Contributions of risk preference, time orientation and perceptions to breast cancer screening regularity

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Abstract

Disparities in breast cancer screening are often explained by socioeconomic factors, although a growing body of papers show that risk preference, time orientation and perceptions may explain mammography use. The aim of this paper is to estimate the relative contribution of socioeconomic factors, risk preference, time orientation and perceptions to disparities in breast cancer screening regularity. These determinants are elicited in an experimental laboratory from 178 women aged between 50 and 75 years in France in 2013. The results reveal that risk aversion accounts for 30% of the variance in screening regularity, which is greater than that attributable to socioeconomic determinants (20%), perceptions (11.5%) or time orientation (2%). These results suggest that further investigation on the relationship between risk aversion and screening behaviors is needed to design more comprehensive public health interventions.

Keywords: France ; behavioral economics ; laboratory experiment ; cancer screening ; risk preference ; perceptions

JEL classification: D03; I18

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1 Introduction

Breast cancer is the principal cause of mortality from cancer among women and especially among those aged 50 and older. As early diagnosis allows treatment at an earlier stage, it induces a better survival prognosis. Most European countries have implemented breast cancer screening programs (Altobelli and Lattanzi (2014)) that usually provide free mammogram every 2 years to women aged 50 to 69 or 74 because mammography is an effective breast cancer detection technique for this age group. The efficiency of these programs in terms of mortality reduction is conditional on screening participation. Although the European Guidelines indicate a reference uptake rate of 70 to 75%, uptake rate ranges from 39% in Poland to 80% in the Netherlands (as of 2010), and most European countries' uptake rates are below 70% of the eligible population.

Screening attendance disparities are usually attributed to socioeconomic characteristics (Devaux (2015), Wübker (2014)). Less educated or poorer women tend to screen less than their richer or more educated counterparts. Psychologists and experimental economists express the view that risk and recovery chance perceptions, risk preference and time orientation may also explain screening disparities (Picone et al. (2004), Chapman (2005), Carman and Kooreman (2014), Katapodi et al. (2004)).

As the decision to screen is a trade-off between delayed or immediate benefits (higher survival chances if found sick or relief if found healthy) and immediate costs (financial costs, physical pain), the weight an individual attaches to short-term or long-term consequences may matter in how she weights costs and benefits. Time orientation refers to how an individual values distant outcomes relatively to present ones. A future-oriented individual would value the screening benefit more than a present-oriented individual (Orbell and Kyriakaki (2008), Orbell et al. (2004)). How the benefits and costs of screening are weighted in the decision-making process may also depend on each individual's attitude toward the risk associated with screening's outcomes. The source of risk is the uncertainty about the true health state prior to screening. Theoretical models studying the relationship between risk aversion and disease screening yield mixed predictions. Risk aversion in screening decisions has received little attention in empirical research despite its potential relevance in screening decisions. The probability of being sick determines the likelihood of the outcome's occurrence and the probability of surviving partly determines the outcome value if an individual is found to be sick.

It could be argued that individual decision-making relies on subjective probabilities instead of the objective probabilities because of the lack of knowledge of information on the prevalence and risk factors. Personal assessments of their risk and recovery chances seem to be central to the decision to screen.

As these determinants have never been jointly investigated, their individual effects and contributions to screening disparities remain unknown. Revealing which type of determinant best explains breast cancer screening disparities would make it possible to highlight the direction toward which the research agenda and public intervention to increase uptake rate may need to be oriented. In addition, previous studies attempt to explain the likelihood of having ever screened or screened in the past two years, but no studies investigate the determinants of screening regularity. This is all the more important because it is regular screening that diminishes breast cancer mortality by 20% on average for women older than 50 (Independent UK Panel on Breast Cancer Screening (2012)).

This paper assesses the relative contribution of socioeconomic and health characteristics, risk preference, time orientation and perceived risk and recovery chances in explaining breast cancer screening regularity among French women. We conducted a survey in the laboratory among French women aged 50 to 75 years, a group for which a national screening program exists in France. Despite the small sample size ($N = 178$), conducting a survey in the laboratory enables us to elicitate risk preferences with an incentive-compatible measure. Although the correlation between risk aversion and primary prevention (smoking cessation, dieting for instance) has been widely investigated, only Picone et al. (2004) study the relationship between risk aversion and secondary prevention (cancer screening) using a hypothetical income-related question and find weak results. Rather than suggesting that risk preference is not an important factor of cancer screening decision, as it has almost not empirically being studied, it is likely that the measure employed to date have not captured how risk preference enters an individual's screening decision. This paper is a first attempt to estimate the relationship between cancer screening and risk preference elicited with an incentive-compatible measure with monetary payoffs.

Decomposing the variance of screening regularity reveals that the main contributors are risk preference (30%) and socioeconomic characteristics (20%). Finally, perceptions account for 11.5% of screening regularity variance.

The remainder of the paper is organized as follows. Section 2 provides information on the functioning of breast cancer screening in France and reviews the literature on the relevant determinants affecting breast cancer screening. Section 3 presents the data and econometric strategy used. Section 4 reports the results, and section 5 discusses them and concludes.

2 Background and literature review

2.1 Background on breast cancer screening

In France, breast cancer screening includes a clinical breast exam and a mammogram, which is an X-ray of the breast tissue that provides detailed images of the breast from 2 angles (frontal and profile). The mammogram is performed and analyzed by a radiologist. Mammogram screening is considered an effective means for detecting breast tumors for women older than 50 years of age. In France, the population-based breast cancer screening program was extended nation-wide in 2004 and provides free breast cancer screening every two years to all women aged 50 to 74 years. In addition to the organized breast cancer screening program, women can screen spontaneously - so-called opportunistic screening - by obtaining a prescription from a physician. Such exams have almost the same medical content as the organized screening, but opportunistic screening is not free. Organized and opportunistic screenings coexist and can be undertaken by all women aged 50 to 74 years, but a distinction between the two is not made in this study. The national program uptake rate has stagnated at 52% of the eligible population since 2008, and opportunistic screening is evaluated to reach 10% of the eligible population in 2008 (Haute Autorité de Santé (2011)).

2.2 Literature review on screening determinants

Risk preference: Ehrlich and Becker (1972) distinguish self-protection (activities diminishing the probability of a loss) from self-insurance (activities diminishing the size of a loss) activities. Breast cancer screening regularity corresponds to self-insurance because it decreases the size of the health loss by increasing the likelihood of detection at an earlier stage, for which treatment may be less invasive. Breast cancer screening regularity may also be considered as self-protection because it decreases the likelihood of occurrence of the worst loss (death) by allowing detection of tumors, which maybe taken away before they develop into advanced metastatic cancers. A body of theoretical papers studies the relationship between self-insurance, self-protection and risk aversion. Dionne and Eeckhoudt (1985) initially proved that risk aversion has a positive impact on self-insurance. But, it has been shown that as soon as the efficiency of self-insurance is unsure, the relationship between risk aversion and self-insurance is ambiguous (Briys et al. (1991)). This refers to the likely situation where cancer screening does not decrease the size of the health loss with certainty. Furthermore, both articles document that the relationship between risk aversion and self-protection is ambiguous, regardless of the efficiency of the self-protection activity. Eeckhoudt and Gollier (2005) explains this result by referring to higher-order risk aversion namely prudence, as defined by Kimball (1990). The rationale is that self-protection has a cost and if the loss occurs i.e. if she has cancer, her utility is reduced both by the loss (due to the disease) and by the upstream costs of self-protection. Self-protection is hence impacted by risk aversion but also by prudence. A prudent individual prefers to face a loss (only due to the disease) with a higher probability than a bigger loss (due to the disease and self-protection costs) with a smaller probability. Therefore, a prudent individual is not always willing to invest in self-protection that would diminish the occurrence of a loss, as she prefers to save this spending to cover the loss in case it occurs. Being risk averse but prudent may lead to lower self-protection. Lastly, if screening is considered as a self-insurance-cum-protection activity (reduces both the probability of death and the size of the health loss), Lee (1998), Grimm and Treibich (2016) also find it has an ambiguous relationship with risk aversion.

Another conceptual feature of cancer screening relies on the fact that cancer screening potentially delivers a bad news, which may provoke anxiety or stress. These emotions may be anticipated during the decision making process (Loewenstein et al. (2001), Kőszegi (2003)). The additional information triggered in cancer screening has an instrumental value (leading to better treatment choice) and an anticipated emotional value. Bousquet (2016) models the decision to screen for cancer by disentangling the effect of risk aversion on the instrumental and emotional values of information. She finds that when the individual is very information averse, risk aversion has a negative effect on the likelihood to screen. In addition, Picone et al. (2004)'s model reveals that when treatment is not sufficiently effective to cure the disease, risk-averse individuals are less willing to pay for screening than are risk-neutral individuals. Overall, theoretical predictions suggest an ambiguous effect of risk aversion on cancer screening.

Some empirical work focus on the relationship between risky health behaviors as smoking, drinking and seat belt use and risk aversion measured with an incentive-compatible elicitation methods (Sutter et al. (2013), Anderson and Mellor (2008), Szrek et al. (2012) and Harrison et al. (2015)).

Results are not consistent across studies and the magnitudes of the effects are sometimes small or null. More studies using hypothetical measures examine the relationship between risk preference and previously mentioned risky health behaviors (among others Barsky et al. (1995), Dohmen et al. (2011)). To our knowledge, only Picone et al. (2004)'s study looks at the relationship between risk aversion (measured with Barsky et al. (1995)'s hypothetical questions) and cancer screening. Using the Health and Retirement Survey, they find a negative but weak correlation between risk aversion and the probability of having undertaken all three cancer screening procedures (Pap smear, mammography, and breast self-exam) in the past 2 years. No significant correlation is found if each preventive care action is considered separately. The last piece of related evidence is Kullgren et al. (2014)'s attempt to increase bowel cancer screening with financial incentives. They find that the lottery payment scheme increased screening while the fixed payment did not. These empirical results suggest a negative relationship between risk aversion and cancer screening.

The present study contributes to this literature by using an incentive-compatible measure of risk preference with monetary payoffs and examines its influence on breast cancer screening regularity.

Time orientation: Heterogeneity in time orientation leads to different decisions on future health care consumption (Crockett et al. (2009)). A future-oriented person should be more likely to engage in screening because she values the future benefits of screening relatively more than its present costs. Time orientation measured with psychometric scales is associated with mammography use (Lukwago et al. (2003)), higher intention of bowel cancer and type 2 diabetes screenings (Orbell and Hagger (2006), Orbell et al. (2004)) and with engaging in exercise (Luszczynska et al. (2004), Hall and Fong (2003)).

Perceptions: Subjective probabilities encompass the subjective distribution of the occurrence of events and are approximated by individual perceptions in this study. We use perception because individuals make preventive care choices based on risk perception rather than on true risk, which is usually only partially known. Carman and Kooreman (2014) estimate both the subjective and objective probabilities of developing breast cancer and find that individuals poorly estimate their risk but that their decision to undertake mammography is based on these estimates. The effects of such perceptions on preventive care consumption are intensively studied in the psychological literature.

Perceived risk is introduced as an important predictive variable of preventive care utilization in health psychology theories (the Health Belief Model of Rosenstock et al. (1988) and the Theory of Planned Behaviors of Ajzen (1985)). Katapodi et al. (2004)'s meta-analysis shows that the effect of perceived risk on mammography uptake yields odds ratios ranging between 0.21 and 3.53 with an average of 1.77 with few studies finding a negative relationship. A recent theoretical paper by Etner and Jeleva (2013) considers the impact of risk perception on primary and tertiary preventions. Although the model setting does not consider screening cases, they distinguish between pessimists and fatalists (i.e., the latter have a higher risk perception than the pessimists) and show that only the pessimists increase their prevention levels.

The perception of recovery chances depends on the perceived efficacy of treatment as a means of reducing mortality and on the individual's capacity to fight the disease. It is believed to be positively associated with cancer screening (Champion (1999)). However, effective treatment can improve survival of interval cancers occurring between two screenings. Therefore, it might reduce the gap in survival between screen-detected cancers and interval cancers. The availability of modern treatment may then decrease the perceived recovery chances due to regular screening.

2.3 Socioeconomic and health characteristics and other determinants of screening regularity

A number of studies document a significant relationship between socioeconomic status and breast cancer screening. Devaux (2015) finds income-related inequalities in breast cancer screening in many OECD countries. In France, there is a 21 percentage point difference in the share of women who screened in the past two years between those in the highest income quintile and those in the lowest income quintile in 2009. Carrieri and Wübker (2013) also find that in many European countries, including France, strong income- and education-related inequalities exist with respect to breast cancer screening.

Although all women aged 50 to 74 years old face the same screening guidelines, they may be compliance heterogeneity between age groups (Carrieri and Wübker (2013) and Jusot et al. (2012)). For instance, newly eligible women (aged 50 to 54) may have not yet frame regular screening as routine care while older women, who were invited several times, consider regular screening as routine care.

Screening utilization also depends on the number of general practitioner (GP) and specialist physician (SP) consultations. Advising their patients to be screened for breast cancer is one of GPs' responsibilities. Although SPs are not required to advise their patients to screen, gynecologists are very likely to do so. Duport and Ancelle-Park (2006) find that having a gynecological examination in the previous 2 years is positively associated with mammography use. Access to health care conjointly depends on how much of an individual's expenses are covered by the National Health Insurance system and whether the co-payment is covered by an individual's complementary health insurance if she has such a plan. The better the health insurance coverage, the more likely individuals are to undertake cancer screening (Hsia et al. (2000) and Trivedi et al. (2008)).

Health status has an ambiguous impact on screening consumption. A person in poor health may wish to limit burdensome treatment, which can reduce (possibly already low) life expectancy, by detecting additional disease as soon as possible. However, empirical evidence shows that sicker individuals tend to screen less. Explanations advanced to date include physical limitations (Bussière et al. (2015)), enhanced anxiety (Wu (2003)) and lower valuation of health, leading to fewer actions to maintain one's health capital (Grossman (2000)).

Women with a family history of breast cancer are strongly advised to screen regularly because of genetic predisposition. Nonetheless, Kash et al. (1992) provide empirical evidence that women with a family history of breast cancer may avoid screening.

A growing body of work reveals that health, health behaviors and social inequalities are influenced by early-life circumstances, including parents' characteristics. Bricard and Jusot (2012) find that smoking trajectory is related to parents' smoking behavior and their socioeconomic status. The effect of parents' characteristics on their descendants' screening behaviors is addressed here.

3 Data and method

3.1 Data

3.1.1 Data collection

Data were obtained by means of a questionnaire survey set in an experimental laboratory. Sessions were conducted at the *Laboratoire d'Economie Expérimentale de Paris* (LEEP) and the Laboratory of Economics of the *Ecole Polytechnique* between June and October 2013. Both experimental laboratories are in the Ile-de-France region, which includes Paris. Payment included a show-up fee of 20 euros and additional earnings depending on the lottery outcome. Participants were paid in cash at the end of each session. Women were recruited through the very large contact database of the LEEP and the Ecole Polytechnique and through an e-mail sent by a company to 10 000 women aged 50 to 75 years. No precise information on the topic of the survey was provided during the recruitment process. Subjects were informed that the survey was on consumption and health behaviors.

The experiment consists of a questionnaire divided into 5 parts. The first part only asks for respondents' age and postal code. The second part inquires about beliefs on breast cancer screening procedure and programs. The third part asks about health behaviors, including mammography use, and the fourth elicits measures of time orientation and risk preference. The fifth part concerns the questionnaire itself (length, comprehensiveness, etc.). The knowledge section displays information on breast cancer screening (as the existence of a program for instance) that may influence perceptions and declared screening habits. To minimize the possibility of different answers induced by different information, we did not randomize the questionnaires' part.

The sample is restricted to female respondents aged between 50 and 75 years, which corresponds to the eligibility criteria for the screening program. Eligibility for the screening program ends after 74 years of age, and thus, women aged 75 years could have participated in the program up until one year ago. We exclude respondents from the sample who have been diagnosed with breast cancer ($N = 4$), as after such a diagnosis, the need for health check-ups changes substantially. Women who were never screened ($N = 10$) have an experience that differs from those who have been screened at least once and were therefore excluded from the sample. The final sample consists of 178 observations. Each observation is a woman between 50 and 75 years of age who participated in the experiment and indicated that she had undergone breast cancer screening at least once in her life. The following subsection describes how screening regularity and the other variables are measured.

3.1.2 Variables' measurement

Breast cancer screening regularity is based on the self-reported frequency of screening. It is the response to the following question "*How often do you screen for breast cancer ?*". Possible answers were every year, every two years, every three years, less than every three years, and once in your life. Nearly 3 out of 4 (74.7%) women declared undertaking screening yearly or every two years, in other words, regularly. Although studies observe that women over-report their mammography use (Holt et al. (2006)), it may be under-reported in the case of screening regularity. Using administrative data from Health Insurance claims, it has been found that 80.6% of women screened regularly (i.e., every two years) between 2006 and 2009 in France (Goldzahl and Jusot (2017)).

Choosing a risk preference elicitation method in health induces a trade-off between incentive-compatibility and domain specificity. On the one hand, hypothetical bias occurs when elicitation procedures don't include real consequences. Hypothetical elicitation methods of risk preference generate less risk averse preferences compared to the one obtained with incentive-compatible elicitation methods using monetary payment (Harrison (2006) for a review). On the other hand, evidence suggests that risk preference is domain specific (Galizzi et al. (2016b) for a review) in such a way that risk preference in the monetary domain fails to capture risk preference in the health domain. Implementing an incentive compatible measure of risk preference with real health consequences in an experimental economic laboratory yields technical issues that we were not able to overcome. The present study investigates the relationship between risk preference and cancer screening using an incentive-compatible measure with monetary payment. By doing so, it contributes to the literature exploring the external validity of laboratory-based measures of risk preferences in the health domain (Galizzi et al. (2016a)).

We use Eckel et al. (2012)'s procedure that is very close to Eckel and Grossman (2002, 2008)'s measure, which is itself derived from Binswanger (1980, 1981). Our measure is better suited than the Holt and Laury (2002)'s elicitation method to capture risk preference in a general population since it limits errors of low math skilled respondents (Dave et al. (2010)). This appears especially important considering that our sample is composed of women aged 50 to 74 years old. In addition, Eckel and Grossman (2008)'s measure is temporally stable, and cross-validated with Dohmen et al. (2011)'s subjective scale from the German Socio-Economic Panel (SOEP) and the Holt and Laury (2002)'s measure (Galizzi et al. (2016a)). In the same study, the authors find that the Binswanger (1980)'s measure significantly predicts BMI and consumption of fruits and vegetables across a wider range of risky health behaviors. The main disadvantage is the inability of the measure to distinguish between risk neutrality and risk seeking. By construction, it also has less predictive accuracy than the Holt and Laury (2002) measure because it classifies individuals into 6 categories instead of ten categories.

Eckel et al. (2012)'s measure consists of choosing one among six possible gambles as presented in figure I. This task displays 6 circles, each of which contains a gamble with a 50% chance to win a high payoff or a low payoff. Payoffs start from 4.50 euros to 13.5 euros with an increment of 2 when increasing and 1 when decreasing. Each gamble allows an equal chance of winning a high payoff or a low payoff. As Eckel et al. (2012) indicate in their paper, a higher return entails higher variance when moving clockwise. The first gamble represents certainty because one has an equal chance of wining 4.50 euros. Gamble 5 and 6 have the same expected payoff but gamble 6 has an increased variance. Choosing gamble 6 displays risk-seeking behavior. We can distinguish varying degrees of risk aversion as shown by the CRRA parameter ranges indicating decreasing risk aversion along the gambles. The CRRA utility function is a relevant functional form, as it is widely employed in health decision models (Wakker (2008)). Each subject has to choose only one gamble, which is then played. Monetary gains are added to the show-up fee and disbursed in cash at the end of the experiment. To summarize, the more the chosen gamble displays high payoffs, the greater the variance in gains that the subject is willing to accept; thus, the less risk-averse she is and the lower the CRRA parameter as presented in Table I. The variable is introduced as a categorical variable in the estimated model and each category refers to a CRRA parameter range as displayed in Table I. The reference category corresponds to the more risk averse individuals. Figure 2 displays the distribution of risk preferences in the sample. To date, this measure has only been used on teenagers, and thus comparing results is not particularly meaningful to the study.

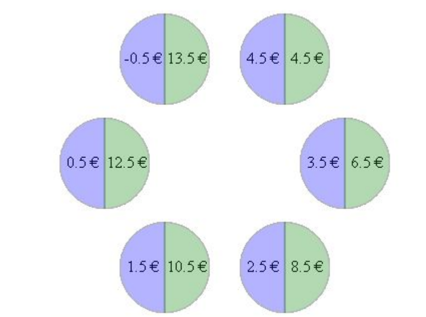

Figure 1: Lottery design

Time orientation was measured using the Consideration for Future Consequences (CFC) scale (Strathman et al. (1994)). The CFC scale is stable through time (Strathman et al. (1994) and has external validity in health behaviors (Orbell and Hagger (2006), Orbell et al. (2004) Morison et al.

Options	Payoffs			Variance	CRRA parameter	N (%)
	Low	High	Expected Value			
1	24.5	24.5	24.5	0	11.9 ;	17.5
2	23.5	26.5	25	2.25	3.9 ; 11.9	13.3
3	22.5	28.5	25.5	9	2.4 ; 3.9	11.2
4	21.5	30.5	26	20.25	1.7 ; 2.4	12.8
5	20.5	32.5	26.5	36	0 ; 1.7	16
6	19.5	33.5	26.5	49.25	; 0	29.2

Table I: Summary of lottery design

(2010)). Joireman et al. (2005) find a correlation between a hypothetical temporal rates and high CFC score. We use the 8 items version that has a higher internal validity (Petrocelli (2003)) and the translation in French by Demarque et al. (2010). This psychological measure is based upon existing literature reporting that future-oriented individuals are believed to consider in their decisions the links between their current behavior and its future consequences. The CFC scale focuses on the degree of consideration that an individual has for the potential long-term as opposed to short-term consequences of his actions. Respondents use a 5-point scale to report whether each of the 8 statements characterizes them. Each item's scores are summed and then divided by the number of items. A low score indicates that subjects display a tendency to focus on the future consequences of their choices, rather than on immediate ones. Figure 2 presents the distribution of the CFC scores in the sample.

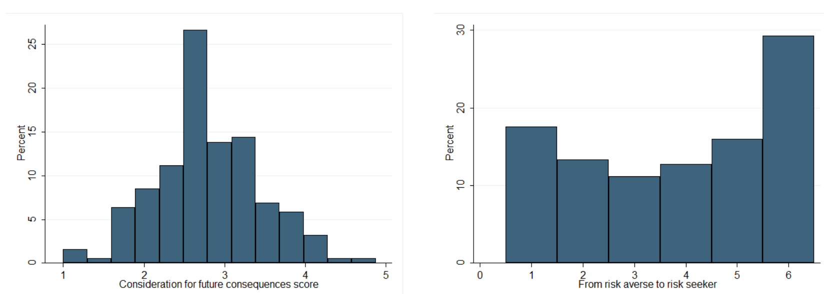

Figure 2: Consideration for future consequences score and risk preference distribution

Responses to the following questions are used to capture perceived risk and recovery chances, respectively: "*What do you think your percentage chance of developing breast cancer in your lifetime is ?*" and "*What is your percentage chance of being cured if you have breast cancer in your lifetime?*". Figure 3 displays both perceptions' distributions. There is a peak at 50% for both. This could either mean that respondents believe that they have 1 chance in 2 of developing breast cancer (or 1 chance in 2 of recovering), or it could also be interpreted as being ignorant of this probability or refusing to respond. If an individual responded 50% to both questions, this could be more confidently interpreted as ignorance or refusal to answer. Only 4% of respondents did. At the bottom right of Figure 3, the difference between risk perception and objective risk (measurement details are bellow) is presented. If this difference is negative, the risk of developing breast cancer is underestimated. This is true for 15% of the sample, which conversely implies that 85% of respondents tend to overestimate their risk.

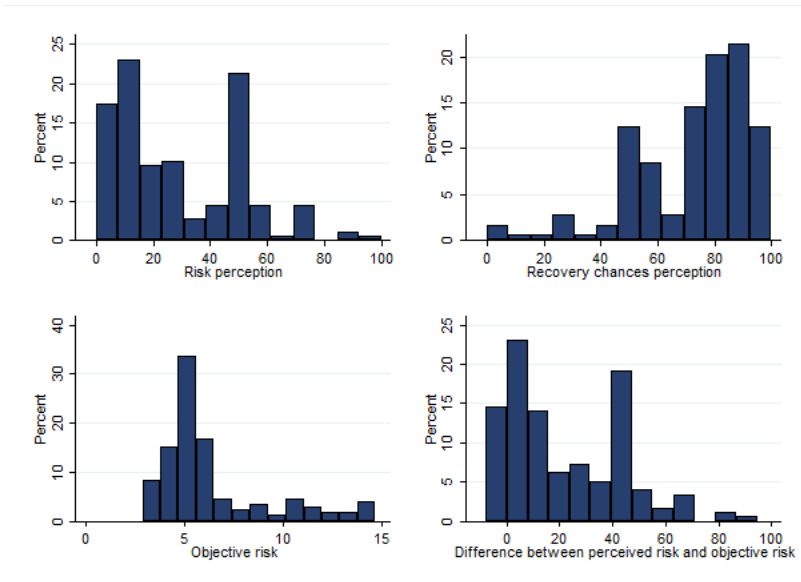

Figure 3: Distributions of objective risk and perceived risk and recovery chances

Other sample characteristics are displayed in Table II. Half of the respondents attended university and half have a household income that exceeds 2500 euros per month (mean monthly household income is 2909 euros in the Parisian region).

Nearly one-quarter of the sample reported having a chronic disease. Respondents also reported whether they had private complementary health insurance. Not being covered by a private complementary health insurance includes Universal Medical Coverage beneficiaries or those without any complementary health insurance. Respondents recorded the number of consultations they had with a GP or a SP in the previous 12 months.

To compute an individual's objective risk of developing breast cancer, we use a tool based on the epidemiological Gail model (Gail et al. (1989)) developed by the US National Cancer Institute (NCI) and available on their website. It estimates an objective risk probability of developing breast cancer in an individual's remaining lifetime according to various risk factors. This breast cancer risk assessment tool uses relative risks (family history, age, having children) and additional relative risk factors (breast density, race, etc.). The survey only enables us to input the relative risk characteristics. The online tool uses age-specific survival rates of breast cancer from the Surveillance Epidemiology and End Results (SEER) database for the US. Although there could be some differences in the risk of disease in France relative to the US, this tool provides an approximation of the individual lifetime risk level for breast cancer. This approximation of objective risk is a continuous variable displaying a percentage risk of developing breast cancer ranging from 2.9 to 14.7%. The average is 6.4%, which is smaller than the national average risk of developing breast cancer (8-10%) according to the French National Cancer Institute. Note that perceived risk can be interpreted as the effect of risk perception on screening regularity, given one's objective risk. Additionally, the number of children decreases the risk of having breast cancer (Weir et al. (2007)), thus it is introduced as a categorical variable in the analysis. The risk of having breast cancer also varies across ethnic groups but collecting such characteristic in not allowed in France.

Three variables are introduced to capture disparities in opportunity costs. The first dummy variable equals 1 if one works overtime (more than 35 hours that is the legal hours worked per week) and 0 otherwise. The second dummy variable equals 1 if she works 0 hours per week and zero otherwise. The last dummy variable equals 1 if she is an executive or has an intellectual profession and zero otherwise. These variables proxy for the opportunity costs of screening, as working more hours leaves less time for health care consumption, and executives or individuals with an intellectual profession may have higher wages and work longer hours. Parents' social and health characteristics are added as controlled variables. Mother's educational attainment is a binary variable that equals 1 if the mother went beyond compulsory education. Parents' vital status corresponds to a binary variable that equals 1 if the parent is still alive.

To check for sample representativeness, we compare the distribution of age, education level and private complementary health insurance coverage in the sample with national figures. The sample is representative of the age and health care coverage distribution in France. However, the level of education in the sample is not; respondents are more educated: 22% of women in our sample have a master's degree, whereas the national figure for 2012 indicates that 9.7% of women aged between

	Sample(%)	National Figure(%)
Education		
High school or lower	43.26	80
University degree	56.74	20
Household Income		
<2501 euros	41.5	
≥2501 euros	58.5	
Age		
50−54 years old	23.4	23.5
55−59 years old	29.8	22.7
60−64 years old	24	22.47
65−69 years old	15	17.8
70−74 years old	8	13.5
Visits to SP in the last 12 months		
0-1 visit	40.5	
2-4 visits	50	
5+ visits	9.5	
Visits to GPs in the last 12 months		
0-1 visit	23.94	
2-4 visits	55.85	
5+visits	20.21	
Chronic disease	23	
Complementary health insurance		
Private complementary health insurance	91.5	94.7
Other	8.5	5.3
Objective risk		
Mean proba. of having breast cancer	6.4	
Mother's education		
No education or compulsory school	60	
More than compulsory school	40	
Parents' characteristics		
Mother is alive		
Yes	50	
No	50	
Father is alive		
Yes	23	
No	77	
Number of children		
0	12.5	
1	30	
2	36.5	
3	11	
≥4	10	
Opportunity costs		
Overtime	38	
Works ≤ 35 hours	62	
Do not work	45.4	
Works at least an hour	54.6	
Executive	19	
Other than executive	81	

Table II: Summary of sample characteristics

55 and 64 years have a master's degree.

3.2 Econometric strategy

3.2.1 Probit estimation

The relationship between breast cancer screening regularity and its determinants can be modeled as follows:

$$Y_i = \alpha E_i + \sum_{k=1}^{2}(\gamma_k.X_{k,i}) + \sum_{k=1}^{2}(\pi_k P_{k,i}) + \delta D_i + \lambda H_i + e_i \qquad (1)$$

where $i = 1, ..., N$ and $k = 1, 2$ is the subscript for risk preference and time orientation, or for risk and recovery chances perceptions. The declared screening regularity Y is a binary variable and is observed for every individual. Variable E is a vector of socioeconomic characteristics. Vector X captures perceptions, and P captures time orientation and risk preference. The vector of demographic characteristics is D, and health status and health care consumption variables are represented by H. Finally, the residual term e is the unobserved heterogeneity that cannot be accounted for by observed determinants.

This model is estimated using a probit model, and errors are clustered at the level of the *département* because the invitation system is organized at the level of the *département*, which may induce correlation between unobservables and may bias estimates.

3.2.2 Decomposing contributions to screening regularity disparities

The goal of this paper is to quantify the relative contribution of each category of determinants (perceptions, risk preference, time orientation, socioeconomic factors, health factors and various demographics) to screening regularity disparities. Decomposing the variance into categories allows us to distinguish the contribution of each category of determinants to screening regularity variance (or disparity). In the linear case, the share of the variance would correspond to decomposing the R^2. However, our model is based on a non-linear model, and as such we cannot use this decomposition technique. Instead, we use the prediction of Y to decompose the pseudo R^2 of McKelvey and Zavoina (1975) into the share associated with each category of determinants (as performed by Tubeuf et al. (2012) to decompose health inequalities). Specifically, we use the estimates of model (1) to compute non-linear predictions of each category of determinants and the predicted value ($\hat{Y}$) also called the probit index. Then we compute the covariance between the predicted value ($\hat{Y}$) and the prediction of each category of determinants. This provides the absolute respective contribution to screening regularity disparities of each category of determinant. The ratios between those covariances and the predicted variance of screening regularity (var($\hat{Y}$)) are computed to obtain the relative contribution of each determinant category to overall disparities in screening regularity. The decomposition results are tested using a bootstrap with 70 replications to generate standard errors and confidence intervals.

4 Results

4.1 Probit estimation

The estimation results of the probit model (equation 1) are reported as coefficient and as average marginal effects in Table III. The results indicate that social inequalities are driven by both educational attainment and household income. Tertiary education induces a 28 percentage points increase in the likelihood of reporting screening regularly, while earning more than 2500 euros per month increases screening regularity by 14.5 percentage points relative to individuals earning less. The opportunity costs related to being an executive decrease screening regularity by 25 percentage points. As the parental variables are not significant, there is no evidence of inequalities related to social background. Consulting a GP two to four times in the past 12 months compared to going once or not at all decreases the probability of screening regularly by 9.5%. Consulting a SP two to four times in the past 12 months compared to only once or not at all increases the probability to screen by 11%. Whereas the effect of GP visits is surprising, the effect of SP visits is in line with previous findings (Duport and Ancelle-Park (2006) and Sicsic and Franc (2014)). Being older than 54 years increases the likelihood to screen regularly relative to individuals below this age (except for those aged over 69 years). The increased adhesion to regular screening may reflect the transition over time from early eligibility for the program to its regular use. Regarding perception variables, the more an individual perceives herself as being at risk, the more likely she is to screen regularly, but the magnitude of the marginal effect is small. Increasing risk perception by 10% results in a 5% increase in the probability of screening regularly. Similarly, higher recovery expectations are positively associated with regular screening, but the effect size is relatively small, such that a 10% increase in recovery perception induces a 3% increase in the probability of screening regularly. As stated in Katapodi et al. (2004)'s meta-analysis, the effect size remains small and is therefore in line with our findings. If an individual's objective risk increases by 1%, her likelihood of screening

Table III: Probit estimation results

	Probability to screen regularly			.
	Coeff.	St. Errors	Marg. Effects	St. Errors
Education (ref: high school or lower)				
University degree	1.304**	(0.538)	0.281***	(0.100)
Household Income (ref: ≥2501 euros)	0.672***	(0.240)	0.145***	(0.044)
Present oriented	-0.292**	(0.138)	-0.063**	(0.031)
Risk aversion-CRRA parameter (ref: >11.9)				
3.9-11.9	-0.044	(0.395)	-0.011	(0.102)
2.4-3.9	-0.376	(0.562)	-0.098	(0.152)
1.7-2.4	1.980**	(0.898)	0.352***	(0.124)
0-1.7	1.340**	(0.670)	0.279**	(0.122)
<0	1.118	(0.707)	0.245*	(0.136)
Risk perception	0.025***	(0.006)	0.005***	(0.002)
Recovery chance perception	0.015*	(0.008)	0.003*	(0.002)
Opportunity cost				
Overtime	-0.158	(0.510)	-0.034	(0.110)
Executive	-1.154***	(0.359)	-0.249***	(0.065)
Zero hours of work	-0.387	(0.320)	-0.084	(0.067)
Parents' characteristics				
Mother's education	-0.417	(0.377)	-0.090	(0.073)
Mother is alive	-0.007	(0.198)	-0.002	(0.043)
Father is alive	-0.062	(0.133)	-0.013	(0.030)
Nb of children (ref:0)				
1	0.650**	(0.313)	0.133**	(0.055)
2	-0.030	(0.173)	-0.007	(0.040)
3	0.837***	(0.324)	0.165***	(0.057)
≥4	0.784	(0.888)	0.156	(0.145)
Age (ref: 50-54)				
55-59	0.808**	(0.328)	0.180***	(0.054)
60-64	0.418	(0.283)	0.099	(0.063)
65-69	1.548***	(0.254)	0.290***	(0.036)
70-74	-0.133	(0.646)	-0.033	(0.164)
Objective risk	-0.098***	(0.025)	-0.021***	(0.005)
SP visits (ref: 0 or 1)				
2 to 4	0.525*	(0.277)	0.110**	(0.051)
≥5	-0.192	(0.371)	-0.045	(0.088)
GP visits (ref: 0 or 1)				
2 to 4	-0.435***	(0.162)	-0.095**	(0.041)
≥5	0.301	(0.262)	0.055	(0.045)
Chronic disease	-0.358	(0.255)	-0.077	(0.054)
Private complementary health insurance	0.015	(0.166)	0.003	(0.036)
Observations	178		178	
Pseudo R^2	0.3235		0.3235	

Note: The higher the CRRA parameter the more risk averse the individual.
Standard errors clustered at the *département* level in parentheses *** p<0.01, ** p<0.05, * p<0.1

regularly diminishes by 2.1 percentage points. As mentioned by Kash et al. (1992), but also by others, being objectively at risk discourages women from screening regularly. Finally, being oriented toward the present decreases the probability to screen by 6.3 percentage points. Any individual with a CRRA parameter smaller than 2.4 (lower level of risk aversion) is more likely to screen than those whose CRRA parameter is greater than 11.9 (higher level of risk aversion). The magnitude of the marginal effects ranges from 24.5 to 35.2 percentage points. If the risk aversion variable is operationalized as a continuous variable instead of a categorical variable, the magnitude of the effect is 6.2 percentage points but it is still significant at the 1% level (Table V in Appendix B). Thus, more risk averse individuals are less likely to screen.

To assess the quality of the model, the ROC curve is plotted (on Figure 4 in appendix A). The area under the ROC curve reaches 86.65%, suggests a good quality model. Some robustness analyses are conducted and show that the results only change marginally when more categories of education and income are added or when the 4% who answered 50% to both perception questions are dropped (Table V in Appendix B). The main difference is that time orientation is not significant anymore when more categories of income are included.

4.2 Decomposition of contributions to disparities in screening regularity

Table IV: Decomposition of contributions to screening regularity

Variable	Share (%)	St. Errors	CI
Risk aversion	29.99	8.55	[13.24 , 46.75]
Present orientation	2.09	1.75	[-1.34 , 5.52]
Perceptions	11.46	7.01	[-2.28 , 25.19]
Risk preception	8.11	6.24	[-4.13 , 20.35]
Recovery chance perception	3.35	3.09	[-2.70 , 9.40]
Socioeconomic status	19.83	8.43	[3.32 , 36.35]
Health factors and healthcare consumption	14.92	7.61	[0.0005 , 29.83]
Health factors	5.26	4.21	[-2.99 , 13.51]
Healthcare consumption	9.66	5.69	[-1.5 , 20.81]
Other demographics	21.71	10.46	[1.21 , 42.21]
Parents' characteristics and the number of children	4.12	5.77	[-7.2 , 15.43]
Age	-2.19	32.43	[-65.76 , 31.38]
Opportunity costs	2.73	5.54	[-8.13 , 13.58]
Predicted total variance	1.55		

*Health factors include chronic disease, objective risk and health insurance status

Table IV displays the decomposition of the contributions to the predicted screening regularity variance. The most important contribution comes from risk preference, which accounts for 30% of the predicted screening regularity disparities. It still accounts for 20% of the predicted screening regularity disparities if risk preference is operationalized as a continuous variable (table upon request). The contribution of time orientation is not different from zero. Perceptions account for 11.5% but their contribution is not statistically significant. When perceptions are considered separately, risk perception contributes twice as much as recovery perception and none of them are statistically significant. Socioeconomic characteristics explain 20% of the predicted screening regularity disparities. Health and other demographic variables respectively account for 15% and 22% of predicted screening regularity.

5 Discussion and concluding remarks

This study contributes to the existing literature by using experimental elicitation of risk preferences and measuring time orientation, risk and perceived recovery chances to assess their relative contribution to disparities in the regularity of breast cancer screening. The main contribution of this paper is to suggest that risk aversion accounts for 30% of the disparities in the regularity of breast cancer screening, a larger share than that explained by socioeconomic factors. If we were to speculate on the policy implication of the effect of risk aversion on screening regularity, we could imagine that health communications should try to make screening appear less risky. If it is done by reducing the perceived health loss associated with breast cancer, one can emphasize the high survival rates associated with early cancer detection.

Some limitations mostly related to the use of the in-laboratory survey must be acknowledged. First, the analysis relies on self-reported data, which, given respondents' anonymity, cannot be verified in administrative data from the National Health Insurance funds. It also implies the possibility of response bias due to social desirability: respondents might have been disposed to report motives they believed that they ought to have held, rather than those they actually held. However, this bias is limited due to their identities being concealed from one another. Second, although women were recruited in a way that offered them little information on the study, with few details on the topic provided to potential respondents, there may nevertheless have been sample selection generated by word-of-mouth among the women who participated. Women who are more comfortable with this topic due to regular cancer screening would be more willing to participate. Third, an attempt to address the endogeneity associated to perceptions due to reverse causality is required to make more assertive public recommendations. Fourth, the results of an incentive-compatible measure of risk preference in the monetary domain may not reflect risk preference in the health domain. Our results need to be confronted with evidence resulting from the use of hypothetical (or even incentive-compatible) measures of risk preference in health. Fifth, our sample is not representative of French women aged 50 to 75 years old as they all live in the Parisian region and their education level is higher than the national average. Hence, public health recommendation with respect to the present study results should be taken with caution as long as the issues of the domain-specificity of risk preference and the size and the representativeness of the sample are not addressed. A survey outside the laboratory among a representative sample, including hypothetical measure of risk preference in the health domain, would extend the evidence on the effect of risk preference on cancer screening.

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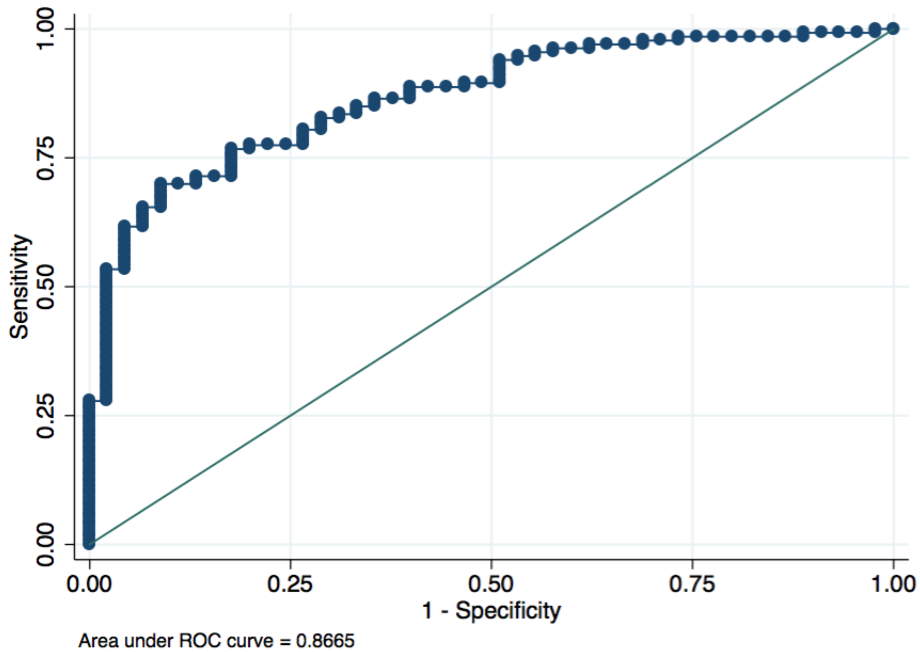
A Area under roc curve

Figure 4: Roc curve derived from the probit model



B Robustness checks

Table V: Probit models for robustness checks

	(1) Main model	(2) Model with risk aversion as continuous var.	(3) Model with education in 3 categories	(4) Model with income in 3 categories	(5) Model without those who said 50% to both perception questions
	Marg. effects	Marg. effects	Marg. effects	Marg. effects	Marg. effects
Education (ref:high school or lower)					
University degree	0.281***	0.268***		0.268***	0.263***
	(0.100)	(0.087)		(0.090)	(0.092)
Income (ref: $\leq$ 2501 euros per month)					
$>$2500	0.145***	0.115**	0.147***		0.139***
	(0.044)	(0.051)	(0.045)		(0.046)
Present oriented	-0.063**	-0.063***	-0.061*	-0.038	-0.068**
	(0.031)	(0.024)	(0.033)	(0.031)	(0.029)
Risk aversion-CRRA parameter (ref: $>$11.9)					
3.9-11.9	-0.011		-0.008	-0.058	-0.026
	(0.102)		(0.103)	(0.086)	(0.098)
2.4-3.9	-0.098		-0.096	-0.122	-0.125
	(0.152)		(0.152)	(0.129)	(0.151)
1.7-2.4	0.352***		0.353***	0.309**	0.339***
	(0.124)		(0.124)	(0.124)	(0.124)
0-1.7	0.279**		0.279**	0.242**	0.292**
	(0.122)		(0.123)	(0.113)	(0.127)
$<$0	0.245*		0.245*	0.210	0.235
	(0.136)		(0.137)	(0.136)	(0.144)
Risk perception	0.005***	0.005***	0.005***	0.006***	0.005***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
Recovery chance perception	0.003*	0.003	0.003*	0.003*	0.003*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Income (ref: $<$ 2001)					
2001-4000				0.079	
				(0.091)	
$>$4000				0.214***	
				(0.078)	
Education (ref: no or primary educ)					
High school level			0.274***	0.259***	
			(0.089)	(0.093)	
University degree			0.290***	0.279***	
			(0.098)	(0.100)	
Risk aversion-CRRA parameter		0.062***			
(continuous variable)		(0.022)			
Other controls	yes	yes	yes	yes	yes
Observations	178	178	178	178	171
Pseudo R^2	0.3235	0.2593	0.3238	0.3299	0.3327

The main model (1) is the same model than in Table III. The income variable with 3 categories represents the income tertiles of the distribution to capture distributional effects.
The higher the CRRA parameter the more risk averse the individual.
Standard errors clustered at the *département* level in parentheses *** p<0.01, ** p<0.05, * p<0.1