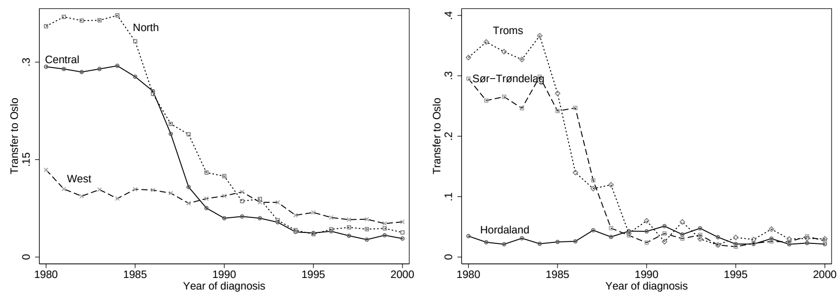
[10]Due to a lack of information about patients' exact residential addresses and the treating hospitals within the regions, we are unable to investigate transfers within health regions.

[11]National guidelines for the diagnosis and treatment of the most prevalent cancer forms were introduced from the mid-1990s, and cancer care was gradually standardized and centralized within the respective health regions in order to ensure optimal treatment and outcomes (see e.g., Wibe et al. (2003) and Kalager et al. (2009) for descriptions of surgical and oncological management of colorectal and breast cancer, respectively). In practice, this resulted in a substantial decline in the number of hospitals performing cancer surgery, from around 65 in the late 1980s to around 20 in the late 1990s and the emergence of multidisciplinary oncology teams providing high-quality care at designated regional hospitals. Throughout the period assessed, guidelines have been in place that require specialized treatment at national hospitals (also after the establishment of the regional cancer wards) for pediatric cancer patients and young adult patients with fertility issues, as well as for patients with certain rare cancer forms. This is to ensure that patients are handled by experienced medical personnel in units that are familiar with relevant diagnostic and treatment protocols.

[12]This also includes education at university colleges.

[13]We restrict the analyses to individuals aged 30 years or older, because, at this age, most individuals have completed their education and because cancer treatment for children and young adults is largely centralized in Norway. We also exclude cancer patients who were older than 75 years at diagnosis. Transfer and survival rates are low for this age group (1.38% and 23.38%, respectively), and comorbid conditions must be taken into account in treatment considerations. About 10% of all patients are diagnosed with more than one form of cancer. We restrict the analyses to patients diagnosed with their first cancer only.

Figure 2: Proportion of cancer patients transferred to Oslo by health region and county with university hospital



Note: The figures display the transfer rate by health region (left panel) and county with university hospital (right panel). Cancer wards were established at the regional hospitals in Hordaland (West), Troms (North), and Sør-Trondelag (Center), in 1972, 1985, and 1987, respectively. A patient is defined as being transferred if he/she was examined and/or received treatment in the Oslo region.

sample the median age at diagnosis is 64.

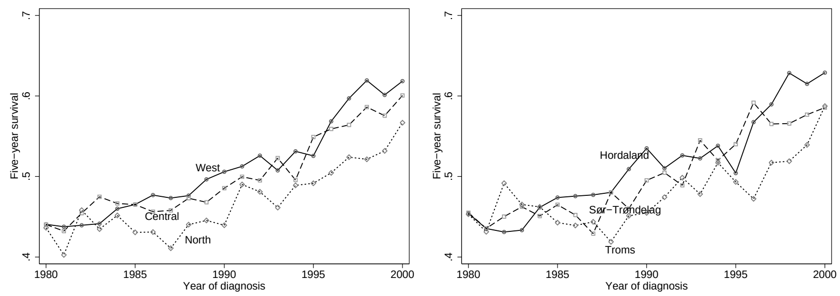
A descriptive overview of the variables used in this paper is provided in Appendix Table A.1. The main outcome variable in our study is a dummy variable equal to one if the patient is alive five years after diagnosis, and zero otherwise (*survival*). A patient is assumed to receive high quality treatment if she/he has been treated and/or examined in the Oslo region, where the two national hospitals are located (referred to as *transfer* in the following).

3.1 Transfer and survival

The left panel of Figure 2 documents the extent of transfers from the Western, Central and Northern regions to the Oslo region. The extent of transfers has decreased over time for all health regions. These changes are mostly due to university hospitals outside Oslo having become better equipped over time in terms of personnel, laboratories, and surgical and radiological equipment. The opening of a cancer ward in Trondheim in 1987 resulted in a drop in the transfer probability from 0.25 in 1986 to 0.11 in 1988. Similarly, the opening of a cancer ward in Tromsø in 1985 resulted in a more gradual drop in the transfer probability from 0.37 in 1984 to 0.13 in 1989.[14] For patients from the Western

[14]There is a slight reduction in the transfer rate in the Central region prior to the opening of a regional cancer ward. This reflects the fact that a small proportion of patients received treatment in the newly opened cancer ward in the Northern region in 1985-1986.

Figure 3: Five-year survival rates by health region and county with university hospital



Note: The figures display the survival rate by health region (left panel) and county with university hospital (right panel). Cancer wards were established at the regional hospitals in Hordaland (West), Troms (North), and Sør-Trondelag (Center), in 1972, 1985, and 1987, respectively. A patient is defined as having survived cancer if he/she is alive five years after cancer diagnosis.

health region, there was no substantial change in the transfer probability during the 1980s. The university hospital in the Western health region opened a cancer ward already in 1972, which was fully operational by 1976.

Because Norway is a outstretched country, traveling distances within health regions are substantial for many patients. For example, the Northern region covers an area that would take about 20 hours to drive across (about 1,000 miles).[15] The traveling distance to the nearest cancer ward may be long even after the establishment of regional cancer wards. Traveling by plane is therefore an option that is likely to be utilized by many patients, and that could also affect the health authorities' decision whether or not to transfer patients to Oslo. The right panel of Figure 2 shows transfer rates for the counties where the university hospitals are located. The decline in transfer rates is more pronounced for this sub-sample. This is reasonable, since traveling time was reduced most for this group of patients.

The five-year all-cause survival rate following a cancer diagnosis increased from 0.43 in 1980 to 0.59 in 2000. As documented in Figure 3, there are some differences between the health regions.[16] In the early 1980s, survival rates were

[15]According to Google Maps, the Central region, the Western region and the Oslo region each cover an area that would take about 9 to 10 hours to drive across (about 350 to 450 miles).

[16]Although individuals living in the Oslo region are not included in the analyses, we include the five-year survival rate for the Oslo region in Appendix Figure A.1 for comparison and completeness purposes.

very similar across all health regions, but the survival rate in Northern Norway started to lag behind from about 1985. This coincided with the opening of the cancer ward in Tromsø. The same pattern is also evident when the analysis is limited to patients residing in the counties where the university hospitals are located (right panel of Figure 3).

As cancer is a serious disease, local physicians are generally quick to refer patients with a suspected malignancy to an appropriate diagnostic work-up. Such work-ups have been available at hospitals at all levels (i.e., local, regional, and national) throughout the period we have studied. It has been possible for local hospitals without their own laboratories to send specimens to either private laboratories or laboratories at larger hospitals for the necessary analyses. It is therefore not surprising that the opening of regional cancer wards did not have a significant impact on the number of patients *diagnosed* with cancer or a differential impact on the respective cancer incidences. Over the period studied, there has been an increase in the number of cancer incidences in all regions, but the changes have been similar and unrelated to the cancer ward openings, as can be seen from Figure 4.[17] Stage at diagnosis also shows a similar development in the Western, Central and Northern regions (see Figure 5). The pronounced change in the number of cancer cases with unknown stage is the result of changes in the coding practice at the Cancer Registry of Norway in the mid-1980s.[18]

3.2 Educational inequalities in transfer and survival

Treatment in the Oslo region and cancer survival are both strongly related to the patients' level of education. In columns (1) and (2) of Table 1, we present results from regressing patients' level of education on transfer and survival using a linear probability model for the whole study period. The results for transfer are reported in the upper panel of the table, whereas the results for survival are reported in the lower panel.[19] The probability of being transferred to the Oslo region is 1.4 percentage points higher for patients with a higher education relative to those with a lower education. The effect is statistically significant at

[17] Neither did the opening of regional cancer wards significantly impact on the number of cancer patients in the Oslo region (see Appendix Figure A.2).

[18] Unless it was positively confirmed that there was no distant spread, cases were from this point onwards coded as having an unknown spread whereas such cases were previously assigned a stage based on their reported degree of spread, locally or regionally. Before the mid-1980s it was thus assumed that, if no distant spread was noted, there was none.

[19] Since all our control variables are discrete, we estimate linear probability models (as recommended by, for example, Angrist 2001).

Figure 4: Number of incident cancers by health region

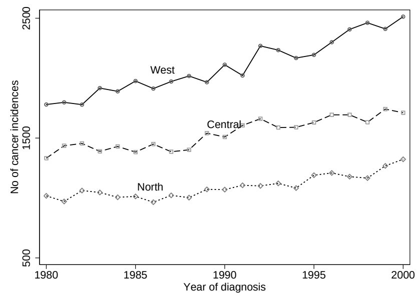
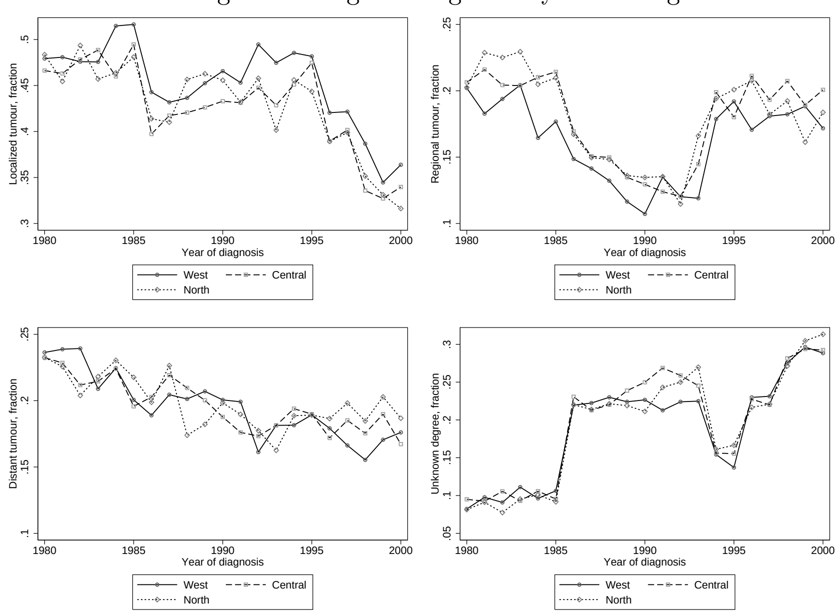
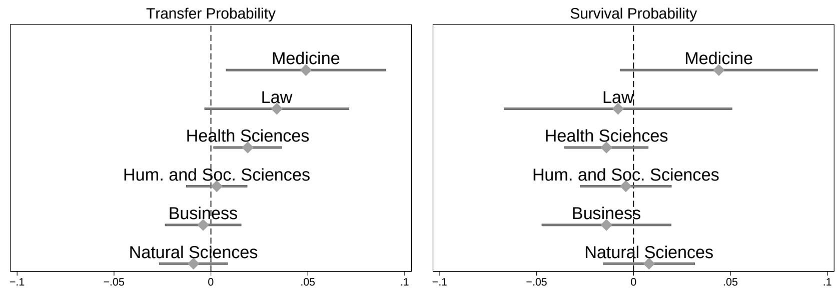


Figure 5: Stage at diagnosis by health region



Note: The figures displays the fraction of patients with localized, regional, distant, and unknown spread, by time of diagnosis and health region.

Figure 6: Differences across educational disciplines in patients with higher education



Note: Estimates and corresponding 95% confidence intervals from linear probability models are reported. The sample is limited to patients with a university level education (n=9,999). Patients educated as teachers comprise the reference group. Time fixed effects, county fixed effects and a full battery of patient and disease characteristics are included. Standard errors are heteroscedastic robust and corrected for clustering at the (residential) municipality level at the time of diagnosis. The mean for survival is 0.65. The mean for transfer is 0.12.

the one percent level. Individuals with a higher education are also more likely to survive cancer. This result has previously been documented for Norway and other countries (see, for example, Kravdal 2000, Du et al. 2006, Lang et al. 2009, Fiva, Hægeland and Rønning 2010, Kravdal and Syse 2011).

Cancer covers many diagnoses that differ greatly with respect to severity and treatability. When controlling for disease characteristics such as cancer type and stage at diagnosis (column (2)), the model improves considerably (the R-square roughly doubles), and the association between level of education and transfer probability increases to 2.6 percentage points. This indicates that patients with a university level education tend to be less in need of specialized care at national hospitals. This is consistent with previous studies that have documented that people with higher education are more likely to be diagnosed at an earlier stage (Clegg et al. 2009). The effect of education on survival, on the other hand, decreases when disease controls are added. Part of the (unadjusted) educational inequality in cancer survival is therefore due to differences in disease severity.

We also relate the probability of transfer and survival, respectively, to patients' type of education. The left panel of Figure 6 shows that being educated as a doctor increases the probability of being transferred to Oslo by about five percentage points relative to those educated as teachers (the reference group). This is an increase of around 40% in the transfer probability relative to the base-

Table 1: The relationship between education and transfer, and education and five-year survival, at regional levels

	Central/North/West		Central		North		West	
			Pre	Post	Pre	Post	Pre	Post
	1980-2000		1980-86	1987-2000	1980-84	1985-2000	1980-86	1987-2000
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Transfer				
Higher education	0.014	0.022	0.042	0.012	0.011	0.037	0.047	0.019
	(0.003)***	(0.003)***	(0.015)***	(0.005)**	(0.040)	(0.007)***	(0.009)***	(0.005)***
				Survival				
Higher education	0.085	0.040	0.072	0.034	0.037	0.045	0.025	0.039
	(0.005)***	(0.004)***	(0.016)***	(0.006)***	(0.024)	(0.010)***	(0.012)**	(0.006)***
Controlling for disease char	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No of obs	99,739	99,739	9,901	22,460	5,126	17,959	13,120	31,173

Note: The dependent variable in the upper panel is a dummy variable that equals one if the patient was examined and/or received treatment in the Oslo region. The dependent variable in the lower panel is a dummy variable that equals one if the patient is alive five years after cancer diagnosis. Each cell represents coefficients from OLS regressions. Standard errors within brackets are heteroscedastic robust and corrected for clustering at the (residential) municipality level at the time of diagnosis. A constant term and dummy variables for age at diagnosis, gender, year of diagnosis and county of residence are included in all specifications. */**/*** denote statistical significance at the 10/5/1 percent levels, respectively.

line transfer rate (13%). Doctors also have about a five percentage points higher probability of surviving cancer. Lawyers and other health care professionals also have a statistically significant higher probability of receiving treatment in Oslo, but this does not manifest itself in a higher survival probability for these groups.

Estimates reported in Figure 6 are from specifications that include a full battery of patient and disease characteristics. Together with the differences with respect to level of education, these findings indicate that, even in an egalitarian welfare state, access to treatment appears to depend on socioeconomic status. Highly educated and better informed patients appear to receive better treatment than others.

3.3 Regional cancer wards and educational inequalities in transfer and survival

In columns (3)-(8) of Table 1, we show separate results for educational inequalities for each health region.[20] We examine the periods before and after the opening of the regional cancer wards separately (henceforth the *pre* and *post*.[21]

During the pre-reform period in the Central region, the probability of being transferred was 4.2 percentage points higher for a patient with a higher education (relative to a patient with a lower education). The difference fell to 1.2 percentage points during the post-reform period, 1987-2000 (see upper panel columns (3) and (4)). A similar pattern was also found for survival (see lower panel columns (3) and (4)). Before the opening of a regional cancer ward, the difference in survival probabilities between patients with higher and lower education was 7.2 percentage points, compared to 3.4 after the opening. This difference is substantial. To provide a perspective, overall survival probability increased from 0.43 to 0.59 from 1980 to 2000, corresponding to an annual increase of 0.8 percentage points. If all the educational inequalities were due to differences in treatment, the difference in survival before the reform corresponded to nine years of progress in cancer treatment (assuming that all changes in cancer survival rates are due to better treatment).

In the Northern health region, the differences in both survival and transfer probabilities for patients with a higher education (relative to patients with a lower education) was highest in the post-reform period (columns (5) and (6)).

[20]Unfortunately, we have too few observations in the pre-reform period to conduct a meaningful statistical analysis based on patients' *type* of education.

[21]The Western region is assigned the same pre-reform and post-reform periods as the Central region.

Table 2: The relationship between education and transfer, and education and five-year survival, at county levels

	Sør-Trøndelag (Central)		Troms (Northern)		Hordaland (West)	
	Pre	Post	Pre	Post	Pre	Post
	1980-86	1987-2000	1980-84	1985-2000	1980-86	1987-2000
	(1)	(2)	(3)	(4)	(5)	(6)
TRANSFER						
Higher education	0.049	0.007	0.017	0.007	0.026	0.014
	(0.011)***	(0.004)	(0.050)	(0.007)	(0.005)***	(0.004)***
SURVIVAL						
Higher education	0.078	0.036	0.041	0.030	0.027	0.042
	(0.009)***	(0.008)***	(0.029)	(0.015)*	(0.015)*	(0.009)***
Controlling for disease char	Yes	Yes	Yes	Yes	Yes	Yes
No of obs	4253	9419	1559	5572	6489	15227

See Table 1.

The point estimates for the pre-reform period are not statistically significant. In the Western health region, which had a regional cancer ward during the entire period under consideration, the difference in transfer probability between education groups was also highest in the period 1980-1986. However, the reverse was true for the difference in survival probabilities, which indicates a general compression of inequalities in cancer survival over time in Norway.

Table 2 reports results based on the sample of patients residing in the counties where the university hospitals are located (Troms, Sør-Trøndelag and Hordaland). The results do not change much for the Central and Western regions when the counties furthest from the university hospitals are excluded. For the Northern region, on the other hand, the estimated effect of education becomes considerably smaller in the post-reform period for both transfer and survival compared to the baseline analysis.

In summary, after the opening of regional cancer wards, the proportion of cancer patients receiving treatment at the national hospitals in Oslo fell dramatically. Moreover, the fall in the transfer rate was relatively steeper for patients with higher education than for patients with lower education (especially when focusing on the county in which the regional cancer ward is located). At the same time, we also saw a decline in the difference in the survival probability between patients with higher and lower education. Taken together, these findings indicate that the newly opened regional cancer wards may have been of lower quality than the wards at the well-established hospitals in Oslo, and that access to or utilization of specialized treatment may in part explain why patients with higher education survived cancer to a greater extent than patients with a lower education. We explore this in more detail in the next section.

4 The effect of specialized treatment on overall cancer survival

The opening of regional cancer wards at the teaching hospitals in Tromsø (Northern region) and Trondheim (Central region) in the 1980s led to sudden and large drops in transfer probabilities from the Northern and Central health regions. At the same time, the transfer probability in the Western health region remained almost unchanged (recall Figure 2). This motivates the following difference-in-difference (DiD) specification:

$$sur_{ijt+5} = CN_{it} + post_{jt} + \psi(CN_{it} * post_{jt}) + X_i\nu + \theta_j + d_t + u_{ijt} \qquad (1)$$

sur_{ijt+5} is a dummy variable that equals one if patient i in county j was still alive five years after being diagnosed with cancer, CN_{it} is a dummy variable taking the value one if the patient was resident in the Central or Northern health region at the time of diagnosis (the 'treatment group') and zero if the patient was resident in the Western health region (the 'comparison group'), while, $post_{jt}$ is a dummy variable taking the value one if diagnosis year $\geq$ the year of the opening of the regional cancer ward (1985 for the Northern and 1987 for the Central region), and zero otherwise. The opening of regional wards may, in principle, have affected the quality of care received by patients residing in the Oslo region.[22] For this reason we do not include patients from this region in our comparison group.

Our parameter of interest is the differences-in-differences parameter ψ. As discussed above, the care provided at newly opened cancer wards may have been of lower quality than the care provided at the well-established national hospitals, especially during the period shortly after establishment. If this was the case, we should expect $\psi < 0$. To account for such temporary start-up effects, we allow for different effects in the short and long run and provide separate results for the first five years after the opening of a regional cancer ward ($post1_{jt}$) and the succeeding period ($post2_{jt}$).[23] Furthermore, X_i is a vector of observed characteristics of the patient/tumor (such as type of cancer (ICD10), stage, age at diagnosis, gender and education), whereas θ_j and d_t are county and year of diagnosis dummies. Finally, u_{ijt} is an error term. Since patients living in the same municipality share primary health care offered by general practitioners, we allow for arbitrary correlation in error terms within the 262 (residential) municipalities (at the time of diagnosis) by clustering the standard errors at this level. [24]

[22]In practice, the opening of new regional cancer wards could have affected the quality of care also in Oslo, for instance through increased capacity at the national hospitals as fewer transfers were made from regions outside this area. When including patients residing in the Oslo region in our comparison group the point estimates decrease a bit, but remain statistically significant.

[23]Post1 = 1987-1991 for the Central region and 1985-1989 for the Northern region. Post2 = 1992-2000 for the Central region and 1990-2000 for the Northern region.

[24]The clusters are based on the municipality structure existing at the end of our sample period (the year 2000). We are left with 262 clusters after the Oslo region has been excluded. The total number of municipalities existing in 2000 is 435.

Table 3 reports the results from estimating equation (1). It shows that the relative prospects for surviving cancer deteriorated substantially for patients when new wards were established in their region. When regional cancer wards were established in the Central and Northern regions, the survival probability declined by 1.6 percentage points for patients residing in those regions compared to those living in the Western region. The effect is statistically significant at the one percent level (see column (1)). The effect does not seem to be transitory, i.e., it is present both in the first five years after the opening (post1) and thereafter (post2) (see column 2).

In the Northern and Central health regions, the opening of the regional wards reduced the rate at which patients were transferred to Oslo with about 20 percentage points (cf. Figure 2).[25] In the terminology of Imbens and Angrist (1994), we can label patients receiving treatment (only) at regional rather than national hospitals as "compliers". Assuming that the entire population level treatment effect is due to patients "complying" with the reform, i.e. patients receiving treatment (only) at regional rather than national hospitals, the average individual-level treatment effect is about 8 percentage points (1.6 * 5) for the compliant subpopulation.[26] Our results therefore suggest that the quality of care provided by the national hospitals was considerably higher than the quality of care at the regional wards.

As already discussed, the establishment of regional cancer wards may have been of particular relevance to those residing close to the university hospitals (due to long travel distances, especially in the North). In order to take this into account, we also conducted separate analyses for the counties where the university hospitals are located (Troms, Sør-Trøndelag and Hordaland). The results, which are presented in columns (3) and (4), show that the point estimates increase slightly relative to column (2), indicating an average individual-level treatment effect of about ten percentage points for the compliant subpopulation.[27] Even though the sample is reduced by 60%, the effect is statistically significant for both post-reform periods at the five percent level. A relative de-

[25]The regression adjusted compliance rate is 18.5 percentage points.

[26]Note that this assumption may fail for two reasons. First, even after the establishment of the regional wards some patients (about ten percent) were still transferred to Oslo. We do not know the extent to which these patients also received treatment at regional hospitals. If this group of patients received more treatment regionally than nationally as a consequence of the hospital reform they may also have contributed to the population-level average treatment effect. Second, both before and after the hospital reforms a majority of patients were treated only regionally. If the hospital reforms changed the quality of regional care for this group of patients they may also have contributed to the population-level average treatment effect.

[27]The regression adjusted compliance rate is 23.4 percentage points.

cline in cancer survival of more than two percentage points is substantial, when we take into account that the overall survival probability was around 50%. It strongly suggests that the treatment received by patients from the counties of Sør-Trøndelag and Troms deteriorated relative to national best practice standards after the establishment of the new wards.

As the treatment is provided at the regional level, this would be the ideal level of clustering. However, with only three clusters this will not provide reliable inference. An intermediate solution is to allow for correlation in the error terms at the local hospital catchment area as they represent a more conservative clustering level than the residential municipalities. One drawback is, however, that there are only 29 hospital catchment areas (after excluding the Oslo region) which is below the benchmark of 42 suggested by Angrist and Pischke (2010). As a supplement to our municipality clustered standard errors we follow Cameron, Gelbach and Miller (2008) and apply (wild) bootstrap resampling methods when clustering at the hospital catchment area level. This is a common method in the case of few clusters (Angrist and Pischke, 2010). Using this method the point estimate in the main specification (column (1)) is statistically significant at the ten percent level (p= 0.076). When restricting the analysis to counties with a university hospital (and only 11 clusters) the effect is not statistically significant at conventional levels (p=0.129).

In a differences-in-differences research design, it is always a concern that the parameter estimate of interest may be biased by differential time trends. If characteristics affecting cancer survival but not controlled for in our analysis changed over time but differently in the regions studied, this could bias our estimates. To check the robustness of our results in this respect, we estimate year-specific DiD estimates, which are shown in Figure 7. It is evident that the survival rate in the Northern health region started to deviate the year after the regional cancer ward opened. This effect is also visible in the raw data (recall Figure 3). The pattern is less clear for the Central region, although point estimates are also negative here for the period 1989-91 compared to the period before the establishment of a regional cancer ward. Importantly, there is no trace of any 'reform' effect prior to the actual reform. The results are reported in more detail in Appendix Table A.2.

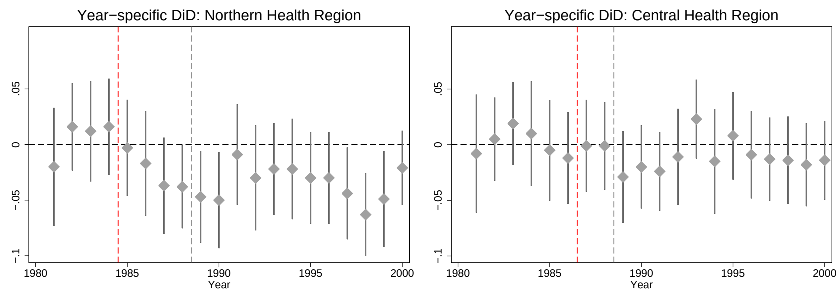
Another concern is that the opening of regional cancer wards also changed the (unobserved) composition of the cancer patients, which could potentially bias our results. Figures 4 and 5, which document an equal trend in both cancer incidences and stage at diagnosis in the Western, Central and Northern

Table 3: The effect of the hospital reforms on survival five years after diagnosis, DiD estimates

	(1)	(2)	(3)	(4)
Treatment*Post	-0.016		-0.024	
	(0.006)***		(0.008)***	
Treatment*Post1		-0.017		-0.026
		(0.007)**		(0.011)**
Treatment*Post2		-0.016		-0.023
		(0.006)***		(0.008)**
Dep var (mean)	0.502	0.502	0.509	0.509
Treatment	Central/North	Central/North	Troms/Sør-Trøndelag	Troms/Sør-Trøndelag
Control	West	West	Hordaland	Hordaland
No of clusters	262	262	84	84
R-square	0.3607	0.3607	0.3691	0.3691
No of obs	99739	99739	42519	42519

Note: The dependent variable is a dummy variable that equals one if the patient is alive five years after diagnosis. Standard errors within brackets are heteroscedastic robust and corrected for clustering at the (residential) municipality level at the time of diagnosis. A constant term, dummy variables for educational level, gender, age at diagnosis, disease characteristics, diagnosis year, and county of residence are included in all specifications. */**/*** denote statistical significance at the 10/5/1 percent levels, respectively.

Figure 7: Year-specific DiD estimates, five-year survival probabilities



Note: The first vertical lines indicate the opening of the regional cancer wards. The second vertical lines indicate when transfer rates reached the same level as that of the Western region.

health regions, suggest, however, that such compositional effects are not driving our results.

According to national guidelines, certain rare cancer forms would continue to be treated at highly specialized hospitals in the Oslo region, also after the opening of the regional cancer wards (see Appendix Table A.3). Examples of such cancer forms include most bone cancer forms, many of the head-and-neck cancer forms, many of the central nervous system (CNS) tumors, and most soft-tissue sarcomas. As a robustness check, we limit our analysis to only include the four most common cancer types in our cohort (colorectal, lung, breast, and prostate cancer). Appendix Table A.4 shows the results based on the inclusion of these four cancer types only. The results are basically similar to those reported in Table 3.

Overall, the results consistently show that the establishment of regional cancer wards had a negative effect on cancer survival. The results are thus informative about the quality of care provided by the highly specialized national hospitals located in Oslo.

5 The effect of specialized treatment on educational inequalities

As already documented in Tables 1 and 2, the difference in both transfer and survival probability between patients with higher and lower education appears to have decreased after the opening of the regional cancer wards. To investigate this pattern in more detail, we estimate the following differences-in-differences-in-differences ($DiDiD$) specification:

$$sur_{ijt+5} = CN_{it} + post_{jt} + \theta Ed_i + \psi(CN_{it} * post_{jt}) + \mu(Ed_i * post_{jt} * CN_{it}) \quad (2)$$

$$+\rho(Ed_i * post_{jt}) + \pi(CN_{it} * Ed_i) + X_i\nu + \theta_j^* + d_t^* + u_{ijt}^*$$

As in equation (1), the parameter ψ measures the average effect of regional cancer treatment on survival. The interaction terms between higher education, Ed_i, the region dummy CN_i and the decentralization dummy $post_{jt}$ are new in equation (2) compared to equation (1).

The new parameter of interest is the parameter μ. A negative μ implies that educational inequalities in survival probabilities fell after the opening of regional cancer wards. The total effect of restricting access to treatment in Oslo for a patient with a higher education is $\psi + \mu$, while it is ψ for a patient with a lower education.

The DiDiD estimates are presented in Table 4. The results clearly indicate that it was the highly educated who were affected most strongly by the reform. All specifications indicate a decrease in the differences in survival rates of about four percentage points, e.g., in column (1), where the decline for those with lower education was 1.4 percentage points, whereas it was 5.8 percentage points for the highly educated. The effect is statistically significant at the five percent level when conducting the analysis at health region level (column (1)). When applying wild bootstrap resampling methods the DiDiD estimate is statistically significantly different from zero (p=0.001), whereas the DiD estimate is not (p=0.13).

When we split the post-reform period into two, we find statistially significant effects of a similar magnitude for both periods. At the county level, the point estimates are statistically insignificant, but similar in magnitude to the baseline analysis.[28]

As in the analysis in the previous section, different time trends in the educational composition of the treatment and control groups may give grounds for concern. In Appendix Figure A.3, we report the trend in the proportion of

[28] Appendix Table A.5 shows the results from including only the four most common cancer types. The results are basically similar to those reported in Table 4.

Table 4: The effect of the hospital reforms on educational inequality in survival probability five years after diagnosis, DiDiD estimates

	(1)	(2)	(3)	(4)
High ed*Treatment*Post	-0.044		-0.036	
	(0.0175)**		(0.019)*	
High ed*Treatment*Post1		-0.044		-0.033
		(0.019)**		(0.023)
High ed*Treatment*Post2		-0.043		-0.038
		(0.019)**		(0.019)*
Treatment*Post	-0.014		-0.022	
	(0.006)**		(0.007)**	
Treatment*Post1		-0.014		-0.023
		(0.007)**		(0.011)**
Treatment*Post2		-0.013		-0.020
		(0.006)**		(0.007)**
Dep var (mean)	0.502	0.502	0.509	0.509
Treatment	North/Central	North/Central	Troms/Sør-Trøndelag	Troms/Sør-Trøndelag
Control	West	West	Hordaland	Hordaland
No of clusters	262	262	84	84
R-square	0.3609	0.3609	0.3693	0.3693
No of obs	99739	99739	42519	42519

Note: The dependent variable is a dummy variable that equals one if the patient is alive five years after diagnosis. Standard errors within brackets are heteroscedastic robust and corrected for clustering at the (residential) municipality level at the time of diagnosis. In all specifications we include dummies for treatment, higher education and year of diagnosis, as well as interactions between year of diagnosis and higher education, and interactions between treatment and higher education. A constant term and dummy variables for gender, disease characteristics, age at diagnosis and county of residence, are also included. */**/*** denote statistical significance at the 10/5/1 percent levels, respectively.

the whole population (between 16 and 75 years) with a higher education separately for the different regions.[29] As the trend is very similar across regions, compositional effects in education are unlikely to drive our results.

Previous research has shown that individuals with a lower education also tend to suffer from other serious diseases and therefore receive different types of treatment for such co-morbidities (Aarts et al 2013). This may further necessitate modifications in the cancer treatment protocol. Unfortunately, we do not have information about such co-morbidities. However, given that the trend in such co-morbidities is likely to be the same in the treatment and control regions, this should not be a source of bias in our research design.

All in all, a very clear pattern emerges from the results reported in this section. Differences in survival rates with respect to education fell substantially after the opening of the new regional cancer wards. As we documented earlier, this went hand in hand with a decline in the transfer probability, which was most pronounced for the highly educated. The results strongly suggest that the relative fall in survival probability for the highly educated was the result of a reduction in the pre-reform advantage they had in terms of access to highly specialized treatment at the national hospitals.

6 Conclusion

The point of departure for this paper is the well-known fact that highly educated individuals survive cancer to a greater extent than others. We test the hypothesis that this may in part be driven by highly educated individuals having better access to, or to a greater extent utilizing, specialized cancer treatment. In a welfare state with strong egalitarian preferences and a publicly financed health care system, differential use of selected treatment options could be seen as an indication that the system is functioning sub-optimally.

We document that, among cancer patients residing outside the Oslo region, highly educated patients, and doctors in particular, are more likely than other patients to be transferred to the two specialized hospitals in the capital. Since these hospitals are likely to offer more advanced treatment provided by a highly skilled staff, such transfers would also be expected to increase survival probabilites. This is hard to investigate empirically, since patients who suffer from the most severe diseases are the ones that are most likely to be transferred. How-

[29] The figure is constructed using additional data collected at the regional level from the Norwegian Social Science Data Service (NSD).

ever, we find that the educational inequalities in transfer probabilities become more pronounced when we condition on a rich set of disease characteristics. It is also striking that patients who have a medical education are the ones with the highest transfer and survival probabilities conditional on disease characteristics. It is possible, of course, that unobserved patient and disease characteristics vary systematically differently across types and levels of education compared to the observed characteristics, but we find this unlikely. While these findings in themselves suggest that educated patients utilize specialized treatment to a greater extent, they do not establish that this explains (part of) the educational inequality in survival.

To do this, we need an exogenous source of variation in access to specialized treatment. Our empirical approach was to utilize reforms in cancer treatment in Norway in the 1980s, when specialized cancer wards were established in the Central and Northern health regions. As a consequence of this, the proportion of patients transferred to the national specialized hospitals fell dramatically because of increased regional capacity and more explicit transfer regulations. We find that the reforms had a negative effect on the survival probability for patients residing in the regions where the new wards were established (i.e., survival improved less than in other regions). This was particularly true for highly educated patients. These results indicate that the initial quality of treatment or care at the new regional wards may have been lower than that offered at the national hospitals, but also that the reforms reduced the educational inequalities in cancer survival. Taken at face value, the point estimates suggest that a substantial part of the educational difference in cancer survival in these regions was due to differences in access to and utilization of specialized treatment at the national level hospitals.

A point of departure for this study was the educational gradient in cancer survival, which may be the result of many complex mechanisms, which are not all related to treatment. What do our quasi-experimental results suggest about the determinants of cancer survival, or the structural parameters of a health production function? As mentioned in the introduction, one mechanism explored by Grossman (1972) is that education affects health directly because educated individuals use available inputs more efficiently. A typical finding by previous studies is that more educated individuals make better use of health-relevant information available to all. Our finding that educated individuals made more use of high quality health inputs (transfer to the specialized hospitals) is a similar mechanism, but goes one step further. It implies not only asymmetric use of information, but also asymmetric use of an input with restricted access. In our case, treatment was not rationed through the price mechanism, but through an allocation procedure that allowed for some discretion. This discretion appears to have favored the highly educated, who gained access to more productive inputs (specialized treatment), possibly using an information or competency advantage.

It is not surprising that a fully privatized health care system can produce social inequalities. Our results suggest that even within in a public health care system, socioeconomic inequalities in cancer survival can arise when health personnel have substantial discretion in referral practices. They also highlight that the organization of health care may involve a painful trade-off between proximity and quality of treatment.

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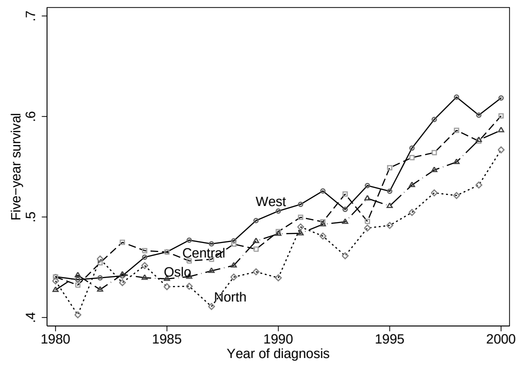
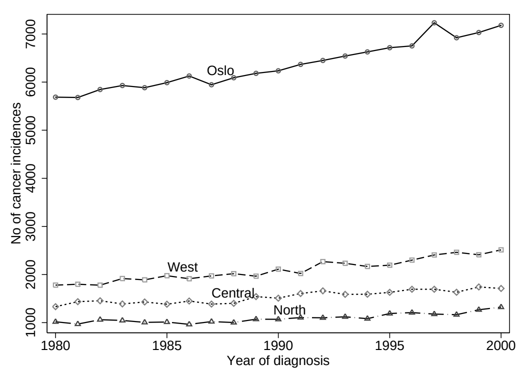
A Appendix

Figure A.1: Five-year survival rates by year of diagnosis and health region, Oslo region included



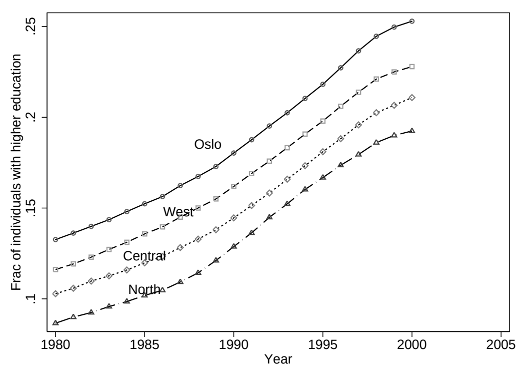
Note: The figures display the survival rate by health region. A patient is defined as having survived cancer if he/she is alive five years after cancer diagnosis.

Figure A.2: Cancer incidence by health region, Oslo region included



Note: The figure display the number of incident cancers by health region.

Figure A.3: Fraction of the population (between 16 and 75 years) with high education by health region.



Note: This figure is constructed using separate regional level data from the Norwegian Social Science Data Service (NSD)

Table A.1: Summary statistics of the variables used in the analyses

	Mean	St.dev	Min	Max
Survival five years after diagnosis	0.502	0.500	0	1
Transfer to the Oslo region	0.113	0.317	0	1
Age at diagnosis	61.4	11.02	30	75
Year of diagnosis	1991	6.07	1980	2000
University level education (15 years or more)	0.100	0.300	0	1
Gender dummy (1=Female, 0=Male)	0.470	0.500	0	1
STAGE AT DIAGNOSIS				
Localized	0.437	0.500	0	1
Regional spread	0.172	0.377	0	1
Distant spread	0.195	0.396	0	1
Unknown spread	0.197	0.398	0	1
CANCER TYPE (ENCODED BY ICD-10)				
Head and neck, incl eye (C00-14, C30-32, C69)	0.033	0.180	0	1
Esophageal (C15)	0.007	0.081	0	1
Stomach (C16)	0.045	0.207	0	1
Small intestine (C17)	0.003	0.059	0	1
Colorectal (C18-C21)	0.141	0.348	0	1
Hepatic/biliary (C22-C24)	0.010	0.101	0	1
Pancreatic (C25)	0.030	0.171	0	1
Lung (C34, C39)	0.099	0.299	0	1
Endocrine (C37, C73-75)	0.019	0.135	0	1
Bone (C40-C41)	0.002	0.040	0	1
Skin (C43-44)	0.067	0.250	0	1
Soft tissue (C45-49)	0.004	0.061	0	1
Peritoneal (C48)	0.002	0.041	0	1
Breast (C50)	0.122	0.327	0	1
Cervical/uterine (C53-55)	0.049	0.216	0	1
Ovarian (C56)	0.028	0.165	0	1
Other female gyn. (C51-52, C57-58)	0.004	0.063	0	1
Prostate (C61)	0.107	0.309	0	1
Testicular (C62)	0.011	0.102	0	1
Penile/other male genital (C60, C63)	0.002	0.040	0	1
Renal/bladder (C64-68)	0.082	0.274	0	1
CNS (C69-72, D32-33)	0.035	0.183	0	1
Leukemia/lymphoma (C81-85, C90-95)	0.070	0.255	0	1
Other or unspecified (C26, C38, C76-80, C86-88, C96-97)	0.028	0.166	0	1

No of observations = 99,739.

Table A.2: The effect of hospital reforms on survival five years after diagnosis, year-specific DiD estimates, separate results for the Northern and Central health region

	(1)		(2)	
Treatment	-0.007	(0.018)	0.017	(0.017)
Treatment*Year (1980=ref)				
1981	-0.020	(0.027)	-0.008	(0.027)
1982	0.016	(0.020)	0.005	(0.019)
1983	0.012	(0.023)	0.019	(0.019)
1984	0.016	(0.022)	0.010	(0.024)
1985	-0.003	(0.022)	-0.005	(0.023)
1986	-0.017	(0.024)	-0.012	(0.021)
1987	-0.037	(0.022)*	-0.001	(0.021)
1988	-0.038	(0.019)**	-0.001	(0.020)
1989	-0.047	(0.021)**	-0.029	(0.021)
1990	-0.050	(0.022)**	-0.020	(0.019)
1991	-0.009	(0.023)	-0.024	(0.018)
1992	-0.030	(0.024)	-0.011	(0.022)
1993	-0.022	(0.021)	0.023	(0.018)
1994	-0.022	(0.023)	-0.015	(0.024)
1995	-0.030	(0.021)	0.008	(0.020)
1996	-0.030	(0.021)	-0.009	(0.020)
1997	-0.044	(0.021)**	-0.013	(0.019)
1998	-0.063	(0.019)**	-0.014	(0.020)
1999	-0.049	(0.022)**	-0.018	(0.019)
2000	-0.021	(0.017)	-0.014	(0.018)
Dep var (mean)	0.501		0.512	
Treatment	North		Central	
Control	West		West	
No of clusters	175		172	
R-square	0.3629		0.3606	
No of obs	67378		76654	

Note: The dependent variable is a dummy variable that equals one if the patient is alive five years after diagnosis. Standard errors within brackets are heteroscedastic robust and corrected for clustering at the (residential) municipality at the time of diagnosis. Included in all specifications are a constant term, dummy variables for educational level, gender, age at diagnosis, disease characteristics, year of diagnosis and county of residence. */**/*** denote statistical significance at the 10/5/1 percent levels, respectively.

Table A.3: Transfer proportions before and after the opening of regional cancer hospitals

	Central		North	
ICD10	0	1	0	1
Head and neck	0.688	0.234	0.724	0.366
Oesophageal	0.356	0.055	0.568	0.057
Stomach	0.031	0.019	0.032	0.025
Small intestine	0.125	0.150	0.182	0.140
Colorectal	0.103	0.036	0.136	0.055
Hepatic/biliary	0.107	0.065	0.125	0.071
Pancreatic	0.042	0.018	0.069	0.025
Lung	0.457	0.041	0.584	0.078
Endocrine	0.333	0.088	0.487	0.186
Bone	0.667	0.429	0.667	0.692
Skin	0.120	0.028	0.228	0.067
Soft tissue	0.520	0.159	0.828	0.391
Peritoneal	0.462	0.170	0.200	0.225
Breast	0.226	0.035	0.353	0.083
Cervical/uterine	0.903	0.180	0.909	0.295
Ovarian	0.717	0.191	0.819	0.262
Other female gyn.	0.776	0.161	0.714	0.299
Prostate	0.062	0.013	0.133	0.032
Testicular	0.767	0.074	0.902	0.159
Penile/other male genital	0.467	0.061	0.429	0.118
Renal/bladder	0.232	0.035	0.262	0.061
CNS	0.452	0.085	0.741	0.177
Leukemia/lymphoma	0.262	0.050	0.289	0.089
Other or unspecified	0.170	0.031	0.227	0.077

Table A.4: The effect of the hospital reforms on survival five years after diagnosis when only including the four most common cancer types, DiD estimates.

	(1)	(2)	(3)	(4))
Treatment*Post	-0.015		-0.035	
	(0.009)*		(0.011)***	
Treatment*Post1		-0.016		-0.036
		(0.011)		(0.013)**
Treatment*Post2		-0.014		-0.035
		(0.009)		(0.011)***
Dep var (mean)	0.502	0.502	0.510	0.510
Treatment	Central/North	Central/North	Sør-Trøndelag/Troms	Sør-Trøndelag/Troms
Control	West	West	Hordaland	Hordaland
No of clusters	262	262	84	84
R-square	0.3552	0.3552	0.3654	0.3654
No of obs	46,830	46,830	20,064	20,064

Note: The included cancer types are: colorectal, lung, breast and prostate.
See also Table 3.

Table A.5: The effect of the hospital reforms on educational inequality in survival probablities five years after diagnosis when only including the most common cancer types, DiDiD estimates.

	(1)	(2)	(3)	(4)
High ed*Treatment*Post	-0.055		-0.008	
	(0.031)*		(0.027)	
High ed*Treatment*Post1		-0.064		-0.012
		(0.037)*		(0.039)
High ed*Treatment*Post2		-0.052		-0.007
		(0.032)		(0.026)
Treatment*Post	-0.012		-0.036	
	(0.009)		(0.011)***	
Treatment*Post1		-0.013		-0.035
		0.011		(0.014) **
Treatment*Post2		-0.012		-0.036
		0.010		(0.011)**
Dep var (mean)	0.502	0.502	0.510	0.510
Treatment	Central/North	Central/North	Sør-Trøndelag/Troms	Sør-Trøndelag/Troms
Control	West	West	Hordaland	Hordaland
No of clusters	262	262	84	84
R-square	0.3554	0.3554	0.3659	0.3659
No of obs	46,830	46,830	20,064	20,064

Note: The included cancer types are: colorectal, lung, breast and prostate.
See also Table 4.