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Assessing inequalities in preventive care use in Europe: A special case of health-care inequalities? *

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Abstract

This paper presents the first cross-country estimation of needs-adjusted income and education-related inequalities in the use of a whole set of preventive care treatments. Analysis is based on the last three waves of the Survey of Health, Ageing and Retirement (SHARE) for individuals aged 50 and over living in 13 European countries. We employ alternative concentration indices based on the CI-corrections for binary outcomes to compute inequalities in the use of breast cancer screening, of colorectal cancer screening, of influenza vaccination, and of routine prevention tests, such as blood pressure, cholesterol, and blood sugar tests. After controlling for needs, we find that in many European countries strong pro-rich and educational inequalities exist with respect to breast cancer screening, cholesterol and blood sugar tests. Furthermore, we find that poor and less educated people are more likely than the better off to use preventive care late, e.g. when health shocks occurred or health problems display already symptoms. Finally, results suggest that access to treatments within a specialist setting is generally less equal than access to treatments provided within a GP setting. Equity implications of the results are then discussed according to different possible theories of distributive justice in health care delivery.

Key-words: Preventive care; socio-economic related inequalities; concentration indices.

JEL-Codes: I14; D63

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1. Introduction

Increasing prevention is one of the most important goals of public health policies across the world. Especially for cancer, early detection is associated with a significant reduction in mortality whilst cancer is currently one of the leading causes of death in developed countries (Jemal *et al.*, 2011). Routine prevention measures, such as blood-pressure checks and blood tests (i.e. cholesterol checks and blood sugar tests), allow the detection of many forms of illness like cardiovascular diseases or diabetes (Steinberg and Gotto, 1999, Kearney *et al.*, 2005). Annual influenza vaccination can prevent premature death, and it has shown to be generally highly cost-effective, but especially for the 'at-risk' group, i.e. for the elderly and people with cardiovascular and respiratory diseases (Maciosek, 2006). Needless to say that increasing prevention measures means to improve the survival and well-being of many people significantly. Moreover, insofar as preventive care for some targeted groups is also more cost-effective than cure, increasing prevention for these groups is also a strategic tool to control health care spending growth (Cohen, Neumann and Weinstein, 2008).

Despite its importance, an increasing bulk of literature shows that not only preventive care is used by significantly less than 100% of the population in need of it, but it is also distributed strongly unequally among individuals. In particular, poorer and less educated individuals use significantly less preventive care than wealthier and better educated ones. Whether an unequal distribution among socio-economic groups is a result of inequity depends on what inequity means in the context of health care and preventive care. This is a heavily debated issue in the normative economic literature. Most popular standpoints will be presented in section 2 to appreciate the normative relevance of analysing inequalities in preventive care.

In this paper, however, we argue that analysing income and education-related inequalities in preventive care is highly relevant even if one is not willing to share any normative judgment value. The argument is grounded in two pragmatic reasons. Firstly, scarce use of preventive care by poor and less educated might be not cost-effective. Social costs of late diagnosis might be higher for low socio-economic status individuals because they are generally less able to convert cure into health (compared to high SES individuals).[1] This would require more subsequent health care use, and, therefore, higher spending. Secondly, inequality in preventive care use might be very informative as it can be considered a more conciliatory way to assess equality in health care delivery. Indeed, while for many health care interventions the definition of needs is highly debated (see Culyer and Wagstaff, 1993; Culyer, 1995), in most preventive care treatments, definition of need is simpler. For many preventive treatments related to cancer screening, virtually all people in the targeted age group need preventive care. For routine preventive treatments, such as cholesterol and blood sugar tests, it is reasonable to assume that all persons need them regularly in their life. Thus, computation of socio-economic-related inequalities in preventive care use, when adjusted for needs, can hardly be disputed on the ground of not taking appropriately health needs into account.

[1] Grossman (1972) gives a theoretical foundation of this argument. For an overview of the empirical literature see Cawley and Ruhm (2012).

Notwithstanding, while theoretical and empirical assessments of inequalities in health care delivery are widespread in the literature (see Bago d'Uva, Jones and van Doorslaer, 2009, Van Doorslaer, Koolman and Jones, 2004; Stirbu *et al.*, 2011, among others), assessment of inequalities in preventive care use is scarce. There are papers using data from several countries which find a significant effect of socio-economic status as a determinant of preventive care use (see Kenkel, 1994; Lairson *et al.*, 2005; Schmitz and Wübker, 2011, Carrieri and Bilger, 2013)), but they do not use concentration indices to quantify the extent of socio-economic-related inequalities. One exception is the paper by McKinnon, Harper, and Moore (2011) who calculate concentration indices and decompose determinants contributing to inequality in cervical cancer screening in 67 countries. They focus on women aged 25–64 years, who participated in the World Health Survey in 2002–2003. The authors find considerable socio-economic-related inequalities in cervical cancer screening in most of the countries analysed and a big heterogeneity across the countries. Another exception is Lorant *et al.* (2002) who estimate socio-economic-related inequalities in preventive care use in Belgium. They focus on people aged 25 and older to calculate a needs-adjusted concentration index. They find a significant inequity for preventive medicine. Inequity is high and favoring the rich for cancer screening (i.e. mammography and pap-test) whereas it is lower for flu vaccination and cholesterol tests but still favoring the rich. However, a more general view across different preventive measures could be useful to understand whether cervical cancer screening is a special case of prevention and whether heterogeneity across different preventive measures exists. In addition, a cross-country analysis of inequalities is useful to understand whether Belgium is an isolated case or not and whether heterogeneity across different health care systems exists.

This paper makes two contributions to the existing literature of inequalities in health care delivery. First, we present the first estimate of both income and education-related inequalities in the use of a wide range of preventive treatments in 13 European countries. In this way, we try to fill the gaps in the literature mentioned above. We use the Survey of Health, Ageing and Retirement in Europe (SHARE) which includes comprehensive information on socio-economic factors, health status, health risk, and on several preventive measures. We analyse inequalities in use of early diagnosis of most prevalent cancers, namely breast cancer (mammography) and colorectal cancer (colonoscopy and fecal occult blood test). We also analyse the use of influenza vaccination and of the most routinely tests such as blood pressure test, cholesterol and blood sugar test. SHARE focuses on individuals aged 50+, thus including the age groups most at risk of developing many forms of cancers and for which routinely treatments are generally recommended.

A second contribution of the paper is to shed light on behavioral differences in preventive care use among socio-economic groups. Poor and less educated might have more problems in understanding the benefits of prevention than the better off and consider treatments as unnecessary in the absence of symptoms (see Filèe *et al.*, 1996). Thus, they might be more likely to use preventive care late, e.g. when health shocks effectively occurred (i.e. a mammogram if a woman had a personal history of breast cancer) or health problems display already symptoms (i.e. a colonoscopy in presence of bowel disorders). To consider this potential "late preventive care use" in the measurement of inequalities we separate

inequalities in "true" preventive care from inequalities in the use of preventive care for diagnostic reasons (i.e. when symptoms of disease already appear or a follow-up is required). Consequently, we standardize inequalities considering two types of needs: specific age groups when referring to routine needs and both subjective and objective health conditions and specific health problems when we refer to diagnostic needs. This distinction may provide insights on whether inequalities in preventive care only reflect health care inequalities or if they are a special case of inequalities in health care delivery.

The paper is structured as follows. The next section briefly discusses different normative views on inequality in health care and prevention. Section 3 describes the data; the analytical methods are discussed in section 4. In the fifth section we present estimates of inequalities with and without adjustment for needs and a decomposition of inequality indexes to assess contribution of demographic factors (i.e. being in target age groups) and health conditions. The last section presents a discussion of the implications of the findings and some final remarks.

2. Inequity and prevention

An unequal distribution of health care among socio-economic groups is not per se inequitable, if one does not define what equity in health care means. Normative economics literature has proposed a variety of definitions of equity in health care. An overview of such definitions is included in Fleurbaey and Shockkaert (2012), Hurley (2006) and in Wagstaff and Culyer (1993). Here, we briefly recall some of the most popular views on equity in health care which can be relevant to define equity in preventive care delivery. We distinguish four different arguments: equality of opportunity, equality of access, capacity to benefit principle and Sen's view on equity in health care.

The equality of opportunity approach proposes to distinguish legitimate vs. illegitimate inequalities according to the degree of individual responsibility exercised by individuals in determining a given outcome (Roemer, 1993; Roemer, 1998; Roemer, 2002). In this perspective, inequalities due to pure circumstances, such as social background (i.e. gender, ethnic group, parental background), should be considered illegitimate, while inequalities due to personal responsibility, such as effort or preferences should be considered legitimate.

The advocates of the "equality of access" view argue that "access" should be equalized across individuals; however, access can be interpreted in several ways. Mooney (1983) suggests that access should be defined in terms of the "opportunities" open to individuals. This perspective is clearly very close to the equality of opportunity principle. An alternative definition of equality of access propose to equalize time and money costs encountered the individuals when using treatments (Le Grand, 1982; Mooney, 1983). Another characterization of access involves both budget and time constraints and requires that the maximum attainable consumption of health care should be equalized for all (Wagstaff and Culyer, 1993).

An Utilitarian' view argues that each unit of resource should be allocated to the person who will gain the highest welfare from it (see Hurley, 2006). It would follow that differences in

use, as this reflects differences in the capacity to benefit from prevention should not be considered a concern. For example, this could mean that a seriously ill person with very low chances to survive the nearby future could not benefit from discovering earlier a cancer as much as a healthy person could. Thus, pro-healthy inequalities in preventive care use could be accepted by a utilitarian. With respect to socio-economic-status-related preventive care inequalities, this view implies that lower access by worse-off people would not be a source of inequity as long as such persons are also less able to benefit from an early diagnosis.

Sen (2002) proposes a complete different perspective to judge inequalities in health care delivery. In principle, according to Sen's theory of justice, an illness unprevented and untreated because of social reasons (i.e. poverty) rather than out personal choice (i.e. a risky behavior) should be considered a serious concern for social justice However, he argues that distinction between achievements (e.g. having good health) and underlying capabilities (e.g. having the capability to attain good health) is not so relevant in most situations related to health care, because people "tend to give priority to achieve good health when they have the real opportunity to choose" (Sen, 2002, p. 660). In this perspective, even negative health behaviors, such as smoking or not doing regular prevention, can be considered a generated 'unfreedom' to conquer the bad habit.

Other possible views on health care equity may exist (see Hurley 2006; Wagstaff and Culyer, 1993 for an informative discussion), but two general approaches in the judgment of inequalities in health care are predominant. A first approach, coherent with Sen`s argument, is to consider all inequalities in use which are not explained by needs as unfair. This approach is also coherent with an equality-of-opportunities approach, which considers the socio-economic status as part of circumstances and the needs as the only source of legitimate inequality (Fleurbaey and Schokkaert, 2012). A second approach is to consider all inequalities in prevention use that are not explained by needs and preferences as unfair. This second perspective may be coherent with the equality of access view, provided that time and money constraints are effectively equal across individuals. In addition, it could be coherent also with an equality of opportunity approach once one has considered correlation between needs and socio-economic status (i.e. a higher morbidity for low SES groups). This in turn, would require to distinguishing the legitimate from the illegitimate part of the needs distribution across SES groups. Finally, a common problem in both approaches is the definition of "need" for health care ,which is heavily debated issue (see Culyer, 1995)[2] .

In this paper we share the pragmatic approach adopted by Morris *et al.* (2005) in the analysis of inequalities in the use of health care in England. Basically, we standardize inequalities in use for need factors, thus measuring differences in use related to income or education not explained by needs. We prefer to call this "inequality" rather than "inequity", thus avoiding any value judgment. People with different views of what constitutes need and what should be considered fair in preventive care distribution can interpret our results in different ways. The main issue we are not able to address regards the distinction between inequalities in use due to need factors vs. inequalities due to individual preferences, such as discounting, risk aversion

[2] Here we mostly refer to curative health care, while definition of need should be less problematic for preventive care, as we mentioned in section 1.

and the value of future. Thus, our empirical approach allows to investigate mainly the extent of inequality consistent with Sen (2002)'s view, which interprets negative health behavior as a generated 'unfreedom' to conquer the bad habit of not doing prevention. However, Cutler and Lleras-Muney (2010) show that in the US and the UK preferences do not account for any of the education gradient in health behaviors, including prevention. If this pattern were also confirmed in the European countries analysed in this paper, our estimates may provide insights also on the presence of equality of opportunity in preventive care use in Europe.

3. Data

Preventive care use

We use data from the first and second wave of the Survey of Health, Ageing and Retirement in Europe (SHARE) to analyse socio-economic related inequalities in preventive care use in 13 European countries.[3] SHARE is a large representative micro data set providing detailed information on health, healthcare use, as well as a variety of other socio-economic characteristics of more than 30,000 individuals above the age of 50 years starting in 2004. The data was collected using a computer assisted personal interviewing (CAPI) program, supplemented by a self-completion paper and pencil questionnaire.[4] This "drop-off questionnaire" includes questions addressing issues of preventive health care utilization. We calculate binary variables for whether (i) a women had a mammogram (to check for breast cancer) in the last two year, (ii) a respondent had a colonoscopy or a test for hidden blood in the stool (to check for colorectal cancer) in the last ten years and (iii) a respondent had a flu vaccination in the previous year.[5] The "drop-off" questionnaire was only sent to a subgroup of the sample and no respondent received it in both waves. Considering colonoscopy and stool examination the according questions were only asked in the first wave.

On top of the data included in the first (2004) and second wave (2006) of the SHARE, we additionally analyse data from the third wave (2009) of the SHARE ("SHARELIFE"). SHARELIFE focuses on people's life histories and contains information on some additional routine preventive measures. Based on the questions included in SHARELIFE we calculate

[3] We do not consider Israel and Ireland because most preventive measures (except flu vaccination for Ireland) are not available for both countries.

[4] For more details on the sampling procedure, questionnaire contents and fieldwork methodology, readers should refer to Börsch-Supan and Jürges (2005).

[5] A 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. For women aged 50-69, mammography has been shown to lower the risk of dying from breast cancer by 35 percent (compare Wübker, 2012 for further details) and to be highly cost-effective (Moore *et al.*, 2009). For this age group it is officially recommended both on the national and European level (e.g. Wübker, 2012). Screening for colorectal cancer clearly reduces colorectal cancer mortality. RCTs demonstrate that screening with fecal occult blood tests (FOBT) reduced colorectal cancer mortality from 15 to 33 per cent (e.g. Walsh and Terdiman, 2003). The reduction in mortality demonstrated in the FOBT screening studies is attributable to the performance of follow-up colonoscopy. Moreover colonoscopy screening can detect advanced polyps and cancers that would otherwise be missed by FOBT (e.g. Walsh and Terdiman, 2003). The recommendation that all men and women aged 50 to 74 years or older regularly (at least every ten years) undergo screening for colorectal cancer is supported by a large body of direct and indirect evidence (e.g. U.S. Preventive Service Taskforce, 2008, Karsa *et al.*, 2008). Annual influenza vaccination is the most effective method of preventing influenza virus infection decreasing the risk of infection substantially and highly cost-effective for the groups at risk, i.e. for the elderly (age 65+) and people with cardiovascular and respiratory diseases and chronically ill (Maciosek *et al.*, 2006). Increasing influenza vaccination rates is one of the main public health goals in many countries (World Health Organization, 2003).

binary variables for whether a respondent (a) regularly (i.e. at least every two years) checks his blood pressure and (b) regularly (i.e. at least every two years) checks his blood for measurements of cholesterol and blood sugar.[6,7] Table 1 provides take-up rates by countries of the preventive measures included in the empirical analysis. As Table 1 indicates take up rate are far from 100 per cent. A little more than half of women got a mammography within the past two years and about 16 per cent of this population underwent a colonoscopy within the past ten years. About 21 per cent got a stool examination within the past ten years. 31 per cent have been immunised against the flu during the preceding year, while about 70 per cent have undergone a blood pressure check and a blood test within the past two years. Moreover there are substantial differences in the means for each preventive measure across the countries.

[Table 1 around here]

Socio-economic status and needs

We capture socio-economic status by two measures: education and equivalent gross household income. Education is measured by ISCED-97 classification.[8] The ISCED-code has a range from 0 (pre-primary education) to 6 (second stage of tertiary education) meaning the higher the ISCED-value the higher the education-level.[9] The income variable is derived from the annual income of the whole household before deductions for income tax and social or national insurance contributions. It mainly comprises labour income, public pensions and income from assets (compare Christelis *et al.*, 2009 for a detailed description of the income variable available in SHARE). To get the annual "equivalent gross household income" we adjust for household size by dividing through the square root of the number of household members.

Following Lorant *et al.* (2002) need for cancer-screening and routine preventive measures (i.e. flu-immunisation, blood pressure and blood tests) was defined as the expected utilization according to well known risk factors and preventive guidelines (e.g. Karsa *et al*, 2008 for cancer, WHO 2003 for influenza, Steinberg and Gotto, 1999 for cholesterol and Kearney *et al.*, 2005 for high blood pressure as well as footnote 5). Need for cancer prevention (i.e. mammography, colonoscopy and stool examination) was related to age (for mammography

[6] High blood pressure (hypertension) increases the risk of heart attack, heart failure, stroke and kidney disease and atherosclerosis (hardening of the arteries) (comp. Kearney *et al.*, 2005 for an overview of the global burden of hypertension). Blood sugar levels are very important to overall health. Checks for blood sugar are made to prevent diabetes and coronary heart diseases. Cholesterol is a type of fat (called lipid) which is made by the body. It is necessary for good health and is found in every cell of the body. However, having a high cholesterol level in the blood (hypercholesterolemia) can increase the risk of coronary heart diseases and stroke (e.g. Steinberg and Gotto, 1999 for an excellent concise historical overview of evidence).

[7] Note that for Greece, only data from the first wave are available, while Poland and the Czech Republic joined SHARE only in the second wave.

[8] ISCED stands for "International Standard Classification of Education". ISCED was designed by UNESCO in the early 1970's to serve 'as a tool to facilitate comparisons of education statistics and indicators of different countries on the basis of uniform and internationally agreed definitions.

[9] Level 0 captures pre-primary education, level 1 mirrors primary education or first stage of basic education, level 2 contains lower secondary or second stage of basic education, level 3 captures (upper) secondary education, level 4 includes post-secondary non-tertiary education, level 5 captures first stage of tertiary education and level 6 second stage of tertiary education.

women aged 50 to 69 years and for colonoscopy and stool examination men and women aged 50 to 74 years) as this is the main screening indication. Diagnostic need was linked to following (risk) factors: a history of cancer (for mammography and colonoscopy or stool examination), self-stated gastrointestinal problems (for colonoscopy and stool examination), a history of intestinal ulcer. For influenza immunisation the following need factors were considered: age 60+, self-assessed health and chronic conditions classified as high risk or intermediate risk (Schmitz and Wübker, 2011). In the data set, these are heart attack, lung disease, asthma, stroke, diabetes, and arthritis. Finally, for blood pressure examinations and blood tests (i.e. cholesterol check) need was related to the most important risk factors for cardiovascular diseases: older age, diabetes, overweight (bmi $\geq$ 25), sex (being a male), heart attack and stroke.[10] Table 1 presents basic sample statistics for all variables included in our analysis.

4. Methods

The empirical analysis is divided into two steps. In a first step we point to the relevance of socio-economic related inequalities in Europe by regressing the dependent variables (i.e. different preventive measures) on the (a) ISCED-categories and (b) income quintiles with and without adjustment for need variables using the sample of all countries.[11] Doing this analysis we provide an easy interpretable quantification of the general association between education (and income respectively) and the preventive measures. In order to get insights in the relevance of need adjustment, we present the results with and without controlling for need variables.

In a second step we use the concentration index (CI) as a comprehensive measure of socio-economic-related inequalities in preventive care use (Wagstaff, van Doorslaer and Paci, 1991).[12] The CI quantifies the magnitude of inequalities described by the concentration curve, which plots the cumulative proportion of the population (ranked according to the socio-economic variable, i.e. income or education) against the cumulative proportion of the preventive care use (i.e. mammogram, colonoscopy or stool, etc.). For illustrative purposes, Figure 1 presents the concentration curves for mammography screening rates in Europe.[13]

[Figure 1 around here]

The curve lies considerably below the diagonal 45 degree line of equality, demonstrating the presence of inequality to the advantage of the rich (or disadvantage of the poor). The CI is defined as twice the area between the concentration curve and the line of equality (the 45-degree line) (Wagstaff, van Doorslaer and Paci, 1991). The index has a range from – 1 to 1

[10] Note, we do not control for some major risk factors that are available in the data. These are tobacco use and alcohol use. We neglect these health behaviour variables since they could be strongly related with preferences.
[11] The seven education levels are recoded into three broader categories: low (ISCED-code 0 to 2), medium (ISCED-Code 4 to 5) and high (ISCED-Code 6 to 7).
[12] The concentration index has become the driving force for a large and rapidly growing empirical literature on socioeconomic inequalities in health care (compare Wagstaff and van Doorslaer, 2000, Fleurbaey and Schokkaert, 2012 as well as the recent survey by van Doorslaer and Van Ourti, 2011).
[13] Because of limited space we do not include the concentration curves for the all countries and measures in this paper. The according concentration curves are available upon request from the authors.

and if there is no socio-economic-related inequality, the concentration index will be zero. In the case of positive health care variables like cancer screening a positive value of the index indicates disproportionate concentration of the health variable among the rich, i.e. inequality to the disadvantage of the poor. On the other hand a negative value would indicate inequality to the disadvantage of the rich.

In its general form the concentration index is computed as follows:

$$(1)\ \ CI = \frac{2}{n\mu}\sum_{i=1}^{n} y_i R_i - 1 = \frac{2}{\mu} * \mathrm{cov}(y,R)$$

Where μ stands for the average rate of the utilization of the respective preventive measure, n for the sample size, y denotes whether the respective preventive measure was taken up by individual i and R_i designates the ith individuals rank within the education (income) distribution. From this equation it becomes evident that the concentration index can be computed conveniently using the covariance between the preventive measure y_i and the fractional rank in the education (income) distribution.[14] However, as pointed out by Kjellsson and Gerdtham (2011), for bounded variables (e.g. mammography screening yes or no) (a) the maximum and minimum value of the CI depends on the average preventive care use in the country (Wagstaff, 2005), (b) the value of the CI depends on the scale of the preventive care variable (Erreygers, 2009) and (c) the CI may rank countries by inequalities in doing a screening or not differently (Clarke *et al.*, 2002). To account for these problems and to enable comparison of the results for different populations, Erreygers (2009) and Wagstaff (2005) developed alternative corrections of the CI for bounded variables.[15] Since the value judgements behind these corrections differ and country rankings might differ in dependence of the adjustment used (compare Kjellsson and Gerdtham, (2011) and Fleurbaey and Schokkaert, (2012) for a recent overview of empirical applications), we calculate and present both adjustments for the CI to check robustness of results in dependence of the underlying value judgments. We refer to the Wagstaff adjustment as W and the Erreygers adjustment as E.[16] We estimate standard errors for concentration indices that are robust to heteroskedasticity and autocorrelation (O´Donnell *et al.*, 2008) and use sampling weights that are available in the SHARE-data.

[14] This calculation holds also for weighted data (compare Lerman and Yitzhaki, 1989) as we use in this paper.

[15] In an exchange in the Journal of Health Economics, Wagstaff (2009) and Erreygers (2009a; 2009b) debate the merits of these corrections. For a nice summary of this discussion and a systematic classification of the pros and cons of both approaches see Kjellsson and Gerdtham (2011).

[16] The Wagstaff corrections answers the question of how far the society, given the level of preventive care use, is from a state where only the individuals in the top of the income distribution are using preventive care, while E (i.e. the Erreygers correction) answers the question of how far the society is from a state where the upper 50% of the distribution are using preventive care independently on the prevalence. Compare Kjellsson and Gerdtham (2011). The normalization formula proposed by Wagstaff (2005), divides the CI by *1- μ*. The formula proposed by Erreygers is $E = \frac{8}{n^2}\sum_{i=1}^{n} z_i \times yi$, where z_i takes on a positive value if the individual i is rich or highly educated (e.g. from the upper half of the income respective education distribution) and a negative value if individual i is poor or less educated (e.g. from the lower half of the income or education distribution).

In order to solve the standardization or need adjustment problem (compare for a critical discussion of alternative standardization methods Fleurbaey and Schokkaert, 2012) we finally apply decomposition methods. As discussed in the introduction, socio-economic inequalities in preventive care as such are not necessarily worrying, if they mirror differences in needs. Therefore, we correct for needs based on the variables discussed in the data section. Following the method proposed by Wagstaff *et al.* (2003) we decompose the CI (or W and E respectively) assuming that the relevant outcome y_i (i.e. preventive care utilization measure) can be written as a linear function of a set of characteristics k as follows:

(2) $y_i = \alpha + \sum_k ß_k x_{ki} + \varepsilon_i$ [17]

Even though it is necessary to assume linearity of this equation for the decomposition, it is possible to extend it to allow for binary health care outcomes (Gravelle, 2003, McKinnon, Harper and Moore, 2011). The concentration index CI (y) can be decomposed as

(3) $CI(y) = \sum_k \eta_k CI(x)_k + 2 * \frac{\mathrm{cov}(\varepsilon_i, \mathrm{R_i})}{\mu(y)}$

Equation (3) reveals that the effect of any need-variables x on CI(y) depends both on its own concentration index CI(x) and on the elasticity η_k of y with respect to x (compare Fleurbaey and Schokkaert, 2012).[18] For example, if older age increases the probability of getting a mammogram (positive elasticity η_k) and it is more concentrated among the rich [positive age related CI(x)], older age will make a positive contribution to the overall CI. A negative contribution therefore indicates that either the determinant decreases the probability of getting a mammogram and the variable is concentrated among the better-off or there is a pro-poor inequality in the determinant (CI (x) is negative) and the determinant increases the probability of getting a mammogram (positive elasticity). As motivated in the introduction we differentiate between two types of needs: specific age groups when referring to routine prevention (routine prevention) and both subjective and objective health conditions and specific health problems when we refer to diagnostic treatments (diagnostic treatment). We use this classification of need to calculate two adjustments of the concentration index. Firstly, we only adjust for "routine needs" (i.e. specific age groups). Secondly, we adjust for routine prevention and "diagnostic needs" in order to see how the CI changes when specific health problems are controlled for. Suppose that we can partition the vector x between "routine needs" variables x_{Ri} and diagnostic needs variables x_{Di}, so that we can rewrite (2) as

(4) $y_i = \alpha + \sum_R ß_R x_{Ri} + \sum_D \beta_D x_{Di} + \varepsilon_i$

Using an indirect standardization method (e.g. Gravelle, 2003) we first calculate a routine-needs-corrected value for preventive care by putting the diagnostic-needs variables x_{Di} in (4) at

[17] Where the $ß_k$ are regression coefficients and ε_i is the error term.

[18] This decomposition approach has been applied to interpret differences in the concentration index between different countries (e.g. van Doorslaer, Koolman, and Jones, 2004 or Bagod'Uva, Jones and van Doorslaer, 2009) and changes over time but also to tackle the standardization problem as in our case (compare Fleurbaey and Schokkaert, 2012).

a fixed value and then focus on the differences between actual preventive care levels and these corrected preventive care levels. In terms of the concentration index this yields:

$$CI^{IND}(y) = CI(y) - \sum_R \eta_R CI(y)_R \quad (5)$$

Secondly, we correct for both (routine needs and diagnostic needs) focusing on the differences between actual preventive care levels and routine needs and diagnostic needs adjusted preventive care levels. In terms of the concentration index this yields:

$$CI^{IND}(y) = CI(y) - \sum_R \eta_R CI(y)_R - \sum_D \eta_D CI(y)_D \quad (6)$$

5. Results

Preventive services and socio-economic status

For each preventive service, Table 2 provides the regression results of the five income quintiles (when ranking on income) with and without controlling for need factors. Regarding income quintiles (note that the highest income quintile is the reference income group) and mammography screening there is a significant, monotonic and strong increasing gradient of use if we do not control for need factors. For example, the probability of getting a mammogram screening for women belonging to the highest income quintile is 26 percentage points higher than for women belonging to the lowest income quintile. The association between income and ”StoolColo” (stool examination or colonoscopy) is much lower but still positive; i.e. higher income groups have significant higher uptake rates than the lowest income group. In contrast, no consistent association is found between income quintiles and blood tests or blood pressure checks and a slight negative correlation is found between higher income and flu-vaccination-uptake.

The picture is different when we control for need variables and two general results are striking: Firstly, almost all need variables are significantly related to take up rates in line with the expected direction. For example, if a woman belongs to the group of women aged 50 to 69 years, the probability of getting a mammogram is 37 percentage points higher than for older women. This means that these women are more than 2 times more likely to undertake a mammography. Regarding influenza vaccination a similar strong relation is found for persons over 60, having a 28 percentage point’s higher probability of getting a flu shot compared to their reference group of persons between 50 and 60 years. Secondly, the association between income quintiles and preventive care uptake changes considerably for some preventive care measures when we control for need variables. After controlling for needs there remains a significant, monotonic and increasing gradient between income and mammography screening. However, the strengths of the effects decrease strongly. This result suggests that the recommended age group (women aged 50 to 69 years) is concentrated among the rich. In contrast, the association between higher income and stool examination or colonoscopy

("StoolColo") remains fairly stable. However, for blood tests and blood pressure checks higher income is associated with higher rates when controlling for needs. Moreover, for influenza vaccination the negative association found before vanishes when controlling for needs. Thus, need factors (heart attacks, stroke, etc.) that have a positive impact on the uptake of these preventive measures might be concentrated among the lower income groups and capture some of the correlation between income groups and the preventive measures. As shown in Table A1 the results are quite robust regarding the choice of socio-economic measure; i.e. if we take education groups as a measure of socio-economic status, the general direction of results does not change much.

[Table 2 around here]

Inequality

For cancer preventive care (i.e. mammography, colonoscopy or stool) the concentration indices are given in Table 3. In order to check the robustness of results in dependence of the socio-economic indicator two proxies for socio-economic status are used: the rows in the upper half of the Table present the calculation for education-related inequalities and the rows in the lower half display the results with regard to income-related inequalities. The first column provides results for the unadjusted concentration index based on Erreygers (E) CI-correction, the second column shows the adjustment for age groups or routine needs according to equation 5 (compare methods section) and the third column presents additional adjustment for diagnostic needs, i.e. overall needs adjusted results according to equation 6. To test the relevance of CI-correction method and thus to check robustness of results in dependence of the underlying normative value judgment, the fourth column provides results for the need adjusted CI-correction based on the method proposed by Wagstaff (2005) (W).[19]

[Table 3 around here]

A negative value (E or W) points to a concentration favouring the poor (less educated), while a positive value implies a concentration in favour of the better off (better educated) individuals. In the following, we explain results for mammography uptake in detail to get a clue on the general interpretation of the results. Regarding mammography, all countries have for both education and income a positive index without controlling for need factors. This indicates that mammography take up is more prevalent amongst the better off (better educated) groups. The concentration among the rich is highest in Italy and lowest in Denmark. More precisely, inequality in mammography uptake in Italy is more than 3 times higher compared to Denmark. A similar picture arises for education-related inequalities. The pattern changes considerably when we adjust for age groups (routine prevention). For both education and income inequalities in mammogram utilization decrease sharply in all countries, however remain significantly in most countries (except Austria, Sweden,

[19] Stars indicate whether results are significant to alternative significance levels of 10, 5 and 1 per cent.

Netherlands and Switzerland for education-related inequalities and Austria, Sweden and Denmark for income-related inequalities). Belonging to the target group related to age (i.e. women aged 50 to 69 years) statistically explains between 85 per cent in Sweden (115 per cent in Sweden) and 16 per cent in Poland (30 per cent in Germany) of income-related (education-related) inequalities. According to equation 3 this result can be explained by the fact that this age group is concentrated among the better off (not shown here) and being in this age group is strongly positively associated with mammography uptake (compare Table 2). Still, Italy is the most unequal country but the index decreases from E = 0.329 to E= 0.241 for income-related inequalities and from E = 0.327 to E = 0.167 for education-related inequalities. Turning to the additional adjustment for "diagnostic needs", i.e. adjusting for all need factors, inequality slightly decreases further in most countries compared to age-group adjusted inequality. The effect of a cancer history on income- and education-related inequalities in mammography uptake, as measured by the difference between the Erreygers index adjusted for age-group and the overall adjusted Erreygers index accounts up to 0.7 index points. However, inequalities in mammogram uptake still remain statistically significant in the same countries as before. Regarding mammogram the results are fairly robust considering the correction method applied to the concentration index; i.e. regarding the value judgment behind them. Especially if the prevalence of screening is close to 50 per cent (e.g. Italy or Spain as shown in Table 1) E and W do not differ very much. For education-related inequalities the ranking of the 5 countries with the most unequal distribution is exactly the same. Regarding income-related inequalities the top 5 ranking differs slightly.

Two major differences compared to mammography are evident when turning to colorectal cancer prevention (i.e. colonoscopy or stool examination): firstly, inequality is sensibly lower. A significant inequality favouring the better-off (better educated) can however still be found in many countries after adjusting for all needs. These are Germany, Sweden, Italy, France, Greece and Belgium considering education-related inequality, and Germany, France and Belgium for income-related inequality. Secondly, needs adjustment has a much smaller impact on inequalities compared to mammography and inequality increases on average slightly in favour of the rich and better educated after adjusting for all needs. E.g. Sweden, Italy and Greece only exhibit a significant pro better educated inequality after adjusting for all needs. These results can be explained by the fact that needs, which are positively related to this preventive measure (compare Table 2), are concentrated among the worse off (worse educated). Moreover, the results are more sensitive regarding the correction method applied to the concentration index. Especially for countries with a low prevalence (i.e. far away from 50 per cent) of colonoscopies and stool examinations (e.g. Belgium and Greece as shown in Table 1) the Wagstaff index gives considerably larger values than the Erreygers index leading to an alternative country ranking as well. Thus, in the case of colorectal cancer prevention, it is relevant to control for alternative corrections of the concentration index (i.e. alternative value judgments) when comparing inequalities across countries.

Results for blood tests, blood pressure checks and influenza-vaccination are given in Table 4. Following general pattern emerges: Firstly, a significant inequality favouring the poor and less educated can be found for each preventive measure in many countries, but not in all

countries, if we do not control for needs.[20] This result contrasts the results found for cancer prevention indicating that in many countries these preventive measures are taken-up more often by the less educated and worse-off. Secondly, if we adjust for age or age groups (routine needs), the pro-poor and pro less-educated inequality decreases remarkably for some countries, while in other countries no effect can be found. In example, the effect of age on income-related inequalities in blood-pressure checks, as measured by the difference between the unadjusted Erreygers index and the age adjusted Erreygers index, ranges from 0.109 index points (Denmark) to 0.012 index points (Greece). The impact on education-related inequalities ranges from 0.065 (Sweden) to 0.003 index points (Poland). The age-group-effect is strongest for influenza vaccination but differs again much across countries. In example, belonging to the age group over 60 years increases the Erreygers index for income-related inequalities in Denmark by 0.194 index points whereas it increases the Erreygers index in Poland only by 0.001 index point. This result suggests that only in some countries like Denmark this age-group (i.e. the 60+) is not only concentrated among the poor but it is also strongly related to the probability of getting a flu-shot (compare Table 2).

Thirdly, if we additionally adjust for risk factors and symptoms (diagnostic needs) the inequality shifts on average even more in favour to a pro-rich or pro better educated inequality. This can be seen comparing age-group adjusted to all-need-adjusted E-index. In example, the effect of blood-pressure risk factors (i.e. self-assessed-health, heart attack, stroke, diabetes, overweight and male) on income-related inequalities in blood-pressure checks, as measured by the difference between the age adjusted Erreygers index and the overall adjusted Erreygers index, ranges from 0.057 index points (Denmark) to -0.005 (Austria) index points. The impact on education-related inequalities ranges from 0.065 (Sweden) to 0.005 index points (Austria). This means that risk factors and health problems are not only concentrated among the poor but also are positively related to higher use of preventive care. Thus, poor and less educated people are generally more likely than the better off to use preventive care late, e.g. when health problems display already symptoms and increase health risks. Moreover, such comparison suggests that pro-rich inequality increases when we adjust our assumption from "Diagnostic needs do differ across income and education groups (only age-adjusted E)" to "Diagnostic needs do not differ across income and education groups" (overall need adjusted E). An increasing figure means that under the assumption that diagnostic needs are equal the inequality would be even higher, but, in fact, needs are pro-poor and less educated distributed; thus inequality would be underestimated if we did not standardize for diagnostic needs.[21] Strikingly is that on average, after adjustment for all needs, a considerable higher inequality favouring the rich (6 out of 13 countries) and better educated (5 out of 13 countries) can be found for blood tests compared to blood-pressure (only 3 pro-rich respectively 2 pro better educated) and influenza vaccination (only 2

[20]One exemption is Poland where we found a pro-rich inequality for each preventive measure.

[21] This result is confirmed for all treatments analysed for which poor and less educated are effectively more in need of diagnosis, as they suffer more from specific health problems (heart attack, stroke, diabetes, gastrointestinal problems, etc.). The only exception is breast cancer screening, where diagnostic needs as measured in our analysis (history of cancer) seem to be distributed effectively equal across socio-economic groups. This is likely due to the fact that breast health problems are difficult to be detected by individuals as they do not produce evident symptoms as other diseases. Thus, the only measure of symptoms we can use is unlikely informative.

pro rich respectively 3 pro better educated). After adjusting for all needs, the concentration among the rich and better educated is highest in Poland for blood pressure checks and blood tests and in Italy (income-related inequality) and Germany (education-related inequality) for influenza vaccination. In general the results for blood tests, blood pressure checks and influenza-vaccination are fairly robust as regards the correction method applied to the concentration index. This indicates that the prevalence of each preventive measure is not far away from 50 percent in most countries. However, for some countries with a high prevalence of blood-tests and blood-pressure checks that is far away from 50 per cent (i.e. Greece or Spain), the Wagstaff index gives considerably larger values than the Erreygers index leading to an alternative country ranking as well.

[Table 4 around here]

6. Conclusion and Discussion

This paper presents the first cross-country estimation of needs-adjusted income and education-related inequalities in the use of a whole set of preventive care treatments. The pragmatic approach we have adopted in the paper aims to measure inequalities without taking a view on the legitimate vs. illegitimate part of them. We argued that such piece of information is relevant because; (a) scarce access to preventive care by poor and less educated people might be not cost-effective as they are generally less efficient to convert cure in health and (b) assessment of inequalities in preventive care is a more conciliatory way to assess equity in health care delivery because need definition is less problematic.

We use the Survey of Health, Ageing and Retirement in Europe (SHARE) which includes comprehensive information on socio-economic factors, health status, health risk, and on several preventive measures of the elderly Europeans (50+). We refer to early diagnosis of most prevalent cancers, namely breast cancer (mammography) and colorectal cancer (colonoscopy and fecal occult blood test), to influenza vaccination and to the most routinely tests such as blood pressure test, cholesterol and blood sugar test. Inequality is computed through alternative concentration indices, based on the CI-corrections for binary outcomes proposed by Erreygers and Wagstaff.

A particular contribution of the paper is to analyse whether poor and less educated are more likely than the better off to use preventive care late, e.g. when health shocks already occurred or health problems display already symptoms. To consider this potential "late preventive care use" in the measurement of inequalities we standardize inequalities (i.e. adjust the CI) considering two types of needs: specific age groups when referring to "routine prevention" and both subjective and objective health conditions and specific health problems when we refer to diagnostic treatments (i.e. potential "late preventive care use").

Our analysis detects some stylized facts in socio-economic related inequalities in preventive care across Europe. Firstly, after adjusting for needs, strong pro-rich (better educated) inequalities in breast screening are detected in nearly all countries with very few exceptions.

A similar pattern is observed for inequalities in blood tests and colorectal cancer prevention with many countries exhibiting pro-rich and educational inequalities in favour of the better educated. On the other side, we do not find considerable inequalities favouring better off for income and education-related inequalities in flu vaccination and for income-related inequalities in blood pressure check. This pattern emerges even in presence of a higher needs concentration among poor and less educated.[22]

The existence of inequalities which resists to a detailed control for needs is a concern for European health policy. The pattern observed seems to recall the importance of an equal access to both specialist doctor and GP. Indeed, empirical evidence around inequalities in doctor utilization in Europe suggests that wealthier and higher educated individuals appear to be much more likely to see a specialist despite their lower needs for such care, while, in contrast, there is little or no evidence of income-related inequity in the probability of a GP-visit (see Van Doorslaer, Koolman and Jones, 2004; Stirbu *et al.,* 2011). Our results go in the same direction because colorectal cancer prevention, mammography and blood tests which are treatments mostly provided in a specialty setting are the most unequally distributed, while, blood pressure and influenza vaccination that are fairly equally distributed are very often provided in a GP setting. A more unequal use of preventive care provided by specialist vs. preventive care provided by GP has been found also by Lorant *et al.* (2002) in Belgium. Interestingly, we find a pro-rich pattern in specialist setting treatments even in countries with universal and comprehensive insurance coverage and little co-payment for specialist visits, such as Denmark. Thus, possible explanations of this pattern may involve factors not directly related to monetary costs of treatments.

Vick and Scott (1998) highlighted that help-seeking processes are influenced by income and education. Poor and less educated persons often do not possess abilities or medical insight to self-refer to a specialist preferring a consultation with a long term physician as a family GP. Other possible explanations of strong inequalities in cancer screening involve the role of psychological factors such as fear and anxiety which seems to be important reasons why sick people are less likely to get cancer screenings as found by Wu (2003). Thanks to the richness of SHARE dataset used, in our paper we can control for detailed need factors for cancer screening (history of cancer, and specific health problems) but a pro-rich and more pro-educated inequality pattern are still present. Thus, it could be that anxiety and psychological factors generate inequalities in cancer screening, because other than being correlated with needs they are negatively correlated with income and education as a long-standing empirical literature seems to suggest (see Dohrenwend *et al.*, 1992 among others). Further research is required in order to understand to what extent an unequal distribution of fear and anxiety problems among socio-economic groups is generating inequalities in screening.

[22] Indeed, with the exception of breast cancer screening (i.e. where high risk age groups are richer and more educated than their counterparts), health care needs are on average more concentrated among poor and less educated. The higher concentration of income and education among high-risk age groups for breast cancer screening (50-69 for mammography) is due to the fact that such individuals are more often active in the labour market while older individuals are more often retired (note that our sample is made of 50+ individuals) while higher concentration of health care needs among poor reflects the well-known pro-poor distribution of morbidity (heart attacks, diabetes, overweight).

A second pattern observed is that poor and less educated people are generally more likely than the better off to use preventive care late, e.g. after health shocks occurred or health problems display already symptoms. This would indicate a bad preventive behavior by worse off. Notwithstanding, this finding requires two cautious notes. The first is that effects are quite small for many countries.[23] The second regards its interpretation. Bad preventive behavior by worse-off could be a choice based on a complete information set or be a choice based on few or wrong information on the relevance of prevention for health. Such a difference is relevant in order to understand whether it is a source of legitimate vs. illegitimate inequality. On one side, this pattern can be due to the fact that worse-off may consider treatments as unnecessary in the absence of symptoms (see Filèe *et al.*, 1996) and only seek examinations when health problems display symptoms. To put it in terms of the Grossman Model (1972) it could be that poor and less educated people are more prone to consume than invest in health care (i.e. seeking an examinations only to confirm an expected diagnosis and therefore to cure an health problem). This pattern may highlight a small attachment to health problems by worse off which can be coherent also with some empirical evidence which suggests that poor and less educated persons demand less information from the physician regarding their health problems (see Vick and Scott, 1998). If this behavior is a matter of preferences and we adopt an equality of opportunity approach, this kind of inequality can be considered legitimate and it would not require a policy intervention.

On the other side, if we recognize that this pattern is due to a lack of information of which poor and less educated individuals have no responsibility this would constitute an illegitimate inequality. O'Malley, Earp and Hawley (2001) show that poor and less educated patients effectively receive less screening recommendations by physicians. In terms of equality of opportunity, such inequality should be considered unfair, as the opportunity of receiving the appropriate information is non-independent of the circumstances. If we adopt Sen's view, this pattern may stem illegitimate inequalities even without knowing whether the information is equally distributed among individuals, as also inequalities due to a bad preventive behavior by poor and less educated may be considered illegitimate as they can be due to an 'unfreedom' to conquer the bad habit of not doing prevention. Again, we do not take a view on this argument. We just observe a concentration of this pattern among worse off in many countries. Unless one is willing to assume that poor and less educated persons in different countries are barely interested in their health, this seems to suggest that not doing prevention might be not a free and perfectly informed choice.

A third characteristic observed is a mild association between inequalities and the generosity of welfare state regimes. A more pronounced inequality pattern is observed in health care systems with higher recourse to private out-of pocket payments (OOP). For instance, in Greece where recourse to OOP is massive (Wendt, 2009), significant pro-rich inequalities are observed for many treatments analysed. A similar pattern is observed in Poland, where OOP payments in the health sector are emerging as a fundamental aspect of health care financing which creates serious access problems to various kinds of health care services (Busse *et al.*,

[23] This can be seen by the difference between age-group adjusted and all-need-adjusted E-index in Tables 3 and 3 which is negligible for many countries and null for some others.

2006). On the other side, systems with public and generally universal coverage (such as Sweden, Denmark and Netherlands) manage quite well in fighting inequalities for quite all treatments. But with the exception of these extreme versions, pro-rich inequalities patterns are quite similar in all welfare models. For instance, breast cancer screening is distributed pro-rich in all mixed private-public systems such as Germany, France and even in some countries with universal coverage such as Italy. Interestingly, only in influenza immunization quite all countries reach to ensure equal access. This is one of the treatments when negative externalities are likely so it could be that systems have a strong efficiency motivation to guarantee widespread access to the treatments other than equity one.

Our paper cannot answer some relevant points. Firstly, it is not able to disentangle inequalities due to supply versus demand factors. A complete assessment of inequalities due to demand factors vs. supply factors is what is really needed to understand whether reduction of inequalities requires interventions which reduce access barriers to health care (supply side) or interventions which increase information regarding the importance of prevention (demand-side). Secondly, it is not able to disentangle inequalities due to a lack of information from inequalities due to preferences. The latter type of inequalities would render policy interventions weakly coherent with a libertarian view of public interventions; on the other side, the former kind of inequality would require more investments in information campaigns and financial incentives for physicians to suggest screenings even to poor and less educated people who do not ask for it. Cutler and Lleras-Muney (2010) show that in the US and the UK individual preferences such as discounting, risk aversion and the value of future do not account for any of the education gradient in health behaviors, including prevention. Further research is required to understand whether this pattern is present also in the European countries analysed in this paper. If it were the case, our limitation may turn out to be not really relevant and also policy interventions would be more clear-cut.

Despite these limitations, this paper proves that socio-economic related inequalities in preventive care are a European issue and not a single country phenomenon. In addition, it demonstrates that inequalities are present even in countries where cost-sharing is zero or very low and it demonstrates that poor and less educated persons are generally more likely to use preventive care late, e.g. after health shocks occurred or health problems display already symptoms. All these factors together seem to suggest that inequalities in preventive care are a special case of health care inequalities for which an equal treatment of equals may also require an equal agency relationship between specialists and patients and an equal access to information on the importance of prevention other (or even more) than very low costs at point of consumption.

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Figure 1

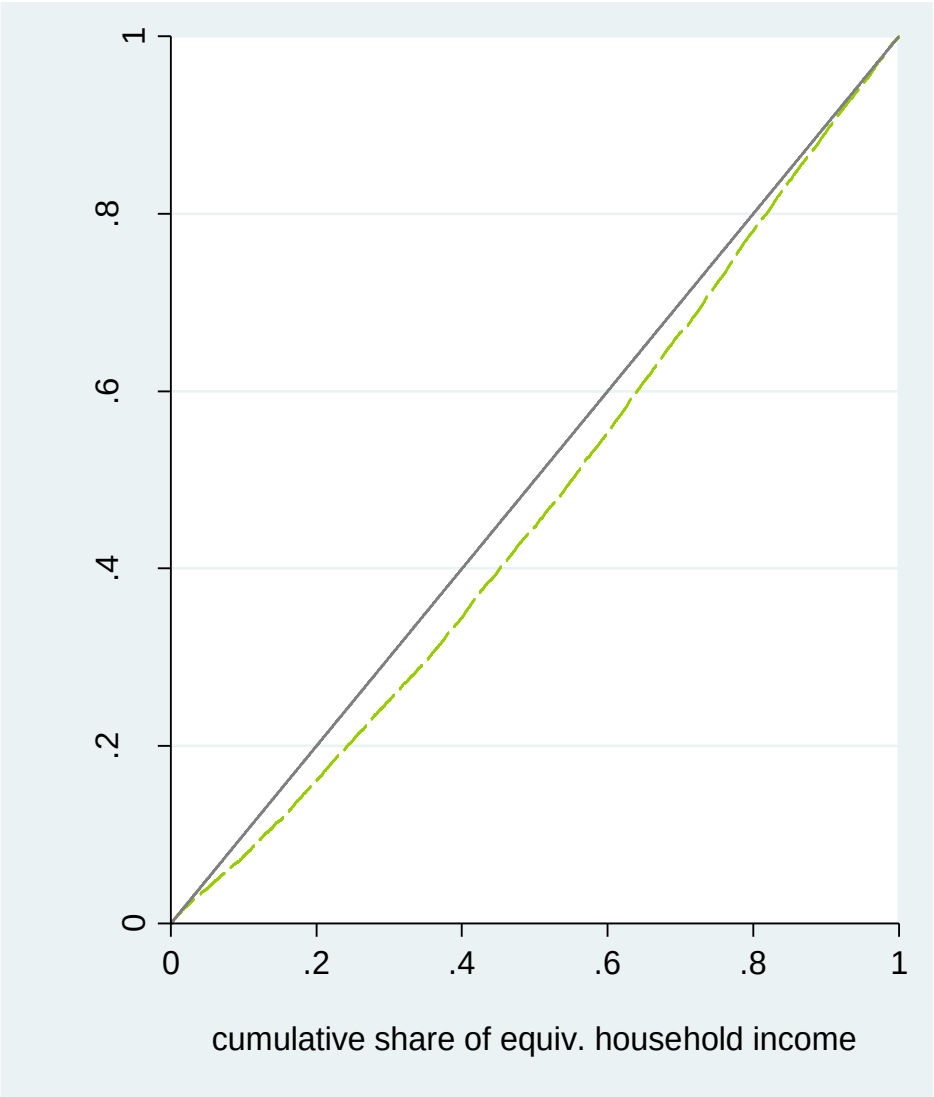

Table 1: Descriptive Statistics

	All		AT		BE		CH		CZ		DK		ES		FR		GE		GR		IT		NL		PL		SE	
Variables	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**	**M[1]**	**SD[2]**
Endogenous																												
Mammogram (%)	51	50	55	49	63	48	39	49	53	50	21	41	51	50	68	47	40	48	34	48	53	50	77	42	34	47	69	46
Colonoscopy (%)	16	37	31	46	15	35	20	40	n/a	n/a	14	35	8.5	28	22	42	26	43	6.1	24	15	35	9.5	29	n/a	n/a	13	34
Stool (%)	21	41	72	45	8.7	28	24	43	n/a	n/a	6.7	25	5.1	22	23	42	66	48	3.9	19	13	34	4.3	20	n/a	n/a	14	35
FluVacc. (%)	31	46	28	45	43	50	31	46	16	37	24	42	42	49	35	48	36	48	18	38	36	48	43	50	11	32	29	45
Bloodpressure (%)	71	45	70	49	84	36	68	47	64	48	49	50	79	41	86	35	64	48	81	39	76	42	62	49	64	48	61	48
Bloodtest (%)	70	46	59	46	84	37	63	48	54	48	51	50	83	38	79	41	71	45	87	33	81	39	52	50	56	50	49	49
Exogenous																												
ISCED	2.6	1.5	2.8	1.3	2.9	1.5	2.9	1.2	2.5	1.1	3.4	1.4	1.4	1.3	2.5	1.8	3.5	1.1	2.2	1.5	1.8	1.2	2.9	1.4	2.3	1.3	2.8	1.5
HH.Inc. (1000 €)	20	22	19	21	20	20	37	29	6.4	5	30	29	14	22	25	26	23	22	16	24	15	12	22	18	4.9	8.5	22	16
Age50_74 (%)	74	44	84	35	83	37	81	38	86	34	85	35	78	41	82	38	88	32	85	35	85	35	87	33	85	34	84	36
Age50_69 (%)	72	45	72	44	71	46	70	46	73	44	74	44	61	49	71	46	77	42	73	44	72	45	76	43	75	43	73	45
Age60+ (%)	61	49	67	47	59	49	62	49	61	49	57	50	68	47	57	49	62	48	57	49	66	47	57	49	54	43	66	47
Age	67	9.5	68	8.9	67	9.7	68	10	66	9.1	66	9.9	69	10.3	67	9.9	67	8.7	67	9.8	68	8.9	66	9	65	9.4	68	9.3
SAH	3.0	1.1	2.9	1.0	2.9	1.0	2.6	1.0	3.3	1.0	2.5	1.1	3.4	0.9	3.1	1.0	3.2	0.9	2.8	1.0	3.2	1.0	2.8	1.0	3.8	1.0	2.5	1.1
Cancer (%)	4.1	20	2.3	15	4.4	21	4.1	20	4.7	21	6.3	24	2.4	15	4.5	21	4.5	20	2.0	14	3.3	17	4.4	20	2.4	15	6.2	24
Heart Attack (%)	11	32	10	30	12	32	5.7	23	15	36	9.2	29	10	30	13	33	11	31	11	31	10	31	8.4	28	21	40	14	35
Lung Disease (%)	4.8	21	4.2	20	4.3	20	3.4	18	4.1	20	5.6	23	5.4	23	4.6	21	5.1	22	3.4	18	7.3	26	5.8	23	5.2	22	2.5	16
Asthma (%)	4.6	20	3.9	20	2.6	16	4.0	20	4.7	21	6.9	25	3.9	20	4.4	21	3.6	18	3.2	18	4.9	22	4.4	21	7.6	26	7.4	26
Stroke (%)	3.2	17	3.2	18	3.3	18	2.3	15	3.9	19	4.1	20	2.2	15	3.1	17	3.3	18	1.8	13	2.5	16	3.7	19	5.2	22	2.6	16
Diabetes (%)	9.6	29	8.9	29	8.1	27	5.3	22	14	35	6.1	24	15	36	8.6	28	12	32	10	30	12	32	8.4	28	10	31	7.7	27
Arthritis (%)	13	34	12	33	22	41	11	32	15	35	26	44	30	46	28	45	13	34	16	37	35	48	10	30	34	48	9.3	29
Gastro. Probl.(%)	13	34	9.6	29	14	35	10	31	16	37	11	31	14	34	16	36	13	34	11	32	16	37	9.5	29	18	39	14	35
intest.ulc.(%)	5.1	22	5.3	22	6.3	24	1.9	14	7.1	26	5.1	22	4.4	21	3.4	18	3.3	18	7.3	26	5.7	23	2.8	17	10	30	3.6	19
Overweight (%)	62	49	64	47	61	49	50	50	73	44	54	50	75	43	56	50	63	48	68	47	64	48	58	49	68	47	56	49
Men (%)	46	50	43	49	47	50	45	50	44	50	48	50	44	50	46	50	47	50	45	50	45	50	48	50	44	50	52	50
30702	1226		4276		1627		1509		2433		2041		2679		2530		2594		3121		2496		1607		2151			

[1]International Standard Classification of Education

Table 2: Effect of income on prevention

	Mam1	Mam2	StoolColo1	StoolColo2	Flu1	Flu2	BT1	BT2	BP1	BP2
Quintile 1	-0.26***	-0.16***	-0.13***	-0.14***	0.06**	0.00	-0.01	-0.05***	0.02	-0.02
Quintile 2	-0.20***	-0.12***	-0.02	-0.05*	0.04*	-0.04*	-0.00	-0.04***	0.04***	-0.01
Quintile 3	-0.16***	-0.09***	-0.01	-0.02	-0.00	-0.06***	0.01	-0.02*	0.02*	-0.01
Quintile 4	-0.05**	-0.03	-0.02	-0.03	0.02	-0.00	0.00	-0.01	0.02	0.01
Age50_69		0.37***								
Cancer		0.25***		0.11***						
Age50_74				0.09***						
Gastrointestinal probl.				0.10***						
Intestinal ulcer				0.12***						
Age60more						0.28***				
SAH						0.01*				
Heart attack						0.10***		0.11***		0.10***
Lung disease						0.11***				
Asthma						0.06**				
Stroke						0.06		0.10***		0.08***
Diabetes						0.10***		0.16***		0.12***
Arthritis						0.01				
Age								0.00***		0.01***
Overweight								0.08***		0.10***
Male								-0.01		-0.02**
Germany	-0.17***	-0.18***	-0.08***	-0.08***	0.07***	0.06**	0.01	0.00	0.05*	0.04*
Sweden	0.22***	0.17***	-0.45***	-0.45***	-0.01	-0.00	-0.21***	-0.19***	0.00	0.03
Netherlands	0.18***	0.17***	-0.65***	-0.64***	0.19***	0.17***	-0.17***	-0.17***	0.03	0.04
Spain	-0.07**	-0.03	-0.66***	-0.67***	0.14***	0.11***	0.14***	0.12***	0.21***	0.18***
Italy	-0.10***	-0.08***	-0.53***	-0.54***	0.10***	0.07***	0.11***	0.10***	0.16***	0.15***
France	0.14***	0.12***	-0.35***	-0.36***	0.07**	0.07***	0.08***	0.09***	0.27***	0.29***
Denmark	-0.24***	-0.30***	-0.49***	-0.49***	-0.05*	-0.02	-0.17***	-0.14***	-0.10***	-0.07***
Greece	-0.25***	-0.25***	-0.68***	-0.68***	-0.09***	-0.12***	0.17***	0.17***	0.22***	0.21***
Switzerland	-0.15***	-0.15***	-0.36***	-0.36***	0.02	0.02	-0.06**	-0.04	0.09***	0.11***
Belgium	0.03	0.04*	-0.56***	-0.56***	0.18***	0.17***	0.14***	0.14***	0.25***	0.25***
Poland	-0.26***	-0.27***	0.00	0.00	-0.15***	-0.20***	-0.15***	-0.16***	0.04*	0.04
Czechia	0.12***	0.07**	0.00	0.00	-0.14***	-0.14***	-0.17***	-0.17***	0.03	0.04
Constant	0.69***	0.37***	0.79***	0.71***	0.26***	0.09***	0.70***	0.41***	0.57***	0.17***
Observations	16988	16988	7687	7687	12845	12845	30702	30702	30702	30702

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

Table 3: Education and income-related inequalities in cancer prevention

	Mammogram				Colonoscopy or Stool			
	E unadjusted	**E adj. for age group**[2]	**E adj. for all needs**(Top 5 ranking in brackets)[3]	**W adj. for all needs**(Top 5 ranking in brackets)[3]	**E unadjusted**	**E adj. for age group**[4]	**E adj. for all needs**(Top 5 ranking in brackets)[5]	**W adj for all needs**(Top 5 ranking in brackets)[5]
Education-related inequalities in cancer prevention								
Austria	.134***	.065	.065	.047	-.075*	-.073*	-.073*	-.093*
Germany	.166***	.093***	.090***	.108***	.099***	.104***	.112*** (2.)	.119** (2.)
Sweden	.141***	-.021	-.020	-.029	.030	.034	.061** (4.)	.080* (5.)
Netherlands	.096***	.001	.001	-.015	-.014	-.013	.000	.025
Spain	.315***	.084***	.081***	.089***	-.027	-.022	-.016	-.048
Italy	.327***	.167***	.160*** (4.)	.167*** (4.)	.051	.077*	.081** (3.)	.074*
France	.255***	.133***	.126*** (5.)	.138*** (5.)	.112***	.120***	.120*** (1.)	.112*** (3.)
Denmark	.122***	.060**	.062**	.076**	.024	.025	.040	.061
Greece	.288***	.168***	.167*** (2.)	.195*** (2.)	.057***	.054**	.053** (5.)	.147** (1.)
Switzerland	.091**	.029	.020	.013	.040	.035	.041	.049
Belgium	.295***	.168***	.163*** (3.)	.184*** (3.)	.035	-.036	.046**	.086*** (4.)
Czechia	.152***	.079*	.087*	.061	n.a.	n.a.	n.a.	n.a.
Poland	.280***	.196***	.180*** (1.)	.236*** (1.)	n.a.	n.a.	n.a.	n.a.
Income-related inequalities in cancer prevention								
Austria	.161***	.058	.053	.057	-.046	-.041	-.034	-.045
Germany	.184***	.131***	.124*** (4.)	.145*** (3.)	.126***	.134	.139*** (2.)	.169*** (1.)
Sweden	.282***	.043	.043	.053	-.001	.001	.021	.030
Netherlands	.157***	.083***	.082***	.122*** (5.)	-.016	-.016	-.010	-.028
Spain	.281***	.140***	.138*** (3.)	.144*** (4.)	-.040	-.038	-.042	-.114
Italy	.329***	.247***	.241*** (1.)	.266*** (1.)	.041	-.046	.048 (5.)	.064
France	.198***	.108***	.101**	.117**	.135***	.142***	.145*** (1.)	.145*** (2.)
Denmark	.098***	.022	.031	.046	-.074*	-.066*	-.041	-.069
Greece	.150***	.089***	.088***	.111***	.026	.022	.025	.073 (5.)
Switzerland	.142***	.086**	.081*	.093*	.064	.072	.078 (3.)	.083 (4.)
Belgium	.217***	.092***	.091*** (5.)	.103***	.040*	.042*	.062*** (4.)	.091*** (3.)
Czechia	.270***	.082**	.079*	.079*	n.a.	n.a.	n.a.	n.a.
Poland	.203***	.171***	.166*** (2.)	.204*** (2.)	n.a.	n.a.	n.a.	n.a.

E = Erreygers Index; W = Wagstaff Index;[2] Age50_69; [3] Age50_69, cancer [4] Age50_74; [5] sah, Age50_74, gastroinstestinal problems, intestinal, ulcer cancer;
* p < 0.10, ** p < 0.05, *** p < 0.01

Table 4: Education and income-related inequalities in routine prevention

	Reg_Bloodtest				Reg_Bloodpressure				Influenza Vaccination			
	E unadjusted	**E adj. for age group**[2]	**E adj. for all needs**(Top 5 ranking in brackets)[3]	**W adj. for all needs**(Top 5 ranking in brackets)[3]	**E unadjusted**	**E adj. for age group**[4]	**E adj. for all needs**(Top 5 ranking in brackets)[5]	**W adj for all needs**(Top 5 ranking in brackets) [5]	**E unadjusted**	**E adj. for age group**[4]	**E adj. for all needs**(Top 5 ranking in brackets)[5]	**W adj for all needs**(Top 5 ranking in brackets)[5]
Education-related inequalities in routine prevention												
Austria	.067*	.078**	.068* (2.)	.046 (4.)	-.001	.011	.016 (5.)	.025 (5.)	-.043	-.028	-.033	-.040
Germany	-.025	-.009	.017	.017	-.054**	-.031	.014	-.004	.005	.035	.067** (1.)	.056* (3.)
Sweden	-.098***	-.066***	-.017	-.025	-.161***	-.096***	-.058**	-.073	-.087**	.016	.051* (2.)	.051* (4.)
Netherlands	-.103***	-.091***	-.041	-.035	-.105***	-.082***	-.037	-.050*	-.161***	-.055*	.015	-.019
Spain	.025	.041*	.066*** (3.)	.126*** (1.)	-.069**	-.022	.009	.012	-.260***	-.125***	-.053*	-.063*
Italy	-.014	.014	.036* (5.)	.039 (5.)	-.079**	-.047	-.022	-.033	-.113***	.013	.050* (3.)	.049* (5.)
France	-.046*	-.021	.012	.036	-.015	.020	.036* (3.)	.068* (2.)	-.120***	-.016	-.017	-.022
Denmark	-.074**	-.038	.006	-.004	-.080***	-.033	.010	.012	-.063**	.020	.034	.047
Greece	-.023	.023	.037** (4.)	.062* (3.)	-.072**	-.028	.021 (4.)	.029 (4.)	-.109***	-.052**	-.008	-.013
Switzerland	-.033	-.007	-.006	.001	-.007	.019	.041 (2.)	.050 (3.)	-.098***	-.050	-.003	.012
Belgium	-.031	-.020	-.012	-.016	-.066***	-.056***	-.036**	-.069**	-.129***	-.064**	-.010	-.017
Czechia	-.046	-.044	-.030	-.041	-.026	-.019	.001	-.007	.029	.025	.045 (4.)	.083 (2.)
Poland	.074**	.061*	.092*** (1.)	.111*** (2.)	.033	.036	.076*** (1.)	.071** (1.)	.022	.024	.034 (5.)	.085 (1.)
Income-related inequalities in routine prevention												
Austria	.060	.062	.055	.049	.008	.025	.020	.027	-.040	-.019	-.030	-.036
Germany	-.00	.013	.048* (5.)	.057*	-.058**	-.040	.01	.006	-.065*	-.043	-.009	-.012
Sweden	-.041	.009	.033	.026	-.067**	.028	.040 (5.)	.042	-.239***	-.086**	-.035	-.039**
Netherlands	-.037	-.026	.009	.005	-.078***	-.061***	-.032	-.038	-.111***	-.062**	.001	-.015
Spain	.015	.003	.039*	.071* (5.)	-.042*	-.011	.005	.001	-.129***	-.034	.009	-.004
Italy	.054**	.062**	.080*** (2.)	.132*** (3.)	.011	.025	.041 (4.)	.056 (5.)	.040	.015	.113*** (1.)	.112*** (2.)
France	-.002	.010	.036	.055	.002	.018	.031	.064 (4.)	.006	.053	.049 (3.)	.050 (3.)
Denmark	-.162***	-.082***	-.018	-.030	-.189***	-.080***	-.023	-.036	-.262***	-.065*	-.015	-.032
Greece	.043**	.052**	.078*** (4.)	.173*** (1.)	.018	.038	.075** (3.)	.121*** (1.)	-.068*	-.029	-.006	-.013
Switzerland	.064*	.086**	.079** (3.)	.084** (4.)	.051	.075**	.081** (2.)	.091** (3.)	-.064	-.009	.037 (4.)	.033 (4.)
Belgium	-.023	-.023	-.00	-.00	-.023	-.011	.004	.006	-.117***	-.051	-.006	-.012
Czechia	-.054	-.049	-.015	-.016	-.043	.000	.022	.022	-.048	-.024	.014 (5.)	.015 (5.)
Poland	.152***	.147***	.157*** (1.)	.161*** (2.)	.097***	.097***	.109*** (1.)	.117*** (2.)	.075***	.076***	.079*** (2.)	.196*** (1.)

E = Erreygers Index; W = Wagstaff Index; [2]age; [3] age, heart attack, stroke, diabetes, overweight and male; [4] Age60more; [5] Age60more, sah, heart attack, lung disease, asthma, stroke, diabetes, arthritis

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

Table A 1: Effect of education on prevention

	Mam1	Mam2	StoolColo1	StoolColo2	Flu1	Flu2	BT1	BT2	BP1	BP2
ISCED0	-0.39***	-0.21***	-0.06	-0.10**	0.15***	-0.02	0.02	-0.07***	0.07***	-0.04*
ISCED1_2	-0.23***	-0.12***	-0.05**	-0.07***	0.05**	-0.04**	0.04***	-0.01	0.08***	0.01
ISCED3_4	-0.05**	-0.02	-0.02	-0.03	-0.04**	-0.05**	0.02	0.00	0.05***	0.03**
Age50_69		0.36***								
cancer		0.25***		0.12***						
Age55_79				0.09***						
Gastrointestinal problems				0.14***						
Intestinal ulcer				0.20						
Age60more						0.27***				
SAH						0.01*				
Heart attack						0.10***		0.11***		0.10***
Lung disease						0.11***				
Asthma						0.06*				
Stroke						0.05		0.10***		0.08***
Diabetes						0.10***		0.16***		0.12***
Arthritis						0.01				
Age								0.00***		0.01***
Overweight								0.08***		0.10***
Male								-0.01		-0.02**
Germany	-0.21***	-0.20***	-0.09***	-0.10***	0.08***	0.05**	0.02	0.01	0.06**	0.04*
Sweden	0.12***	0.11***	-0.53***	-0.54***	0.01	0.01	-0.22***	-0.21***	0.01	0.02
Netherlands	0.22***	0.20***	-0.63***	-0.62***	0.16***	0.16***	-0.17***	-0.16***	0.02	0.05*
Spain	0.08***	0.06**	-0.62***	-0.61***	0.07**	0.10***	0.14***	0.15***	0.19***	0.20***
Italy	0.02	-0.00	-0.49***	-0.50***	0.06**	0.07***	0.10***	0.12***	0.14***	0.16***
France	0.19***	0.15***	-0.36***	-0.36***	0.05*	0.07***	0.08***	0.10***	0.27***	0.30***
Denmark	-0.37***	-0.37***	-0.57***	-0.58***	-0.02	-0.02	-0.17***	-0.16***	-0.09***	-0.08***
Greece	-0.16***	-0.20***	-0.64***	-0.63***	-0.14***	-0.13***	0.17***	0.18***	0.21***	0.22***
Switzerland	-0.16***	-0.15***	-0.39***	-0.38***	0.03	0.04*	-0.07***	-0.05*	0.07***	0.10***
Belgium	0.07***	0.07***	-0.54***	-0.54***	0.16***	0.16***	0.14***	0.15***	0.25***	0.26***
Poland	-0.20***	-0.23***	0.00	0.00	-0.18***	-0.21***	-0.14***	-0.15***	0.04	0.04*
Czechia	0.02	0.01	0.00	0.00	-0.11***	-0.12***	-0.18***	-0.19***	0.04	0.03
Constant	0.66***	0.35***	0.78***	0.70***	0.29***	0.11***	0.67***	0.38***	0.54***	0.13***
Observations	17277	16753	7631	7628	12760	12752	30436	30290	30436	30290

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