Are female-dominated cancers underfunded?*

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Abstract

This paper documents that female-dominated cancers, in which the number of male deaths is less than or equivalent to that of female deaths, are underfunded and tries to identify the mechanisms behind the unequal distribution of cancer research funding in Europe. We use two novel owned-collected datasets of projects related to cancer research and innovation awarded by the European Research Council (ERC) from 2007 to 2020, and by the European Commission under the Seventh Framework Programme (FP7) from 2007 to 2013 and the Horizon 2020 (H2020) Framework Programme from 2014 to 2020. Our analysis reveals that 10 percentage point increase in male relative mortality, which is measured by the ratio between male mortality and total mortality of each cancer type, is statistically significant associated with approximately 0.3% increase and 0.8% increase in the awarded research fund in the ERC dataset and the FP7 & H2020 dataset, respectively. This presents a 4,420 euro increase over the ERC sample mean and a 12,402 euro increase over the FP7 & H2020 sample mean. We provide some potential explanations of the unequal distribution of funding: (i) over-representation of male scholars in cancer research in Europe, who are less likely to work on female-dominated cancers; (ii) gender bias against women in the allocation of funds, who are more likely to lead female-dominated cancer projects; (iii) higher share of male members in the evaluation panel favors male-dominated cancer projects; and (iv) higher amount of resources devoted to male-dominated cancers due to their higher mortality.

JEL CODES: I10, I14, I19

Keywords: Cancer Research, Funding, Gender

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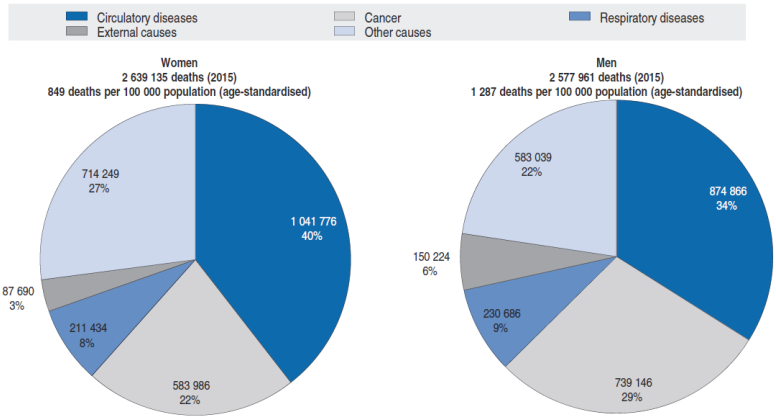
1 Introduction

Cancer is one of the most serious health problems around the world. According to the World Health Organization, cancer is a leading cause of death worldwide with approximately 10 million deaths in 2020 (World Health Organization, 2021). Due to its relevance, in the last few decades, cancer research has received increased attention from both national and international funding bodies. Many leading funding bodies have increased the number and size of cancer research projects granted over time. Schmutz et al. (2019) report that cancer research funding is distributed across 107 countries with 44% in the United States, 21% in Europe and 16% in Asia, and the total number of funding sources has more than doubled since 2008.

However, the literature on cancer research funding reports the existence of a mismatch between the societal burden of cancer types and the distribution of research funding to specific projects. For instance, Kamath et al. (2019) report that non-profit organizations' funding by cancer type is misaligned with the societal burden of cancer. In an earlier study, Begum et al. (2018) document a sizeable mismatch between funding levels and the societal and economic burdens of cancer types in Europe. Using data from Web of Science (WoS) during the period of 2002-2013, they show that some cancer types are over-funded, such as breast cancer and blood cancer, while others, including pancreatic and oesophageal cancers, appear to be underfunded. Evidence of funding discrepancies is also found in other parts of the world; for example, Carter and Nguyen (2012) present findings from the United States, and Coronado et al. (2018) discuss similar issues in Canada.

Furthermore, the literature has paid little attention to the allocation of cancer research resources through the lens of sex-dominance in cancer types. To the extent of our knowledge, there are only two articles that report funding disparities against female cancers. Begum et al. (2018) show that several female-specific cancers, including ovarian, cervical, uterine, and vulvar cancers, are underfunded and under-researched relative to their disease burden in Europe. Additionally, Spencer et al. (2019) document that funding disparities exist in the allocation of resources, particularly in funding for lethality scores for gynecologic cancers, which are significantly lower than for other cancer types in the United States. In this paper, we aim to fill that gap in the related literature by investigating whether projects focusing on female-dominated cancers receive less funding than those focusing on male-dominated

cancers in Europe.[1, 2]



Note: External causes of death include accidents, suicides, homicides and other causes.
Source: Eurostat Database.

Figure 1. Main Causes of Mortality Among Women And Men in EU Countries, 2015

We select Europe as the focus of our study because, despite comprising only 9% of the global population, it bears a significant burden of cancer, accounting for one-fourth of global cases (Ferlay et al., 2018). Cancer is a major health concern on the continent, ranking as the second leading cause of death and morbidity after cardiovascular diseases (Joint Research Centre, ECIS – European Cancer Information System,, 2020). Figure 1 illustrates the leading causes of mortality among men and women in Europe in 2015, with cancer contributing to 29% of male deaths and 22% of female deaths. Specifically, cancer ranks as the second leading cause of death among men and the third among women. Figure 2 depicts gender disparities in cancer mortality rates across different cancer types in Europe. These variations in mortality rates by gender provide an opportunity to explore the allocation of cancer research funding through the lens of gender-specific cancer types.

To address our research question, we use two novel owned-collected datasets comprised of projects related to cancer research and innovation. These datasets include projects awarded by the European Research Council (ERC) from 2007 to 2020, and those awarded by the European Commission under the Seventh Framework Programme (FP7) from 2007 to 2013, as well as the Horizon 2020 (H2020) Framework

[1]Female-dominated cancer are cancer types that their number of male deaths is less than or equivalent to that of female deaths.

[2]Male-dominated cancers are cancer types that their number of male deaths is more than that of female deaths.

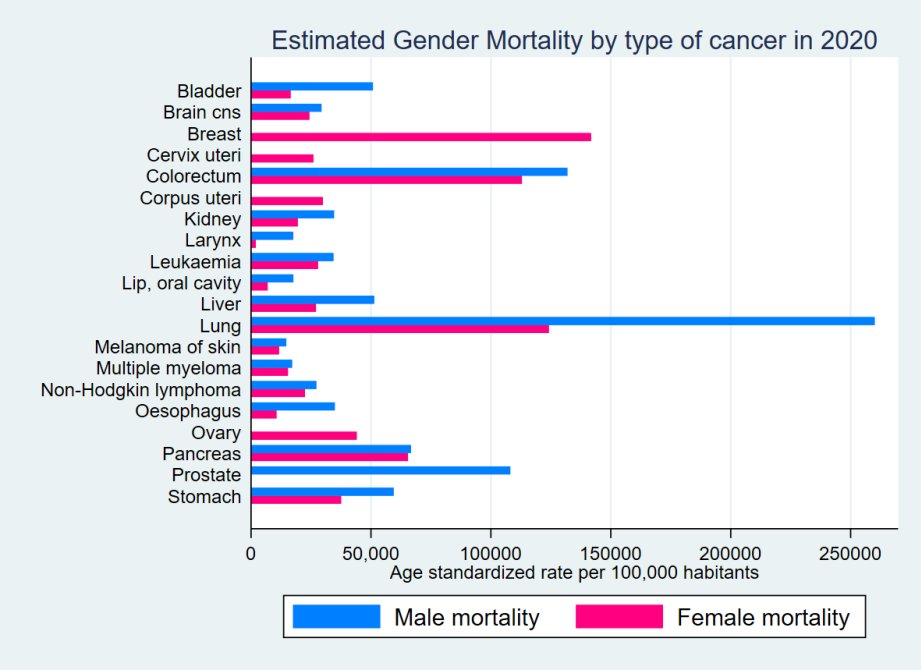


Figure 2. Estimated Mortality by Cancer in 2020 - Comparison by Sex

Source: European Cancer Information System

Programme from 2014 to 2020, excluding ERC's projects.[3] Our analysis reveals that a 10 percentage point increase in male relative mortality is statistically significant, associated with approximately a 0.3% increase in the awarded research fund in the ERC dataset and a 0.8% increase in the FP7 & H2020 dataset, respectively. This presents a 4,420 euro increase over the ERC sample mean and a 12,402 euro increase over the FP7 & H2020 sample mean.[4]

Furthermore, we offer potential explanations for the unequal distribution of funding. Firstly, the over-representation of male researchers, who are less likely to engage in research on female-dominated cancers, may result in fewer scholars working on projects related to these cancers, thereby leading to reduced funding allocation for them. Secondly, gender bias against women in fund allocation, as they are more inclined to conduct research on female-dominated cancers, likely contributes to the inadequate funding for these types of cancers. Notably, our analysis reveals suggestive evidence of funding bias in the FP7 & H2020 sample, wherein female researchers

[3]We choose the European Commission as the funding body because the European Commission provides grants to projects through open and competitive calls for proposals.

[4]Male relative mortality is measured by the ratio between male mortality and total mortality of each cancer type.

receive, on average, approximately 12% less funding than their male counterparts.

Thirdly, the gender composition of evaluation panels plays a crucial role in the allocation of grants for both female-dominated and male-dominated cancer projects. We find that a higher representation of male members on evaluation panels favors male-dominated cancer projects in the ERC sample. Lastly, disparities in mortality rates between female-dominated and male-dominated cancers may influence funding allocations. Our findings indicate that male-dominated cancers exhibit higher mortality rates than female-dominated cancers in Europe, potentially leading to a larger allocation of resources towards male-dominated cancers.

Our findings contribute to several strands of the research literature. First and foremost, we highlight the unequal distribution of cancer research funding through the perspective of sex-dominance in cancer types. While previous studies such as those by Begum et al. (2018) and Spencer et al. (2019), have addressed the under-funding of female-specific cancers, our study stands out as the first attempt to examine the relationship between competitive research funding and the male relative mortality of cancer types using novel and unique datasets.

Our second contribution is providing descriptive evidence of the glass ceiling faced by female researchers in science, particularly in health research. While existing literature has documented the under-representation of women in fields like radiation oncology (Jagsi and Tarbell, 2006) and academic surgery (Zhuge et al., 2011), limited evidence exists regarding gender inequality in cancer research. Our study reveals that male researchers are disproportionately represented in cancer research, particularly in top-ranking positions.

Furthermore, we contribute to the literature on gender disparities in grant and personnel award funding rates by examining gender differences in research fund allocation within a broader context. While most studies focus on the national level, we provide evidence at the regional level. Our findings align with those of several articles, including Raj et al. (2016), Zhou et al. (2018), Burns et al. (2019) and Oliveira et al. (2019).

Lastly, we present a novel finding concerning the decision-making process of evaluation panels regarding the gender aspect of cancer types. Existing literature has documented evidence indicating that the gender composition of scientific committees can influence their decision-making processes (Bagues et al., 2017; Hospido and Sanz, 2021). However, most studies have focused on decisions related to female and male candidates. To the best of our knowledge, our study provides the first evidence

demonstrating that a higher representation of male members on evaluation panels favors projects focusing on male-dominated cancers.

The remainder of the paper proceeds as follows. Section 2 provides a summary of data and method. We then present our empirical result in Section 3 and potential mechanisms in Section 4. Finally, Section 5 discusses and concludes.

2 Data and Method

2.1 Sample and Data Collection

We employ a purposive method to identify cancer-related projects funded by the European Research Council (ERC), the European Commission within the Seventh Framework Programme (FP7), and within the Horizon 2020 (H2020) Framework Programme. First, we conduct keyword searches for *cancer* on the official ERC website and within the Community Research and Development Information Service (CORDIS) database, encompassing all research projects funded under FP7 and H2020.[5] The search yields 1,231 projects from the ERC and 2,831 projects from FP7 and H2020 (excluding ERC projects) containing the term *cancer* in their abstracts. Subsequently, we screen the abstracts of these projects, selectively including only those with a primary focus on cancer research in our samples.[6]

Our ERC sample comprises 263 projects detailing cancer types, grant types, start and end dates, maximum funding, principal investigators, and their affiliated institutions. In comparison, the FP7 & H2020 sample consists of 714 projects providing information on cancer types, funding types, start and end dates, maximum European Commission (EC) contributions, and awarded institutions. To identify researchers (scientific coordinators or research fellows) in the FP7 & H2020 sample, we extract data from the acknowledgment sections of published journal articles associated with grant-funded projects. Researchers' gender in both samples is gathered from their personal webpages and other social media platforms such as LinkedIn and Twitter. Additionally, we collect data on researchers' quality, measured by the cumulative number of citations up to the year of the funding call, from the Scopus database. Our dataset covers the period from 2007 to 2020, with the year of each project identified as the year of its corresponding funding call.

[5]CORDIS database. https://erc.europa.eu/projects-figures/project-database

[6]The European Research Council operates within both the Seventh Framework Programme and the Horizon 2020 Framework Programme.

We access mortality data related to cancer through the official web-page of the European Cancer Information System (ECIS). This web-page compiles incidence and mortality data categorized by cancer type, gender, and age group from approximately 200 population-based cancer registries across most European countries, as well as data from the European Statistical Office (EUROSTAT) and the World Health Organization (WHO). It is important to note that ECIS provides historical data up to 2012 and estimates for 2020. For mortality data spanning from 2013 to 2019, we utilize the WHO mortality database.[7] Additionally, we collect information on evaluation panels for all projects in the ERC sample from the ERC website, where this data is publicly available. Subsequently, we identify the gender of evaluators through Google searches, their curriculum vitae, and personal web-pages.

2.2 Descriptive Statistics

In this study, we categorize the topics of granted projects into 11 cancer types, including blood cancer, brain cancer, pancreatic cancer, colorectal cancer, melanoma-skin cancer, lung cancer, liver and intrahepatic bile duct cancer, female breast cancer, prostate cancer, other and primary site unknown cancers, and mixed cancers, where the project focuses on more than one cancer type. Within the ERC sample, grants are divided into five types: Starting Grants, Advanced Grants, Consolidator Grants, Proof of Concept, and Synergy Grants. In contrast, the FP7 & H2020 sample includes eight main funding types: Small and medium collaborative projects (FP7 only), Research and Innovation (H2020 only), other collaborative projects (FP7 and H2020), Standard Marie Curie Postdoc (FP7 and H2020), Marie Curie-International dimension (FP7 and H2020), Marie Curie Reintegration or Career Restart (FP7 and H2020), SME Instrument 1 (H2020 only), and other SME funding (FP7 and H2020).[8] More details about grant types and action types are provided in Appendix A: Description of Grants. The key distinction between ERC Grant Types and FP7 & H2020 Funding Types is that ERC Grant Types specify maximum funding values and project durations for each grant type, while FP7 & H2020 funding types do not have such requirements. This dissimilarity prompts separate analysis of the two samples.

Tables 1 and 2 display descriptive statistics derived from our dataset. Notably,

[7]The WHO mortality database, https://platform.who.int/mortality

[8]The Horizon 2020 Framework Programme only retained four funding schemes from the Seventh Framework Programme including Future and Emerging Technologies (FET), European Research Council (ERC), Marie Curie and Infrastructures. Moreover, the European Commission imposed several modifications or changes of retained funding schemes.

significant disparities in research funding are evident across grant and funding types in both samples. The average project duration in the FP7 & H2020 sample is approximately half that of the ERC sample (2.75 versus 4.09 years), while the average male relative mortality rates are comparable between the two samples. Furthermore, the average research quality of scholars in the ERC sample markedly exceeds that of the H2020 sample (0.09 versus 0.02). This discrepancy can be attributed to the ERC's focus on supporting innovative, bottom-up research endeavors, solely evaluated based on the scientific excellence of the researchers and their proposals. Consequently, ERC recipients are typically esteemed researchers with outstanding research quality. Regarding gender diversity among researchers, the proportion of female researchers is relatively small in the ERC sample (0.22), similar to that observed in collaborative projects (Columns 2 to 4 in Table 2), but lower than that in Marie Curie funding schemes (Columns 5 to 7 in Table 2).

Table 1. Descriptive Statistics in the ERC Sample

	(1) Total Sample	(2) Starting Grant	(3) Advanced Grant	(4) Consolidator Grant	(5) Proof of Concept	(6) Synergy Grants
Research fund	1473.13	1508.11	2395.44	2024.50	149.42	9153.89
	(1128.3)	(294.1)	(316.9)	(183.4)	(2.010)	(1160.4)
Log (research fund)	6.82	7.30	7.77	7.61	5.01	9.12
	(1.183)	(0.159)	(0.150)	(0.0816)	(0.0138)	(0.127)
Project duration	4.09	5.16	5.10	5.13	1.49	5.50
	(1.692)	(0.424)	(0.403)	(0.306)	(0.223)	(0.707)
Female PI	0.22	0.23	0.18	0.24	0.24	0.38
	(0.416)	(0.426)	(0.385)	(0.431)	(0.428)	(0.530)
Male relative mortality (M=1)	0.48	0.51	0.45	0.43	0.49	0.55
	(0.287)	(0.273)	(0.282)	(0.328)	(0.284)	(0.00594)
Male relative mortality 2007 (M=1)	0.47	0.51	0.45	0.42	0.49	0.53
	(0.286)	(0.270)	(0.285)	(0.324)	(0.283)	(0.0240)
Cancer burden	5.51	5.24	6.46	4.82	5.44	4.58
	(4.606)	(4.189)	(5.358)	(2.909)	(5.164)	(2.617)
Number of citations	0.09	0.02	0.18	0.04	0.10	0.12
	(0.121)	(0.0142)	(0.137)	(0.0349)	(0.143)	(0.147)
Female share	0.34	0.32	0.29	0.30	0.42	0.29
	(0.0862)	(0.0771)	(0.0841)	(0.0648)	(0.0418)	(0.0240)
N	263	77	62	46	76	2

Note: The mean coefficients are presented with their standard deviation in parentheses. Male relative mortality is the ratio between male deaths and total deaths caused by a cancer type in a given year. Male relative mortality 2007 is the ratio between male deaths and total deaths caused by a cancer type in 2007. Cancer burden is the ratio between potential years of life lost due to cancer types in 2006 and 100,000. Table B1 in Appendix A: Description of Grants provides more details of variables in this study.

Table 2. Descriptive Statistics in the FP7 & H2020 Sample

	(1) Total Sample	(2) S&M CPs	(3) R&I	(4) Other CPs	(5) Std. MC	(6) MC Int. Dim.	(7) MC RI/CAR	(8) SME Inst. 1	(9) Other SME funds
Research fund	1550.25	4311.16	5591.24	4817.21	185.70	1256.68	124.53	50.00	2297.29
	(2451.7)	(1428.7)	(2301.8)	(4172.8)	(26.35)	(1514.0)	(54.66)	(0)	(839.6)
Log (research fund)	6.00	8.31	8.56	7.88	5.21	6.36	4.73	3.91	7.67
	(1.674)	(0.348)	(0.364)	(1.405)	(0.141)	(1.238)	(0.450)	(0)	(0.389)
Project duration	2.75	4.17	4.57	3.47	2.07	3.34	3.24	0.45	2.77
	(1.415)	(1.153)	(1.012)	(1.267)	(0.300)	(0.937)	(0.971)	(0.121)	(0.742)
Female PI	0.40	0.28	0.22	0.21	0.47	0.32	0.47	0.50	0.50
	(0.433)	(0.447)	(0.399)	(0.335)	(0.501)	(0.470)	(0.501)	(0)	(0)
Male relative mortality (M=1)	0.46	0.46	0.38	0.46	0.44	0.48	0.51	0.48	0.43
	(0.307)	(0.282)	(0.315)	(0.263)	(0.309)	(0.329)	(0.304)	(0.308)	(0.306)
Male relative mortality 2007 (M=1)	0.45	0.47	0.36	0.46	0.43	0.48	0.51	0.47	0.43
	(0.308)	(0.277)	(0.312)	(0.262)	(0.309)	(0.334)	(0.306)	(0.309)	(0.311)
Cancer burden	5.86	5.35	5.26	6.07	6.08	4.72	6.22	5.82	7.71
	(4.998)	(4.909)	(3.931)	(4.531)	(4.962)	(4.136)	(5.792)	(4.991)	(6.184)
Number of citations	0.02	0.05	0.06	0.05	0.00	0.02	0.01		
	(0.0487)	(0.0646)	(0.0735)	(0.0849)	(0.00369)	(0.0262)	(0.0186)		
N	714	63	68	41	218	85	113	86	40

Note: The mean coefficients are presented with their standard deviation in parentheses. Male relative mortality is the ratio between male deaths and total deaths caused by a cancer type in a given year. Male relative mortality 2007 is the ratio between male deaths and total deaths caused by a cancer type in 2007.Cancer burden is the ratio between potential years of life lost due to cancer types in 2006 and 100,000. Table B1 in 5 provides more details of variables in this study.

3 Empirical Model and Results

3.1 Empirical Model

Our objective is to examine the relationship between the maximum awarded research fund and male relative mortality, quantified by the ratio of male mortality to total mortality for a given cancer type. We employ a linear regression model incorporating fixed effects for grant type or funding type and a period dummy variable that takes the value of 1 if the project was granted after 2013, and 0 otherwise.[9] The descriptive statistics presented in Tables 1 and 2 reveal significant disparities in research funding across various grant and funding types. To achieve a more precise analysis, we define our outcome variable as the logarithm of the awarded research fund for each project. Our estimating equation is formulated as follows:

$$\begin{aligned} Y_{ict} = \alpha + \beta \times \text{Male relative mortality}_{ict} + \gamma \times X_{ict} \\ + \mu_i + \mathbb{1}_{\text{t} \geq 2014} + \mu_i \times \mathbb{1}_{\text{t} \geq 2014} + \epsilon_{ict} \end{aligned} \tag{1}$$

where Y_{ict} represents the logarithm of the research fund (in thousand euros) for project i awarded in year t that focuses on cancer type c. Male relative mortality$_{ict}$

[9]Note that the Horizon 2020 funding programme commenced in 2014, while the Seventh Framework Programme concluded in 2013. Therefore, we choose 2013 as the threshold year to distinguish between projects granted under the H2020 programme (coded as 1) and those granted under the FP7 framework (coded as 0) in the period dummy variable.

is the male relative mortality of the cancer type c in project i in year t, which is a continuous variable with the value ranging between 0 and 1. X_{ict} includes control variables: duration of project i awarded in year t with cancer type c; burden of cancer type c in project i in 2006, measured by potential years of life lost due to cancer.

μ_i represents the fixed effects of grant type or funding type for project i. We include grant type or funding type fixed effects to control for characteristics specific to ERC grant types or FP7 and H2020 funding types that may influence the awarded research fund. It is important to note that, in the ERC sample, projects from Synergy Grants are not included due to the limited number of observations, with only two projects identified. $\mathbb{1}_{t \geq 2014}$ is the period dummy that equals to 1 if the project was granted after 2013, and 0 otherwise. This indicator variable allows us to control for any differences that may influence the awarded research fund between the Seventh Framework Programme and the H2020 Framework Programme.[10]

Moreover, we include the interaction term between grant type or funding type fixed effects and the period dummy, which allows for the impact of grant type fixed effects or funding type fixed effects on the outcome variable to change over period. Finally, ϵ_{ict} is the error term, which we allow to be heteroscedastic and correlated across cancer types. In practice, we cluster the standard errors at the cancer type level. The coefficient β captures the association between maximum research fund and male relative mortality.

3.2 Main Results

Table 3 presents estimated results from equation 1 in the two samples. Panel A displays the findings for the ERC sample, while Panel B presents the results for the FP7 & H2020 sample. In column (1) of Panel A, the coefficient $\hat{\beta}$, which represents the percent change in the awarded research fund when male relative mortality increases by one unit, is positive but not statistically significant. However, after including the control variable *Cancer burden* in column (2), which measures the severity of cancer types, the estimated coefficient becomes positive and statistically significant at the 10% level (0.031).

[10]There are significant differences between the Seventh Framework Programme and the H2020 Framework Programme. H2020 introduced streamlined procedures for participation, evaluation, proposal, and project management compared to FP7. Furthermore, H2020 underwent significant restructuring, with parts of the former Cooperation Programme from FP7 now categorized under Industrial Leadership and Societal Challenges.

Table 3. Result of the Linear Regression Model in the ERC and the FP7 & H2020 Samples

	Dependent variable is Log(research fund)			
	(1)	(2)	(3)	(4)
Panel A: ERC sample				
Male relative mortality (M=1)	0.027	0.031**		
	(0.015)	(0.013)		
	[0.050]	[0.035]		
Male relative mortality 2007 (M=1)			0.032	0.036*
			(0.020)	(0.018)
			[0.047]	[0.031]
Cancer burden		0.001		0.001
		(0.001)		(0.001)
Grant type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Grant type FE × Period dummy	No	Yes	No	Yes
Mean Dep. Var.	*1473.13*	*1473.13*	*1473.13*	*1473.13*
Observations	261	261	261	261
Adjusted R^2	0.990	0.990	0.990	0.990
Panel B: FP7 & H2020 sample				
Male relative mortality (M=1)	0.109***	0.077***		
	(0.030)	(0.020)		
	[0.028]	[0.000]		
Male relative mortality 2007 (M=1)			0.125***	0.086***
			(0.038)	(0.021)
			[0.004]	[0.002]
Project duration		0.398***		0.397***
		(0.036)		(0.036)
Cancer burden		-0.002		-0.002
		(0.002)		(0.002)
Funding type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Funding type FE × Period dummy	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1550.25*	*1550.25*	*1550.25*	*1550.25*
Observations	714	711	714	711
Adjusted R^2	0.900	0.928	0.901	0.928

Notes: Standard errors, clustered at the cancer type level, are shown in parentheses. Research fund is the maximum awarded grant in the ERC sample and the maximum contribution of the EC in the FP7 & H2020 sample (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Columns (3) to (4) of Panel A replicate the regression analysis with *Male relative mortality 2007* as the variable of interest, yielding consistent results with the previous columns. The result indicates that 10 percentage point increase in male relative mortality is associated with approximately 0.3% increase in the awarded research fund, holding all other independent variables constant. This represents a 4,420 euro increase over the sample mean.

In column (1) of Panel B, the estimated coefficient $\hat{\beta}$ is positive and statistically significant at the 1% level (0.109) when considering only the variable of interest and funding type fixed effects. Adding more control variables in column (2) does not alter the sign or significance level of the estimated coefficient. Notably, most FP7 & H2020 funding types do not specifically impose a maximum project duration, as discussed in Subsection 2.2, hence we include the control variable *Project duration* in this column.

The result suggests that a 10 percentage point increase in male relative mortality is associated with approximately a 0.8% increase in the awarded research fund, holding all other independent variables constant. This represents a substantial increase of 12,402 euros over the sample mean. Furthermore, the result remains consistent when using *Male relative mortality 2007* as the variable of interest in columns (3) and (4).

Comparing the estimated coefficient in the FP7 & H2020 sample to that in the ERC sample, the magnitude in the FP7 & H2020 sample is larger. However, both estimates are positive and statistically significant, supporting the hypothesis that higher male relative mortality is associated with higher grant amounts, or conversely, that female-dominated cancers are underfunded.[11]

3.3 Robustness

In this subsection, we conduct several robustness checks. Table 4 includes an additional control variable, *Incidence 2007*, in the regression to address potential concerns that *Cancer burden* may not fully capture the severity of all cancer types. *Incidence 2007* refers to the count of newly diagnosed cases (in hundred thousands) categorized by cancer type in the year 2007.[12] Panel A presents results for the ERC sample, while Panel B shows findings for the H2020 sample. In columns (1) and (2) of Panel A, the magnitudes of the estimated coefficients (0.033 and 0.038) are very similar to those in Panel A of Table 3. Similarly, when considering the FP7 & H2020 sample in Panel

[11] The result remains when we exclude the interaction term between grant type/funding type fixed effects and period dummy.

[12] The selection of the incidence data from 2007 corresponds to the commencement of the coverage period in both samples.

B, we obtain results consistent with the positive association between male mortality rate and awarded research fund observed in Panel B of Table 3.

Table 4. Robustness Check in the ERC and the FP7 & H2020 Samples

	Dependent variable is Log(research fund)	
	(1)	(2)
Panel A: ERC sample		
Male relative mortality (M=1)	0.033**	
	(0.012)	
	[0.034]	
Male relative mortality 2007 (M=1)		0.038**
		(0.017)
		[0.024]
Cancer burden	0.001	0.000
	(0.001)	(0.001)
Incidence 2007	0.004	0.005
	(0.004)	(0.004)
Grant type FE	Yes	Yes
Period dummy	Yes	Yes
Grant type FE × Period dummy	Yes	Yes
Mean Dep. Var.	*1473.13*	*1473.13*
Observations	261	261
Adjusted R^2	0.990	0.990
Panel B: FP7 & H2020 sample		
Male relative mortality (M=1)	0.068***	
	(0.008)	
	[0.002]	
Male relative mortality 2007 (M=1)		0.078***
		(0.010)
		[0.000]
Project duration	0.398***	0.397***
	(0.036)	(0.036)
Cancer burden	-0.000	-0.000
	(0.003)	(0.003)
Incidence 2007	-0.019	-0.018
	(0.020)	(0.020)
Funding type FE	Yes	Yes
Period dummy	Yes	Yes
Funding type FE × Period dummy	Yes	Yes
Mean Dep. Var.	*1550.25*	*1550.25*
Observations	711	711
Adjusted R^2	0.928	0.928

Notes: Standard errors, clustered at the cancer type level are shown in parentheses. Research fund is the maximum awarded grant in the ERC sample and the maximum contribution of the EC in the FP7 & H2020 sample (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Incidence 2007 is the number of new cases by cancer type in 2007 (in hundred thousands). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

In Table 5, we employ a different dependent variable, *Project cost*, to assess the robustness of the main results in the FP7 & H2020 sample. It is important to note that *Project cost* includes contributions from both the European Commission and other funding bodies.

Columns (1) to (3) in Table 5 show that when our variable of interest is *Male relative mortality*, the results indicate a positive correlation between male relative mortality and project cost. On average, a 10 percentage point increase in male relative mortality is associated with approximately a 10% increase in project cost, representing an 18,498 euro increase over the sample mean. This finding remains consistent when using *Male relative mortality 2007* as the variable of interest in columns (4) to (6).

Table 5. Result of the Linear Regression Model with Another Dependent Variable - Log(project cost)

	Dependent variable is Log(project cost)					
	(1)	(2)	(3)	(4)	(5)	(6)
Male relative mortality (M=1)	0.131***	0.097***	0.092***			
	(0.032)	(0.017)	(0.015)			
	[0.055]	[0.009]	[0.032]			
Male relative mortality 2007 (M=1)				0.147***	0.107***	0.102***
				(0.037)	(0.018)	(0.015)
				[0.033]	[0.001]	[0.019]
Project duration		0.393***	0.393***		0.392***	0.392***
		(0.035)	(0.035)		(0.035)	(0.035)
Cancer burden		-0.002	-0.001		-0.002	-0.001
		(0.002)	(0.003)		(0.002)	(0.003)
Incidence 2007			-0.012			-0.011
			(0.019)			(0.019)
Funding type FE	Yes	Yes	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes	Yes	Yes
Funding type FE × Period dummy	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1849.82*	*1849.82*	*1849.82*	*1849.82*	*1849.82*	*1849.82*
Observations	706	703	703	706	703	703
Adjusted R^2	0.903	0.929	0.929	0.903	0.929	0.929

Notes: Standard errors, clustered at the cancer type level, are shown in parentheses. Project cost contains both fund contribution from the European Commission and from other funding agencies (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Incidence 2007 is the number of new cases by cancer type in 2007 (in hundred thousands). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6 displays the results of the linear regression model when we integrate both samples. In column (1), when we include only funding type or grant type fixed effects, period dummy, and their interaction terms, the estimated coefficient β is positive and statistically significant at the 1% level (0.089). Upon including additional control variables in column (2), the magnitude of the estimated coefficient for *Male relative mortality* changes, but maintains its positive sign and significance level (0.053). The result remains stable when we use *Male relative mortality 2007* as the variable of interest in columns (3) and (4). Further robustness checks with time trend (Table B3) and Tobit model with the ERC sample (Table B4) in Appendix B: Additional Tables yield consistent findings, affirming the positive association between awarded research fund and male relative mortality.

Table 6. Results of Linear Regression Model with the Integrated Sample

	Dependent variable is Log(research fund)			
	(1)	(2)	(3)	(4)
Male relative mortality (M=1)	0.089***	0.053***		
	(0.022)	(0.008)		
	[0.016]	[0.008]		
Male relative mortality 2007 (M=1)			0.103***	0.062***
			(0.031)	(0.016)
			[0.000]	[0.010]
Cancer burden		0.000		0.000
		(0.002)		(0.002)
Project duration		0.368***		0.368***
		(0.036)		(0.036)
Incidence 2007		-0.011		-0.010
		(0.015)		(0.015)
Funding/Grant type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Funding/Grant type FE × Period dummy	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1529.48*	*1529.48*	*1529.48*	*1529.48*
Observations	975	972	975	972
Adjusted R^2	0.918	0.939	0.918	0.939

Notes: Standard errors, clustered at the cancer type level, are shown in parentheses. Research fund is the maximum awarded grant in the ERC sample and the maximum contribution of the EC in the FP7 & H2020 sample (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Incidence 2007 is the number of new cases by cancer type in 2007 (in hundred thousands). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

4 Mechanisms

The results presented in this paper are consistent with the hypothesis that female-dominated cancers are underfunded in Europe. In this section, we provide some potential explanations for the unequal distribution of funding.

4.1 Over-representation of Men in Cancer Research in Europe

Our analysis of two samples reveals that 27.6% of male researchers work on female-dominated cancer projects, while 72.4% of them focus on male-dominated cancer projects. This indicates a tendency for male researchers to prioritize cancer types associated with their gender. Therefore, if men are over-represented in cancer research, there may be fewer researchers dedicated to female-dominated cancers compared to male-dominated cancers. This imbalance could potentially result in fewer projects and less funding allocated to female-dominated cancers.

To test this hypothesis, we compile a list of cancer research scholars, who have registered on the online platform Publons, from 27 European Union (EU) countries up to November 2021, as well as from the United Kingdom, Switzerland, Norway, and several other nations.[13] We include some countries outside the European Union since EU grants are open to researchers in the host institution not only from an EU Member State, but also from associated countries. Publons provides us with the names of researchers and their affiliations. We then gather information on their gender, citation count, h-index (or Hirsch index), and research fields through Google search, Scopus, and their peer-reviewed publications.[14] Our final list comprises 927 cancer researchers, with 559 male scholars and 368 female scholars, resulting in an overall male percentage of 60.3%.

Figure 3 presents the structure of the list of cancer researchers in Europe. Out of 927 researchers, there are 251 researchers (equivalent to 27% of total cancer researchers) that do not work on any specific cancer type. Those researchers mainly focus on cell biology, deoxyribonucleic acid (DNA) repairs and general cancer treatment, such as chemotherapy, radiation or immunotherapy. Out of 676 researchers

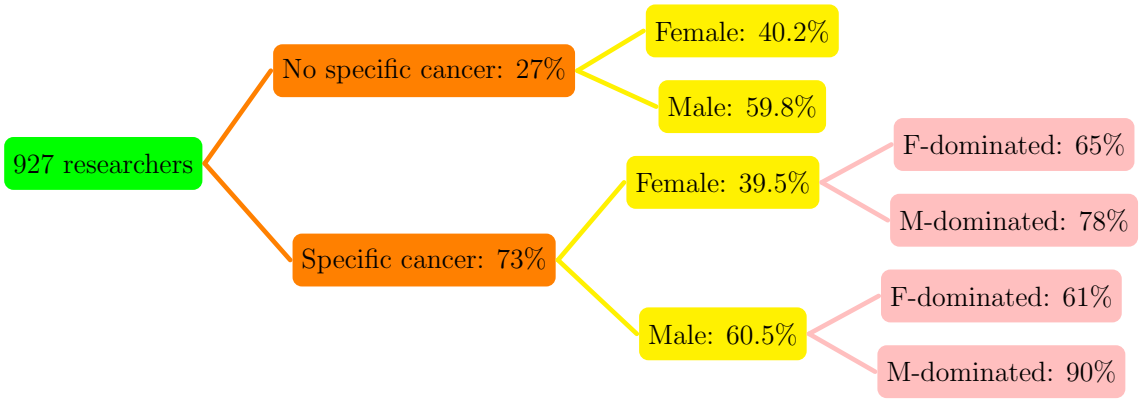
[13]Publons, owned by Clarivate, is a platform that enables researchers to track, verify, and showcase their peer review and editorial contributions for academic journals. With a user base exceeding 3,000,000 researchers across various fields of research, the platform serves as a valuable resource for scholarly communication.

[14]The h-index or Hirsch index is the highest number of publications of a researcher that received h or more citations each while the other publications have not more than h citations each.This metric represents both the productivity and the impact of a researcher.

(equivalent to 73% of total cancer researchers) that work on specific cancer types, there are 267 female researchers (39.5%) and 409 male researchers (60.5%).

In terms of their research interest on female- or male-dominated cancers, 65% of female and 61% of male researchers focus on female-dominated cancers, while 78% of female and 90% of male researchers study male-dominated cancers. The list shows that male researchers predominantly focus on male-dominated cancers and more so than their female counterparts. Interestingly, female researchers are inclined to study male-dominated cancers, but are more likely than their male colleagues to work on female-dominated cancers.

Figure 3. Structure of the List of Cancer Researchers in Europe

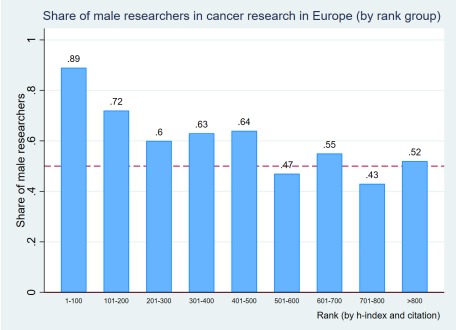


Next, we show that male researchers are over-represented in cancer research in Europe, especially in the top ranks. From the list of scholars that we gather from Publons, we rank researchers by their h-index, and if several scholars have the same h-index, we use the number of their citations as the second criterion. Figure 4 illustrates the prevalence of male researchers across various rank groups in European cancer research.

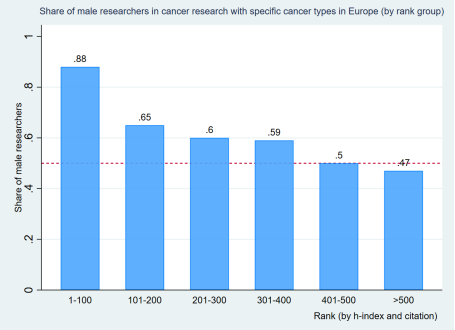
In Panel (a), encompassing all cancer research, it is evident that in the top 100 researchers, 89% are male. This over-representation persists in subsequent rank groups, with 72%, 60%, 63%, and 64% of researchers in the 101st to 200th, 201st to 300th, 301st to 400th, and 401st to 500th positions being male, respectively. Panel (b) focuses specifically on the 676 researchers conducting research in particular cancer types, revealing a consistent pattern similar to Panel (a). Male researchers continue to dominate in numbers among the top 100 researchers and remain over-represented even up to the 301st to 400th rank group.

Figure 4. Share of Male Researchers in Cancer Research in Europe

(a) Share of male researchers in all cancer research



(b) Share of male researchers in specific cancer type research



4.2 Funding Bias against Female Researchers

In this subsection, we explore the next potential explanation that might be behind the main results. Our hypothesis is that female-dominated cancers are underfunded due to funding bias against female researchers. Subsection 4.1 presents suggestive evidence indicating that female researchers are more inclined to focus on female-dominated cancers compared to their male counterparts. This tendency may contribute to their higher likelihood of leading projects related to female-dominated cancers. Our data also supports this argument since in the two samples, there is 35.6% of female researchers and 27.6% of male researchers that lead female-dominated cancer projects.

Moreover, the related literature reports evidence of gender gaps in grant and personnel award funding rates, such as: Raj et al. (2016), Zhou et al. (2018), Burns et al. (2019) and Oliveira et al. (2019). Therefore, if female researchers receive less funding than their male counterparts, there will be less granted money for female-dominated cancers. We then test our hypothesis in both samples by adding the variable *Female* PI_i, which represents the ratio of female investigators to the total number of investigators in project i, to equation 1.

Table 7 presents the findings from our two samples. In Panel A, columns (1) and (3) display the results from the ERC sample. The coefficients associated with *Female* PI_i are negative in these columns, but they are not statistically significant when we use both *Male relative mortality* and *Male relative mortality 2007*. We then introduce *Citation* in columns (2) and (4) because, in addition to gender, female and male researchers might differ in research quality. However, the results remain unchanged. We find no evidence of funding bias against female researchers in the ERC sample, as

the estimated coefficients $\hat{\beta}$ remain very stable across all specifications, approximately around 0.03 as the baseline result. The lack of evidence regarding the gender gap in granting may be explained by the fact that in the ERC sample, we can only observe granted projects, and the maximum awarded fund is very similar across projects within the same grant type.

In Panel B of Table 7, we present the regression results for the FP7 & H2020 sample. In columns (1) and (2), the coefficients of *Female PI* $_i$ are negative, significant at the 1% level, and similar in magnitude. This result indicates that, on average, female researchers receive 12% less funding than their male counterparts. We do not include the control variable *Citation* in this Panel since the FP7 & H2020 sample contains not only individual investigators but also enterprises.

4.3 Impact of the Evaluation Panel's Gender Composition on Awarding Grants

This subsection investigates the impact of the gender composition of evaluation panels on the awarding of grants for female-dominated and male-dominated cancers. The related literature documents evidence that the gender composition of scientific committees can influence committee decision-making (Bagues et al., 2017; Hospido and Sanz, 2021). However, most studies focus on decisions regarding female and male candidates. We contribute to the existing literature by examining evaluation panels' decisions regarding the gender aspects of research topics. We gather information on scientific committees in the ERC sample due to data availability.

Figure 5 illustrates the share of female evaluators in committees across four ERC grant types since 2007. This ratio is calculated based on the composition of evaluation panels corresponding to granted projects in our ERC sample. In general, there is an upward trend in the share of female members in evaluation panels across all grant types, although the female share has never exceeded 50%. The increase in the female share of evaluation panels over the years can be attributed to the integrated approach to research and innovation in the Horizon 2020 Framework Programme. Specifically, between 2014 and 2020, the European Union's strategy on gender equality aimed to ensure gender balance in decision-making, with a target of 40% representation of the under-represented sex in panels.

Table 7. Do Female Researchers Receive Less Funding?

	Dependent variable is Log(research fund)			
	(1)	(2)	(3)	(4)
Panel A: ERC sample				
Male relative mortality (M=1)	0.033**	0.032**		
	(0.012)	(0.015)		
	[0.031]	[0.074]		
Male relative mortality 2007 (M=1)			0.038*	0.037*
			(0.017)	(0.020)
			[0.039]	[0.078]
Female PI	-0.005	-0.006	-0.005	-0.005
	(0.015)	(0.016)	(0.015)	(0.016)
	[0.698]	[0.699]	[0.700]	[0.707]
Citation		-0.009		-0.007
		(0.069)		(0.070)
Other controls	Yes	Yes	Yes	Yes
Grant type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Grant type FE × Period dummy	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1473.13*	*1473.13*	*1473.13*	*1473.13*
Observations	261	261	261	261
Adjusted R^2	0.990	0.990	0.990	0.990
Panel B: FP7 & H2020 sample				
Male relative mortality (M=1)	0.043***			
	(0.007)			
	[0.000]			
Male relative mortality 2007 (M=1)		0.053**		
		(0.017)		
		[0.000]		
Female PI	-0.122***	-0.121***		
	(0.037)	(0.037)		
	[0.007]	[0.005]		
Other controls	Yes	Yes		
Funding type FE	Yes	Yes		
Period dummy	Yes	Yes		
Funding type FE × Period dummy	Yes	Yes		
Mean Dep. Var.	*1550.25*	*1550.25*		
Observations	669	669		
Adjusted R^2	0.930	0.930		

Notes: Standard errors clustered at the cancer type level in parentheses. Female PI is the ratio between the number of female principal investigators/scientific coordinators/fellows and the total number of principal investigators/scientific coordinators/fellows in one project. Citation is the ratio between the researcher's cumulative citations (until the year that they applied for the grant) and 100,000. The definition of other variables is as in previous tables. Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

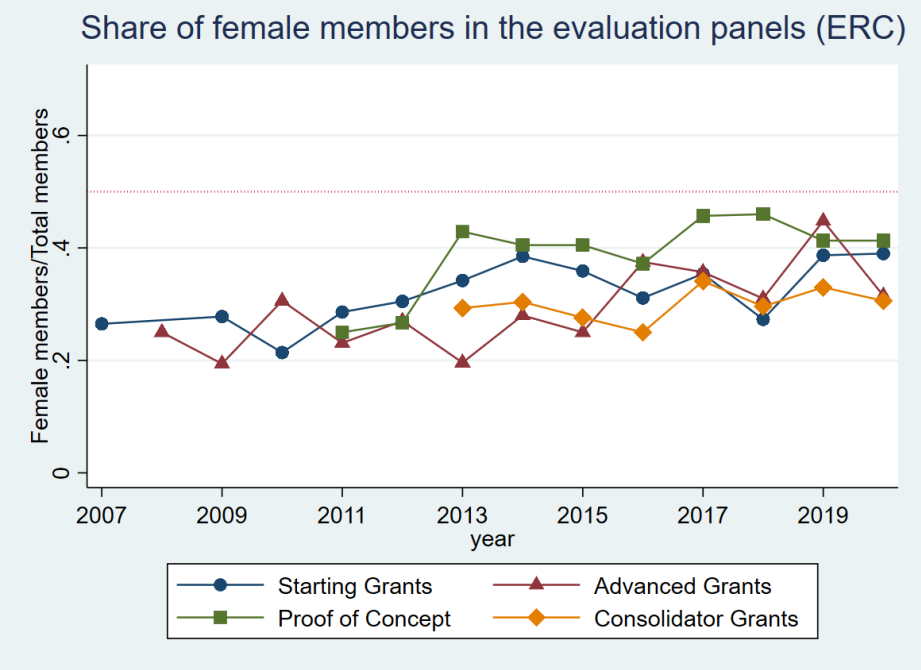


Figure 5. Gender Composition in the Evaluation Panels (ERC)

Next, we merge the data on the share of female members in the evaluation panels into the ERC sample. To facilitate interpretation of the results, we introduce two new variables of interest: *Dummy male relative mortality* and *Dummy male relative mortality 2007* ($D_{ict/2007}$). These dummy variables are defined as follows:

$$D_{ict/2007} = \begin{cases} 1 & \text{if male relative mortality of cancer type } c \\ & \text{in project } i \text{ in year } t \text{ or year } 2007 > 0.5 \\ 0 & \text{otherwise} \end{cases}$$

In Table 8, we present the results of regressing our dependent variable on several variables of interest, including *Male relative mortality*, *Male relative mortality 2007*, *Dummy male relative mortality* and *Dummy male relative mortality 2007*. We also include *Female share*$_i$, which is the share of female members on the evaluation panel for examining project i, correspondent interaction terms, some control variables, and grant type fixed effects.

Columns (1) and (2) present results when we use *Dummy male relative mortality* and *Dummy male relative mortality 2007* as the variables of interest. Row (1) of column (1) and and row (2) of column (2) indicate that male-dominated cancers receive around 13% more funding than female-dominated cancers when there is no female

evaluator in the panel, holding other variables constant. Row (5) of the corresponding columns shows that when the project focuses only on female-dominated cancers, there is a positive association between the share of female evaluators and awarded research funding, albeit not significant.

Table 8. Does Gender Composition of the Evaluation Panels Matter?

	Dependent variable is Log (research fund)			
	(1)	(2)	(3)	(4)
Dummy male relative mortality (M=1)	0.131*			
	(0.063)			
	[0.041]			
Dummy male relative mortality 2007 (M=1)		0.145*		
		(0.073)		
		[0.042]		
Male relative mortality (M=1)			0.182*	
			(0.090)	
			[0.055]	
Male relative mortality 2007 (M=1)				0.203*
				(0.111)
				[0.042]
Female share	0.221	0.236	0.206	0.235
	(0.229)	(0.244)	(0.236)	(0.264)
Dummy male relative mortality × Female share	-0.333*			
	(0.164)			
	[0.025]			
Dummy male relative mortality 2007 × Female share		-0.352*		
		(0.181)		
		[0.025]		
Male relative mortality × Female share			-0.451*	
			(0.222)	
			[0.065]	
Male relative mortality 2007 × Female share				-0.500*
				(0.267)
				[0.056]
Controls	Yes	Yes	Yes	Yes
Grant type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Grant type FE × Period dummy	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1550.25*	*1550.25*	*1550.25*	*1550.25*
Observations	261	261	261	261
Adjusted R^2	0.990	0.990	0.990	0.990

Notes: Standard errors clustered at the cancer type level in parentheses. Dummy male relative mortality equals 1 if the cancer is male-dominated, and 0 otherwise. Dummy male relative mortality 2007 equals 1 if the cancer is male-dominated in 2007, and 0 otherwise. The definition of other variables is as in previous tables. Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Furthermore, the negative and significant estimated coefficients in row (6) of column (1) (-0.333) and row (7) of column (2) (-0.352) imply that when the female share

in the evaluation panel increases, the funding bias toward male-dominated cancers reduces. The result remains unchanged in columns (3) and (4) when we use the continuous variable *Male relative mortality*, *Male relative mortality 2007* as the variables of interest. In principle, the result suggests that when there are more female evaluators in the evaluation panel, there is less funding bias toward male-dominated cancer projects.

4.4 Differences in Mortality between Female-dominated Cancers and Male-dominated Cancers

One important feature of cancer is its differential impact on men and women due to biological differences, such as sex hormones (Folkerd and Dowsett, 2010), and behavioral factors (Dong et al., 2020). Additionally, Dong et al. (2020) report that males generally exhibit lower overall survival rates than females. This evidence suggests a potential explanation for our study. We hypothesize that male-dominated cancers have higher mortality rates compared to female-dominated cancers, leading to a larger allocation of resources. To test this hypothesis, we analyze mortality data by cancer type and gender in 2007.

Figure 6 depicts the relative mortality of each cancer type against male relative mortality. The relative mortality of each cancer type on the vertical axis represents its contribution to overall cancer-related deaths, measured in percentage. Female-dominated cancers are represented by pink dots, male-dominated cancers by blue dots, and gender-balanced cancers by purple dots. It is important to note that this graph only includes cancers from our ERC and H2020 samples.

All female-dominated cancers, except female breast cancer, account for less than or equal to 5% of total deaths, while four male-dominated cancers (lung cancer, colorectal cancer, stomach cancer, and prostate cancer) each contribute to more than 5% of total deaths. Notably, lung cancer alone causes approximately 25% of total deaths, followed by colorectal cancer (9.1%), stomach cancer (6.6%), and prostate cancer (6.3%). The fitted regression line demonstrates a positive relationship between male relative mortality and the relative mortality of each cancer type, indicating that cancers with higher male relative mortality contribute more to total deaths caused by all cancers. These statistics confirm our hypothesis regarding differences in mortality between male-dominated and female-dominated cancers, which may consequently affect the allocation of funding.

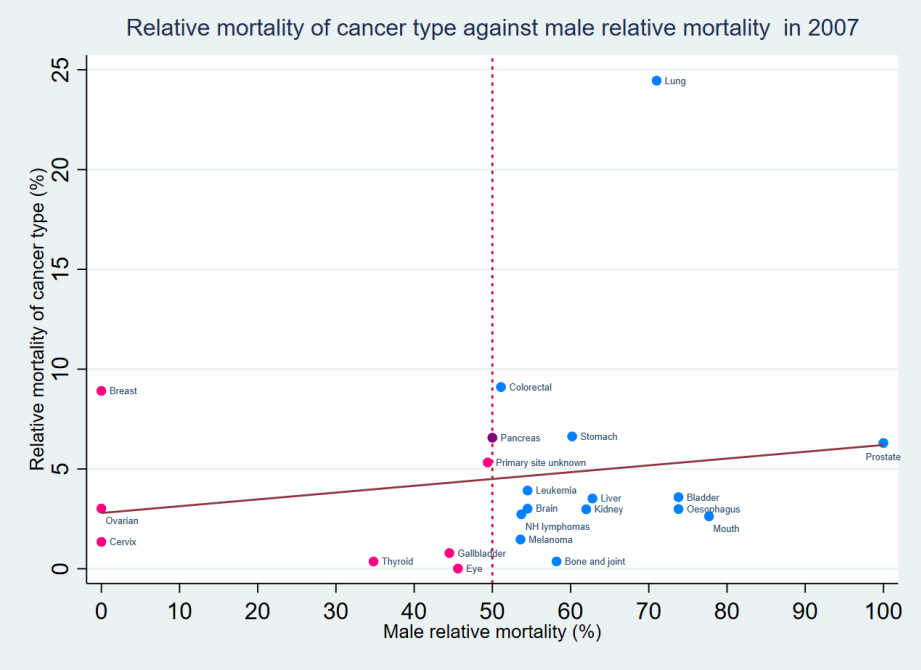


Figure 6. Relative Mortality of Cancer Type against Male Relative Mortality in 2007

5 Discussion and Conclusion

In this paper, we have presented novel evidence on the underfunded situation of female-dominated cancers in Europe. The data used in this paper are collected from the European Research Council and two European Framework Programmes for Research and Innovation. The utilization of granted projects through open and competitive calls for proposals provides a powerful tool to reduce selection bias in the sample.

The main finding of this study is as follows. First, we document that female-dominated cancers are underfunded in Europe. Our analysis reveals that a 10 percentage point increase in male relative mortality is statistically significant, associated with approximately a 0.3% increase in awarded research funding in the ERC dataset and a 0.8% increase in the FP7 & H2020 dataset. This corresponds to a 4,420 euro increase over the ERC sample mean and a 12,402 euro increase over the FP7 & H2020 sample mean.

Second, we provide four potential mechanisms behind the main results. Initially, by constructing a list of cancer researchers in Europe, we demonstrate that male scholars are over-represented, especially in the top ranks. This over-representation

implies fewer researchers conducting research in female-dominated cancers compared to male-dominated cancers, potentially resulting in fewer projects and less funding for female-dominated cancers. The next explanation is funding bias against female researchers, as they are more likely to work on female-dominated cancers. In the FP7 & H2020 sample, we find that, on average, female researchers receive 12% less funding than their male colleagues, contributing to the lack of funding for female-dominated cancers. The third mechanism involves the impact of the gender composition of evaluation panels. We show that in the ERC sample, a higher share of male panel members favors male-dominated cancer projects. The fourth and final explanation is that male-dominated cancers have higher mortality rates than female-dominated cancers, leading to a larger allocation of resources.

In conclusion, the insights provided by this study into the unequal distribution of cancer research funding based on sex-dominance in cancer types hold significant implications for policymakers in Europe. The mechanisms of over-representation of male scholars in cancer research and the impact of gender composition in evaluation panels highlight the need for targeted interventions to address the underfunding of female-dominated cancers. Specific strategies, such as providing incentives to support female cancer researchers and promoting gender diversity in evaluation panels, are crucial steps towards achieving equitable funding allocation. As cancer remains a significant global health concern impacting individuals of all ages and regions, ensuring equitable distribution of resources towards sex-dominated cancers is of paramount importance. By prioritizing this objective, policymakers can enhance outcomes for those affected by cancer and contribute to collective efforts aimed at fighting against this disease.

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Appendix A: Description of Grants

European Research Council (ERC) grant types:[15]

1. **Starting grants**: Researchers of any nationality with 2-7 years of experience since completion of PhD. Starting Grants may be awarded up to **€1.5 million** for a period of 5 years. (pro rata for projects of shorter duration). However, an additional **€1 million** can be made available to cover eligible "start-up" costs for researchers moving from a third country to the EU or an associated country and/or the purchase of major equipment and/or access to large facilities and/or other major experimental and field work costs.

2. **Advanced Grants**: Applicants for the ERC Advanced Grants - called Principal Investigators (PI) - are expected to be active researchers who have a track-record of significant research achievements in the last 10 years. The Principal Investigators should be exceptional leaders in terms of originality and significance of their research contributions. No specific eligibility criteria with respect to the academic requirements are foreseen. Advanced Grants may be awarded up to **€2.5 million** for a period of 5 years. (pro rata for projects of shorter duration). However, an additional **€1 million** can be made available to cover eligible "start-up" costs for researchers moving from a third country to the EU or an associated country and/or the purchase of major equipment and/or access to large facilities and/or other major experimental and field work costs.

3. **Consolidator Grants**: Researchers of any nationality with 7-12 years of experience since completion of PhD. Consolidator Grants may be awarded up to **€2 million** for a period of 5 years. (pro rata for projects of shorter duration). However, an additional **€1 million** can be made available to cover eligible "start-up" costs for researchers moving from a third country to the EU or an associated country and/or the purchase of major equipment and/or access to large facilities and/or other major experimental and field work costs.

4. **Proof of concept**: All Principal Investigators in an ERC frontier research project, that is either on going or has ended less than 12 months before 1 January 2020, are eligible to participate and apply for an ERC Proof of Concept Grant. The Principal Investigator must be able to demonstrate the relation between

[15] European Research Council, "Homepage," European Research Council, accessed March 21, 2021, https://erc.europa.eu/

the idea to be taken to proof of concept and the ERC frontier research project (Starting, Consolidator, Advanced or Synergy) in question. Work Programme 2020 will continue to pilot the award of Proof of Concept grants on the basis of a lump sum of **€150 000**. The ERC has started piloting the use of Lump Sums for the ERC-2019-PoC call, as a simplified funding mode for PoC. This will test efficiency and viability of such funding method compared to the current funding mode which is based on the declaration of actual costs.: The financial contribution will be awarded as a lump sum of **€150 000** for a period of 18 months.

5. **Synergy Grants**: A group of two to maximum four Principal Investigators (PIs) – of which one will be designated as the correspondent PI (cPI) – working together and bringing different skills and resources to tackle ambitious research problems. No specific eligibility criteria regarding the academic training are foreseen for ERC Synergy Grants. PIs must present an early achievement track-record or a ten-year track-record, whichever is most appropriate.Synergy Grants can be up to a maximum of **€10 million** for a period of 6 years (pro rata for projects of shorter duration). However an addition **€4 million** can be requested in the proposal in total to cover: i) eligible 'start-up' costs for Principal Investigators moving to the EU or an Associated Country from elsewhere as a consequence of receiving an ERC grant and/or; (ii) the purchase of major equipment and/or; (iii) access to large facilities.

The different funding types funded under the FP7 and Horizon 2020 framework programs: [16, 17]

1. **Collaborative projects (FP7)**: support should be provided for transnational cooperation at an appropriate scale across the Union and beyond, in a number of thematic areas correspondent to major fields of the progress of knowledge and technology, where research should be supported and strengthened to address European social, economic, environmental, public health and industrial challenges, serve the public and support developing countries. The maximum rates of the financial contribution of the European Union: 75% for reach and techno-

[16] European Commission, "CORDIS - Community Research and Development Information Service," accessed June 20, 2021, http://cordis.europa.eu/fp7/dc/index.cfm.

[17] European Commission, "Horizon 2020 Online Manual," accessed July 21, 2021, https://ec.europa.eu/research/participants/docs/h2020-funding-guide.

logical development activities, 50% for demonstration activities, and 100% for other activities.

2. **Marie Curie actions (FP7)**: individuals should be stimulated to enter the research profession, European researchers should be encouraged to stay in Europe, researchers from the entire world should be attracted to Europe, and Europe should be made more attractive to the best researchers. The European Union covers up to 100% of the budget of the action.

3. **The Capacities programme (FP7)**: support the use and development of research infrastructures; innovative capacities of SMEs and their ability to benefit from research; the development of regional research-driven clusters; the research potential in the Union's convergence and outermost regions; bringing science and society together in European society; the coherent development of research policies at national and Community level; horizontal actions and measures in support of international cooperation.

4. **Research and innovation actions - RIA (H2020)**: Funding for research projects tackling clearly defined challenges, which can lead to the development of new knowledge or a new technology. This action is for consortia of partners from different countries, industry and academia. Funding rate: 100% of eligible costs.

5. **Innovation actions - IA (H2020)**: Funding is more focused on closer-to-the-market activities. For example, prototyping, testing, demonstrating, piloting, scaling-up etc. if they aim at producing new or improved products or services. These actions are for consortia of partners from different countries, industry and academia. Funding rate: 70% of eligible costs (except for non-profit legale entities, where a rate of 100% applies)

6. **Coordination and support actions - CSA (H2020)**: Funding covers the coordination and networking of research and innovation projects, programmes and policies. Funding for research and innovation per se is covered elsewhere. These actions if for single entities or consortia of partners from different countries, industry and academia. Funding rate: 100% of eligible costs

7. **Marie Sklodowska-Curie actions - MSCA**: Funding for international research fellowships in the public or private sector, research training, staff exchanges. These actions are for early stage researchers or experienced researchers

(of any nationality), technical staff, national/regional research mobility programmes.

8. **SME Instrument - SME (H2020)**: This instrument is aimed at highly innovative SMEs with the ambition to develop their growth potential. It offers lump sums for feasibility studies, grants for an innovation project's main phase (demonstration, prototyping, testing, application development...); lastly, the commercialisation phase is supported indirectly through facilitated access to debt and equity financial instruments. This action is for only SMEs can participate. Either a single SME or a consortium of SMEs established in an EU or Associated Country.

Appendix B: Additional Tables

Table B1. Description of Variables Used in The Study

Variable	Definition
Cancer types	1 = Blood cancer; 2 = Brain cancer; 3 = Pancreatic cancer; 4 = Colo-rectal cancer; 5 = Melanoma - skin cancer; 6 = Lung cancer; 7 = Liver and intraheptic bile duct cancer; 8 = Female breast cancer; 9 = Prostate cancer; 10 = Other and primary site unknown cancers; 11 = Mixed (when the project focuses on more than 1 cancer type)
Research fund	Maximum ERC funding (ERC projects) or EC maximum contribution (H2020 projects), in thousands of Euros
Female PI	The ratio of female principal investigators, scientific coordinators, or fellows to the total number of principal investigators, scientific coordinators, or fellows in a project (Male=0, Female=1, SME=0.5)
Duration	Duration of the project, measured in years, calculated from the start date to the end date.
Grant type	1 = Starting Grant; 2 = Advanced Grant; 3 =Consolidator Grant; 4 = Proof of concept; 5 = Synergy Grants (ERC)
Funding type	1= Small and medium collaborative projects (only in FP7); 2=Research and innovation (only in H2020); 3= Other collaborative projects (both in FP7 and H2020); 4 = Standard Marie Curie Postdoc (both in FP7 and H2020); 5= Marie Curie-International dimension (both in FP7 and H2020); 6 = Marie Curie Reintegration or Career Restart (both FP7 and H2020); 7 = SME instrument 1 (only in H2020); 8 = Other SME funding (both in FP7 and H2020)

Cancer burden	Potential Years of Life Lost (PYLL) is calculated by summing the deaths occurring at each age and multiplying this figure by the number of remaining years of life up to a selected age limit. This age limit corresponds to the life expectancy of men and women in Europe in 2006. The cancer burden is then determined by dividing the PYLL by 100,000.
Male relative mortality	The ratio of male deaths to total deaths for each cancer type in the year when the project was granted, represented as a continuous variable with values ranging from 0 to 1
Male relative mortality 2007	The ratio of male deaths to total deaths in 2007 for each cancer type, represented as a continuous variable with values ranging from 0 to 1
Incidence 2007	Number of incidences for each cancer type per hundred thousand
Citation	The ratio of PI's cumulative citations (until the year that they applied for the grant) over 100,000
Female share	The ratio of female evaluators to the total number of evaluators on the panel that evaluated their project proposal

Table B2. Summary Statistics in the ERC and the FP7 & H2020 Samples

	Sum	Mean	SD	Min	Max	N
Panel A: ERC sample						
Research fund	387,432.8	1,473.13	1128.29	139.1	9,974.45	263
Log (research fund)	1,793.1	6.82	1.18	4.94	9.21	263
Project duration	1,074.4	4.09	1.69	1	6.5	263
Female PI	58.75	0.22	0.42	0	1	263
Male relative mortality	125.42	0.47	0.29	0	1	263
Male relative mortality 2007	124.57	0.47	0.29	0	1	263
Cancer burden	1449	5.5	4.6	0	20.36	263
Citation	22.84	0.09	0.12	0.00041	0.71	263
Female share	89	0.34	0.09	0.07	0.55	263
Panel B: FP7 & H2020 sample						
Research fund	1,106,878	1,550.25	2,451.66	30	14,999.33	714
Log (research fund)	4284.07	6.00	1.67	3.4	9.62	714
Project duration	1958.1	2.75	1.41	0.17	8.5	711
Female PI	267	0.40	0.433	0	1	669
Male relative mortality	326.27	0.46	0.31	0	1	714
Male relative mortality 2007	323.04	0.45	0.308	0	1	714
Cancer burden	4182.1	5.86	4.99	0.0011	20.36	714
Citation	11.17	0.022	0.049	0	0.38	511

Table B3. Robustness Check with Time Trend

	Dependent variable is Log(research fund)							
	ERC				FP7 & H2020			
Male relative mortality (M=1)	0.022	0.032***			0.067**	0.040*		
	(0.016)	(0.010)			(0.027)	(0.018)		
	[0.159]	[0.027]			[0.071]	[0.0470]		
Male relative mortality 2007			0.029	0.037**			0.080**	0.047**
			(0.021)	(0.016)			(0.030)	(0.020)
			[0.120]	[0.041]			[0.043]	[0.022]
Time trend	0.009**	0.009**	0.009**	0.009**	0.018	0.038***	0.018	0.037***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.010)	(0.009)	(0.010)	(0.009)
Other controls	No	Yes	No	Yes	No	Yes	No	Yes
Grant/Funding type FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1473.13*	*1473.13*	*1473.13*	*1473.13*	*1550.25*	*1550.25*	*1550.25*	*1550.25*
Observations	261	261	261	261	714	711	714	711
Adjusted R^2	0.990	0.990	0.990	0.990	0.871	0.896	0.871	0.896

Notes: Standard errors, clustered at the cancer type level, are shown in parentheses. Research fund is the maximum awarded grant in the ERC sample and the maximum contribution of the EC in the FP7 & H2020 sample (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Incidence 2007 is the number of new cases by cancer type in 2007 (in hundred thousands). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table B4. Robustness Check with Tobit Model in the ERC Sample

	Dependent variable is Log(research fund)			
	(1)	(2)	(3)	(4)
Male relative mortality (M=1)	0.028*	0.036***		
	(0.016)	(0.012)		
	[0.020]	[0.015]		
Male relative mortality 2007 (M=1)			0.034	0.041**
			(0.021)	(0.017)
			[0.014]	[0.020]
Cancer burden		0.001*		0.001*
		(0.001)		(0.001)
Incidence 2007		0.003		0.004
		(0.003)		(0.004)
Grant type FE	Yes	Yes	Yes	Yes
Period dummy	Yes	Yes	Yes	Yes
Grant type FE × Period dummy	Yes	Yes	Yes	Yes
Mean Dep. Var.	*1473.13*	*1473.13*	*1473.13*	*1473.13*
Observations	261	261	261	261
Pseudo R^2	1.451	1.452	1.452	1.453

Notes: Standard errors, clustered at the cancer type level, are shown in parentheses. Research fund is the maximum awarded grant in the ERC sample and the maximum contribution of the EC in the FP7 & H2020 sample (in thousand euros). Male relative mortality is the ratio between the number of male deaths and the total deaths caused by a cancer type in a given year (range between 0 and 1). Male relative mortality 2007 is the ratio between the number of male deaths and the total deaths caused by a cancer type in 2007 (range between 0 and 1). Cancer burden is the number of potential years of life lost caused by a cancer type in 2006 (divided by 100,000). Incidence 2007 is the number of new cases by cancer type in 2007 (in hundred thousands). Inference is also conducted using a cluster robust wild bootstrap procedure that follows Davidson and Flachaire (2008), and the corresponding p-values are reported in brackets. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.