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Explaining variations in breast cancer screening across European countries*

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Abstract (136 Words)

This paper explores variations in the uptake of breast cancer screening and associated factors influencing utilisation of mammography screening among women aged 50 to 69 years in 13 European countries. We focus on the relative importance of individual (e.g. age, education, etc.) and institutional (e.g. public screening program) factors in explaining cross-country variation in the utilisation of mammograms. We take advantage of (a) newly available individual level data from the SHARE as well as (b) regional and country level data on institutional factors. We find that observed individual factors like age, education, health status, etc. are associated with screening uptake within countries but cannot statistically explain cross-country differences. In contrast, observed institutional factors like the availability of an organized screening program can statistically explain about 40 per cent of the between country differences in screening rates.

JEL-Classification: C 01, I 11, I 18; KEY WORDS: health economics, prevention, multilevel models, SHARE, cross country differences

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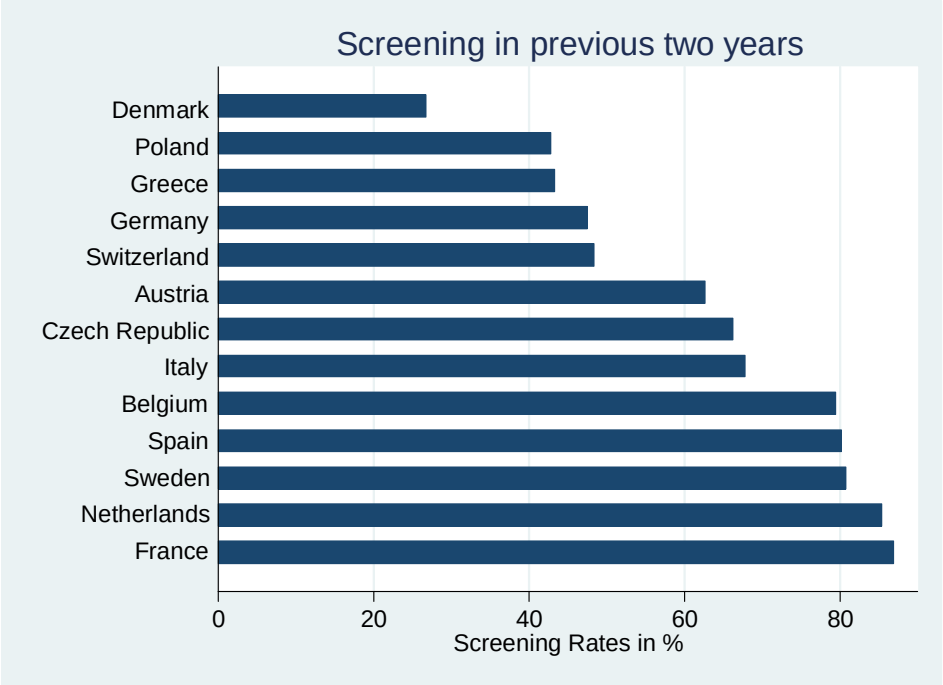
1 Introduction

Breast cancer is the most common cause of cancer death in the member states of the European Union (von Karsa *et al*., 2008). According to estimates of incidence and mortality by the International Agency for Research on Cancer (IARC), there were 331,000 new cases and 90,000 deaths due to breast cancer in the EU in 2006 (von Karsa *et al.*, 2008). Breast cancer accounts for almost one out of three new cancer cases and one out of six (17 per cent) cancer deaths. One in nine women gets breast cancer at some point in her life and one in thirty dies from the disease (OECD, 2009). Due to demographic trends a significantly higher proportion of women will be confronted with breast cancer in the future (Ferlay *et al*., 2007). Moreover, breast cancer is associated with high costs for national health care. Overall spending for breast cancer typically amounts to about 0.5-0.6 per cent of the total health care expenditure of developed countries (OECD, 2009). Breast cancer typically takes years to develop. At the onset of the disease, most breast cancers cause no symptoms. As long as the cancer has not metastasized, i.e. has not moved to the lymph system or to other organs of the body, patients have a five-year survival rate of 96 per cent. If the cancer has spread to the nearby lymph nodes, the rate drops down to 81 per cent. Women whose breast cancer has metastasized to other organs of the body have a five-year survival rate of 26 per cent (Fang and Wang, 2010). Mammogram screening is the best tool available for detecting breast cancer in the early stage, i.e. before symptoms appear. Mammography can detect a breast lump before it can be palpated; it can save lives by detecting breast cancer in the earliest stage. On the basis of several randomized clinical trials, the World Health Organization concluded in 2002 that in areas with screening attendance of at least 70 per cent, a reduction in breast cancer mortality by about 25 per cent may be expected in women screened between ages of 50 and 69 years.[2] In light of this evidence, the International Agency for Research on Cancer expert working group (IARC, 2002) advises that mammography screening should be offered as a public health policy directed to women aged 50–69 every two years in order to reduce the risk of death from breast cancer and also EU guidelines and national guidelines promote regular screening (i.e. every two years) for women of these ages (see Wübker, 2011 for further details).

[2] Compare for an overview (IARC 2002).

Despite these public health efforts to promote screening uptake, the use of screening mammography is not without controversy. Critics point to methodological limitations in some of the randomized trials (Kalager *et al.*, 2010) which might lead to overestimation of the effectiveness of screening.[3] The discussion amongst the critics and advocates of breast cancer screening titled the "Mammography Wars" by Quanstrum and Hayward (2010) might be one reason why screening rates in most European countries remain far from 100 per cent and differ much between European countries as shown by Figure 1.

Figure 1: Mammography screening rates of women aged 50 to 69 years in European countries in 2006 based on SHARE data



As argued by Skinner (2012) or Chandra, Cutler and Song (2012) the largest regional variations in treatment can be found in "supply-sensitive" care or "grey area medicine", where clinical value of treatment is debated and thus in which clinical judgment plays a key role.[4]

Following Bolin *et al.* (2008) and building on the "geographic variation literature" (Skinner (2012) or Chandra, Cutler and Song (2012)), differences in healthcare utilization might be explained by (i)

[3] Especially the omission of harms of screening due to false positive diagnosis and overdiagnoses is criticized by different authors (e.g. Raftery and Chorozoglu (2011)).
[4] For a definition of "gray area medicine" compare Chandra, Cutler and Song (2012)

differences in demographic and socioeconomic composition of the population (individual factors), (ii) differences in health system regulation, financing and provision (explicit institutional factors) and (iii) differences in culture, tradition and norms (implicit institutional factors).

In this paper we focus on individual and explicit institutional factors and do so by laying out some theoretical and empirical arguments for the association between these factors and mammogram uptake. There exists a considerable amount of empirical and theoretical research in health economics on the predictors of screening and preventive behaviour. Theoretical economic models include those of Grossman (1972), Cropper (1977), Giuffrida and Gravelle (1998), Byrne and Thompson (2001), Howard (2005) or Fang and Wang (2010). Jepson et al. (2000) and Schueler *et al.* (2008) provide good reviews of the empirical literature on determinants of mammography screening uptake and recommendations for increasing uptake. While there is considerable evidence on factors associated with mammography screening, the reasons for country differences in screening remain unclear. This paper advances the literature on the determinants of screening uptake by providing first time empirical evidence on the factors statistically explaining country differences. Awareness of the statistical causes behind these country differences might provide useful information for the design of appropriate public health policies for influencing mammography uptake within countries.

To analyse the individual and institutional causes of screening differences across 13 European countries, we take advantage of (a) newly available internationally comparable individual level data which we combine with (b) regional level data on institutional factors. Individual level data are taken from the first three waves of the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE is a representative micro data set for the Europeans aged 50+ years including comprehensive information on health status, health risk, socioeconomic factors and mammography screening behaviour. We merge these data with country and regional level information on different institutional factors (e.g. relative number of mammography units or radiologists, existence of an organized screening program, age groups included in the screening program, intensity of screening program) which are taken from different sources (e.g. European Commission; von Karsa et al. 2008) as explained in the bottom of Table 2. Plausibly, the most important institutional factor influencing

screening uptake is whether a region has introduced an organized population based screening program. Within an organized screening program eligible women (i.e. women aged 50-69 years) typically get regular (i.e. every two years) personal invitations to participate in free mammography screening at a location nearby imposing strong (economic) incentives fostering screening uptake. Incentives for screening uptake are even strengthened by the fact that within an organized screening program the screening process is accompanied by a comprehensive quality assurance. Moreover, women receive an information booklet which explains the pros and cons of mammography screening. In Europe we see enormous regional differences, across and within countries, in the availability of such screening programs and we exploit these differences to identify the impact of organized screening on screening uptake.

The analytical approach is based on multilevel statistical models. These models allow us to decompose the total variance in mammography screening rates into fractions that are due to differences in individual and regional factors within countries and due to differences in individual, regional and country factors between countries. These models enable us to statistically explain the variation (inequality) in screening uptake within a country as well as the differences in screening rates across countries.

We find the following main results: First, observed individual factors like age, income, education, health status, etc. can statistically explain screening uptake within countries. However, despite of considerable differences in the means for almost each individual factor across the countries, they cannot explain differences in uptake rates across countries. Second, in contrast, observed institutional factors like the availability of an organized screening program can statistically explain about 40 per cent of the between country differences in screening rates.

The remainder of the paper is organized as follows: Section 2 illustrates the theoretical and empirical screening determinants. Section 3 presents some information on the data sets. Section 4 explains the empirical strategy and section 5 presents the results. Section 6 discusses the results and adds some concluding remarks.

2 Mammography screening and its determinants

Individual factors

Differences in mammography screening within and across countries can be explained both by differences in individual and institutional factors, which affect demand and supply of screening. Michael Grossman's model of the demand for health care provides a useful framework for understanding the demand side, i.e. an individual's demand of preventive health care services. In this model, the decision to undergo mammography screening is an investment decision. Such an investment is worthwhile if the expected present value of the reduction in disease and in the probability of death is larger than the opportunity costs of the intervention (comp. Grossman, 1972, Cropper, 1977, Dardanoni and Wagstaff, 1990 or Chang, 1996 for a formalization of these notions). Existing empirical studies – motivated by economic demand theory – found that individual factors like better education, better cognitive abilities, higher income, having a partner, younger age, a healthy lifestyle, and better health are associated with higher rates of receipt of screening (e.g. Lairson *et al.*, 2005, Wübker, 2011).

Alternatively, supply side factors have an important impact screening behaviour. Agency theory (e.g. McGuire, 2000) suggests that physician behaviour (i.e. whether a physician recommends screening) can be expected to influence the decision for screening, since asymmetric information is particularly widespread in health care markets often forcing expert physicians to act on behalf of their less informed patients. Moreover, individual perception of risks is often biased (e.g. Viscusi, 1990). Breast cancer is no exception in this regard and even women with a high risk of getting breast cancer may have false perceptions of the risks and the seriousness of breast cancer (Richards *et al.*, 2010). For this reason, physicians often need to act as agents for their less-informed patients, and they play an important role in determining mammography screening take-up.[5] Empirical evidence clearly indicates that women tend to follow their physician`s advice for mammography screening (e.g. May *et al.*, 1999, Meissner *et al*., 2008). For example, May *et al.* (1999) find in an US-study that 66 per cent of women

[5] An additional theoretical supply-side approach to explaining geographic variations arises by allowing the production function to differ across regions or physicians. Compare Skinner (2012).

who received a recommendation adhered and of women receiving a documented recommendation, 75 per cent adhered. Alternatively Meissner *et al.* (2008) found for the US that 80 per cent of non-screeners who reported having access to healthcare did not receive a recommendation for a mammogram.

Institutional factors

The Grossman model follows an individual level approach wherein choices are made to maximise discounted lifetime utility subject to a number of monetary, time and other health systems constraints (Grossman, 1972). In this model, changes in the constraints have influence on individual behaviour. Indeed, empirical studies reveal that public health interventions within a health system which influence financing, delivery, etc. and therefore change the constraints of an individual have a strong impact on screening rates (for an overview compare Peek and Han, 2004). For example, a meta-analysis (Legler *et al.*, 2002) shows that demand side interventions that enhance access (e.g. mobile vans, transportation services), reduce perceived costs (e.g. coverage of mammography by insurance) or influence perceived benefits of screening (e.g. community education, or mass media campaigns, introduction of guidelines) were all very successful in increasing mammography use within a country. Moreover researchers identified that supply side interventions like providing clear and non-conflicting guidelines for providers (e.g. Yasmeen *et al.*, 2012),[6] bonus payments (i.e. Pay for Performance) for providing mammograms (e.g. Li *et al.*, 2011) or effort to change mammography prescribing behaviour of the physicians by reminder systems/office prompts (e.g. Mandelblatt and Yabroff, 1999) have shown to be effective and increased significantly mammography use.[7]

An organized population based screening program is a comprehensive public health intervention that combines many of the interventions just mentioned. Within an organized screening program eligible women (i.e. women aged 50-69 years) get regular (i.e. every two years) personal invitations to

[6] The authors show for the US that physicians consistently recommended mammography to women aged 50-69 years (the age group where leading professional societies consistently recommend screening) whereas widely differ with recommendation for younger women (e.g. aged between 40 and 49 years) and older women (over 75 years) where leading professional societies in the US issue conflicting recommendations.

[7] Additionally Hamblin (1991) found that physician's recommendation of mammography was much lower when the mammography unit was far away.

participate in free mammography screening.[8] Moreover the screening is offered at a location nearby, women receive an information booklet which explains the pros and cons of mammography screening and screening is accompanied by comprehensive quality assurance for equipment, radiographers (technicians) as well as radiologists.

From an economic point of view and in accordance with the Grossman model and agency theory (e.g. McGuire, 2002) an organized screening program should increase mammography uptake since it changes the constraints for the woman concerned and physician involved. It provides incentives in terms of reduced access, information, transaction as well as time costs and plausibly increase perceived benefits of mammography screening. The introduction of an organized screening program plausibly "sends a message to providers" regarding the benefits of screening which might change physicians priorization, targets and incentives making them more prone to recommend screening. Compared to the alternative of opportunistic screening,[9] organized screening puts a much greater emphasis on the quality of the screening process as measured by factors such as, tumour characteristics, cancer detection rates and false-positive biopsy rates (Miles *et al.*, 2004). Thus, it provides better protection against the harms of screening—including overscreening, poor quality, and complications of screening—and poor follow-up of those who test positively (Levin *et al.*, 2012, Miles *et al*., 2004.) Accordingly, Strumpf, Chai and Kadiyala (2010) found that the implementation of an organized mammography screening program in Quebec strongly increased adherence to cancer screening guidelines and screening uptake.[10]

[8] In the EU-member states the characteristics of organized screening programs are widely generalizable, since the Commission of the European Communities succeeds to ensure a strict evidence base for implementing screening programs and the recognition of EU guidelines on best practice in the EU-member states (Com 2008). The IARC (2005) has defined the elements of an organized screening program. These include: 1) an explicit policy with specified age categories, method and interval for screening; 2) a defined target population; 3) a management team responsible for implementation; 4) a healthcare team for decisions and care; 5) a quality assurance structure; and 6) a method for identifying cancer occurrence in the target population.

[9] Opportunistic screening happens when someone asks their doctor or health professional for a mammogram.

[10] The authors measured compliance as the change in age-specific screening rates at the guideline-recommended initiation age (i.e. women older than 50 years). The authors found that after adjusting for age trends and other covariates, being above age 50 in Quebec, which is the only province where an organized screening program existed, increased the probability of being screened by 19 percentage points, from an average screening rate of 24% among 40-49 year old women. None of the other regions exhibited a statistically significant change in screening rates at age 50.

3 Data

We use data from the first (2004), second (2006) and third (2009) wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) to explore variations in the uptake of breast cancer screening and associated factors influencing utilisation of mammography screening among women aged 50 to 69 years in 13 European countries. SHARE is a large representative micro data set providing detailed information on health, healthcare use, as well as a variety of other socioeconomic characteristics of more than 30 000 individuals above the age of 50 years starting in 2004.[11] Using the third wave of the SHARE (SHARELIFE) we calculate our dependent variable. SHARELIFE focuses on people`s life histories and contains detailed information on historical mammography screening use. The dependent variable measures whether a woman had regularly a mammogram at least every two years before 2007.[12]

In this paper, we restrict the sample to women aged 50-69, since for this group mammography screening is officially recommended at both European level and the national level of the countries included. Therefore, the estimation sample consists of 11,409 observations in total. Table 1 provides descriptive statistics for the individual variables included in the empirical analysis for the sample as a whole as well as for each country separately. A more detailed description of the variables included and the exact specification can be found in Table A1 of the Appendix. Explanatory variables include individual factors like age (dummy variables for different age groups), health status (SAH and number of ADL), a history of breast cancer, family structure (having a partner), income, education (as measured by ISCED-groups), cognitive abilities (as measured by verbal fluency), working, health behaviour and risk factors (taking medications). The rationale for including them is described in more detail in Wübker (2011). As Table 1 indicates, there are substantial differences in the means for almost each individual factor across the countries, which make it important to control for individual factors,

[11] For comprehensive information on the sampling procedure, questionnaire contents, and fieldwork methodology see Börsch-Supan and Jürges (2005).

[12] For calculation of our dependent variable we use following questions: 1. Have you ever had mammograms regularly over the course of several years?; 2. In which year did you start having mammograms regularly?; 3. When you were having mammograms, how often was that on average? (Response options: 1. At least once a year; 2. Not every year, but at least every two years; 3. Less often); Since then, have you always had mammograms regularly?

when analysing the impact of differences in institutions (see Bolin et al., 2009). For example, the average age varied from 61 years in Poland to 64.4 years in Austria.

Table 1: Descriptive Statistics for women aged 50 to 69 years (average of 2004 and 2006)

	Mamm.	Age	SAH	ADL	Hist. BC	ISCED	Verbal Fluency	Having Partner	Log Income	Work-ing	Dent Prevent.	Smoker	No Medic.
Austria	0.68	64.44	3.16	0.09	0.023	2.75	22.04	0.56	2.66	0.17	0.44	0.19	0.27
Germany	0.48	63.19	3.25	0.08	0.026	3.41	22.64	0.80	2.92	0.38	0.73	0.14	0.35
Sweden	0.82	63.97	2.83	0.10	0.024	3.14	25.17	0.76	3.02	0.54	0.74	0.21	0.39
Netherlands	0.86	62.48	3.01	0.09	0.022	2.84	21.61	0.78	2.92	0.34	0.70	0.26	0.40
Spain	0.78	63.01	3.60	0.12	0.011	1.59	15.44	0.81	2.26	0.22	0.21	0.12	0.26
Italy	0.66	63.38	3.40	0.08	0.020	1.90	15.65	0.81	2.42	0.18	0.24	0.16	0.28
France	0.85	62.57	3.19	0.09	0.023	2.61	21.59	0.61	2.84	0.41	0.29	0.14	0.25
Denmark	0.26	61.80	2.75	0.08	0.038	3.65	24.00	0.68	3.32	0.54	0.84	0.27	0.43
Greece	0.43	62.43	2.91	0.08	0.016	2.23	15.08	0.63	2.28	0.24	0.34	0.27	0.25
Switzerland	0.49	62.59	2.66	0.07	0.019	2.84	22.62	0.66	3.39	0.50	0.67	0.22	0.46
Belgium	0.80	62.60	3.03	0.12	0.037	2.92	21.20	0.72	0.03	0.30	0.47	0.16	0.25
Cz. Republ.	0.65	62.01	3.35	0.07	0.013	2.49	20.53	0.68	1.73	0.29	0.53	0.21	0.26
Poland	0.43	61.05	3.83	0.35	0.012	2.39	16.72	0.75	1.21	0.20	0.13	0.26	0.29
Total	0.64	62.73	3.14	0.11	0.023	2.69	20.27	0.72	2.65	0.33	0.49	0.20	0.31

SAH = Self Assessed Health; ADL = Number of limitations in Activities of Daily Living; ISCED = International Standard Classification of Education (level 0 = Pre-primary education to level 6 = Second stage of tertiary education), Hist. BC = History of Breast Cancer

Table 2 provides information for the institutional variables included in the empirical analysis. The data refer to the situation in the years 2004 as well as 2006 and are derived from different international sources (compare bottom of Table 2). Of special interest are the variables that refer to the availability and organization of screening programs in the different European countries. The most important variable includes whether an organized screening program exists, since it imposes strong (economic) incentives fostering screening uptake (compare section 2). In contrast to the other institutional variables, which are only available on country level, we can also take advantage of regional variation of the availability of an organized screening program within countries (Nuts 2 code level). Some countries implemented an organized screening program in all regions (e.g. Sweden, Netherlands), whereas other countries offered it only in some regions (Italy, Denmark, Switzerland, Germany) and other countries (e.g. Poland, Greece) did not implement it at all.

Further explanatory variables regarding the organization of screening programs include, i) the share of women who are personally invited, ii) the screening interval in years, iii) the year in which the first screening program started, iv) the type (opportunistic versus organized) and geographical spreading

(national versus regional) of the screening programs, v) whether the screening program is extended to age groups beyond women aged 50 to 69 years (e.g. 40 to 75 years), vi) the number of radiologists (i.e. the physicians who perform screening) per million women and vii) the number of mammography units per million women. Higher invitation rates, a shorter screening interval, a broader geographical spreading, an extended age range as well as higher numbers of radiologists and mammography units are c.p. all expected to lead to higher levels of utilisation, because they should lower information, transaction and access costs of screening. Moreover, Table 2 provides other regulatory (e.g. physician payment) and demand side (i.e. incidence of breast cancer) differences than the ones mentioned above which may affect mammography uptake. The data in Table 2 indicate that there are remarkable differences in the availability and organization of screening programs across the countries.

Table 2: Descriptive statistics on screening programs and other (institutional) factors

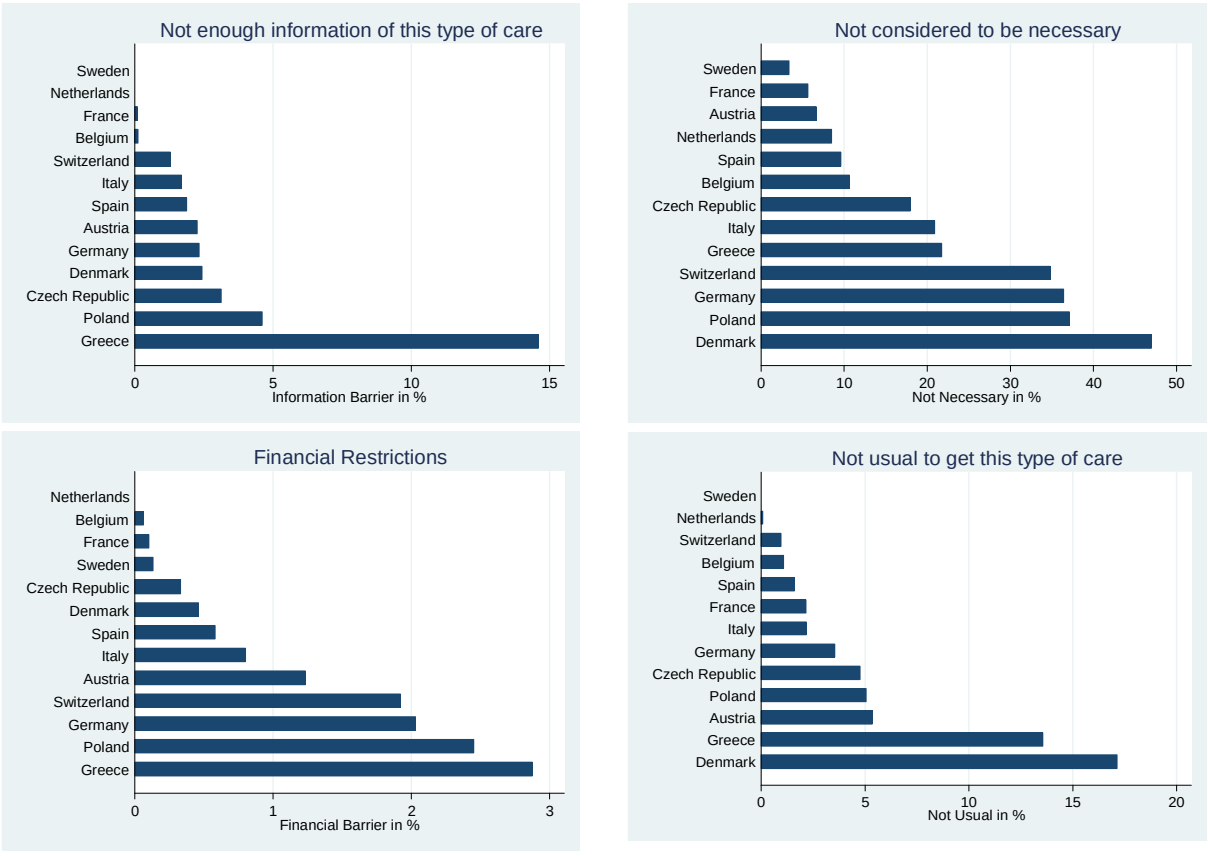
	Organized screening availability [1,2]	Measures of screening intensity: Personally invited of target population in 2006 [1,2]	Measures of screening intensity: Screening interval (years) [2]	Year first screening program started [2]	Current (2006) Program Type [2]	Age Range Extended (years) [2]	Number of Radiologists per million women after 2002 [3]	Number of Mammography units per million women (year) [3]	GP as Gate-keeper [4]	Type of Health Care System [4]	Doctors type of payment [4]	Incid. Breast Cancer per 100,000 in 2004 [5]	Mortality Breast Cancer per 100,000 in 2004 [5]
Austria	0.00	0.00	(1) 2	1999	Org. S., Reg; Opp. S., N	1 (40-69)	226.19	100 (2005)	No	Social insurance decentralized	C	91.5	24.6
Germany	0.08	0.05	2	2005	Org. S., N; Opp. S. ,N	0 (50-69)	149.27	51 (2001)	No	Social insurance	F	121.2	26.5
Sweden	1.00	0.67	1.5	1986	Org. S., N; Opp. S., N	1 (40-74)	214.07	38 (2006)	Yes	Tax financed decentralized	S	125.8	21.1
Netherlands	1.00	0.47	2	1989	Org. S., N; Opp. S., N	1 (50-75)	101.10	20 (2005)	Yes	Social insurance decentralized	C	122.6	29.8
Spain	1.00	0.44	2	1990	Org. S., N; Opp. S., N	1 (45-70)	177.77	52 (2004)	Yes	Tax financed decentralized	S	93.6	19.2
Italy	0.65	0.27	2	2002	Org. S., Reg; Opp. S., N	0 (50-69)	334.56	86 (2005)	Yes	Tax financed decentralized	C	105.3	24
France	1.00	0.52	2	2002	Org. S., N; Opp. S., N	1 (50-74)	238.22	87 (2006)	No	Social insurance	F	127.4	25.9
Denmark	0.22	0.08	2	1991	Org. S, Reg.; Opp. S., N	0 (50-69)	383.21	20 (2003)	Yes	Tax financed decentralized	C	122.6	34.5
Greece	0.00	0.00	(1) 2	1989	Opp. S. N	0 (40/50-64)	442.48	72 (2005)	No	Tax financed	S	81.8	21.7
Switzerland	0.41	0.125	2	1999	Org. S, Reg.; Opp. S., N	0 (50-69)	174.87	79 (2005)	No	Priv. financed decentralized	F	126.5	22.8
Belgium	1.00	0.50	2	1994	Org. S, Reg.; Opp. S., N	0 (50-69)	276.08	55 (2006)	No	Social insurance	F	137.8	33.5
Cz. Republic	0.00	0.00	2	2002	Opp. S, N	1 (45-69)	246.76	28 (2003)	No	Social insurance decentralized	C	93.1	26.7
Poland	0.00	0.00	2	2007	Org. S, N	0 (50-69)	121.21	23 (2005)	Yes	Social insurance decentralized	C	74.1	20.9

[1] A value of zero indicates that no organized screening program is available and a value of 1 signals that an organized screening program is nationwide available. Values between 0 and 1 point to regional variation in screening programs within countries. For example in Denmark only Kopenhagen-city, Funen and Frederiksberg provided an organized screening program until 2006. We set for these regions a dummy variable and calculated the share of women that had access to an organized screening program based on SHARE-data. Thus the value of 0.22 for Denmark means that 22 percent of Danish women included in the SHARE data had access to an organized screening program. General information on the implementation status of organized screening programs were derived from Karsa *et al.* (2008); Detailed regional information for countries with regional variation regarding the implementation of screening programs were provided by following sources: Kooperationsgemeinschaft Mammographie (2012) (Germany), Giorgi et al. 2007 (Italy), Jørgensen, Zahl, Gøtzsche (2010) (Denmark); Schhopper, de Wolf (2007) (Switzerland); Org. S. = Organized Screening; Opp. S. = Opportunistic Screening, N = Nationwide, Reg = Regional

Sources: [1]Schopper and de Wolf (2007); [2]von Karsa *et al.* (2008) and National Cancer Institute; International Cancer Screening Network (2012), see http://appliedresearch.cancer.gov/icsn/; [3]Autier and Ouakrim (2008); [4]Country reports of European Observatory on Health Systems and Policies, see http://www.euro.who.int; Biesheuvel, Weigel and Heindel (2011); [5] Ferlay *et al.* (2006).

Finally, we use data on the reasons why women did not regularly take-up a mammography screening. SHARELIFE explores the causes why women had never had, or stopped having mammograms done regularly by focusing on perceived benefits, information issues, financial restrictions, time costs and availability of mammography services. Figure 2 reveals that there are enormous differences between countries in the self-stated reasons for not participating in screening. Regarding "Not considered to be necessary" 47 per cent of women in Denmark mention this factor as a cause for not getting a mammogram and only about 4 per cent of women in Sweden state this as a reason. As to "not usual" there are also wide variations. About 17 per cent of women in Denmark state this as a reason.[13]

Figure 2: Self-stated reasons for not participating in mammography screening of women aged 50 to 69 years



[13] The question in SHARELIFE is "What are the reasons you [have never had/stopped having] mammograms regularly?" providing following possible answers: 1. Not affordable, 2. Not covered by health insurance, 3. Did not have health insurance, 4. Time constraints, 5. Not enough information about this type of care, 6. Not usual to get this type of care, 7. No place to receive this type of care close to home, 8. Not considered to be necessary.

In contrast, in Sweden and the Netherlands this factor plays no significant role for not getting regular mammograms. "No information about this type of care" plays an important role in Greece (14.6 per cent) and Poland (4.6 per cent) for not undergoing mammograms. Financial restrictions are most important in Greece (2.8 per cent), Germany (2.0 per cent) and Poland (2.4 per cent).

To summarize, there are enormous differences in mammography take-up between European countries (Figure 1) and the individual (Table 1) and institutional factors (Table 2) determining screening take-up as well as the reasons for not undertaking mammogram screening (Figure 2) vary strongly between them.

4 Estimation strategy

The goal of this study is to measure the reasons for differences in mammography screening rates between European countries. Special focus is put on the relative importance of individual versus institutional factors in explaining country differences in screening uptake. Therefore our basic regression models are linear multilevel models (MLM).[14] MLM enable us on the one hand to identify the individual and institutional determinants of mammography screening uptake. On the other hand MLM make it possible to analyse whether the differences in individual and institutional factors across countries can explain country differences in screening rates.[15]

We define the following two-level random-intercept model:

$$y_{ij} = \beta_0 x_0 + \beta' x_{ij} + \nu_i + \varepsilon_{ij}, \qquad (1)$$

where y_{ij} is whether a woman j in country i gets regularly (i.e. every two years) a mammography screening, x_0 is a constant, x_{ij} is a vector of the explanatory variables and β_0 and β are coefficient estimates. All variables are centered around zero by subtracting their grand mean from the individual values and thus the parameter β_0 can be interpreted as the mean intercept (i.e. screening ratio) across

[14] We also estimated a multilevel logit model due to the binary nature of the dependent variable. The marginal effects are very similar to the estimated coefficients of the OLS regressions. Therefore, and because computation is much easier in the linear model, we constrain the presentation of results to the linear probability model. It turns out that depending on the specification, between 3.8 (Model 2; 309 obs.) and 2.7% (Model 7; 437 obs.) of all observations have a predicted value outside the range of [0,1]. We feel that this is a reasonably low figure.

[15] For a nice overview of multilevel models and the application of these models in health economics see Rice and Leyland (1996) or Rice and Jones (1997).

all individuals in all countries. The model has two error components: ν_i is the random error for the *i*th country. This error term captures unobserved (i.e. factors that are not controlled for) country specific factors like institutional differences in health system regulation, financing and the provision that cause differences in screening uptake across countries. ε_{ij} is an individual-level random error for the jth woman within the *i*th country.[16] This error term captures unobserved individual factors like preferences for prevention, genetic factors, time preferences, exposure to screening when a friend is affected by breast cancer, etc. that might explain individual differences in screening uptake within a country.

We estimate seven variations of equation 1. The first model (Model 1) includes only an intercept mirroring average screening rates across countries. This model enables us to estimate the intra cluster correlation coefficient from the unconditional model as will be explained in greater detail below. Model 2 adds individual and Model 3 institutional explanatory variables. Models 4 to 7 add the different reasons for not participating in regular mammography screening as explanatory variables. The rationale behind this strategy is to identify in a first step the individual (Model 2) and institutional (Model 3) determinants of mammography uptake within a country ("Analysis of determinants") as well as the "channels" through which individual and institutional variables determine screening uptake (Models 4 to 7).[17]

In a second step ("Analysis of variance") this strategy enables us to analyse whether differences across countries in the individual and institutional screening determinants are related to screening differences across countries using the same sequential estimation strategy as above. To this aim we analyse the importance of the country level error v_i term in equation 1 and whether the error term decreases after

[16] By assumption the both error terms have zero mean and constant variances ($\sigma_\nu^2, \sigma_\varepsilon^2$).

[17] Including the reasons for not participating in screening sequentially helps for example to identify the relationship between organised screening and the different reasons for not participating in regular mammography screening. This identification is done by analysing the change of the coefficients of the individual and institutional variables after including the reasons for not participating as additional controls and is explained in more detail in the result section. This could be alternatively analysed by using the different reasons for not participating as outcome variables and regressing them on all other explanatory variables. However, we decide to insert these variables as explanatory variables, since we try to analyse in the following "Analysis of variance" how country differences in the reasons for not undertaking a mammogram are associated with country differences in screening rates after controlling for individual and institutional factors (i.e. we want to figure out what factors drive remaining country differences in screening uptake).

individual (Model 2), institutional (Model 3) and the other controls (Models 4 to 7) are included in the equation. The idea behind analyzing the change in the magnitude of the country specific error term for explaining country differences is the following: As explained above, the error term captures unobserved country specific factors like institutional differences in health system regulation, financing and providing that cause differences in screening uptake across countries. The bigger the differences in screening rates across countries, the higher the value of the error term will be. The relative decrease in the error term as more individual and institutional controls are added to the model indicates the model's ability to statistically explain cross country differences. Moreover, to identify the relationship between country differences in screening rates and the different reasons for not participating in screening, we sequentially add these different reasons to the model. Finally, to understand the ability of the models to explain country differences even better, we calculate additionally the intra-class correlation coefficients (ICC) as a relative indicator of country variation in screening rates:

$$\mu_\upsilon = \sigma_\nu^2 /(\sigma_\nu^2 + \sigma_\varepsilon^2) . \qquad (2)$$

The coefficient μ_υ defines the proportion of variability in screening rates attributable to the level of the countries and is bounded between 0 and 1. The closer the ICC is to 0 , the smaller the proportion of the total variance at country level and the lower the relevance of country specific factors (e.g. institutional factors) for differences in screening rates. In contrast, large values of μ_υ indicate that differences in screening rates are attributable to country specific factors.

5 Results

Baseline results

Analysis of Determinants

Table 3 presents the results of the analysis of screening determinants. The results of Model 1, which is used as the baseline model, indicate that the estimated mean screening rate across all countries is 63 per cent. Model 2 adds individual factors as explanatory variables. Almost all individual controls are significant.

Table 3: Determinants of mammography screening

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
50 <= Age < 55		0.088***	0.091***	0.092***	0.087***	0.081***	0.048***
		(6.36)	(6.74)	(6.88)	(6.52)	(6.17)	(4.10)
55 <= Age < 59		0.094***	0.094***	0.093***	0.089***	0.085***	0.047***
		(7.51)	(7.75)	(7.72)	(7.40)	(7.13)	(4.44)
60 <= Age < 64		0.059***	0.059***	0.060***	0.055***	0.052***	0.026*
		(4.86)	(4.97)	(5.12)	(4.72)	(4.54)	(2.52)
Self-assessed Health		-0.013**	-0.011*	-0.011*	-0.011*	-0.010*	-0.011**
		(-2.84)	(-2.50)	(-2.51)	(-2.44)	(-2.26)	(-2.81)
ADL		-0.014	-0.016	-0.014	-0.014	-0.017*	-0.014
		(-1.65)	(-1.90)	(-1.71)	(-1.70)	(-2.11)	(-1.94)
Hist. Breast Cancer		0.223***	0.203***	0.196***	0.191***	0.186***	0.113***
		(8.39)	(7.81)	(7.62)	(7.44)	(7.34)	(5.03)
ISCED 0		-0.120***	-0.112***	-0.105***	-0.099***	-0.092***	-0.053*
		(-4.17)	(-4.01)	(-3.78)	(-3.57)	(-3.36)	(-2.20)
ISCED 1 to 2		-0.050***	-0.054***	-0.048***	-0.044***	-0.041***	-0.021*
		(-3.92)	(-4.32)	(-3.89)	(-3.58)	(-3.41)	(-2.02)
ISCED 3 to 4		-0.011	-0.013	-0.013	-0.012	-0.011	-0.000
		(-0.91)	(-1.12)	(-1.08)	(-1.06)	(-0.99)	(-0.05)
Verbal_Fluency		0.003***	0.003***	0.002***	0.002***	0.002**	0.001*
		(4.90)	(3.84)	(3.65)	(3.47)	(3.16)	(2.17)
Having_Partner		0.032***	0.035***	0.032***	0.030***	0.029**	0.014
		(3.40)	(3.79)	(3.56)	(3.30)	(3.24)	(1.72)
Log_Income		0.019***	0.014**	0.015***	0.015***	0.014**	0.005
		(4.22)	(3.02)	(3.39)	(3.39)	(3.24)	(1.27)
Working		-0.005	-0.006	-0.002	-0.003	-0.002	0.001
		(-0.45)	(-0.55)	(-0.15)	(-0.28)	(-0.15)	(0.07)
Dentist		0.099***	0.096***	0.093***	0.093***	0.091***	0.061***
		(10.83)	(10.71)	(10.56)	(10.55)	(10.43)	(8.00)
Smoker		-0.024*	-0.029**	-0.030**	-0.028**	-0.026**	-0.014
		(-2.31)	(-2.86)	(-3.00)	(-2.81)	(-2.60)	(-1.64)
No_Medication		-0.070***	-0.072***	-0.071***	-0.073***	-0.073***	-0.048***
		(-7.39)	(-7.67)	(-7.75)	(-7.97)	(-7.98)	(-6.03)
OrgScreen			0.387***	0.377***	0.370***	0.355***	0.191***
			(22.90)	(22.46)	(22.20)	(21.48)	(13.26)
Ext_AgeRange			0.151*	0.146	0.141	0.136	0.075*
			(2.08)	(1.95)	(1.85)	(1.89)	(1.98)
Fin_Restriction				-0.353***	-0.339***	-0.344***	-0.351***
				(-8.57)	(-8.29)	(-8.47)	(-9.80)
No_Time				-0.440***	-0.413***	-0.408***	-0.420***
				(-11.52)	(-10.86)	(-10.84)	(-12.65)
Not_Near				-0.242***	-0.148**	-0.123*	-0.046
				(-4.95)	(-3.02)	(-2.53)	(-1.06)
No_Information					-0.306***	-0.236***	-0.180***
					(-11.84)	(-9.03)	(-7.79)
Not_Usual						-0.290***	-0.339***
						(-14.38)	(-19.05)
Not_Necessary							-0.536***
							(-57.19)
Constant	0.630***	0.632***	0.646***	0.647***	0.647***	0.646***	0.642***
	(11.57)	(10.88)	(17.73)	(17.16)	(16.96)	(17.92)	(33.96)
Observations	11409	11409	11409	11409	11409	11409	11409

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

More precisely, a younger age (reference category women aged 50 to 69 years), better health (as measured by sah and adl), better education (i.e. higher ISCED, reference category ISCED 5 to 6) and

better cognitive abilities (verbal fluency), having a partner, higher income, not working, a healthy behaviour (i.e. visit a dentist for prevention issues) and taking no medications (i.e. lower risk group) are consistently associated with higher rates of screening take-up.[18]

Model 3 adds institutional variables. The probability that a woman gets a mammogram increases by 38.7 percentage points if a region provides an organized population based screening program. Given the average screening rate of 63 per cent, this is a remarkable amount. Moreover, in countries where a screening program is offered to women outside the age group of 50 to 69 years, the screening probability is on average 15 percentage points higher. After controlling for self-stated financial restrictions, other access problems (e.g. not near available) (Model 4) and the reason "lack of information" (Model 5) the coefficients of the individual and institutional explanatory variables decrease slightly. For example, the coefficient of the organized screening program drops from 0.387 to 0.370 (i.e. by about 4 per cent).[19] This means statistically that the dummy for organized screening is negatively correlated with the variables included in Models 4 and 5 (i.e. financial restrictions, access and information problems). With regard to interpretation, organized screening programs seem to reduce financial restrictions as well as access and information problems. However, including the variables "not usual" (Model 6) and especially "not necessary" (Model 7) as additional controls have a much bigger impact on the coefficients of the institutional explanatory variables. For example the coefficient of an organized screening program drops statistically significant by about 50 per cent from 0.37 (Model 5) to 0.19 (Model 7) indicating that the availability of an organized screening program strongly reduces the probability that a woman believes a screening is "not necessary". Moreover, the coefficients of many individual variables drop sharply towards zero (e.g. education, age, having a partner and income drop between 40 and 60 per cent, the decrease is statistically significant for the age categories, income and "ISCED 1 to 2"- category) and partly lose significance. This result suggests

[18] For example, a woman who regularly visits a dentist for preventive issues has a 9.9 percentage points higher probability of getting regularly a mammogram compared to a woman who does not visit a dentist for preventive issues. However, the interpretation of these variables is not of major interest in this paper, since we are interested only in general relevance of individual factors and whether differences in these are relevant for explaining country differences in screening rates. More details results of screening determinants are presented in Wübker (2011).

[19] Note, this decrease is not statistically significant.

that belonging to the elderly, having low income, being poor educated and not having a partner is strongly related to believing that screening is not necessary.

In summary, individual and institutional factors can statistically explain screening uptake within a country. Quantitatively, the most important factor is the provision of an organized screening program and a central mediating factor for most of the individual and institutional variables is whether a woman thinks that the screening is necessary or not. However, the question remains, to what extent differences in individual and institutional factors across countries can statistically explain country differences in screening rates. This question will be answered in the following section.

Analysis of Variance

As described in section 4, a unique feature of multilevel regression analysis is the ability to partition the variance of the dependent variable at different levels (here country versus individual). Table 4 presents two absolute (standard deviation and variance) and one relative (ICC) indicator of variation in screening rates for the different models. For the sake of simplicity we focus on the interpretation of the standard deviation and the ICC. Model 1 with no explanatory variables reveals a standard deviation in screening rates across countries of 19.5 per cent. After controlling for individual factors (Model 2), the standard deviation in screening rates between countries increases slightly by 1.3 percentage points to 20.8 per cent. Thus country differences in individual factors (i.e. age, sah, etc.) cannot explain country differences in screening rates but even lead to increased unexplained differences. Individual factors that are positively associated with screening rates seem to be more prevalent in countries with lower screening rates. By contrast, unexplained country differences in screening rates decrease sharply after controlling for institutional factors (e.g. organized screening program). More precisely, the standard deviation drops by 7.94 percentage points from 20.86 to 12.92 (i.e. in relative values by 38 per cent). The impact of the further inclusion of the self-stated reasons for not participating in screening to the regression model is analysed in Models 4 to 7. Stated financial restrictions and access problems (Model 4), “lack of information” (Model 5) and “not usual” (Model 6) cannot additionally explain differences in screening rates.

Table 4: Variance and standard deviation of mammography screening

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**
Variance components (random intercept Model)							
Between countries **variance** $\delta^2\upsilon(k)$	383***	435***	167***	179***	183***	164***	43.7***
Between countries **standard deviation** in per cent $\delta\upsilon(k)$	**19.57*** **	**20.86*** **	**12.92*** **	**13.37*** **	**13.54*** **	**12.80*** **	**6.61** **
Between individuals **variance** $\delta^2\varepsilon(jk)$	1799***	1847***	1767***	1730***	1709***	1679***	1311***
Between individuals **standard deviation** in per cent $\delta\upsilon(k)$	42.42***	42.98***	42.04***	41.60***	41.34***	40.98***	36.21***
Intra-cluster correlation (ICC)							
Intra-cluster correlation in per cent (ICC$\delta^2\upsilon(k)$)	21.28	23.56	9.4	10.3	10.7	9.7	3.3
Variance components (random slope Model)							
Between countries **variance** $\delta^2\upsilon(k)$	383***	419***	148***	161***	165***	149***	40.9***
Between countries **standard deviation** in per cent $\delta\upsilon(k)$	**19.57*** **	**20.47*** **	**12.15*** **	**12.67*** **	**12.86*** **	**12.20*** **	**6.40*** **
Between individuals **variance** $\delta^2\varepsilon(jk)$	1799***	1815***	1728***	1696***	1679***	1652***	1296***
Between individuals **standard deviation** in per cent $\delta\upsilon(k)$	42.42***	42.61***	41.58***	41.18***	40.97***	40.64***	36.02
Intra-cluster correlation (ICC)							
Intra-cluster correlation in per cent (ICC$\delta^2\upsilon(k)$)	21.28	23.08	8.5	9.5	9.8	9.0	3.2

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

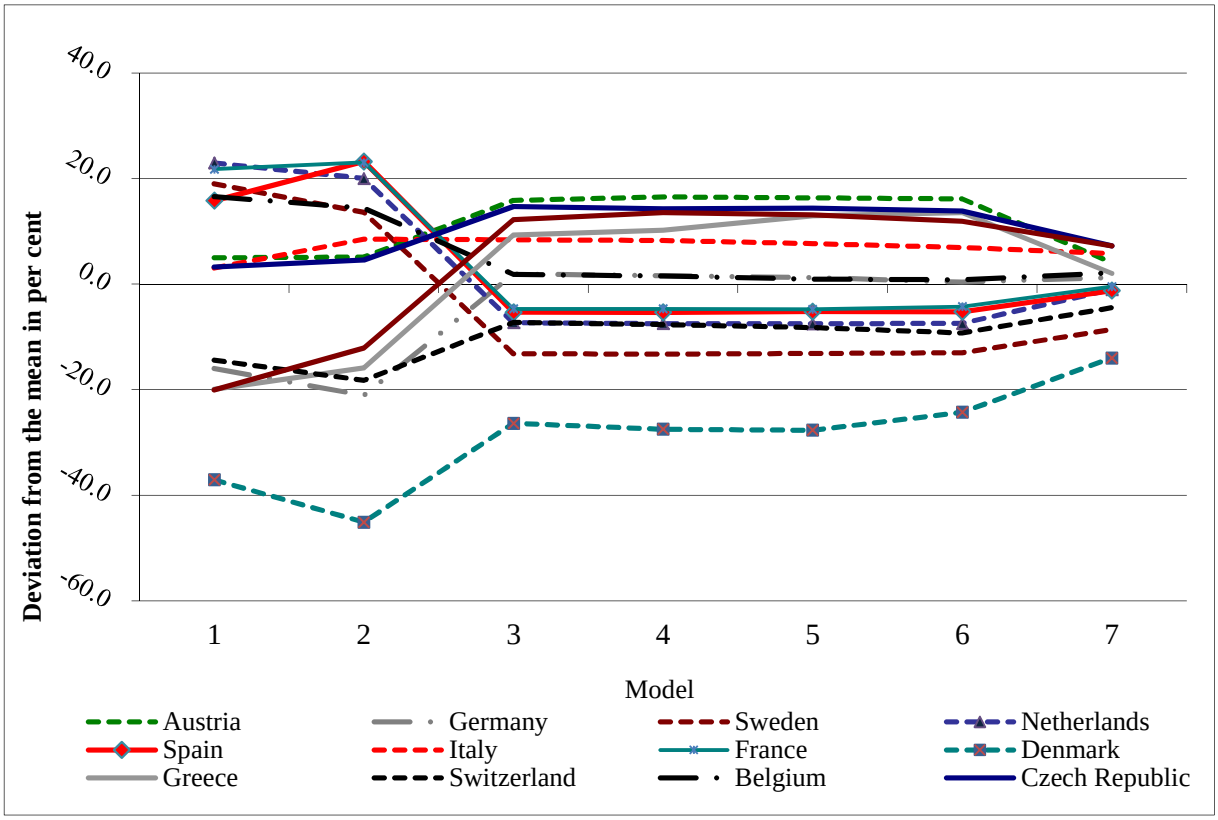
In contrast, controlling for "not necessary" has an additional enormous impact on the unexplained standard deviation in screening rates between countries. Even after institutional and individual variables are controlled for, the standard deviation decreases by additional 6.19 percentage points from 12.8 to 6.61 (i.e. in relative values by 52 per cent). Turning to the ICC results show that in the model with no controls 21.3 per cent of the overall variance can be partition to the country level, this increases to 23.5 per cent after controlling for individual factors and drops sharply to 9.4 per cent when controlling for institutional factors and drops further to 3.3 per cent when including all reasons for not participating.

Figure 3 visualises the additional explanatory power of each model and summarizes the three striking results:[20] First, observed individual factors cannot explain country differences. Secondly, observed institutional factors explain most of the country differences. For example, the higher screening rate in

[20] Note that each variable is centered around zero and thus Figure 3 presents average country screening rates under the assumption that individual variables (Model 2), institutional variables (Model 3), etc. would not be different across countries.

countries like Spain, the Netherlands, France or Sweden (compared to average screening rate across countries) is almost completely statistically explained by institutional factors (i.e. the availability of an organized screening program and whether a screening program is offered to women outside the age group of 50 to 69 years). Thirdly, "not necessary" is the most important factor for explaining country differences even after individual and institutional factors are controlled for. For instance perceptions and attitudes to screening as measured by "not necessary" (Model 7) seem to be a big barrier in Denmark explaining much of the under-screening in this country (compared to the other countries).

Figure 3: Explanatory power of the models



Results of sensitivity analysis

So far we assumed that the coefficients of the individual variables are identical for each country. However one could argue the impact of these variables depend on the institutional framework within a country. For example, whether income has an impact on the individual screening decision depends on whether a woman has to pay for screening. Thus, the coefficients of the individual controls might

differ across the countries. To account for different coefficients across countries, we re-estimate our baseline models and additionally apply a random slope specification for the individual controls in each sequential model. A random slope model adds a random error term to each coefficient of β in equation 1, accounting for possible differences in the relationship between explanatory and dependent variable across countries.[21] Results are presented in the bottom of Table 4. In general, allowing for a more flexible form using random slopes is associated with slightly smaller standard errors and variances. Thus, adjusting for random slopes explains country differences slightly better than not allowing for random slopes. However, in general, results remain robust if we allow for random slopes.[22]

Another restrictive assumption within the multilevel model framework is that the country specific effects (error terms) are uncorrelated with the independent variables. This assumption can be relaxed by a country fixed effects regression approach allowing for possible correlation of the country specific effects with the independent variables. Thus we re-estimate Models 1 to 7 by including a dummy variable for each country in equation 1 instead of inserting a country specific random error term. However, a problem of the country fixed effects regression approach is that we cannot control for institutional variables that vary across countries, but display no within country variability (i.e. Extended Age Range). Thus, Table 5 presents the results of fixed effects regression without controlling for country level institutional variables, i.e. for whether a country provides screening to an age range beyond 50 to 69 years. The results can be summarized as follows: First, the coefficients of the individual and institutional explanatory variables are quite similar to those in the multilevel models. Secondly, the differences between the country dummies decrease much after controlling for i) an organized screening program and ii) for "not necessary" as reason for not participating in screening. This is shown by the variances and standard deviations of country dummies presented in the bottom of Table 5. More precisely we calculate the variance (Var) of country dummies as follows:

$$\text{Var} = \frac{1}{13}\sum_{i=1}^{13}(di - d)^2 , \qquad (3)$$

[21] This means that it is assumed that the effect of the explanatory variable varies randomly within the population of countries.

[22] The results reveal that the error term for random slopes is significant for some of the individual explanatory variables, meaning that there is considerable variation in these coefficients across the countries. The complete results are available upon request.

where *13* is the number of countries included, *di* is the dummy of country *i* and *d* is the average of the 13 country dummies as calculated by

$$d = \frac{1}{13}\sum_{i=1}^{13} di \ . \qquad (4)$$

The Var for Model 1 is thus a measure of the total differences in screenings rates between countries, while the Var for Models 2 to 7 are measures of the remaining unexplained differences, when taking account of an increasing number of individual and institutional characteristics as well as the different reasons for not participating in regular mammography screening.

The results indicate the convergence of the variance of country dummies as we move from Model 1 with enormous differences across countries (variance 355 per cent, standard deviation 18.85 per cent) to Model 3 with much lower differences (variance 202 per cent, standard deviation 14.24 per cent) to Model 7 with only minor differences (variance 53 per cent, standard deviation 7.34 per cent) in screening rates across countries. Thus, in general, the results found are also robust to these changes in specification. Finally, we tried alternative institutional variables (see Table 2 for these variables) for explaining country differences in screening rates. Since these variables are only available on country level and we have only 13 countries we cannot put them into the models simultaneously. The results are presented in Table A2 of the appendix. In the top of the table, results are presented without controlling for whether an organized screening program exists. In the bottom of the table we control for the availability of an organized screening program. We find a strong statistically significant positive relation between screening uptake and "Age Rate Extended" as well as "Personally Invited". Countries that offer screening to women beyond the age range of 50 to 69 years had a 27 percentage point's higher screening uptake rate compared to countries that do not. Moreover, countries that have a 10 percentage point higher invitation rate had a 6.2 percentage point's higher screening uptake rate.

Table 5: Results of country fixed effects regression

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Austria	0.680***	0.683***	0.902***	0.907***	0.901***	0.897***	0.734***
Germany	0.470***	0.419***	0.608***	0.607***	0.606***	0.599***	0.626***
Sweden	0.821***	0.768***	0.600***	0.598***	0.596***	0.594***	0.594***
Netherlands	0.861***	0.833***	0.661***	0.657***	0.653***	0.651***	0.674***
Spain	0.789***	0.866***	0.681***	0.679***	0.677***	0.673***	0.673***
Italy	0.661***	0.717***	0.671***	0.672***	0.668***	0.662***	0.672***
France	0.849***	0.863***	0.688***	0.685***	0.681***	0.683***	0.680***
Denmark	0.257***	0.178***	0.320***	0.312***	0.312***	0.348***	0.467***
Greece	0.430***	0.472***	0.684***	0.695***	0.725***	0.733***	0.636***
Switzerland	0.485***	0.448***	0.513***	0.511***	0.508***	0.499***	0.564***
Belgium	0.796***	0.776***	0.602***	0.602***	0.598***	0.598***	0.631***
Czechia	0.663***	0.678***	0.891***	0.883***	0.881***	0.873***	0.767***
Poland	0.428***	0.510***	0.715***	0.731***	0.728***	0.718***	0.693***
50 <= Age < 55		0.088**	0.090***	0.092***	0.086***	0.081***	0.047***
55 <= Age < 59		0.093***	0.094***	0.093***	0.088***	0.084***	0.046***
60 <= Age < 64		0.059***	0.058***	0.060***	0.055***	0.052***	0.025*
Self-ass. Health		-0.013*	-0.011*	-0.011*	-0.011*	-0.010*	-0.011**
ADL		-0.014	-0.016	-0.014	-0.014	-0.017	-0.014
Hist Breast Cancer		0.223***	0.203***	0.197***	0.191***	0.186***	0.113***
ISCED 0		-0.121*	-0.111***	-0.104**	-0.098**	-0.091**	-0.052
ISCED 1 to 2		-0.050	-0.054***	-0.048***	-0.044***	-0.041**	-0.022
ISCED 3 to 4		-0.011	-0.014	-0.013	-0.013	-0.012	-0.001
Verbal_Fluency		0.003*	0.003***	0.002***	0.002***	0.002**	0.001*
Having_Partner		0.032*	0.035**	0.032**	0.030**	0.029**	0.013
Log_Income		0.019*	0.014**	0.016**	0.015**	0.015**	0.006
Working		-0.005	-0.005	-0.001	-0.002	-0.001	0.001
Dentist		0.099***	0.096***	0.094***	0.093***	0.092***	0.063***
Smoker		-0.024	-0.029*	-0.030**	-0.028*	-0.026*	-0.014
No_Medication		-0.070***	-0.071***	-0.071***	-0.073***	-0.072***	-0.048***
OrgScreen			0.392***	0.382***	0.375***	0.361***	0.196***
Fin_Restriction				-0.353***	-0.340***	-0.344***	-0.351***
No_Time				-0.440***	-0.413***	-0.409***	-0.421***
Not_Near				-0.242***	-0.149**	-0.124*	-0.047
No_Information					-0.307***	-0.236***	-0.180***
Not_Usual						-0.289***	-0.337***
Not_Necessary							-0.535***
Observations	11409	11409	11409	11409	11409	11409	11409
Variance Country Dummys in per cent	355.19	404.24	202.77	208.71	208.85	189.22	53.93
Standard Deviation Country Dummys in per cent	18.85	20.11	14.24	14.45	14.45	13.76	7.34

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The results change strongly if we control for an organized screening program indicating a strong correlation between the availability of an organized screening program and both variables. The association between "Age Rate Extended" and screening uptake drops by 50 per cent but still remains significant and the relation between invitation rate and screening uptake vanishes. The other institutional variables (Mammogram units, Gatekeeper, Fee for Service etc.) show, with and without

controlling for an organized screening program, no statistical significant relation to screening uptake and hardly influence the coefficient of organized screening demonstrating the dominant role of organized screening in explaining mammography decision.[23] Lastly, we analyzed the relation between screening uptake and breast cancer incidence as well as breast cancer mortality. Without controlling for organized screening we find a positive correlation between screening and incidence and a negative correlation between screening and mortality. However, the correlation between incidence of breast cancer and screening uptake turns out to be negative if we control for organized screening indicating a positive association between breast cancer incidence and the availability of an organized screening program.

6 Discussion and Conclusion

Breast cancer is the main cause of cancer-mortality among women in Europe. Screening mammography helps to detect breast cancer before it becomes invasive, and mortality can be significantly reduced by regular mammography screening. Even though mammography is officially recommended both on the national and European level for women aged 50 to 69, screening rates in most European countries remain far from 100 per cent and differ much between European countries. Due to lack of comparable cross national data no study exists that analyses the statistical causes of screening differences across countries and the fundamental reasons for these variations remain largely unexplored and not well understood. Against this background the purpose of this paper was to explore the statistical causes of these country differences in screening rates of woman aged 50-69 using data from the SHARE. Since differences in screening rates across countries might stem from differences in individual or institutional factors (Bolin et al. 2009), special focus is put on the relative importance of individual versus institutional factors in explaining country differences in screening uptake.

The results indicate that observed individual factors (i.e. age, education, etc.) can statistically explain within country variation in screening rates but cannot explain between country variations in screening

[23] This makes sense, since the supply of an organized screening program mirrors a comprehensive public health intervention influencing incentives on both the demand and supply side as described in section 2.

rates. Further, observed institutional factors (i.e. the availability of an organized screening program and whether screening is provided beyond the age group of 50 to 69 years) can statistically explain about 40 per cent of the between country differences in screening rates. The impact of these institutional factors seem to be mediated to a minor extent (by about 4 per cent) by solving financial restrictions, access problems as well as "lack of information" and to a major extent (by about 50 per cent) by avoiding that a woman believes a screening is "not necessary". This result might indicate that the availability of a screening program increases perceived benefits of screening reflecting that national screening programs have reduced mortality over time (Kalager *et al.*, 2010). It also might resolve concerns about false positive treatments, the treatment of potentially benign tumours or identifications of mainly low risk cancers,[24] since there is some evidence that organized screening protects better against harms compared to traditional opportunistic screening.[25] Thirdly, and additionally to the indirect association of "not necessary" with individual and institutional factors, differences across countries in whether a woman believes that screening is not necessary can statistically explain an additional 50 per cent of the between country differences.

Policy Implication

In terms of health policy implications the results found suggest that the availability of an organized screening program (i.e. differences in the institutional framework) strongly matters for explaining current screening differences across European countries. Since it is not clear to what extent people have an understanding of harms (e.g. overtreatment, anxiety associated with false positive results) associated with screening when weighing up the costs and benefits of screening, this analysis can provide some insights about patient attitudes and understanding and it highlights the importance of the availability of an organized screening program for individual screening decisions. Moreover, the analysis reveals that, if policy intends to increase screening rates, changes in the institutional setting

[24] There might be a reduction in quality of life due to false positive findings and possibly unnecessary treatment (although the magnitude of the extent or significance of over-treatment is debatable with a number of studies estimating small degrees of over-treatment). Compare Raftery and Chorozoglu (2011) and Hackshaw (2012) on a discussion of these issues. But even the quality of life decrease from treatment may not be that large if patients are convinced they have successfully treated a life threatening cancer.

[25] Compared with opportunistic screening, organized screening focuses much greater attention on the quality of the screening process, including follow-up of participants. Compare Miles et al. (2004).

might in particular address the perceived necessity of screening. Since patients both (a) often follow physician recommendation and (b) provider counselling about screening is more important for screening decision than poor patient acceptance (e.g. Haas *et al.*, 2007), public health interventions might address physicians recommendations on screening. Future research might investigate which public health interventions (e.g. pay for performance) might be most cost-effective in influencing the decision to recommend a screening by a physician.

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Table A1: Sample means and description

Variables		Variable description	Mean
Endogenous			
	Mammogram	Mamm. screening at least every two years(Yes=1, No=0)	0.64
Exogenous			
Age	50 <= Age < 55		0.25
	55 <= Age < 60		0.28
	60 <= Age < 65		0.25
Health Status	SAH	Self-Assessed Health (excellent =1 to poor = 5)	2.92
	ADL	Number of limitations in Activities of Daily Living	0.11
	Hist, Breast Cancer	A history of breast Cancer	0.023
Family Structure	Having Partner	Women has a partner	0.72
Income	Log_Income	Logarithmized household income adjusted by the square root of the household size	2.64
Education	ISCED 0	International Standard Classification of Education (ISCED) level 0	0.027
	ISCED 1 to 2	ISCED level 1 to 2	0.431
	ISCED 3 to 4	ISCED level 3 to 4	0.342
Cognition	Verbal Fluency	Counts the number of different animals the respondent is able to state within 1 min	20.27
Working	Working	Women is working or self employed	0.33
Health Behaviour	Smoking	Women is currently smoking	0.49
	Dent_Prevent	Women visited dentist for routine control or prevention	0.20
Risk_Group	No_Medication	Women takes not regularly medication	.31
Institutional factors (only those included in the main analysis, Compare Table 2 for the other ones)	Organized Screening	Organized Screening available	0.55
	Age Range Extended	Screening available to age groups beyond 50 to 69	0.40
Self-stated reasons for not having a mammogram	Financial_Constraint	"Too Expensive" or "Not Covered by Insurance" or "No Insurance"	0.009
	Not Available	"No place to receive this type of care close to home"	0.007
	No Time	"No time"	0.011
	No Information	"Not enough information about this type of care"	0.026
	Not Usual	"Not usual to get this type of care"	0.043
	Not Necessary	"Not considered to be necessary"	0.196

Table A2: The association between screening uptake and alternative institutional controls

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8	Model 9	Model 10
Without Controlling for Organized Screening										
Org. Screen.	0.390***									
	(23.06)									
Ext_Age Range		0.279***								
		(3.17)								
Real invited			0.582***							
			(3.42)							
Mamm. Units				0.002						
				(0.70)						
Radiologists					-0.001					
					(-1.18)					
Gatekeeper						0.025				
						(0.21)				
Fee for Serv.							-0.007			
							(-0.05)			
Start program								-0.004		
								(-0.49)		
Incidence BC									0.001	
									(0.30)	
Mortality BC										-0.010
										(-0.77)
Individual Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
With Controlling for Organized Screening										
Org. Screen.	0.390***	0.387***	0.394***	0.390***	0.390***	0.391***	0.391***	0.392***	0.394***	0.390***
	(23.06)	(22.90)	(22.80)	(23.05)	(23.00)	(23.08)	(23.06)	(23.08)	(23.26)	(23.09)
Ext_Age Range		0.151*								
		(2.08)								
Real Invited			-0.163							
			(-0.94)							
Mamm. Units				0.001						
				(0.98)						
Radiologists					-0.000					
					(-0.75)					
Gatekeeper						-0.090				
						(-1.10)				
Fee for Serv.							-0.077			
							(-0.86)			
Start program								0.007		
								(1.17)		
Incidence BC									-0.004*	
									(-2.29)	
Mortality BC										-0.012
										(-1.42)
Individual Controls[1]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	0.656***	0.646***	0.652***	0.657***	0.653***	0.657***	0.652***	0.655***	0.644***	0.647***
Observations	11409	11409	11409	11409	11409	11409	11409	11409	11409	11409

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; [1] All control variables are included (compare Tables 3 and 4)