The Effect of Organized Breast Cancer Screening on Mammography Use: Evidence from France

Thomas C. Buchmueller[1] and Léontine Goldzahl*[2]

[1]Ross School of Business, University of Michigan and NBER

[2]LEDa-LEGOs, University of Paris–Dauphine

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Abstract

In 2004, France introduced a national program of organized breast cancer screening. The national program built on pre-existing programs in some, but not all, *départements*. Using data from multiple waves of a nationally representative biennial survey of the French population, we estimate the effect of organized screening on the percentage of women obtaining a mammogram. The analysis uses difference-in-differences methods to exploit the fact that the program was targeted at women in a specific age group: 50 to 74 years old. We find that organized screening significantly raised mammography rates among women in the target age range. Just above the lower age threshold, the percentage of women reporting that they had a mammogram in the past two years increased by over 10 percentage points after the national program went into effect. Mammography rates increased even more among women in their sixties. Estimated effects are particularly large for women with less education and lower incomes, suggesting that France's organized screening program has reduced socioeconomic disparities in access to mammography.

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1 Introduction

Breast cancer is the most frequently diagnosed cancer and the leading cause of death from cancer among women worldwide, accounting for one-quarter of all new cancer cases and roughly 15 percent of cancer deaths (Torre et al., 2015). The incidence of breast cancer is generally higher in more developed countries, though incidence rates have risen recently in less developed countries. In 2015, roughly 154,400 women in the 28 countries of the European Union and 46,400 women the the U.S. died of breast cancer (Ferlay et al. (2015)).

If detected early, breast cancer is highly treatable, with very high rates of survival. Survival rates depend importantly on the stage at which breast cancer is detected. Five-year relative survival rate for breast cancer are 99 percent for localized cancers, 85 percent for regional cancers and 26 percent for metastatic cancers (Siegel, Miller and Jemal, 2016). Early screening increases the likelihood to detect a cancer at a more local stage, thereby improving survival.

The most common method of early detection is mammography, low dose X-ray imaging of the breasts used to identify abnormalities. In light of evidence from clinical trials indicating that screening mammography reduces mortality by detecting tumors at an earlier stage (Duffy and Paci, 2012), expert organizations, including the World Health Organization's International Agency for Research on Cancer and the American Cancer Society, recommend regular, biennial screening mammograms starting at age 50 (Perry et al., 2008). Nearly every European country has established a national breast cancer screening program that make mammograms available free of charge for women in the recommended age range (Altobelli and Lattanzi, 2014).

Despite the central role that organized screening programs play in national cancer prevention strategies, there is surprising little research evidence on their impact. A basic question regarding the impact of organized program is whether it is effective in increasing the number of women who receive mammograms. In this paper, we examine this question using data from France. The first organized programs in the country were introduced in the late 1980s and early 1990s at the level of the *département*.[1] In 2004, France established a national program that built on and strengthened the early local programs in several ways. In particular, the target age range was expanded slightly and the recommended frequency for mammography screening was increased to once every two years from once every three years. By 2009, France's organized breast cancer screening program was the largest in the European Union in terms of the number of mammogram performed each year (Séradour, 2010).

[1] The *département* is the fundamental administrative and political jurisdiction in France. There are 96 *départements* in "metropolitan France", with an average land area of 5,666 square kilometers (three and half times the median land area of US counties). In terms of population, in 2015 *départements* varied in size from 76,000 to 2.6 million, with an average population of 670,000.

We evaluate the impact of both the national program and the earlier local programs using data from a nationally representative survey of the French population spanning the period 2000 to 2008. We estimate difference-in-differences models that exploit variation in exposure to organized screening related to age, geography and time. Our main outcome is an indicator variable that equals one for women who report having had a mammogram at some point in the last two years.

Numerous studies from multiple countries have documented significant disparities related to socioeconomic status in the use of a wide range of preventive health services, including cancer screening. An important objective of population-based screening programs is to reduce such disparities in utilization and thereby reducing disparities in cancer detection and survival. We consider whether France's organized screening program has had this effect by testing for heterogeneous treatment effects related to education and income.

Our results indicate that the early local programs increased the percentage of women who had a mammogram in the past two years by roughly 6 percentage points, a 14 percent effect relative to the rate in areas without an organized program. We find even larger effects for the national program that went into effect in 2004. In *departements* that did not have a local program, the effect of introducing the national program was roughly twice as large. Although the percentage of women reporting a recent mammogram increased for all ages within the target range, the change was greatest among women in their sixties. This result combined with the fact that we find a weaker effect of the program on the probability of *ever* having had a mammogram, suggests that the program has increased not only initiation to mammogram use, but also the regularity with which women obtain screening. Because we find that France's organized screening program had a larger effect on mammography rates for women with lower socioeconomic status, the gradients with respect to education and income have declined since the national program has been in place.

2 Background and Previous Literature

2.1 Breast Cancer Screening

Breast cancer screening typically includes a clinical breast exam, a physical examination of the breast by a physician or nurse, 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. Screening mammograms are given to asymptomatic women to look for suspicious markers. Diagnostic mammograms are typically given to women who have had a previous abnormal screening mammogram, have a family history of breast cancer, or have certain symptoms, such as the presence of lumps.

The accuracy of a mammogram depends on the density of the breast tissue, which tends to decline with age. For women over age 50, the sensitivity of the test (the probability of detecting an existing cancer) ranges between 66 and 90 percent and specificity (the probability that the test is negative for someone without the disease) reaches 95 percent (Smith, 2003). Thus, mammography is seen as an effective means of detecting breast tumor for women older than 50 years old. It is considered less appropriate for younger women whose breast tissue tends to be denser.

Several studies based on randomized control trials have concluded that mammography screening leads to a significant reduction in breast cancer mortality (Duffy and Paci, 2012). These results led to recommendations by medical societies and public agencies that women receive regular mammograms as well as public policies aimed at increasing mammography rates. Reviewing evidence from a number of micro-simulation studies, Cutler (2008) concludes that nearly half of the reduction in breast cancer mortality in the U.S. between 1990 and 2004 can be attributed to increased screening.

Recently, however, there has been some debate about how the benefits of mammography related to reduced mortality should be weighed against the cost associated with false positive results and overdiagnosis possibly leading to overtreatment (Gøtzsche and Jørgensen, 2013). In 2009, the U.S. Preventive Services Task Force (USPSTF) generated some controversy when it revised its guidelines to recommend that women begin to receive regular mammograms starting at age 50, rather than at 40 as it has previously recommended. The USPSTF also revised its recommendation regarding the frequency of screening mammograms from annual to biennial. In 2012, a U.K. expert panel conducted a meta-analysis of the randomized trial evidence concluded that screening mammograms reduced the relative risk of mortality by 20 percent, while acknowledging the problem of overdiagnosis (Marmot et al., 2012). The panel's conclusions supported the NHS policy of organized breast cancer screening beginning at age 50.

2.2 The Effect of Public Policies on Screening

Most countries have policies aimed at increasing the number of women who receive a regular mammogram. In the U.S., with its fragmented system of health care financing, different strategies have been targeted at women with different types of insurance coverage. Between the late 1980s and early 2000s, nearly every state enacted laws requiring private health insurance plans to include screening mammograms as a covered benefit. Recent research indicates that these benefit mandates significantly increased the percentage of women obtaining a mammogram, with especially large effects occurring when plans were prohibited from charging cost-sharing for the service (Bitler and Carpenter, 2015).[2] The requirement that private insurance plans provide first-dollar coverage for screening mammograms became national policy starting in 2010 as a result of the Affordable Care Act. A different U.S. policy, the National Breast and Cervical Cancer Early Detection Program (NBCCEDP), aims to increase breast cancer screening among uninsured low-income women. Although it is a Federal program, the NBCCEDP was rolled out incrementally by different states throughout the 1990s. Research exploiting that implementation pattern finds that this program also significantly increased the percentage of women obtaining mammograms (Adams et al., 2003; Bitler and Carpenter, 2016).

In Europe, breast cancer prevention strategies have centered on organized screening programs (Altobelli and Lattanzi, 2014). The earliest programs, established at the local level, date to the 1980s. Finland, Luxembourg, the UK and Sweden expanded their programs to the national level in the early 90s. In 2003, the European Commission formally recommended population-based screening for women between the ages of 50 and 69. Soon thereafter, nearly every European country had established a national organized breast cancer screening program.[3] Although the exact details vary, these national programs share several common elements. The modal program targets 50 to 69 year-olds.[4] Every two years,[5] women in the target age range receive a letter inviting them to receive a free mammogram. The standard protocol involves two images per breast and double reading of normal mammograms.[6] Today, digital mammography is the most common screening method used.

Two recent studies evaluate the effect of organized breast cancer screening programs on the utilization of mammography, using difference-in-differences research designs similar to the approach we use in this paper. Pletscher (2015) analyzes the impact of organized screening in Switzerland, where a program targeted at women between the ages of 50 and 69 was rolled out over several years at the level of the canton. This pattern of implementation provides variation related to geography, age and time. However, it is not clear that this variation is orthogonal to other factors affecting cancer screening. According to Pletscher (2015), Cantons that did and did not implement screening programs differed in terms of breast cancer incidence, treatment

[2] A related literature from the U.S. examines the effect of insurance coverage on mammography use. Busch and Duchovny (2005) and Finkelstein et al. (2012) find a positive effect of Medicaid on mammography use. Several recent studies examine the effect of Massachusetts' 2006 health reform, which significantly increased insurance coverage. The results regarding the effect of this coverage expansion on mammography use are mixed (Kolstad and Kowalski, 2012; Keating et al., 2013; Sabik and Bradley, 2015).

[3] Greece, Hungary, Lithuania, Romania, Slovakia and Slovenia do not currently have national programs but do have local or regional programs that incorporate the key features of the national programs in other countries.

[4] In addition to France, in the Netherlands extends the target age range to 74. In Ireland and Estonia, the upper age limit is 64 and 65, respectively. In the Czech Republic, Hungary and Portugal, organized screening begins at age 45. Eligibility for the national program of Austria and Sweden start at 40 years old.

[5] Malta and the United Kingdom have a 3 years invitation cycle.

[6] Austria, Latvia and the United Kingdom don't have a double reading of every normal mammogram.

patterns, the supply of radiologists and patient preferences (as indicated by public approval for public policies relate.d to health insurance). In addition, the survey data he uses has an important limitation: the only question related to mammography use asks if female respondents had *ever* had a mammogram. Thus, to the extent that organized screening affects not only initiation to mammography but also the regularity of screening, his analysis will understate the impact of the policy. Pletscher (2015) finds that organized screening is associated with a 4.6 percentage point increase in the probability of every having had a mammogram.

Carrieri and Wuebker (2016) use data from the Survey of Health, Ageing and Retirement in Europe (SHARE) to estimate cross-sectional difference-in-differences models that compare women from 13 different countries who were exposed to organized screening to those who were not exposed because of their age or geographic location. Their dependent variable is an indicator for whether a woman had a mammogram in the past two years. This outcome is well suited for evaluating the impact of organized screening programs, given that that these programs typically invite women to receive a mammogram every two years. One limitation of their research design is that the geographic variation is measured at the level of the NUTS-2 region, a statistical unit which does not map directly to political or administrative divisions, and therefore does not necessarily correspond to the geographic area covered by an organized screening program.[7] For example, NUTS-2 regions in Switzerland are larger than cantons, the level at where the organized screening programs analyzed by Pletscher (2015) were implemented. Similarly, the NUTS-2 regions defined for France encompass multiple *départements*. Thus, it is likely that some women in Carrieri and Wuebker (2016)'s treatment group were not actually exposed to an eligible screening program, while some women in their control group were. And, even more than in the case of Switzerland's cantons, differences in health care financing and delivery among European countries raise concerns about the comparability of this study's "treatment" and "control" groups. Their main estimates imply that organized breast cancer screening programs raise the probability that a women in the target age range has had a mammogram in the past 2 years by roughly 17 percentage points. Although their regression model allows the direct effect of age to be non-linear, they do not test whether the effect of organized screening varies with age.

Numerous studies document significant socioeconomic disparities in breast cancer screening. Jusot, Or and Sirven (2012) use data from the 2004 and 2006 waves of the SHARE to examine the socioeconomic correlates of several types of preventive care. They find that, controlling for other factors, women in the highest education group are more than 50 percent more likely than women with the lowest level of education to have had a mammogram in the past two years. Carrieri and Wubker (2013) conduct a similar analysis

[7]NUTS stands for Nomenclature of Units for Territorial Statistics. The system was developed by Eurostat for developing, collecting and analyzing harmonized statistics at the sub-national level.

using SHARE data from 2009. They also find that after controlling for proxies for need, screening rates increase significantly with education and income. Significant disparities in mammography use have also been documented in the U.S. (Sabatino et al., 2008; Lantz et al., 2006; McMorrow, Kenney and Goin, 2014) and Canada (Katz and Hofer, 1994; Katz, Zemencuk and Hofer, 2000). In a comparative study of 19 OECD countries, France ranked fourth in terms of income-related inequalities in mammography use (Devaux, 2015).

If cost is an important reason that lower income women make less use of mammography and other types of preventive care, organized programs that make mammograms available free of charge should reduce disparities in utilization. Similarly, to the extent that disadvantaged women have low rates of breast cancer screening because they are not well-informed about the benefits of mammography, the information that is provided as part of an organized program can also reduce disparities. On the other hand, more educated, higher income women may be more efficient user of health inputs, and therefore they may be more responsive to the reduced cost and informational intervention associated with an organized screening program. Thus, it is possible that an organized program could amplify rather than reduce disparities in mammography use related to socioeconomic status (Goldman and Lakdawalla, 2001).

The existing evidence on the effect of public policies on disparities in mammography utilization is limited and mixed. Adams, Breen and Joski (2007) find that although the NBCCEDP increased breast and cervical cancer screening in the U.S., the program did not reduce disparities in screening outcomes related to race or ethnicity. Similarly, in his analysis of organized screening in Switzerland, (Pletscher, 2015) tests for heterogeneous effects related to education and income and finds no clear pattern with respect to either. In contrast, Carrieri and Wuebker (2016) find that organized screening programs have a larger effect on mammography uptake among women with the lowest levels of education compared to those with medium or high levels of education.

Descriptive studies reporting changes in mammography use after the introduction of an organized screening program also provide mixed results. Espinas et al. (2011) report changes in the percentage of women in Catalonia reporting that they "regularly" have a mammogram before and after an organized screening program was extended to the entire Catalan population in 2002. They find significantly larger changes in regular mammography use among women with a primary school education or less compared to women with a higher level of education. In contrast, a similar analysis for Belgium suggests that the effect of that country's national breast cancer screening program was similar for all education groups, leaving the gradient with respect to education essentially unchanged (Puddu, Demarest and Tafforeau, 2009).

2.3 Organized Breast Cancer Screening in France

As in other European countries, organized screening in France began in the 1980s at the local level. Figure 1 summarizes the timing of program implementation. All dark (from black to light grey) départements had local programs. Between 1989 and 1998, programs were launched in 27 *départements*. These *départements*, which are shown as the darkest ones on the map, are scattered throughout the country. This effectively random geographic dispersion and the fact that France's health care system is highly centralized, with essentially uniform policies concerning insurance benefits and provider reimbursement being applied nationwide, minimizes the concern that the distribution of these local programs was correlated with other factors that likely influenced the demand for or supply of mammography.

The earliest programs sent invitation letters every three years to women between the ages of 50 and 69. The protocol for these early programs involved a single image, which was read by one radiologist. In the next couple of years, additional programs were launched and the protocols used by existing programs evolved. By 2000, there were 32 local programs, half of which were sending invitation letters once every two years. The transition to a national program began in 2001, at which time a new protocol was established (the lightest grey on the map). In addition to the 2-years invitation cycle, the new protocol includes two images per breast, independent readings by two radiologists,[8] and a clinical breast exam. Also, the upper limit of the target age range was extended to 74 from 69. By the end of 2002, 22 *départements* had adopted the new protocol including already existing local programs that switched to the new protocol in 2001 or 2002, or local programs implemented during those two years. By 2004 an organized screening program using the new protocol was operational nationwide. The current system is financed at the national level by the public health insurance funds and is overseen by the national cancer institute, though the operation of the program is still managed at the level of the *département*, typically by a non-profit organization.

The invitation letter sent to eligible women includes information about the benefits of mammography in general as well as the specific advantages of the organized program, such as the second reading, as well as a list of radiologists participating in the program. Participating radiologists must undergo a specific training, perform a minimum of 500 mammograms per year and agree to have their equipment inspected by a national agency. The goal of these requirements is to assure a standard level of quality throughout the country. For women who accept the invitation to the organized screening program, there is no charge for the mammogram.

Whether or not a woman receives a letter of invitation, she can screen "opportunistically" by obtaining a

[8] While the early local programs also included a second reading it was not independent in 30% of cases.

prescription from a physician (usually a gynecologist or a general practitioner). In that case she would face some out-of-pocket expenses. Currently, the amount that the public insurance system pays for a mammogram (the "standard tariff") is 66.42 euros. Women screening opportunistically would need to pay upfront, though 70 percent of the standard tariff would be reimbursed by the public health insurance system and part of the remaining or all 30 percent would be reimbursed by private complementary insurance. Some radiologists are allowed to charge more than the standard tariff. It is estimated that in 2008 the physician's fee exceeded the standard tariff for over 80 percent of the mammograms performed outside of the national program, with an average extra-billing amount of 6 euros (Haute Autorité de Santé, 2011). This extra-billing is not reimbursed by the public system, though part may be reimbursed by private complementary insurance, depending on the contract. Thus, the organized screening program can be expected to increase mammography utilization by lowering the financial cost of screening. The program may also increase utilization via an educational effect, through the information provided in the invitation letter and, perhaps, by affecting perceptions of the quality of the screening.

With the program's two-year invitation cycle, women in the target age range receive an invitation letter 20-22 months after their last mammogram received through the program—if they took up the previous offer—or their last invitation letter—if they did not. In the absence of an organized program, there would be no such follow-up for women who had obtained a mammogram by getting a prescription from their doctor. Thus, an organized screening program may not only affect the likelihood that a woman ever receives a mammogram, but the regularity with which she does. Goldzahl and Jusot (2017) find evidence that is suggestive of such an effect. Using a data set formed by linking survey data to medical claims from France's public health insurance funds, they find that women who participate in the organized screening program are more likely than women who obtained a mammogram outside of the program to receive a second mammogram within two years.

3 Data and Methods

3.1 Data: The ESPS

Our analysis is based on data from the *Enquete santé et Protection Sociale* (ESPS), a representative population-based survey that has been conducted biennially since 1988 by the *Institute de Recherche et Documentation en Economie de la Santé* (IRDES). The ESPS is administered to a sample of French households randomly drawn from public health insurance files. The survey provides information on both the household and its members collected using both interviews (telephone or face to face) and self-administered questionnaires.[9]

We use data from the 2000, 2002, 2006 and 2008 surveys.[10] This timing of the surveys is well-suited for our study for several reasons. First, we have two periods of data before and two periods of data after the implementation of the national screening program in 2004. Second, all but one of the local programs (with old protocol) that pre-dated the national program were in place by 2000.[11] This facilitates clear cross-sectional comparisons during the "pre" period and simplifies the implementation of the difference-in-differences model to estimate the effect of the national program. Third, the fact that our first year of "post" data is two years after the program was put in place nationally, means that nearly all women in the target age group should have received a letter of invitation from the program by the time they responded to the survey. Fourth, the four-year gap between our last year of data pre-dating the national program and our first year of "post" data means that our estimates should not be affected by short-run dynamic effects around the implementation year. That is, our estimates should not be subject to an upward bias caused by women delaying a mammogram they otherwise would have had in 2003 in order to benefit from the program or by a downward bias from a "learning curve" in the initial year of the program.

There are two timing issues that may affect our estimates of the effect of the earlier local programs represented by the various share of grey on figure 1. One is that 8 of the 32 early local programs were started in 1998 or later. So, while the program was in place by 2000, some eligible women may not have received their invitation letter by the time they completed the 2000 ESPS. This may cause the effect of those local programs to be understated. As a robustness check, we estimate the model without the year 2000 during which respondents may have been exposed to variation in local program's invitation from 1998 to 2000. The results are the same. The second issue is that many of the *départements* with local programs began transitioning to the new protocol in 2001. In those *départements* there will be slight differences in program features between 2000 and 2002. In particular, in those *départements*, the target age range will have expanded from 50-69 in 2000 to 50-74 by the end of 2002. In most of our analysis, we use the current age range of 50 to 74 to define our target group in order to have consistent definitions across *départements*

[9] More information on the ESPS, including questionnaires for every year, is available at http://www.irdes.fr/recherche/enquetes/esps-enquete-sur-la-sante-et-la-protection-sociale/actualites.html.

[10] The ESPS has a longitudinal component, whereby half of the sample is interviewed every 4 years. Thus, some respondents were interviewed two or three times in the four survey waves that we analyze. In our main analysis we keep all observations for respondents who where interviewed more than once (N = 22,877). As a sensitivity check, we randomly select one observation for such individuals (N = 17,961) and also use the panel dimension (4,849). The three samples present qualitatively similar results.

[11] The exception was the Essonne, a *département* in the Parisian greater region, which established its program in January 2000.

and over time. As a robustness checks we estimate models in which the definition of the target group varies depending on the rules in place in a particular *département* and year. We also estimate models that drop *départements* that strengthened their programs before 2004. The results are not sensitive to these changes.

In each of the four years that we analyze, the ESPS asks women whether they have ever had a mammogram. Those answering yes are then asked to give the date of their last mammogram. Based on these responses, we create a binary variable that equals one for women who have had a mammogram in the past two years and zero for all others, including both women who have never had a mammogram and women whose last mammogram was more than two years earlier. Although the mammography question is asked of all female respondents over age 15, mammography rates for younger women are extremely low. Therefore, we limit our main analysis sample to women age 35 and older.

Table 1 presents summary statistics for the full sample and for women living in *départements* with and without a local organized screening program respectively in the pre and post-period. In the pre-period, the two subsamples, which represent 45 and 55 percent of the sample, respectively, are remarkably similar in terms of observable characteristics. The mean age is 54 years old in *départements* that had an organized screening program and 54.8 years old in those that did not. Thirteen percent of women in each group report their health as fair, while 18 percent report their health as excellent. Twelve percent of women in each type of *département* are current smokers. The percentage with private complementary health insurance—which has been shown to be positively correlated with the utilization of outpatient care (Buchmueller et al., 2004)—is nearly identical (88.9 percent in *départements* with a local program, 87.5 percent in those without) as is the distribution of income. The one notable difference is that *départements* with local programs tend to be less rural. These strong similarities between the two subsamples suggest that women living in *départements* without a local screening program are a good comparison group for women who were exposed to such a program before the national program was established.

3.2 Empirical Strategy

The quasi-experimental variation in our data allows for several different estimates of the effect of organized breast cancer screening programs on mammography use. Let T_t^k be the screening rate for women in the target age range (50 to 74), and C_t^k be the screening rate for women outside this age range, i.e., the "control" group. The superscript k indexes two types of *départements*: those with (L) and without (N) local screening programs. The subscript t indexes two time periods. The "pre" period (t=0) consists of the years 2000 and 2002, before the national program was established; the "post" period (t=1) consists of data from 2006 and

2008, when the national program was in place in all *départements*.

Using this notation, a simple cross-sectional estimate of the average effect of the pre-existing local programs can be obtained by comparing the screening rates for the target age group in the two types of *départements*:

$$\Delta_L = T_0^L - T_0^N. \tag{1}$$

An obvious concern with this estimate is that it will be biased if there are other unobserved factors that cause the screening rate to be different in *départements* with and without programs. One can imagine the bias going in either directions. On one hand, the "first mover" *départements* may be those that already had good referral networks and radiologists with a strong orientation toward population screening. On the other hand, some *départements* may have established organized programs in response to low rates of opportunistic screening. If these other factors have the same effect on women within and outside the target age range, this potential bias can be eliminated by using a cross-sectional difference-in-differences estimate:

$$\Delta\Delta_L = (T_0^L - T_0^N) - (C_0^L - C_0^N). \tag{2}$$

The effect of the national program can be estimated by calculating changes in screening rates for target group women who were not exposed to the earlier local programs, using changes for control group women in the same *départements* to account for the effect of other factors that may have caused screening rates to change over time. This difference-in-difference estimate can be calculated as

$$\Delta\Delta_N = (T_1^N - T_0^N) - (C_1^N - C_0^N). \tag{3}$$

Given that the national program put in place in 2004 is stronger in several respects than the pre-existing local programs, it is of interest to test whether screening rates increased in those areas that had local programs in place in the "pre" period. The difference-in-difference estimate

$$\Delta\Delta_{LN} = (T_1^L - T_0^L) - (C_1^L - C_0^L) \tag{4}$$

captures the combined effect of those specific elements of the national program that differ from the local programs: the use of a 2-year rather than 3-year invitation cycle, the extension of program eligibility to age 74 rather than 69, two images per breast are taken instead of one, and the fact that women receive a clinical exam in addition to a mammogram.

Because we have no data from years before the local programs were established, we cannot directly estimate the full effect of the national program in these *départements*. However, we can construct an estimate of that effect by summing the cross-sectional difference-in-differences estimate of the effect of the local program, Δ_L, with our estimate of the effect of moving from the local program to the national program $\Delta\Delta_{LN}$. Comparing this measure with our direct estimate of the effect of the national program, Δ_N, provides a useful specification check. Our basic model assumes that the effect of the program is immediate and constant over time and is homogeneous across *départements*. If these assumptions hold, the two estimates of the full program effect should be similar.

These various estimates can be obtained from the following regression estimated on pooled data:

$$\begin{aligned} y = \alpha_1 Local + \alpha_2 Target + \alpha_3 Post \\ + \beta_1 Local \times Target + \beta_2 Local \times Post + \beta_3 Target \times Post \\ + \gamma Local \times Target \times Post + X'\theta + \epsilon \end{aligned} \quad (5)$$

In this equation *Local* is an indicator variable that equals one for women who live in a *département* that had a local screening program before 2004, *Target* is an indicator for women between the ages of 50 and 74, the indicator *Post* equals one for years after 2004, and X is a vector of control variables. The various estimates are then:

Effect of local program:	$\Delta\Delta_L =$	β_1
Effect of national program:	$\Delta\Delta_N =$	β_3
Effect of transition from local to national program:	$\Delta\Delta_{LN} =$	$\beta_3 + \gamma$.

4 Results

4.1 Unadjusted Difference-in-Differences Estimates

Table 2 presents the percentage of women who had a mammogram in the past two years tabulated by membership to the target age group of 50 to 74 years old, residence in a *département* with a local program, and the years before or after the implementation of the national program. These figures can be used to calculate the various estimates just described.

Panel A reports data from the "pre" period (2000 and 2002).[12] The first row pertains to women outside the target age range. Because women in this age group are never exposed to organized screening programs, the difference between the mammography rates in the two types of *départements* provides information on whether there are other factors affecting mammography that are correlated with the existence of a program. The fact that the difference is not statistically significant, suggests that other confounding factors are not a concern. As a result, when we compare mammography rates across *département* types for women in the target group, the simple difference, Δ_L, and the difference-in-differences estimate of the program effect, $\Delta\Delta_L$ are essentially identical. Both imply that the local programs raised mammography rates among women in the target age range by roughly 6 percentage points, or by about 14 percent of the rate in *départements* without an organized screening program.

Panel B presents screening rates in 2006 and 2008, after the national program was in effect. The comparisons across *département* types again suggest a strong similarity between those with and without an organized screening program in place before 2004. Among women outside the target group, the screening rate is slightly higher in *départements* with a local programs, but the difference is small although significant at the .10 level($p = 0.08$). The results for women in the target age range indicate that the implementation of the national screening program eliminated the gap in screening rates between *départements* with and without local program. In the "post" period, 56.2 percent of women in *départements* with an already established local program and 57 of women who were not exposed to organized screening prior to 2004. The 0.8 percentage point difference between these two rates is not statistically significant.

The effect of implementing the national program can be estimated based on changes over time, which are reported in Panel C of the table. Again, it is informative to note the differences that are not statistically significant. In both types of *départements* we see that there was no significant change for women outside the targeted age range. This suggests that there were not other contemporaneous factors, such as a general increase in breast cancer awareness or a change in clinical guidelines that might have caused screening to increase over time.

In contrast, for women in the target group who were not previously exposed to a local organized screening program (column 1), the percentage with a mammogram in the past two years increased by 16.8 percentage points, a 40 percent effect relative to the baseline rate. Since there was no significant change for women outside the target group, the difference-in-differences estimate of the effect of the program is essentially

[12]For each of the four groups defined by target status and *département* type, there is no significant change in mammography utilization between 2000 and 2002.

identical. This is very similar to the estimated effect of organized screening reported by Carrieri and Wuebker (2016). The fact that this estimated effect is substantially larger than the estimated effect of the local programs suggests that the ways in which the national program strengthened the local programs had a meaningful effect. This conclusion is reinforced by the finding that screening rates increased over time in *départements* where there was already a local organized screening program in place. The difference-in-differences estimate of the effect of this change is 9.1 percentage points ($\Delta\Delta_{LN}$= 0.100 - 0.009 = 0.091).

4.2 Basic Regression Results

In Table 3 we report key results from linear probability regressions that generate the same set of estimates. In the upper panel of the table we report estimated coefficients and robust standard errors (clustered by *département*). Below, we calculate the three difference-in-differences estimates of interest. The model reported in column 1 includes no covariates and therefore corresponds directly to the cross-tab results in Table 2. The specifications in column 2 adds the following covariates: age, age squared, age cubed, quintiles of household income, self-reported health status (5 categories), education (5 categories), current or former occupation (7 categories), complementary health insurance status (3 categories) and indicator variables for smoking, having at least one chronic health condition, living in a rural area and living in the greater Paris region.

For the most part, including covariates does not have a major impact on the coefficients on the variables of interest. One important exception is the coefficient on the indicator for being in the target group, which is large and statistically significant in column 1 (0.174, p=0.000) and is a precisely estimated zero in the adjusted model (p=0.999). This result provides support for our difference-in-differences approach as it indicates that in the absence of an organized program there is not a discrete change in the probability of having a recent mammogram associated with turning 50 or turning 75. In other words, our estimates of the effect of organized screening are not capturing the effect of other factors, such as age-based clinical guidelines.

The full regression results are reported in Appendix Table 7. In addition to the positive effect of age, the estimated coefficients on the other control variables are consistent with results from previous studies on the determinants of mammography use.[13] Women with private complementary insurance are more likely to have a recent mammogram than women who either have no complementary coverage or are covered by means-tested public insurance. Current smokers are significantly less likely than non-smokers to have had a recent mammogram, a result that may reflect preferences regarding risk and preventive medical care.

[13]Schueler, Chu and Smith-Bindman (2008) provide a comprehensive review of studies using data from the U.S. For a recent analysis of the correlates of mammography use in France, see Sicsic and Franc (2014) and Goldzahl and Jusot (2017)

There appears to be an inverse U-shaped relationship with self-reported health. The probability of having a mammogram in the past two years is highest for women who report their health as good and lower for those who say it is fair, poor or excellent. The results for education and income indicate a positive gradient with respect to socioeconomic status, an issue which we return to below.

Turning to the coefficients that represent the effect of organized screening program, we see that the adjusted differences-in-differences estimates are qualitatively similar to those from the unadjusted model. According to the model reported in column 2, the local programs raised the percentage of target aged women having a mammogram in the past two years by 6.7 percentage points. Modifying those programs to conform with the new national protocols and standards raised the two-year mammography rate by an additional 6.2 percentage points. The models with covariates imply that going from no program to the national program led to a 14 percentage point increase in screening.

In column 3 we exploit the limited longitudinal feature of the ESPS data by limiting the sample to respondents who appear more than once in the data and estimating a model with individual fixed effects. In column 4, we limit the sample to one observation per respondent. Neither change has a major impact on the qualitative results.

Columns 5 and 6 report results a different outcome: a binary variable that equals one if a woman has ever had a mammogram and zero otherwise. The results from the model with covariates (column 6) imply that both the local program and the national program raised the percentage of women who had ever had a mammogram by between 4 and 5 percentage points. These estimates are remarkably similar to the effects that Pletscher (2015) finds in his evaluation of organized breast cancer screening in Switzerland. A comparison between these results and the results for our preferred specification suggests that not only do organized screening programs increase initiation to mammography, but they increase the regularity with which women screen.

4.3 Alternative Samples

In Table 4, we report key results from models using alternative estimation samples. For ease of comparison, the covariate-adjusted results from column 2 of Table 3 are presented again in the first row. The next three rows illustrate the impact of changing the age criteria used to form the estimation sample. Because very young and very old women may not be good controls for women in the target age range, in row we limit the sample to women between the ages of 40 and 80. The point estimates are slightly smaller than the results for the full sample, though the basic pattern is the same. In row 3, the sample includes all women 35 and older with the exception of those who are 50 or 51 at the time of the survey. The reason for dropping women right above the lower age threshold is that while they are eligible for the program, some may have not yet received an invitation letter. The estimates for this sample are slightly larger than our baseline results, but again the differences are not material. In raw 4, the target age group is restricted to 50-69 years old in line with the eligibility criteria of the local program protocol. We expect to find a lower impact of the national program as part of its additional features compared to the local one is the age extension to 74 years old. Indeed, this is what we find. The small reduction in the point estimate of the local program may be due to the fact that this target group definition does account for the effect on mammography use of local program that transitioned to the new protocol (age eligibility extended to 74 years old) from 2001.

A particular feature of our research design is that the control group combines women who are too young to participate in the program and women who are too old. These two groups are not only quite different in terms of their demand for mammography in the absence of the program, but also in the extent to which their behavior may be influenced by the program. Women under the age of 50 are a "cleaner" control group as they should have never received a letter inviting them to have a mammogram through the program. In contrast, some women above the age of 74 will have participated in the program, especially by 2008. Additionally, to the extent that their recall is not perfect, some women who received a mammogram through the program, say, three or four years ago, may mistakenly say that they had one in the past two years. Thus, we would expect to find stronger effects of the program if we compare women in the target group only to those under age 50 than if we compare them to women over age 74. In fact, this is exactly what we find (rows 5 and 6). When we limit the estimate sample to women between the ages of 35 and 74, our estimates of Δ_L and Δ_N are slightly larger than the corresponding estimates for the full sample, though again the difference is small. In contrast, we find considerably weaker effects when we drop women under age 50 and estimate the program effect by comparing 50 to 74 year-olds to women age 75 and older. In the next section, we investigate differences related to age more completely.

In the two last rows, we report results from a model estimated on a sample that excludes data from 2000 and 20002, respectively. The reason for this exclusion is the fact that some of local programs were relatively new in 2000, which means that some women in the target group and interviewed in 2000 may not have yet received an invitation letter. As might be expected, the estimated effect of the local program is slightly larger than in the full sample, though the difference is small and not statistically significant. While there is no variation in exposure for those interviewed in 2002, the protocol of the program has changed for some respondents of ESPS 2002. The reason is that some local programs transitioned to the new protocol during

2001 and 2002. Dropping data from 2000 or 20002 has no impact of the estimated effect of the national program ($\Delta\Delta_N$), which is not surprising because that estimate is based entirely on changes in *départements* without programs in 2000 or 2002.

None of these changes materially affect our results. We continue to find that both the national and the earlier local screening programs significantly raised mammography rates, with the effect of the former being more than twice as large as the latter.

The last statement is true except when we adopt the restrictive definition of a *départements* with a local program. This definition overestimate the impact of local programs because we only kept those that covered the entire period (1998 to 2002) while most of the local programs started after and 1997. This is also why there is no statistically significant change in mammography use when the national program was implemented.

4.4 Accounting for Heterogeneous Effects by Age

Even though the covariate-adjusted models reported in Table 3 control flexibly for the main effect of age, they restrict the impact of organized screening to be the same for all women in the target groups. In Figure 2 and Table 5 we present analyses that allow the effect of the program to vary with age. We stratify the analysis by *département* type to account for baseline differences in policy. The figure uses two-year bins; in the regression we interact the indicator variable for the "post" period with five-year age categories.

The results for *départements* without a pre-existing program (panel A of the figure and column 1 of the table) provide the clearest evidence of the impact of the national program. When there was no organized screening program in place, mammography rates increased with age up to age 60 and declined thereafter. A comparison of the age profiles for the "pre" and "post" periods indicates that the implementation of the national program had no effect on mammography rates for women under the age of 50. This is visually apparent from the figure and can be seen by the fact that the coefficient on "post", which represents the change over time for 35 to 40 year olds and the interaction of that variable and indicators for the next two age categories (40-45, 45-49) are all insignificantly different from zero. Again, these null results for women who were not eligible for the organized screening program suggest that there is little reason to worry about unobservable shocks that might have affected mammography rates in France during this period.

The results indicate that the implementation of the screening program increased mammography rates for all age groups within the 50 to 74 year-old target range, but the effect was not uniform. The percentage of women between the ages of 50 and 54 having a mammogram in the past two years jumped by 10 percentage points after the national screening program was put in place. After the program was in place, mammography rates increased slightly up until around age 70 and then began to decline thereafter. Because mammography rates peaked at an earlier age during the "pre" period, the implied effect of the program is stronger for women in their 60s and 70s than women in their 50s. The probability of having a recent mammogram increased by 21 percentage points for women in their 60s and by 26 percent for women between 70 and 74. This pattern provides further evidence suggesting that an important way that the program increased screening was by affecting the regularity of mammography use among women in the target age range.

There was also a statistically significant increase among women between the ages of 75 and 79, who are just outside the target age range. Given that the dependent variable equals one for women who had a mammogram in the past two years, many of these women may have participated in the national screening program. Indeed, a supplementary analysis suggests that this is the case. We ran separate regressions for 75–79 year-olds, allowing the effect to differ between 75–76 year-olds, who would have been eligible for the organized program during the two year look-back period, and 77–79 year-olds, who would not have been. For the younger group, the probability of having a recent mammogram increased by 25 percentage points, which is comparable to the effect for 70–74-year olds. The increase was roughly half as large for 77–79 year-olds, though it was still statistically significant (0.13, p=0.005). This effect for women just above the upper age threshold may reflect a true spillover effect. For example, after being exposed to the organized program women may continue to have a strong demand for screening even after they age out of the program. Alternatively, it could reflect measurement error: women may be understating the time since their last mammogram.

4.5 Impacts on Disparities in Screening

Both the basic difference-in-differences results and the models allowing for heterogeneous effects by age indicate that France's national breast cancer screening program significantly increased the percentage of women receiving mammograms. We now turn to the question of whether organized screening has also reduced socioeconomic disparities in mammography utilization. Table 6 presents utilization rates tabulated by education and income categories. Because we are interested in how utilization changed among affected women after the national program was implemented, we focus on women in the target age range of 50 to 74 years old. To account for differences in baseline conditions, we present separate results for *départements* with and without pre-existing local programs.[14]

[14] Some studies in the literature on health disparities focus on unadjusted differences among groups, while others condition on proxies for health need and preferences as well as, in some cases, other observable characteristics. Because we are interested in overall differences in mammography use among targeted women, we focus on unadjusted differences across education and income groups. For a useful discussion of methodological issues concerning the measurement and analysis of health-related

Looking first at *départements* without pre-existing local programs, we see that before the national program was established there were strong gradients with respect to education and income. Women with a middle school education were 16 percentage points more likely to report having had a mammogram in the past 2 years than women with a primary school education or less. The utilization rate is higher still for women with high school educations and those with university degrees. The ratio between the rate for the highest education category to the rate for the lowest category was 1.8. The percentage of women with a recent mammogram also increased monotonically with income, with a slightly larger ratio between the highest and lowest quintiles. After the national program was put in place, mammography rates in those *départements* increased for all education and income categories, though the change was generally larger at the lower ends of each distribution. The changes were 20.6 and 22.5 percentage points for the lowest education and income categories, respectively, compared to roughly 9 percentage points for the highest categories. The ratio between the top and bottom income quintiles fell from 2 to 1.4.

In *départements* with pre-existing local programs, the baseline gradients were less steep, which also suggests that organized screening reduces socioeconomic disparities. There, we also see greater increases over time for women in lower education categories, though the differences were less pronounced than what we observe for *départements* that went from having no program to implementing the national program. In the "post" period, the ratio of the mammography rates for the top and bottom education category and income categories were similar in the two types of *départements*.

The 2006 and 2008 ESPS surveys asked not only whether a woman had a mammogram in recent years, but those who had a mammogram were asked whether or not they received it through the organized program. In the last column of the table we present the percentage of women in each education or income category that participated in the program. For these calculations, the sample is limited to women who had a mammogram in the past 2 years. Because the overall utilization rate and the gradients are so similar across *département* types, we pool *départements* with and without pre-existing local programs. The results indicate that a strong negative relationship between socioeconomic status and the decision to obtain a mammogram through the organized program. Seventy percent of women with a primary education or less who had a mammogram in the past two years received it through the program, compared to 53 percent of women with at least a university degree. Similarly, the percentage using the program ranged from 71.5 percent in the lowest income quintile to 55.8 percent in the highest. Multiplying these percentages by the mammography rates for the post period, gives the percentage of women in each group participating in the program. This calculation shows

disparities, see Cook, McGuire and Zaslavsky (2012).

that program participation was quite similar across groups and that the gradients that remain are driven by the fact that higher SES women are more likely to go outside the program to receive a mammogram. Overall, the results in Table 6 suggest that the organized program had the effect of reducing disparities in mammography use.

5 Discussion and Conclusion

Although breast cancer is a leading cause of death for women, if detected early it is highly treatable, with high rates of survival. Because mammography is considered the most effective means of early detection, nearly every European has a population-based program providing free mammograms to women in a target age range. France's national program, which was established in 2004, is representative of these efforts.

We estimate the impact of France's breast cancer screening program on the percentage of women receiving a mammogram in the past two years. Our main analysis uses a difference-in-differences strategy that compares changes in mammography use for women who were targeted by the program to changes for women who were not eligible for the program. We also estimate cross-sectional difference-in-differences models to examine the impact of earlier programs established at the local level.

Our results provide clear evidence that the national program increased mammography rates among women in the target age range. In *départements* where there was no pre-existing local program, the percentage of women obtaining a mammogram over a two year period increased by between 12 and 17 percentage points, or by roughly 30 to 40 percent relative to baseline rates, after the program was implemented in 2004. The fact that we find no change over time in mammography rates for women who were not targeted by the program suggests that the changes we do find are true program effects rather than the effect of other factors, such as increasing breast cancer awareness or secular changes in technology diffusion or clinical practice.

The implementation of the national program around 2004 meant that all pre-existing local programs adopted the new protocol, which involved invited women to screen every two years (as opposed to every three under the old protocol), having images read by two independent radiologists (as opposed to one reading under the old protocol) and a clinical breast exam (which was not included under the old protocol). We find that the implementation of the new protocol led to an increase in mammography rates in *départements* where there already was a program. Although we cannot determine exactly which of these enhancements is most responsible for the increase in utilization, this finding suggests that the content and quality of a screening program matters. Further research on how women perceive and value different aspects of organized programs could shed light on this question.

Interestingly, we find the largest effects for women in their mid-60s, who are in the middle of the target age range. This result combined with the fact that we find weaker effects on the probability on the probability of *ever* having a mammogram suggest that the most important effect of the program may not be on mammography initiation, but rather on the regularity of screening.

By eliminating financial barriers and increasing awareness of the importance of screening, organized programs have the potential to reduce socioeconomic disparities in cancer screening. Consistent with other research on France and other European countries, in the years prior to the introduction of the national program, we observe significant positive gradients in mammography use with respect to education and income among target age women. The implementation of the national program increased mammography rates for women of all education and income levels. However, because the increases were greater for women of lower socioeconomic status, the policy had the effect of reducing disparities in mammography utilization.

While our results suggest that France's organized breast cancer screening program was successful at increasing mammography use, the ultimate goal of any such program it to reduce mortality through the timely detection of treatable tumors. Although the benefits of mammography have long been taken as given, the strongest empirical evidence comes from randomized clinical trials, not population-based screening programs. The extent to which the higher rates of mammography use generated by this program led to reductions in mortality is an empirical question that merits further research.

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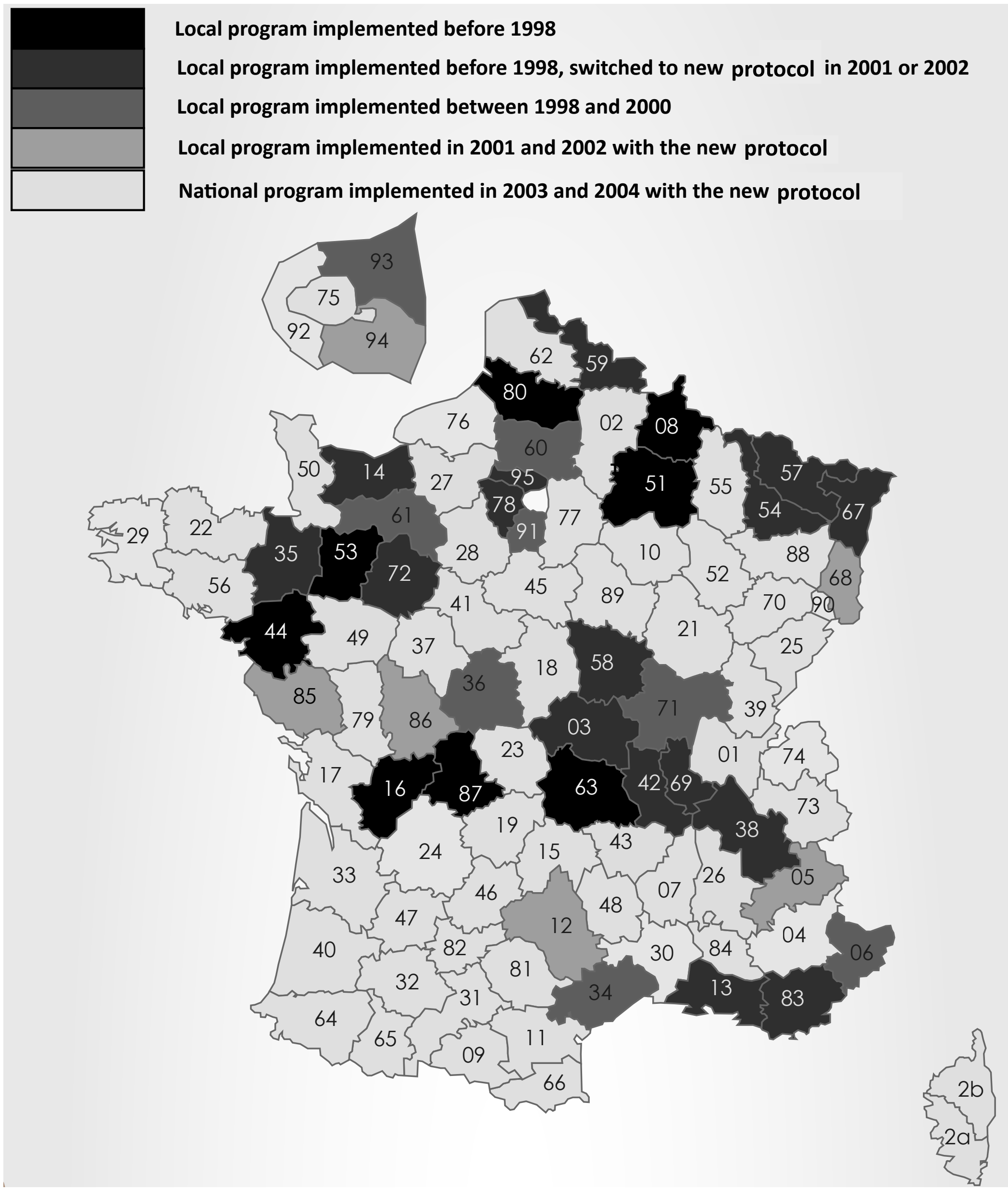
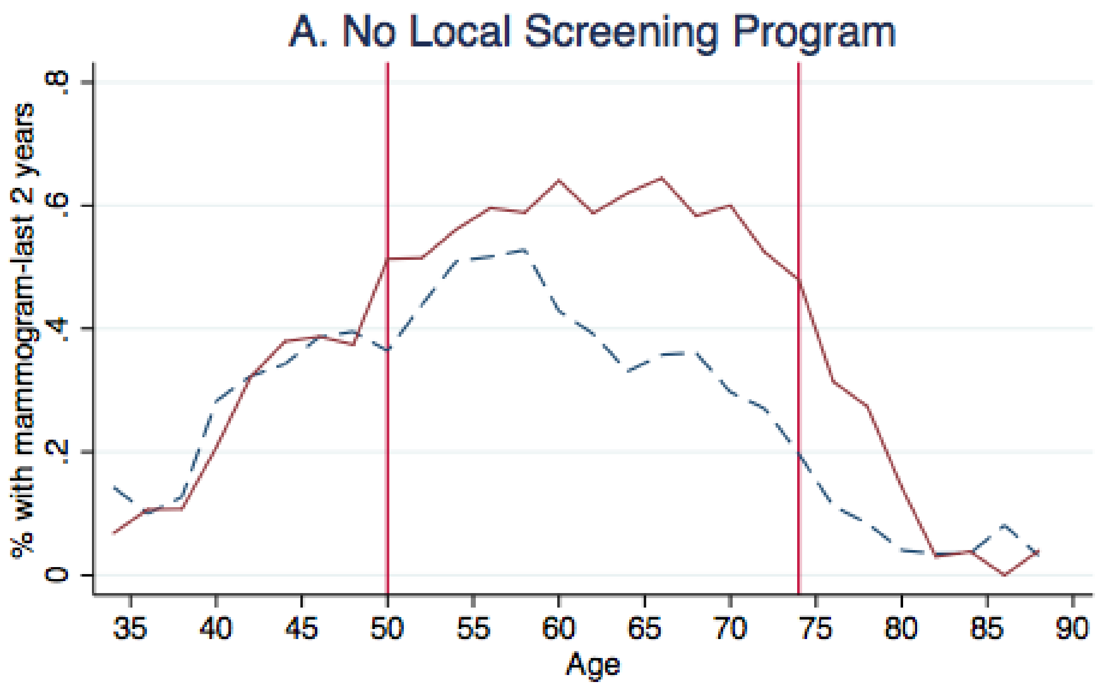
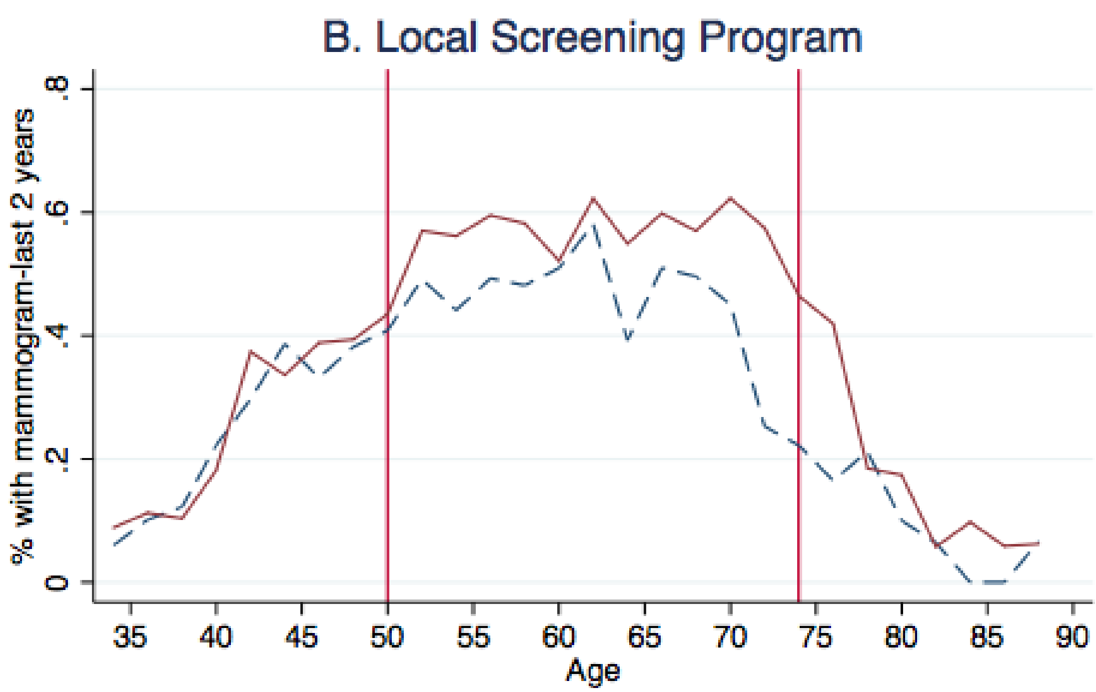


Figure 1: Implementation of the local and national programs [a]

[a]Corsica includes département 2A and 2B and are referred to as département 20. Among the départements that adopted a local program between 1998 and 2000, all of them except départements number 71 and 34 adopted the new protocol in 2002. For sake of clarity, this distinction is not observable on the map.



The dashed line represents the pre-period. The solid line represents the post-period.



The dashed line represents the pre-period. The solid line represents the post-period.

Figure 2: **The Percentage of Women with a Mammogram in the Past 2 Years by Age**

Table 1: Summary statistics

	All		Depts w/o a local program (1)		Depts with a local program (2)		Diff (1) - (2)
	Mean	Std.	Mean	Std.	Mean	Std.	
Mammo. <2 years	0.385	0.487	0.377	0.485	0.395	0.489	-0.017
Ever had mammo.	0.535	0.499	0.528	0.499	0.542	0.498	-0.014
Poor health	0.039	0.194	0.038	0.192	0.040	0.196	-0.002
Fair health	0.155	0.362	0.154	0.361	0.156	0.363	-0.002
Excellent health	0.178	0.382	0.180	0.385	0.175	0.380	0.006
Health unknown	0.290	0.454	0.292	0.455	0.287	0.453	0.005
Good health	0.338	0.473	0.335	0.472	0.341	0.474	-0.007
Compl. health insu	0.878	0.327	0.882	0.323	0.874	0.332	0.008
CMU	0.065	0.246	0.063	0.243	0.067	0.250	-0.004
NC	0.045	0.208	0.044	0.205	0.047	0.212	-0.003
ALD	0.143	0.350	0.144	0.351	0.143	0.350	0.001
Smoker	0.134	0.340	0.135	0.342	0.132	0.338	0.004
No education	0.294	0.456	0.295	0.456	0.293	0.455	0.002
Middle school	0.259	0.438	0.253	0.435	0.265	0.442	-0.012
High school	0.208	0.406	0.210	0.407	0.207	0.405	0.003
University degree	0.196	0.397	0.202	0.401	0.188	0.391	0.014
Other	0.043	0.203	0.040	0.197	0.047	0.212	-0.007
Farmer	0.046	0.209	0.055	0.228	0.035	0.185	0.020
Craftsman	0.048	0.214	0.053	0.223	0.043	0.202	0.010
Executive	0.082	0.274	0.083	0.276	0.080	0.271	0.003
Intermediate occup.	0.176	0.381	0.181	0.385	0.170	0.376	0.011
Employees	0.431	0.495	0.416	0.493	0.449	0.497	-0.034
Workers	0.163	0.369	0.162	0.368	0.165	0.371	-0.003
Other/Unknown	0.053	0.224	0.049	0.215	0.058	0.234	-0.009
1st quintile	0.294	0.456	0.103	0.304	0.096	0.295	0.007
2nd quintile	0.130	0.336	0.134	0.340	0.125	0.331	0.008
3rd quintile	0.133	0.340	0.135	0.342	0.131	0.337	0.005
4th quintile	0.174	0.379	0.166	0.372	0.184	0.387	-0.017
5th quintile	0.189	0.391	0.186	0.389	0.193	0.394	-0.007
Refused to answer	0.274	0.446	0.276	0.447	0.272	0.445	0.004
Rural	0.292	0.455	0.341	0.474	0.233	0.422	0.108
Paris	0.131	0.337	0.125	0.330	0.138	0.345	-0.014
Age‘	54.638	13.573	55.015	13.823	54.173	13.245	0.842
Radiologist density	8.997	2.353	8.877	2.437	9.145	2.237	-0.268
2000	0.230	0.421	0.229	0.420	0.230	0.421	-0.001
2002	0.236	0.424	0.235	0.424	0.237	0.425	-0.002
2006	0.262	0.440	0.263	0.440	0.260	0.439	0.002
2008	0.273	0.446	0.274	0.446	0.272	0.445	0.001

Table 2: Unadjusted Difference-in-Differences Estimates

	Local Program			
	No	**Yes**	**Difference**	**t-statistic**
	1	2	(2) – (1)	
A. Before National Program				
Control group	0.237	0.239	0.002	0.15
Target Group	0.4126	0.4620	0.049	3.08
B. After National Program				
Control group	0.227	0.249	0.022	1.87
Target group	0.57	0.562	-0.008	-0.558
C. Difference (B – A)				
Control group	-0.0110	0.009		
t-statistic	-0.954	0.688		
Target group	0.1575	0.1		
t-statistic	10.72	6.13		
DiD estimates				
Δ L	5.9			
$\Delta\Delta$L	4.7			
$\Delta\Delta$N	16.8			
$\Delta\Delta$LN	9.1			

Table 3: Basic regression results

	Mammogram Last 2 Years?				**Mammogram Ever?**	
	(1)	(2)	(3)	(4)	(5)	(6)
Local (α_1)	0.004	-0.094	-0.103	-0.00102	0.007	-0.004
	(0.015)	(0.012)	(0.0616)	(0.0135)	(0.015)	(0.012)
Target (α_2)	0.177***	-0.007	-0.0690**	-0.0137	0.186***	-0.046***
	(0.013)	(0.012)	(0.0277)	(0.0126)	(0.015)	(0.014)
Post (α_3)	-0.005	-0.027**	-0.0555**	-0.0202*	0.077***	0.036***
	(0.009)	(0.010)	(0.0250)	(0.0110)	(0.011)	(0.008)
Local x Target ($\beta 1$)	0.060***	0.065***	0.0742**	0.0568***	0.031	0.036**
	(0.021)	(0.018)	(0.0358)	(0.0176)	(0.022)	(0.017)
Post x Local ($\beta 2$)	0.015	0.010	0.009	0.00567	0.005	0.016
	(0.014)	(0.015)	(0.025)	(0.0161)	(0.015)	(0.014)
Post x Target ($\beta 3$)	0.176***	0.138***	0.160***	0.145***	0.084***	0.046***
	(0.016)	(0.016)	(0.0331)	(0.0160)	(0.019)	(0.014)
Post x Local x Target (γ)	-0.089***	-0.073***	-0.0770**	-0.0751***	-0.065**	-0.049**
	(0.022)	(0.020)	(0.0359)	(0.0225)	(0.027)	(0.021)
$\Delta\Delta L$ ($\beta 1$)	0.068***	0.065***	0.0742**	0.0568***	0.031	0.036**
	(0.018)	(0.018)	(0.0358)	(0.0176)	(0.022)	(0.017)
$\Delta\Delta N$ ($\beta 3$)	0.176***	0.138***	0.160***	0.145***	0.084***	0.046***
	(0.016)	(0.016)	(0.033)	(0.0160)	(0.019)	(0.014)
$\Delta\Delta LN$ ($\beta 3 + \gamma$)	0.087***	0.065***	0.083**	0.062***	0.019	-0.003
	(0.014)	(0.012)	(0.035)	(0.016)	(0.020)	(0.015)
N	22,876	22,876	9,697	17,960	22,876	22,876
Covariates?	No	Yes	Yes	Yes	No	Yes

Note on column 3: We conducted an individual Fixed-effects model on the panel dimension of our data. There are 2 observations for each of the 4,849 individuals. The model is adjusted for age, age squared, age cubed, health status, the density of radiologist and chronic disease because they are the only ones to sufficiently change over time.

Table 4: Regression results of robustness check specifications

	$\Delta\Delta L$	$\Delta\Delta N$	$\Delta\Delta LN$
1. Full Sample (N = 22,876)	0.065***	0.138***	0.065***
	(0.018)	(0.016)	(0.012)
2. Ages 40 to 80 (N = 19,014)	0.064***	0.128***	0.061***
	(0.020)	(0.016)	(0.014)
3. Drop 50 & 51 Year-olds (N = 21,545)	0.067***	0.141***	0.074***
	(0.019)	(0.017)	(0.014)
4. Target age 50-69 (N=22,876)	0.0464***	0.0873***	0.03**
	(0.0154)	(0.0158)	(0.012)
5. Control group 49 and younger (N=20,539)	0.078***	0.154***	0.065***
	(0.019)	(0.016)	(0.013)
6. Control group 75 and older (N=13,282)	0.026	0.066**	0.049**
	(0.027)	(0.023)	(0.026)
7. Drop 2000 (N=17,622)	0.074***	0.140***	0.059***
	(0.024)	(0.020)	(0.015)
8. Drop 2002 (N = 17,486)	0.059***	0.140***	0.072***
	(0.021)	(0.020)	(0.017)

Table 5: Regression results by age

	Depts with no Local Program		Depts with Local Program	
	Coefficient	Std. Error	Coefficient	Std. Error
Age (ref: 35-39) Age 40 to 44	0.219***	(0.020)	0.210***	(0.019)
Age 45 to 49	0.337***	(0.017)	0.323***	(0.024)
Age 50 to 54	0.382***	(0.019)	0.442***	(0.021)
Age 55 to 59	0.450***	(0.020)	0.466***	(0.024)
Age 60 to 64	0.364***	(0.025)	0.444***	(0.027)
Age 65 to 69	0.343***	(0.022)	0.458***	(0.032)
Age 70 to 74	0.228***	(0.022)	0.330***	(0.040)
Age 75 to 79	0.082***	(0.023)	0.201***	(0.038)
Age 80 to 84	0.035*	(0.020)	0.025	(0.036)
Age 85+	0.049*	(0.028)	-0.006	(0.031)
Post	-0.029	(0.019)	-0.006	(0.017)
Post x 40 to 44	-0.020	(0.027)	-0.037	(0.025)
Post x 45 to 49	-0.021	(0.026)	-0.005	(0.029)
Post x 50 to 54	0.097***	(0.026)	0.014	(0.024)
Post x 55 to 59	0.062**	(0.027)	0.035	(0.026)
Post x 60 to 64	0.190***	(0.032)	0.066*	(0.034)
Post x 65 to 69	0.173***	(0.040)	0.068	(0.043)
Post x 70 to 74	0.258***	(0.037)	0.149***	(0.041)
Post x 75 yo 79	0.175***	(0.037)	0.037	(0.047)
Post x 80 to 84	0.026	(0.030)	-0.012	(0.047)
Post x 85+	-0.045	(0.035)	-0.024	(0.040)
N	12,627		10,249	

Table 6: Percentage of Women Receiving a Mammogram in Past 2 Years by income and education categories

	Dépt with no Local Program				**Depts with Local Program**					**% Screened via Organized Program**
A. Differences by Education										
	Pre-2004 (N = 2,562)	Post-2004 (N = 3,202)	Change*		Pre-2004 (N = 2,072)	Post-2004 (N = 2,592)		Change*		Post-2004 (N = 3464)
Primary or less	31.8%	52.4%	20.6%	***	42.8%	53.5%		10.7%	***	70.3%
Middle School	47.8%	62.9%	15.1%	***	50.0%	63.0%		13.0%	***	59.6%
High School	53.8%	65.8%	12.0%	***	56.7%	60.0%		3.3%		61.7%
University degree	56.8%	65.6%	8.8%	**	63.1%	68.2%		5.1%		53.0%
University/Primary or less	1.79	1.25			1.47	1.27				
B. Differences by Income										
	Pre-2004 (N = 1,856)	Post-2004 (N = 2,444)	Change*		Pre-2004 (N = 1,492)	Post-2004 (N = 1,997)		Change*		Post-2004 (N = 3464)
1st Quintile	33.6%	56.0%	22.4%	***	50.2%	55.6%		5.4%		71.5%
2nd Quintile	42.0%	63.5%	21.5%	***	54.5%	64.6%	**	10.1%		66.0%
3rd Quintile	53.7%	70.0%	16.3%	***	60.3%	63.5%		3.2%		67.0%
4th Quintile	61.6%	69.5%	7.9%	**	66.4%	70.9%		4.6%		61.3%
5th Quintile	66.7%	75.7%	9.0%	**	66.2%	70.4%		4.2%		55.8%
5th Quintile/1st Quintile	1.99	1.35			1.32	1.27				

* We assess if the change is statistically significant using t-tests.

Table 7: Basic regression results with covariates

	Coefficient	Std. Error
Local	-0.009	(0.012)
Target	-0.007	(0.012)
Local X Target	0.065***	(0.018)
Post	-0.027**	(0.010)
Post X Local	0.01	(0.015)
Post X Target	0.138***	(0.016)
Post X Target X Local	-0.073***	(0.020)
Health status (ref: good)		
Poor	-0.090***	(0.017)
Fair	-0.021**	(0.008)
Excellent	-0.031***	(0.008)
Unknown	-0.454***	(0.011)
Complementary HI (ref: private)		
Unknown	-0.041**	(0.020)
None	-0.089***	(0.011)
Public	-0.075***	(0.015)
Chronic disease	0.015*	(0.008)
Smoker	-0.044***	(0.008)
Education (ref: primary or lower)		
Junior High school	0.034***	(0.008)
High school	0.034***	(0.008)
University degree	0.042***	(0.011)
Other	-0.001	(0.013)
Occupation (ref: executive)		
Farmer	-0.038*	(0.020)
Shopkeeper, craftswomen	-0.024	(0.019)
Intermediary profession	0.011	(0.011)
Employee	-0.015	(0.012)
Worker	-0.040**	(0.015)
Not working/other	-0.072***	(0.019)
Income (ref: 1st quintile)		
2nd quintile	0.025**	(0.011)
3rd quintile	0.046***	(0.013)
4th quintile	0.062***	(0.012)
5th quintile	0.087***	(0.013)
Unknown	0.002	(0.011)
Rural	-0.005	(0.007)
Paris	0.008	(0.011)
Radiologist density	0.007***	(0.001)
Age	0.181***	(0.010)
Age squared	-0.002***	(0.000)
Age cubed	0.000***	(0.000)
Constant	-3.730***	(0.185)
Observations	22,876	
R-squared	0.334	