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ABSTRACT

Recently adopted federal health reform requires insurers to cover mammograms without cost-sharing. We examine similar state insurance mandates that vary substantially in the timing of adoption and in specifying the ages of women eligible for different mammography benefits. In triple differences models we find that mandates requiring coverage of annual mammograms significantly increased past year mammography screenings by about 8 percent, representing over 800,000 additional women screened from 1987-2000. Mandates that explicitly prohibit deductibles are especially effective at increasing screenings among high school dropouts, suggesting that federal health reform is likely to further increase use of screening mammography.

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1. Introduction

The recently adopted federal health care reform requires that new or substantially altered private insurance plans cover a variety of preventive health services and prohibits insurance companies from imposing cost-sharing for those services, with the goal of increasing preventive health services use. Mammography, the standard screening test for breast cancer, is one of the most common preventive services used by adult women and played a prominent role in debates about health reform in part due to controversy among the United States Preventive Services Task Force (USPSTF), the American Cancer Society (ACS), and other major medical organizations regarding the appropriate age at which women should begin obtaining mammograms. All interested parties, however, agree that women age 50 to 75 should have regular mammograms, and indeed routine mammography rates among adult women are substantially below the recommended levels of both the USPSTF and the ACS.

Expanding coverage of mammography through federal health care reform therefore has the potential to increase mammography rates, but there is surprisingly very little research showing that more generous insurance coverage will, in fact, increase utilization. We provide evidence on this question by studying state experimentation with very similar insurance coverage expansions in the form of benefits mandates. Specifically, from 1987-2000, 42 states adopted laws requiring private insurers within the state to include screening mammography benefits in insurance plans, and eight of those states further imposed requirements similar to those in federal health reform that insurance companies may not impose cost-sharing on women for obtaining mammograms.[1] These policies have not been previously studied using quasi-experimental methods and thus provide a unique opportunity to understand whether mandating insurance coverage for relatively low-cost preventive health services can increase utilization. In so doing, our research also provides valuable insight into the possible effects of federal health reform in increasing mammography rates.

To evaluate the utilization effects of state mammography mandates, we draw on data with information about mammography use for over a half million women from the Centers for Disease Control's 1987–2000 Behavioral Risk Factor Surveillance System (BRFSS). We evaluate the effects of these state mammography mandates using triple differences models that

[1] Firms which purchase insurance are directly affected by these mandates; self-insured firms are not required to comply due to the well-known exemption provisions of the Employee Retirement Income Security Act (ERISA). We revisit this issue below.

take advantage of variation in the timing of adoption across states as well as the fact that the mandates specify different benefits for women of different ages. This provides us variation at the state by year by age group level, meaning that we can estimate models with fixed effects for state, year, and age group, as well as for each two-way interaction. In these augmented models, the effects of the mandates are identified from differences in mammography screenings for women whose age makes them treated compared to the associated outcomes for women whose age makes them untreated coincident with the timing of policy adoption within each state.

To preview, we find strong evidence that state mandates requiring insurance coverage for an annual mammogram significantly increased past year mammography rates among prime-age women by about 8 percent, representing over 800,000 additional women being screened from 1987-2000. These effects are plausibly driven by insured women and are not found for procedures such as clinical breast exams (which are also intended to catch early breast cancer but were not covered by mandates and can be carried out during a typical visit to a general practitioner (GP)) or cervical cancer screenings, suggesting that the mandate effects are unique to mammography and are not reflecting unobserved determinants of women's health more generally. We also find that mandates prohibiting deductibles for mammography—similar to provisions in the recently adopted federal health reform bill which require that screening mammography consistent with the 2002 USPSTF guidelines be covered without cost-sharing—significantly increased mammography rates among high school dropouts relative to mandates without such limitations on out-of-pocket costs. Overall our results confirm that mandating insurance coverage for low-cost preventive health services can have meaningful effects at increasing utilization rates and suggest that federal health reform is likely to further increase mammography screenings.

The paper proceeds as follows: Section 2 outlines institutional details regarding mammography and the insurance mandates under study, and it also briefly describes the previous literature. We describe the research design, data, and empirical approach in Section 3, and Section 4 presents the results. Section 5 concludes.

2. Breast Cancer, Screening, Institutional Details, and Relevant Literature

Breast cancer is the most commonly diagnosed cancer and the second leading cause of cancer death among women in the United States; 40,000 women die of breast cancer each year.

Early detection of breast cancer through regular screening mammograms is commonly understood to be a key if not the most important determinant of survival. Cutler (2008), for example, argues that increases in routine cancer screenings such as mammography represent the most important factor behind the reversal in age-adjusted cancer mortality rates that occurred in the 1990s, while Berry et al. (2005) find that the share of the decrease in the rate of breast cancer deaths from 1975 to 2000 due to screening ranged from 28% to 65% (with treatment accounting for the rest). Indeed, the increase in population mammography rates was particularly broad-based from 1987 to 2000: screening rates among prime-age (adult, non-elderly) women about doubled for women of different age, race/ethnicity, marital status, education, and even household income groups (Figure 1). As such, the increase in mammography over the 1990s is one of the more striking improvements in women's preventive public health behaviors.

In mammography, a woman's breasts are placed on a machine that takes low-dose X-ray pictures to check for abnormalities. Mammograms are typically given to asymptomatic women to look for suspicious markers (screening mammograms) or to help determine whether cancer is present (diagnostic mammograms). Screening mammography is different from diagnostic mammography in that the latter is typically done in the presence of a physician with on-site interpretation of the results, while the former can be done in a variety of settings and is not generally read on-site. Diagnostic mammography usually occurs when a woman has had a previous abnormal screening mammogram (approximately 10% of those screened in the early 1990s), as well as among women with a family history of breast cancer (Dans and Wright 1996) or women with certain symptoms (e.g., presence of lumps in a breast or changes in a nipple or breast). In addition to diagnostic mammography, abnormal screening results can also lead to more invasive procedures such as biopsy.

The majority of states adopted mammography benefits mandates for qualified private health insurance plans from 1987 to 2000. The modal state mammography mandate adopted in the late 1980s and early 1990s calls for private insurance plans within the state to cover (or, much less commonly, offer) baseline screening mammograms for 35 to 39 year olds, biennial mammograms for 40 to 49 year olds, and annual mammograms for women age 50 and older. These mandates apply to the insurance companies who sell insurance to private employers (or, in some cases to individuals). Women who have their own employer-related private insurance coverage or who have insurance through employed husbands or others would be affected by these mandates if the firm was not self insured.[2]

These age-based benefits reflect the age-specific mammography frequency recommendations supported by the American Cancer Society (ACS) from 1983 until 1991. In 1992 the ACS eliminated the recommendation that 35 to 39 year olds obtain a baseline screening mammogram, and in March 1997 the ACS further revised its recommendations to state that annual screening mammography should begin at age 40.[3] In recognition of these changes, some of the mammography mandates adopted in the latter part of our sample period revised pre-existing rules to require plans to cover (or less commonly offer) annual mammography screenings for women age 40 and older.[4] Moreover, a handful of states have used different age-based cutoffs in their laws. For example, Wisconsin's 1990 law requires coverage for two mammograms for women age 45 to 49, provided they have not had one within two years (i.e., this law mandated coverage of nearly biennial mammography beginning at age 45). Texas' 1987 mandate requires coverage for annual mammograms for all women age 35 and older. As such, there is substantial age by state by year variation in the frequency of screenings whose coverage is required in state laws that forms the basis of our identification in the triple differences (DDD) empirical models below.

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[2] More precisely, these mandates cover private plans where the risk is not taken on by the purchaser. Employers who self-insure and take on the risk of the insurance themselves are therefore exempt from such mandates under ERISA.

[3] Importantly, there is not uniform agreement across major medical organizations with respect to these recommendations. The US Preventive Services Task Force (USPSTF), for example, did not recommend routine screening mammography (every 1-2 years) for women age 40 and older until 2002—prior to this, the USPSTF only recommended screening mammograms at this frequency for women age 50 and older and in 2009 revised their recommendations to only include regular screenings for all women 50 and older. Despite the fact that different organizations have used different age cutoffs for screening mammography recommendations, a study by Rathore et al. (2000) shows that the ACS guidelines are the ones that are most commonly applied in state mammography mandates. For our preferred triple difference models described below, it is important to note that our estimates of the effects of mandates will rely only on variation at the state by age group by year level coincident with the timing of mandate adoption; any recommendations from major medical organizations will be absorbed by the age group times year interactions since, although the recommendations themselves are age-based, they are nationwide (i.e., not state-specific) guidelines.

[4] This discussion highlights (and Figures 3-5, described below, make visually apparent) that the state by year by age group identifying variation in the mandates is only weakly correlated with variation in guidelines. The failure of most states to consistently update their laws in response to changes in national screening guidelines from ACS and USPSTF (which are themselves contradictory) provides us substantial variation for disentangling the independent effect of insurance-based eligibility for mammography screening from the effect of guidelines on mammography utilization. For an analysis of the effects of such guidelines in the US and Canada, see Kadiyala and Strumpf (2010, forthcoming).

Surprisingly, there is very little research that estimates the effects of state insurance benefit mandates requiring coverage of mammography.[5] Two public health studies find positive associations between mammography mandates and utilization using cross-sectional designs (Mor and Shackleton 2005, Pettibone 2003).[6] Of course, unobserved fixed differences across states could contribute both to the presence of a mammography screening mandate and to mammography screening behaviors. Dans and Wright (1996) examined claims data for outpatient mammograms for women in Maryland's Blue Cross Blue Shield plan before and after the state's 1991 mammography mandate was implemented; they found evidence of a modest increase in overall screening rates. There is, however, no quasi-experimental work that uses the timing of mandate adoption for multiple states to control for fixed differences across states.

This absence of a substantial literature on the utilization effects of mammography benefits mandates is striking for several reasons. As noted previously, mammography is one of the most commonly mandated benefits at the state level (Bunce and Wieske 2008), and over this time period when most states were adopting mammography mandates, there were unprecedented increases in mammography rates for older women.[7] The lack of research on mammography benefits mandates also contrasts markedly with other types of state level insurance benefit mandates, some of which have received a great deal of attention. Pregnancy benefits, (Gruber 1994a), infertility treatment (Bitler 2010; Bitler and Schmidt forthcoming; Schmidt 2007; Bundorf, Henne, and Baker 2007; Buckles 2008; and others), mental health parity (Pacula and

[5] We do not review here an enormous literature in public health that documents associations between demographic characteristics and mammography rates. This literature includes several studies on the relationship between health insurance coverage and mammography (see, for example, Trivedi, Rakowski, and Ayanian 2008), though these studies are largely descriptive and do not directly address what drives variation across individuals in the presence or type of coverage.

[6] A handful of studies have evaluated changes in Medicare reimbursement policy for screening mammography. Given the existing studies, the nearly universal coverage of Medicare for women 65 and older (and large effects of eligibility for Medicare on various utilization measures documented in Card, Dobkin, and Maestas 2008a and 2008b), and the fact that the laws we evaluate refer to private insurance, we focus on women under age 65 in our analysis. These studies, however, are clearly related to the questions we study here since they relate to the utilization effects of changes in public policy related to insurance coverage of mammography. Kelaher and Stellman (2000) find that when Medicare Part B began covering biennial mammography in 1991, past two year mammography rates for Medicare eligible women significantly increased relative to younger women who were not eligible for Medicare.

[7] Indeed, public health studies that have documented the increasing trend in mammography over the 1980s and 1990s discuss the role of mammography mandates as a seemingly well-documented determinant of the improvement in women's preventive health. Nelson et al. (2002), for example, write in *JAMA* that "[e]ducational campaigns directed toward health care practitioners and the general public, state mandates for insurance coverage of mammograms, and programs for providing mammography services to low-income women have all played a role in increasing breast cancer screening in nearly all states."

Sturm 2000; Harris, Carpenter, and Bao 2007; Busch and Barry 2008; and others), and overnight hospital stays for newborn deliveries (Liu, Dow, and Norton 2004) are just some of the examples of mandated insurance benefits that have generated substantial literatures.

Importantly, researchers have identified a number of considerations for understanding the extent to which any mandated benefits laws should be expected to affect utilization. First, it is commonly argued that mandated benefits laws can cause employers—particularly small firms—to reduce offers of health insurance in response to the rising costs when mandated benefits laws are adopted. While the empirical evidence on this is very mixed (Gruber 1994b, Jensen and Gabel 1989, Jensen and Morrisey 1999), any such effects would reduce the potential for benefit mandates to increase utilization. Second, as we noted above, certain insurance plans are exempted from compliance requirements with any state health insurance mandates. The largest of these is the exemption because of ERISA for self-funded insurance plans which generally affects large employers.[8] Buchmueller et. al. (2007) use the MEPS-IC and find that this is the most important factor that reduces the potential population covered by mental health parity mandates.

Third, it is possible that benefits mandates do not have much "bite" to the extent that pre-existing private health insurance plans were already covering or offering the services addressed in the mandates. However, available evidence indicates that benefits coverage for these services did not become widespread until the mid 1990s despite the fact that the lifesaving benefits of mammograms were established in the mid 1970s, implying that there was substantial latitude for mammography benefits mandates to affect benefits coverage and, subsequently, utilization.[9]

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[8] Whether and to what extent self-insured firms respond to state insurance mandates (perhaps due to competitive labor market concerns) is an empirical question that has not been settled in the literature. While they are not directly affected by laws, concerns about adverse selection for firms offering benefits are no longer apparent after there are mandates. Butler (2000) estimates that about a third of women have private insurance that would potentially be affected by mandates such as those we study here. The 2000 Medical Expenditure Panel Survey (MEPS) Household Component for 2000, for example, finds that 72.4% of adults 18–64 had private coverage in 2000, while 7.6% had public coverage and the rest were uninsured. The Insurance Component of the MEPS allows for tabulations of the share of workers who are enrolled in private insurance by various characteristics. For 2000, the MEPS IC suggested that of private employees, 89.4% were at firms which offered health insurance. At firms which offered insurance, 64.1% of employees were enrolled in health insurance, and of those enrolled, 48.3% were in self-insured plans (plans which are exempt from these types of mandates). This means that around 30 percent of workers were enrolled in non-self insured plans ((1-.483) * .641 *.894 = .296). If we assume that the same share of women with private insurance as workers with private insurance are enrolled in these type of plans, this would suggest about 21% of women would have private insurance subject to these type of regulations (.296 * .724 = .214).

[9] A 1986 article in *The New York Times* lamented that "health insurance plans rarely, if ever, cover screening mammograms, which can detect problems at the earliest and most curable stage" (Brozan 1986). Detailed microdata on employer-sponsored insurance plans is extremely rare, and the most commonly used datasets do not include

Sullivan and Rice (1991), for example, report that the Health Insurance Association of America (HIAA) employer benefits survey fielded in 1990 showed that about 68 percent of private plans were covering mammograms in 1990. McKinney and Marconi (1992) similarly report that 63 to 72 percent of non-self-insured plans (i.e., those potentially subject to the benefits mandates) covered screening mammography in the 1990 HIAA survey. By 1999 the Kaiser/HRET Survey of Employer-Sponsored Health Benefits found that 94 percent of conventional plans and 98 percent of HMO plans were covering mammography screening, suggesting a large increase in mammography coverage over a period of significant mandate adoption. These patterns indicate that: 1) private insurance coverage of these services was far from universal at the time the first mandates were adopted; and 2) this rate increased substantially over the 1990s, such that private insurance coverage of mammography was nearly universal by 2000.

Finally, it is natural to ask—given the fairly low cost of low-dose screening mammography ($50—$150 per screening according to Breen and Brown 1994)[10]—why weren't all employers and health plans covering these screenings even in the absence of a mandate? Note that although the cost of an individual screening is relatively low, the population at risk of using a mammogram is very large: currently, the ACS recommends that all women age 40 and older get screening mammograms annually. In contrast, most benefits mandates that have been studied previously (e.g., infertility treatment, substance use/alcoholism treatment) have the potential to affect a much smaller portion of the population and are for services that, while more expensive on a per-person basis, are used far less frequently than are screening mammography. And, even though the direct costs of the actual screening are fairly low, the subsequent costs associated with a positive screening—biopsy, chemotherapy, mastectomy, and other cancer treatments—can be much larger. Like many screening tests, mammograms have a high false

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specific cancer screening benefits information or fail to include large samples of firms subject to the mandates (e.g., Medstat's Marketscan Research Database, HealthLeaders Interstudy Health Plan Data, and Mercer/Foster-Higgins Surveys of Employer Sponsored Health Plans) and/or do not cover our time period (e.g., the Medical Expenditure Panel Survey – Insurance Component).

[10] We are not aware of good estimates of how the costs of mammography have changed over time. Mammography technology, however, seems not to have changed substantially over the period we study, in part motivating our choice to study this period. More recently, however, use of computer-aided detection (CAD), designed to assist radiologists in reviewing suspicious areas of the breast, has increased. The Food and Drug Administration approved the first use of CAD in June 1998, though CAD use was very rare through 2001. Fenton et al. (2010) note that for Medicare patients for example, use of digital mammography was very rare until after 2000, when Congress established national Medicare coverage of digital mammography. The clinical efficacy of CAD has not been fully documented (Fenton et al. 2007). More recently, it has become common to use MRIs for screening some groups of women.

positive rate: given that upwards of 10 percent of screening mammograms can produce abnormal results, these costs are potentially very large. Poplack et al. (2005), for example, used New Hampshire mammography registry data to find that 13 percent of women had diagnostic imaging after a screening; .7 percent had non-benign biopsies. Total direct costs per capita (using Medicare reimbursement rates) were $99 per woman if the woman only had a screening mammogram but rose to $286 per woman with diagnostic imaging and $993 per woman if there was a biopsy.[11]

3. Research Design, Data Description, and Empirical Approach

We are interested in identifying the casual effects of state laws requiring private insurers within a state to cover or offer screening mammography on population mammography rates. An obvious concern with the raw associations between mandates and mammography use is that unobserved characteristics about women living in states with mandates may contribute both to screening behaviors and to policy adoption. Alternatively, there were other changes to the health care delivery system over our time period that could introduce bias: HMO penetration increased over this time period in a way that could plausibly be correlated with policy adoption, for example, and it is generally believed that HMOs are particularly good at increasing use of preventive services. A third way in which simple correlations might be misleading is if states engaged in public outreach efforts that corresponded with the timing of the mandates. In all three of these cases, the association between the mammography mandates and screening outcomes is likely to be overstated due to omitted variable bias.

The standard approach in economics to deal with these potential omitted variables is to use variation in the timing of adoption of the policies in state- and year-level fixed effects models of mammography use. To the extent that the unobserved factors contributing both to outcomes and to policy adoption are time invariant within a state or within a year, the two-way fixed effects models will remove this bias. Moreover, direct controls for adoption of other relevant programs, policies, and state characteristics (such as managed care and HMO penetration) can

[11] Note that ideally we would observe the marginal premium cost of adding mammograms to the insurance policy. Evidence from a 2000 Texas Department of Insurance report on the cost of mandates suggests that the Texas mandate for mammography screening was responsible for 0.6% of total premium costs (Albee et al. 2000). This figure is slightly smaller than the analogous premium shares for the 5 mandates identified as "expensive" in Gruber (1994b) but is still substantial and similar in magnitude to benefits related to alcohol treatment, chiropractor services, and continuation of health insurance coverage.

further reduce the omitted variables bias problem. In these difference-in-differences models the key identifying assumption is that there were no other unobserved shocks to outcomes coincident with policy adoption that affected screening outcomes.

Fortunately, our setting for the mammography insurance mandates provides another source of variation in addition to the staggered timing of mandate adoption and on a margin that is clearly exogenous: age. As described above, most state mammography mandates have age-based rules regarding the frequency with which mammography is required to be covered. The age-based variation means that we can relax the identification assumption in the difference in differences model by including age group by state, age group by year, and state by year fixed effects in a triple difference setting. In this augmented model we identify the effects of the mammography mandates on outcomes only using the variation in outcomes for "treated" women at or above the age-based eligibility threshold relative to outcomes for "control" women under the age-based eligibility threshold coincident with timing of mandate adoption. Note that any nationwide age-specific confounders such as age-based cancer screening guidelines adopted by major medical organizations are subsumed by the age group by year interactions. State by age group fixed effects further control for time invariant differences across women of different ages within each state. And, state by year policies are absorbed by state by year fixed effects. This is the key advantage of this fully interacted DDD specification: most of the other important likely confounders which *do* vary at the state-by-year level such as HMO penetration, the extent of self-insurance within the state, and/or other state laws relating to health insurance and women's health do not plausibly vary by age. For example, it is extremely unlikely that 35 year old women (who are generally treated by a subset of the mandates we study) are differentially likely to be enrolled in HMOs or to work for firms that self-insure compared to 34 year old women. It is even less plausible that any such age differences are correlated with the timing of the mandates. In any case, these other factors that do not vary by age are completely accounted for when we include a full set of state by year indicators.[12] As such, the only remaining threats to identification in the fully interacted model are those omitted variables that are themselves age-specific in the same way as the mandates and that are correlated with the timing of mandate adoption. Such biases are likely to be very small.

[12] The triple difference approach also alleviates concerns about policy endogeneity: while one may worry that unobserved shocks to mammography rates drive mandate adoption, those same shocks would have to differ by age in a systematic way to bias the estimated mandate effect in the augmented model.

Our main data come from the Center for Disease Control's Behavioral Risk Factor Surveillance System (BRFSS). Fielded annually since 1984, the BRFSS has included questions about mammograms in every year since 1987 and is designed to be representative at the state level. Surveys are fielded by the individual states and then sent to CDC to be compiled into a public-use dataset. State participation in the BRFSS increased over the late 1980s; the last state joined in the mid-1990s. In practice, this means that we have an unbalanced panel; because many states adopted laws prior to 1990 we use all available data (i.e., any state/year combination with BRFSS data), though in robustness we focus on the subset of states in a balanced panel.[13] Our analysis focuses on the period 1987-2000, a period during which over 42 states adopted or changed mandates. We stop our sample in 2000 for 2 reasons. First, there was a significant change in reimbursement by Medicare for digital mammography in 2000 which appears to have lead to widespread diffusion of the more expensive technology (Fenton et al., 2010). Second, there was a federal law passed in 2000 regarding funding for breast cancer treatments for low-income uninsured women (the Breast and Cervical Cancer Prevention and Treatment Act).[14]

The BRFSS breast health questions allow us to create consistent measures of mammography use along several dimensions for women age 18 and older (as discussed below, we restrict our eventual sample to women 25–64). Specifically, women were asked: "A mammogram is an X-ray of each breast to look for breast cancer. Have you ever had a mammogram?" Women who report ever having had a mammogram are then asked about the timing of their most recent mammogram, as well as the reason for their most recent mammogram.[15] We create three key outcome variables related to mammography use: first, we

[13] The number of states in the balanced panel changes depending on the first year of the panel. This is because the mammography questions were only asked as part of a women's health module in 1988 (questions in modules of the BRFSS are not administered by all states). The 15 states observed in all years from 1987 to 2000 includes: California, Illinois, Indiana, Kentucky, Maine, Maryland, Montana, Nebraska, New Hampshire, New Mexico, New York, North Carolina, South Carolina, Washington, and Wisconsin. If we create a panel starting 1989, however, several more states are included. The same is true if we simply eliminate 1988 data to create a 1987–2000 (less 1988) balanced panel.

[14] Specifically, the BCCPTA gives states the option to use their Medicaid programs to cover breast cancer treatments for previously uninsured women who were screened through the National Breast and Cervical Cancer Early Detection Program (NBCCEDP). The National Council of State Legislatures reports that 49 states have adopted these programs. We do not examine this program because we lack information on breast cancer treatments; moreover, the total number of women served by the BCCPTA is very small relative to the number of women screened through the NBCCEDP (small itself as a share of women screened). We do, however, control for whether the state has implemented a pilot or full NBCCEDP program in all specifications.

[15] Beginning in 1989, the survey eliminated an introductory screener question about whether the respondent had heard of a mammogram (this screener was preceded by text informing women that a mammogram was an X-ray of the breast to detect cancer). After this, the introduction to the question about lifetime mammography use included a

identify Ever Had Mammogram as equal to one if the woman reports ever having had a mammogram and zero otherwise. Second, we create Mammogram in the Past Year as equal to one if the woman reports that she had a mammogram within the past year and zero otherwise.[16] Third, we create Mammogram in the Past Two Years as equal to one if the woman reports that she had a mammogram within the past two years. Recall of the timing of a woman's most recent mammogram beyond one year is likely to be problematic (Warnecke et. al. 1997); as such, we focus on Mammogram in the Past Year as our main outcome of interest. Finally, women are also asked about the reason for their most recent mammogram. We create a variable called Routine Mammogram in the Past Year that equals one if a woman reports she had a mammogram in the last year and also reports that her most recent mammogram was 'routine' (as opposed to being due to 'cancer' or a 'problem'). We create a similar variable called Non-Routine Mammogram in the Past Year that equals one if a woman reports she had a mammogram in the last year but does not report that her most recent mammogram was 'routine'. These last 2 variables provide an important robustness check on our findings since the effects of the mandates should be mainly observed for routine screenings. The analysis sample for these outcomes includes all women 25-64—including those who have not ever had a mammogram—since we are interested in effects on population mammography use. We also observe (and control for) standard demographic characteristics in the BRFSS, including age, race, education, and marital status. The BRFSS also includes a very basic measure of health insurance coverage: we are able to identify whether the woman is covered by "any health plan".[17]

To estimate the effect of the various public policies on outcomes we use straightforward difference-in-difference and augmented triple difference models (DDD models) that identify the effects of the mandates using variation across states in the timing of adoption and in the ages of women treated by the various policies. We begin with the fully saturated triple difference model,

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sentence defining a mammogram. We code women in the early waves who report that they had not ever heard of a mammogram as also not ever having had a mammogram (this is a very small share of women).

[16] Item non-response is fairly low for these questions. We omit observations with a "don't know" or "refused" response to the mammogram questions.

[17] One might be concerned that this "any health care coverage" measure is picking up some women who have Medicaid for example, and are not affected by the mandates. We have examined data from the March Current Population Surveys for 1987-2000 to see what share of health care coverage is from private insurance. For women 25-64, 90% of those with any health coverage in the CPS had private coverage. The share for most subgroups of interest is also at least 90% (e.g., high school graduates 25-64, women with some college 25-64, college graduates 25-64, and non-Hispanic white women 25-64). For non-Hispanic blacks and Hispanics 25-64, the relevant figure is above 75%. Even for high school dropouts 25-64, 65% of those with any health coverage had private coverage.

which embeds our difference in differences specification. Specifically, we formulate the triple difference model as:

(1) $Y_{iast} = \beta_0 + \beta_1 X_{iast} + \beta_2$(Share of Relevant Reference Window Treated by a Mammography Mandate for Baseline Screening)$_{ast}$ + β_3(Share of Relevant Reference Window Treated by a Mammography Mandate for Biennial Screening)$_{ast}$ + β_4(Share of Relevant Reference Window Treated by a Mammography Mandate for Annual Screening)$_{ast}$ + $\beta_5 Z_{st} + \beta_6 S_s{*}A_a + \beta_7 T_t{*}A_a + \beta_8 S_s{*}T_t + \varepsilon_{iast}$

where Y_{iast} are the various dichotomous screening outcomes for woman *i* in age group *a* in state *s* at time *t*. X_{iast} is a vector of individual level demographic controls that includes: 5-year age group dummies, race/Hispanic ethnicity, education, and marital status.[18] The first three policy variables reflect the mammography mandates which vary at the age, state, and year level.[19] Recall that the modal mandate adopted in the late 1980s requires coverage for a baseline screening mammogram for women age 35–39, a biennial mammogram for women age 40–49, and an annual mammogram for women age 50 and older.[20] Thus for a state with the modal mandate, the baseline screening mammogram law dummy would be on for women 35–39, the biennial screening mammogram law would be on for women 40–49, and the annual screening mammogram law would be on for women 50–64.[21]

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[18] Specifically, we include dummies for age group (30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64), race/ethnicity (non-Hispanic black, other non-Hispanic, Hispanic), education (less than high school, high school degree, some college, and don't know/refused), and marital status (widowed/divorced/separated, never married, cohabitating, and don't know/refused). Thus, the omitted categories are: age group is 25–29, race/ethnicity is white non-Hispanic, education is college degree or more, and marital status is currently married.

[19] There is a great deal of variation across states in the language regarding when the laws are supposed to take effect. Some states set a date after which "all policies sold or renewed after that date" must comply with the mandate, while others state that benefits must be changed effective immediately. We have coded plans as taking effect January 1 of the year after the year in which they are passed, with the logic that most policies are negotiated in the fall to take effect at the beginning of the following calendar year.

[20] Our policy data come from the National Cancer Institute's State Cancer Legislative Database (SCLD). SCLD tracks every piece of legislation pertaining to different types of cancers, including breast cancer. We used a SCLD-produced table showing every state's mammography mandate activity that included information on substantive revisions to the state laws, the year and quarter of law adoption, the age groups and mammography frequency described in the law, and whether the law is an offer or a cover mandate. To verify the information in the SCLD table we next consulted actual text of each state's laws by calling up individual records in SCLD. Discrepancies were discussed between the two authors. Our information on state participation in the NBCCEDP program comes from personal correspondence with Janet Royalty at the CDC. Our information on direct access laws comes from Baker and Chan (2007).

[21] Note that the BRFSS questions introduce a "reference window" problem due to the fact that the questions typically ask about screening behavior over some recent period. Given this, it is important to account for the systematic BRFSS interview structure when defining someone as treated by the policy in question. Specifically, we can make use of the fact that BRFSS interviews take place almost uniformly across the calendar year. This information, coupled with our decision rule regarding when individuals are first treated, means that we can create a

Dummy variables for each state are captured by S_s, and in the DD models, control for time-invariant state-specific factors. Dummy variables for each survey year are captured by T_t, and in the DD specifications, control for period-specific shocks common to all states in any given year.[22] S_s*A_a is a full set of state by age group dummies, T_t*A_a is a full set of year by age group dummies, and S_s*T_t is a full set of state by year dummies. The T_t*A_a indicators remove biases common to all women of a particular age in a given year; for example, the introduction of age-specific screening guidelines on a national level. The S_s*A_a indicators account for other age-specific state effects which would arise, for example, if a certain state targeted women of a certain age through education campaigns. Finally, the full set of state by year interactions S_s*T_t account for any other efforts to increase mammography rates in a particular state and year that would be expected to affect women of different ages equally (e.g., general state education campaigns, other state laws that are not age-specific). In this augmented triple difference model, the coefficients of interest, β_2–β_4, use variation at the age by state by year level to identify the effects of screening mammography mandates from differences in screening rates for women whose age makes them treated compared to the associated outcomes for women whose age makes them untreated coincident with the timing of policy adoption within each state. Throughout, we cluster the standard errors at the state level (Bertrand, Duflo, and Mullainathan 2004). Regressions are weighted to be population representative, and the main sample is all women aged 25–64 interviewed by the BRFSS in survey years 1987–2000.

In practice, we also estimate more standard DD models with state and year fixed effects which would be appropriate and the best we could do if we did not have additional age-based

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more precise treatment variable that captures the share of the recent period that the individual was treated by the mammography mandate. The intuition here is straightforward: since we define a policy to turn "on" in January 1 of the year following adoption, it is true that people interviewed in, say, February of what we define as the first treatment year will have only been exposed to two months of treatment while people interviewed in, say, November of that same year in that same state will have been exposed to 11 months of treatment. Similarly, for the past two year outcomes we code individuals interviewed in January after the adoption year as being treated 1/24, February of the adoption year as being treated 2/24, and so forth, until December of the following year (i.e., December in the second year after adoption) as being fully treated (i.e., 24/24). Note that even if our assumptions about when insurance policies reset are incorrect, it remains the case that people interviewed toward the beginning of the calendar year after implementation will, by construction, have less potential treatment than individuals interviewed toward the end of the calendar year no matter when the policy was implemented. Finally, note that since we do not observe birth date information in the BRFSS we are incorrectly coding some fraction of the reference window for people who "aged into" eligibility within the reference window (generally people who turned age 35, 40, or 50 within the reference window). Given a uniform distribution of birthdays and correct self-reports of age, this measurement error will result in attenuation of our coefficients of interest.

[22] We also include month of interview dummies throughout (though not shown in the equation) to account for idiosyncratic month effects (e.g., October is Breast Cancer Awareness Month).

variation in the laws. For the models without the state by year (and state by age and age by year) fixed effects, we also include covariates that vary at the state and year level and that are standard in such two-way fixed effects models. These variables are captured in Z_{st} (which falls out of the fully interacted DDD model), a vector of state economic and demographic characteristics, including: the unemployment rate, the HMO penetration rate, the number of obstetric beds in the state per 1000 women age 15–44, the share of women age 15–44 with private health insurance, the share of women age 15–44 who work (or whose spouses work) at private firms of various sizes (<25, 25–99, 100+), the fraction black, the fraction Hispanic, and the fraction urban. The Z_{st} vector also includes controls for other relevant public policies that may be expected to affect outcomes, including: the presence of a state law requiring women to be able to see an OB/GYN without first obtaining a referral from her primary care provider; the presence of a state low-income screening program through the National Breast and Cervical Cancer Early Detection program; the presence of a state law requiring insurance coverage of cervical cancer screening tests; Medicaid expansions for pregnant women (a proxy for generosity of the states' public health insurance programs); and welfare reform.[23]

Finally, we explicitly examined provisions of mandates similar to the federal health reform requirement that insurance plans must not impose cost sharing for obtaining preventive services such as mammograms. Specifically, the relevant provision says that mammograms satisfying the USPSTF guidelines from 2002 (mammograms every 1-2 years for women 40 and older) must be covered for non-grandfathered plans. We identified 8 state mandates that explicitly prohibit deductibles for obtaining a mammogram, and we expect that these laws should increase mammography use more than laws without such explicit prohibitions. For this model we interact each main mandate variable with an indicator variable equal to one for states that prohibit deductibles, while including the main effect. If this specific provision is meaningful for increasing screening, we expect this interaction term to be positive and statistically significant, particularly for low-educated women (since the prohibition on out of pocket costs should be more meaningful for them).

[23] Baker and Chan (2007) do not find any relationship between direct access laws and mammography use among women age 40–64 using data from the 1996–2000 BRFSS. The NBCCEDP was created by the 1990 Breast and Cervical Cancer Mortality Prevention Act. This program provides federal funds for cancer screening of low-income uninsured women, and states began participating at various times from 1991–1996. Adams et al. (2003, 2006) find a positive and significant relationship between the age of a state's NBCCEDP program and rates of past two year mammography among women age 40–64.

4. Results

In Figure 1 we show trends in past year mammography use from 1987 to 2000. We present trends for four age groups: 25 to 34 year olds (who were almost never treated by mammography mandates), 35 to 39 year olds (who were usually targeted in provisions calling for baseline mammograms), 40 to 49 year olds (who were usually targeted in provisions calling for biennial mammograms), and 50 to 64 year olds (who were usually targeted in provisions calling for annual mammograms). Several features are notable in Figure 1. First, there was almost no improvement in recent mammography for women age 25 to 34 years old; this fact is rarely reported in the public health literature since older women are typically the subject of these studies. Second, there was noticeable improvement in recent mammography for 35 to 39 year old women from 1987 to until about 1993, after which the rates fell substantially; this is likely attributable to the removal of the "baseline" screening mammogram recommendation from the American Cancer Society Guidelines in 1992. Third, there were steady, long-lasting, and remarkably large increases in mammography use for the two older groups of women: 40 to 49 year olds and 50 to 64 year olds. Past year mammography rates among both groups of older women roughly doubled over this period 1987 to 2000. The patterns in Figures 1 are visually consistent with a role for mammography mandates in increasing mammography use: note that the majority of the legislative action regarding mammography occurred in the 1987–1992 period only for women age 35 and older; indeed, these age groups all saw increases in mammography use over this time period.

Figure 2 shows these same patterns in a slightly different way. Specifically, we show in Figure 2 the age profile of past year mammography for three different years: 1987 (the first year of our sample), 1994 (the middle of our sample), and 2000 (the last year of our sample). Figure 2 shows that there was a large improvement in recent mammography screening rates for 50-64 year olds between 1987 and 1994, with slightly smaller increases for 40-49 and 35-39 year olds over this same period. From 1994 to 2000, Figure 2 shows essentially no change in screening rates for 35-39 year olds and some modest increase for 40-64 year olds. Again, given that the timing of mandate adoption was mostly between 1987 and 1992, the visual patterns in Figure 2 are again consistent with a role for mandates in increasing mammography rates.

Interestingly, Figure 2 also reveals some evidence of increases in mammography screening rates at the age thresholds recommended by the American Cancer Society and other various medical organizations. This same issue has been examined using more recent versions of the BRFSS and other data by Kadiyala and Strumpf (2010, forthcoming). For example, Figure 2 shows that in 1987 there is a discrete spike in past year mammography rates exactly at age 35 that subsequently reverts to lower levels. This is consistent with some proportion of women responding to the ACS recommendation in 1987 that women get a baseline screening at age 35. The evidence of a jump at age 35 is much weaker in the age profiles for 1994 and 2000 which may reflect that the ACS removed the 'baseline' screening recommendation in 1992. There is also some evidence of a discrete increase in past year mammography screening rates at age 40, consistent with the ACS guideline and prior USPSTF recommendations, though there is not strong visual evidence of increases in screenings at age 50.

A natural question that arises from Figure 2 and previous work, then, is: how much of the increase in mammography screening that we document below and attribute to mammography mandates should be more properly attributed to recommendations of ACS, USPSTF, and other major medical organizations? Indeed, since many states explicitly base the benefits in their mammography mandates on these guidelines, it is natural to ask to what extent we can reasonably identify the effects of mandates separately from changes in these age-specific guidelines over time. To provide direct commentary on this issue, we present visual evidence in Figures 3-5 that our identifying mandate variation is distinct from the major guideline variation over this time period.

Specifically, Figure 3 shows, for each year of our sample, the share of women age 25-64 in our BRFSS data who: 1) we code as being treated by a mandate providing for a baseline mammogram screening in each year; 2) would be subject to a recommendation for a baseline mammogram screening according to the ACS guidelines in each year; and 3) would be subject to a recommendation for a baseline mammogram screening according to the USPSTF in each year. An increasing share of women are eligible for a baseline mammogram benefit over our sample period due to state policy adoptions. This proportion levels off by about 1994 at about 12 percent of the sample. In contrast, the proportion of women who would be subject to either an ACS-recommended baseline screening (equal to about 15 percent of the sample until 1993, when it drops to 0 after the ACS removed the baseline screening recommendation from its guidelines) or a USPSTF-recommended baseline screening (equal to 0 percent of women over the entire period since the USPSTF never recommended baseline screenings) exhibit very different time series patterns over this time period. Figures 4 (for biennial screenings) and 5 (for annual screenings) make the same basic point and show clearly that the time series variation in the proportion of women subject to each type of mandate is very different than the associated variation in the proportion of women subject to either an ACS or a USPSTF guideline for the same frequency of screening.

Table 1 presents descriptive statistics of the key health outcomes and the policy variables and shows that, as seen in Figures 1 and 2, mammography rates are strongly increasing with age, and the same is true when we consider whether the woman reports a mammogram in the last year and says her most recent mammogram was routine.[24] Table 1 also shows that there is a much weaker age gradient for the Non-Routine Mammogram variable. We also show in Table 1 the means of the mandate policy variables. Specifically, we report means of the "share of the previous year" policies that take into account the reference windows for past year outcomes. We find that nearly half of our sample (48.6 percent) are treated by any mammography mandate for baseline, biennial, or annual screenings, and this figure is increasing in age. Table 1 also shows the share of women treated by mandates for baseline screenings, biennial screenings, and annual screenings, respectively. The majority of women treated by any mammogram mandate are treated by a mandate for an annual mammogram (25.5 of the 48.6 percent). The next 2 rows of Table 1 show that the vast majority of the mandates are of the 'cover' variety as opposed to 'offer' laws. Finally, we show that a small but nontrivial proportion of women in our sample are subject to mandates that explicitly prohibit deductibles for obtaining a mammogram.

We present the first set of results in Table 2 for the Mammogram in the Past Year outcome. We present coefficient estimates on the key mandate variables of interest, and in each column we add successively more controls. Column 1 shows the raw association net of age group dummies, Pap screening mandates, NBCCEDP programs, and direct access laws. Column 2 adds individual demographic characteristics. Column 3 adds the state economic and demographic variables, as well as the remaining policies in the Z vector (e.g., welfare reform). Column 4 adds state, year, and month fixed effects, akin to the standard difference in differences approach that relies on the staggered timing of policy adoption. Column 5 adds state by age group, year by age group, and state by year fixed effects and is the fully saturated DDD model.

[24] Information on descriptive statistics regarding demographic variables is presented in Appendix Table 1.

The first column of Table 2 shows results for the model that includes only the policy variables directly related to mammography screening, Pap screening, NBCCEDP programs, direct access laws, and age group indicators; we report coefficients only for the mandate variables. The results in column 1 of Table 2 indicate that there is a strong raw association between most of the mandates and the probability that a woman age 25–64 reports having had a mammogram in the past year. For example, the presence of a mandate for annual mammography is associated with a 5.3 percentage point increase in the probability of past year mammography screening. In the second and third columns we find that these relationships are largely unchanged when we control for individual and state demographic characteristics and other state policies. In column 4 we control for unrestricted state and year fixed effects, and the magnitudes of the coefficient estimates fall substantially for every policy variable, though the coefficients on the biennial and annual mammography mandates remain statistically significant.

Turning to our preferred augmented DDD model in column 5 with a full set of two-way interactions for age, state, and year, we continue to find that mandates for annual mammography significantly increase the probability of having had a mammogram in the past year, by 1.6 percentage points, or about 8 percent of the baseline annual mammography rate. To get a sense of the true effect size of the annual mandate, one should weight up the estimate to account for the fact that only about a third of women in the BRFSS were likely directly treated by the mandate (i.e., privately insured women whose insurance is not subject to ERISA exemptions) (Butler 2000). The true effect size of an annual mandate on past year mammography rates (treatment effect on the treated), then, is closer to 4.5 percentage points. Given that past year mammography rates increased by about 22.4 percentage points over our time period (see Figure 2), we estimate that mandates for annual mammography account for about seven percent of the overall increase (1.6/22.4=.071). The other coefficients on the mammography mandates are also substantially smaller and generally insignificant in the DDD specification.

In all subsequent models for mammograms we only report results from our preferred triple difference specification that includes the full set of age group, state, and year fixed effects and their two-way interactions.[25] These results are shown in Table 3 (which in column 1 reprints the DDD results for past year mammography from column 5 of Table 2). We estimate that mandates for annual (biennial) mammography screening increase past two-year mammography

[25] Results from the less saturated models generally produced larger associations and are available upon request.

rates by approximately 2 (2.5) percentage points, and this effect is statistically significant in column 2. In column 3 we estimate that mammography mandates for biennial and annual screening are estimated to significantly increase lifetime mammography use by 1.9 and 1.3 percentage points, respectively. Finally, column 4 of Table 3 suggests that mammography mandates for biennial and annual screenings increased the likelihood that a woman reports she received a mammogram in the last year and that her most recent one was routine by 2.1 and 2.0 percentage points, respectively. Having a non-routine mammogram in the last year is not significantly associated with the mandates (not shown in table but available upon request). Since the bulk of any increase in mammograms driven by changes in coverage should be for routine reasons, this supports our interpretation that the mandates increased coverage of screening mammography and that this increased coverage led to more routine mammograms.[26]

In Table 4 we provide more direct evidence on the most likely mechanism through which mandates affect utilization: a change in insurance coverage of mammograms channel. Specifically, we begin by estimating a triple difference model where the outcome variable is an indicator for whether the woman currently has any health plan. This is the closest proxy we have to health insurance coverage; as noted above the overwhelming majority (90%) of women with 'any insurance' are actually covered by private insurance for women age 25-64 over this time period according to our tabulations of March CPS data. Recall that one possible employer response to rising costs of state mandates is to reduce offers of health insurance to employees; as such, it is possible that mandates such as those we study here could reduce health insurance coverage (though we have argued that this is unlikely given the age-specific nature of the benefits and our empirical models). In column 1 of Table 4 we show that insurance mandates for biennial and annual screenings are not meaningfully associated with changes in health insurance coverage of women.[27] In column 2 we show that among women with a health plan, there are statistically significant utilization effects of mandates for annual mammograms on past year

[26] While some share of women whose most recent mammogram was not routine might have also had a routine one in the last year, it seems unlikely that the most recent one would be for routine reasons if a previous recent one was diagnostic. Also note that any causal effect on diagnostic use would be a tiny share of the effect on screenings, as only a share of screenings result in diagnostic mammograms.

[27] In results not reported but available upon request, we also used the March Current Population Surveys to estimate DDD models of the likelihood of being covered by private insurance, using the same right hand side controls as in our preferred specification (i.e., column 5 of Table 2). These models returned no evidence that mandates were related to private insurance in an economically or statistically significant way. Again, this is not surprising given that the DDD models are identified from differences across women of different age groups coincident with mandate adoption.

mammography rates. As expected, we do not find that mandates significantly increased utilization rates among women without a health plan (results in column 3).

In Table 5 we examine whether mandates affected other screening behaviors by women that are also related to preventive health. Specifically, we consider clinical breast exams (manual examinations of the breast performed by a physician that do not involve X-rays) and Pap tests (the standard cervical cancer screening test). Both CBEs and Pap tests are cheaper than mammograms and are typically carried out during an office visit to a GP or OB/GYN, unlike mammograms which are typically done in a separate facility and by a different person than one's GP/OB/GYN. If mandates were significantly related to women's health more generally (particularly in an age-specific way), we might be less convinced that the effects we have identified are really due to the effects of the insurance mandates and may instead be proxying for other types of outreach efforts or information campaigns regarding women's preventive health behaviors other than mammography screening for breast cancer.[28] In Table 5 we show that the relationship between mandates for annual screening mammograms and past year screenings is unique to mammography. Specifically, in columns 1 and 2 we show that neither past-year clinical breast exams nor past-year Pap tests, respectively, were significantly related to mandates for annual mammography screenings. This further supports the hypothesis that mandates affected insurance coverage for mammography only (with subsequent utilization effects that were unique to mammography).[29]

We performed several other robustness tests, results of several of which are included in the appendix. For example, Appendix Table 3 shows that our main results for past year mammography are robust to: 1) restricting attention to states constituting a balanced panel in the BRFSS data; 2) replacing our 5-year age group dummy variables with single year of age dummy variables; 3) separately considering cover from offer mandates (whereby cover mandates have larger and more precisely estimated effects)[30]; and 4) ignoring the baseline/biennial/annual

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[28] In Appendix Table 2 we show that the relationship between mandates for annual mammograms and past year mammography is robust to restricting attention to the sampled years in which we observe the other outcomes.

[29] All of the models in Table 5 include the full set of controls in the triple difference specification.

[30] Cover mandates require privately sold plans to include coverage of mammography while offer mandates only require that insurers offer at least one such plan to an employer. We would typically expect the effects of offer mandates to be weaker than cover mandates (i.e., have smaller or no effects on utilization) since the latter should more strongly reduce barriers to screening mammography for those privately insured women who did not have coverage previously. If there were no incentives to adjust coverage decisions besides the text of the laws, employers in offer states who did not wish to add the coverage could simply choose plans which did not include the "offered" coverage of mammograms. In practice, the bulk of our results pertain to cover mandates because they are far more

distinctions among the various mammography benefits and simply controlling for an indicator variable equal to one if the woman is covered by any type of mammography mandate. We also performed other robustness exercises not reported in the appendix. For example, we controlled for leads of the laws to rule out policy endogeneity, finding no evidence that the policies were driven by increases in mammography rates. We also estimated models dropping women who were exactly 35, 40, or 50, as some of these women may have received their mammograms before reaching the age when the laws apply. Neither of these had a significant effect on our main findings.[31]

In Table 6 we provide evidence relevant to understanding whether the mandate-induced increases in mammography are beneficial from a public health perspective. The motivation for doing so stems from recent and high-profile controversy surrounding the appropriateness of routine mammography for younger women. Major medical groups such as the American Cancer Society (ACS) and the American College of Radiology (ACR) have since the early 1990s recommended that all women begin annual breast cancer screening beginning at age 40 based on evidence from randomized controlled trials (RCTs) about the effects of such screenings at reducing breast cancer mortality. In contrast, the United States Preventive Services Task Force (USPSTF)—a panel of expert scientists commissioned to review the state of the evidence about a variety of preventive services, including mammography—did not adopt a recommendation that asymptomatic women obtain a routine mammogram beginning at age 40 until 2002, and in November 2009 the USPSTF again revised its recommendations to state that women age 40-49 should generally not obtain routine screening mammograms. The November 2009 recommendation from USPSTF advises women age 50-74 obtain routine biennial mammograms.

At the heart of the controversy is the fact that mammography in younger women around age 40 is less likely in absolute terms to detect cancer and can lead to a variety of costly outcomes, including: a nontrivial risk of a false positive screen (due in part to the fact that

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common in our setting than are offer mandates: only three states ever had an offer mandate for screening mammography which did not subsequently become a cover mandate over our sample period. Measured differently, the proportion of women in our sample covered by any type of mammography mandate is 48.6 percent; fully 44.4 percent of these are cover mandates. Conley and Taber (2010) show that over rejection can be severe in difference in differences models with a small number of policy changes, thus raising concerns that the standard errors on our 'offer mandate' variables may be too small.

[31] We also estimated models separately by race and education group (see Appendix Table 4). We found significant increases for white women; coefficient estimates also indicated meaningful increases in past year mammography for non-Hispanic black and Hispanic women, though these estimates were not statistically precise given the smaller sample sizes.

mammography quality is lower in younger women due to denser breast tissue), potentially unnecessary follow-up procedures such as diagnostic mammograms and biopsies, and the associated anxiety experienced by women who receive a false positive screen. A related concern is that some proportion of the cancers that are caught early through routine mammography (i.e., 'in-situ' cancers) would likely not progress to be fully invasive. As evidenced by the revised November 2009 USPSTF recommendation, there is far more scientific consensus that mammograms for women near age 50 are on net beneficial.

We use several different approaches for understanding whether the mandate-induced increases in mammography are likely to be welfare enhancing. First, we simply re-estimate equation 1 separately for 25-44 year old women and 45-64 year old women, with the intuition that large effects of mandates for annual mammograms in the older age group relative to the younger age group would be more likely to be beneficial from a health perspective since there is more medical agreement about the appropriateness of routine mammography for these women. We present these results in columns 1 and 2 of Table 6 and find that, indeed, there are economically meaningful and statistically significant effects of mandates for annual mammograms on the probability a 45-64 year old woman had a mammogram in the past year. This gives us confidence that the mandates were effective at increasing screenings in a group of women where screening is more unambiguously positive.

In Table 6 we also try to differentiate whether it is simply the increased insurance coverage or its interaction with existing guidelines that lead to the increased annual mammography rates. We do so by dividing each main mandate variable into two separate mandate variables based on whether the state's mandate in that year for that age group was or was not adherent to the ACS and USPSTF guidelines at the time of interview.[32] This approach tells us something about how mandates and each organization's mammography guidelines interact with respect to determining mammography rates. Note that if it were just the insurance coverage aspect making mammograms more accessible to women, then whether the mandate were adherent with a guideline would not matter for increasing mammography rates (i.e., the two mandate coefficients would be the same) In contrast, if it were the case that only ACS-adherent

[32] Note that ideally we would examine an alternative dependent variable indicating whether each mammogram was adherent or not adherent to ACS or USPSTF guidelines. Unfortunately, women are only asked about their most recent mammogram, and we are unable to create meaningful variables for adherence without having each woman's entire mammography history at each age in each year.

or USPSTF-adherent mandates (as opposed to non-adherent mandates) were associated with increases in past year mammography use, this would suggest some interaction between mandates and guidelines. For example, if a woman gets a mammogram when her physician recommends it and when it is covered by insurance, and if physicians respond to guidelines, then we might expect to see mammography rates increasing only in the presence of mandates that were adherent to ACS or USPSTF guidelines.

We present these results in columns 3 and 4 of Table 6 for ACS and USPSTF-adherent mandates at the time of the interview, respectively. The evidence in these columns is mixed. On the one hand, we continue to find that adherent-mandates for annual mammograms (whether ACS-adherent or USPSTF-adherent) are significantly related to increased mammography rates. Moreover, non-adherent mandates for annual mammograms are also sizable in magnitude and positive, though only the coefficient in column 4 is statistically significant. These results therefore suggest that the mandates may be operating through both channels.[33]

Finally, we present evidence on the effectiveness of provisions in several state mandates that prohibit insurance companies from imposing cost-sharing to women who want to obtain mammograms. This type of provision is very similar to one in recently adopted federal health reform, which also prohibits such out of pocket costs for individuals obtaining preventive health services such as mammograms. Do mammography mandates with these types of provisions have larger effects at increasing mammography use than mandates without such provisions, and if so are these effects concentrated among low-SES women (who should be more sensitive to limits on out of pocket costs)? We address this question by re-estimating equation (1) with interactions between a dummy variable indicating the state has this type of provision and the relevant mandate variables. To conserve space, we only report the coefficients on the mandate variable for annual screening and its interaction with the variable indicating the state mandate prohibits deductibles, though the models are fully saturated.

In Table 7 we find evidence that these provisions matter, particularly for low-educated women. For the full sample in column 1 we confirm the main effect of mandates for annual mammograms, and we estimate a positive but statistically insignificant interaction coefficient. In

[33] In results not reported, we also examined how the effects of mandates operated through current guidelines; these suggest much of the increase was driven by policies not adherent to current best practices from the ACS or USPSTF guidelines. This suggests that at least from the perspective of current knowledge, not all the increases in mammograms were beneficial at the population level.

columns 2 through 5 we show the results from similar models where we restrict attention to high school dropouts (column 2), women with a high school degree (column 3), women with some college (column 4), and women with at least a college degree (column 5). Prohibitions on deductibles for obtaining mammograms should be expected to have larger effects on low-educated women who are likely to have lower incomes and lower ability to pay such out-of-pocket costs. Indeed, we find in column 2 that in addition to the significant main effect of mandates for annual mammograms, there is also a significant and large positive interaction coefficient, suggesting that for high school dropout women the prohibition on deductibles for obtaining mammograms significantly increased mammography rates over and above the main mandate effect. For women in all other education groups in columns 3 through 5 we also estimate positive interaction coefficients, though none is statistically significant. In results not reported, these patterns also held when we restricted attention to women with a health plan. These results suggest that similar rules in federal health reform are likely to further increase screening among low-SES women.

5. Discussion and Conclusion

Our results suggest that state laws requiring private insurers to cover annual screening mammograms played an important role at increasing the rates of past year mammography over an unprecedented period of improved preventive health behaviors among women from 1987 to 2000. Specifically, we estimate that mammography mandates account for about 7 percent of the overall doubling of the annual mammography rate among 25–64 year old women over this time period. How many additional screenings are attributable to these mandates? Consider that there are approximately 60 million 25-64 year old women in the United States. We estimate that mandates for annual mammography screenings increased the population screening probability by about 1.6 percentage points, or by about 960,000 women. Measured differently, about 20 percent of women age 25-64 (or 12 million women) had a past year mammogram in 1987; by 2000 this figure had about doubled. We estimate that mandates for annual mammography screenings can account for about 7 percent of this 12 million increase, or about 840,000 additional women who were screened due to mandates. Thus, these state insurance mandates were responsible for over 800,000 mammograms among prime-age women from 1987-2000.

What factors account for the remainder of the increase? Several possibilities are likely. First, previous research has identified direct provision of mammograms to low-income women through the National Breast and Cervical Cancer Early Detection Program (which expanded greatly over our time period) as a significant determinant of mammography use (Adams et al. 2006, Adams et al. 2003).[34] Second, the adoption of screening guidelines from the American Cancer Society and the United States Preventive Services Task Force were likely responsible for some of the secular age-specific increases in use initiated by both patients and providers. Finally, educational outreach about the lifesaving effects of mammography is likely important. To the extent these efforts were correlated with mammography mandate adoption (as is plausible), these effects are likely reflected in part by the much larger associations between mammography mandates and mammography use we identify in our state and year fixed effects models in Column 4 of Table 2 (i.e., without the age by state, age by year, and state by year fixed effects). For example, mandates for an annual mammogram in the DD models were estimated to increase past year mammography rates by 4 percentage points, or an effect 2.5 times as large as our preferred estimate.

Given that nearly all states have already adopted these public policies, what are the public policy implications of our study? There are several. First, there is still wide variation in the ages of women who are targeted by these laws. Moreover, most states' existing recommendations are *not* in accordance with current recommendations from the American Cancer Society or the United States Preventive Services Task Force. Specifically, the majority of state mandates still cover annual screening mammograms for women age 50 and older, despite that the ACS now recommends annual mammograms for women beginning at age 40 and the USPSTF now recommends biennial mammograms for women beginning at age 50. Second, recently adopted federal health care reform has the potential to further increase screening rates because the state mandates are not binding for firms that self-insure under well-known provisions of ERISA. Since most self-insured firms will have to comply with the federal reform's requirement that no cost-sharing can be imposed on mammography consistent with the 2002 USPSTF guidelines, it is possible that women whose insurance is from a self-insured organization will see increases in

[34] These programs were also targeted to women over age 40, and throughout we have controlled for the differential timing of statewide implementation of pilot and full NBCCEDP efforts. We did not find consistent evidence that these programs increased mammography rates, though we do not have good measures of the intensive margin of service provision across states.

the generosity of insurance coverage for mammography. Finally, a minority of state mandates include provisions prohibiting insurance companies from imposing deductibles for obtaining a mammogram. Again, federal health reform prohibits these out of pocket costs for any new or substantially revised private insurance plans, further suggesting potential for public policy to increase screening rates among low-SES women (for whom out of pocket costs are likely to be more salient).

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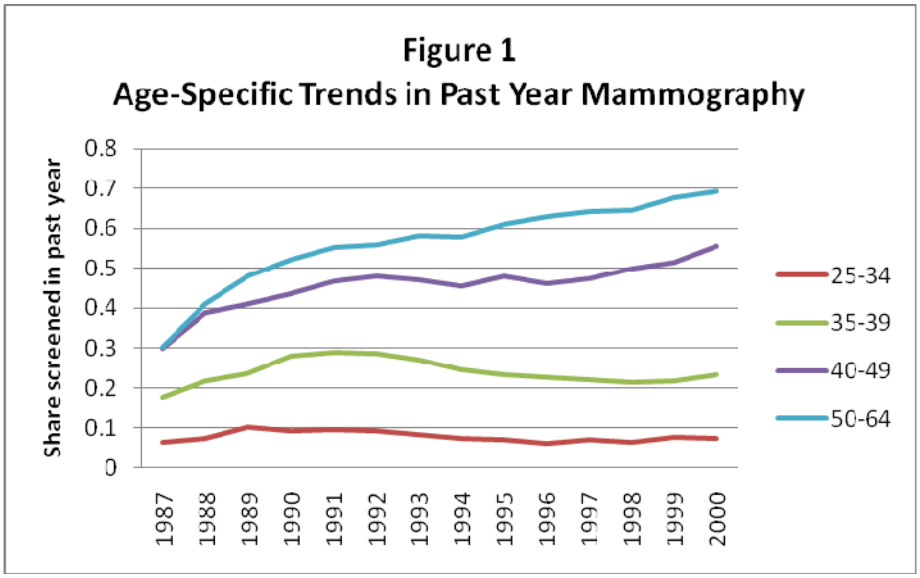


Figure 1 presents weighted mean share of women of various ages in pooled 1987-2000 BRFSS sample who report having had a mammogram in the previous year.

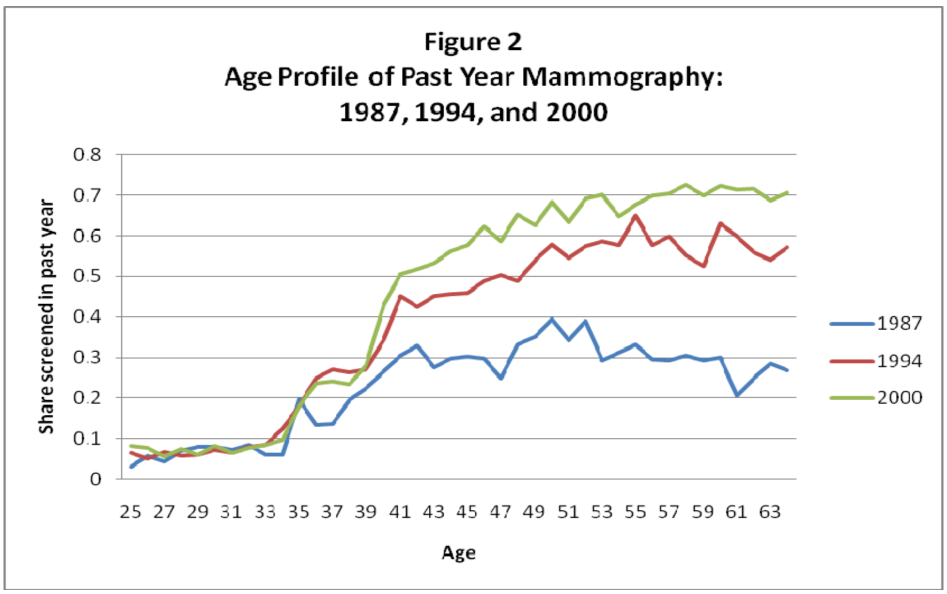


Figure 2 presents share of women of each age in pooled 1987-2000 BRFSS sample who report having had a mammogram in the previous year for survey years 1987, 1994, and 2000.

Figure 3
Mandate Variation ≠ Guideline Variation:
Baseline Screenings

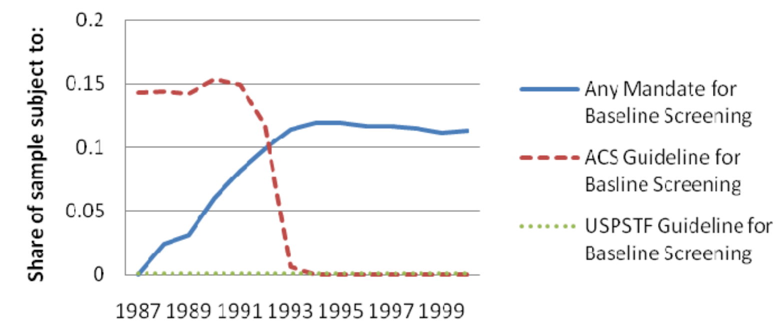


Figure 4
Mandate Variation ≠ Guideline Variation:
Biennial Screenings

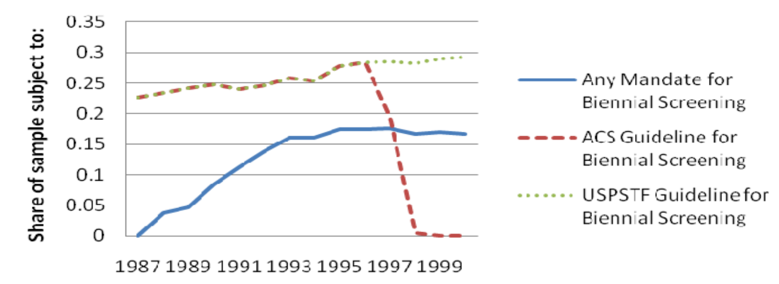
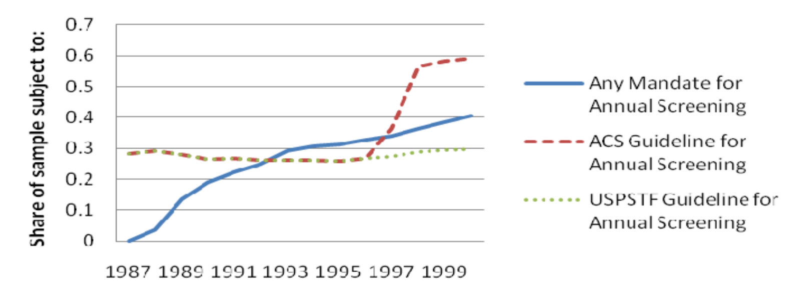


Figure 5
Mandate Variation ≠ Guideline Variation:
Annual Screenings



Figures 3,4, and 5 present the weighted mean share of women age 25-64 in pooled 1987-2000 BRFSS sample by survey year according to three criteria. The first (solid) line in each figure is the weighted mean share of women in each year who live in a state where a mandate for a baseline (Figure 3), biennial (Figure 4) or annual (Figure 5) screening mammogram was in effect for them. The second (dashed) line in each figure is the weighted mean share of women in each year for whom ACS screening guidelines recommended a baseline (Figure 3), biennial (Figure 4), or annual (Figure 5) screening mammogram. The third (dotted) line in each figure is the weighted mean share of women in each year for whom USPSTF screening guidelines recommended a baseline (Figure 3), biennial (Figure 4), or annual (Figure 5) screening mammogram.

Table 1:
Mammogram Outcomes and Mandate Variables, BRFSS Females

Variable	All ages 25–64	Age 25–34	Age 35–39	Age 40–49	Age 50–64
Ever had a mammogram	.550	.174	.459	.760	.817
Had a mammogram w/in 1 year	.346	.080	.241	.469	.583
Had a mammogram w/in 1 year and most recent was routine	.311	.055	.191	.421	.540
Had a mammogram w/in 1 year and most recent was not routine	.042	.021	.040	.053	.056
Had a mammogram w/in 2 years	.451	.115	.344	.636	.709
Means of policy variables for past year outcomes:					
Share treated by any mandate	.486	.016	.603	.687	.707
Share treated by mandate for baseline screening	.092	0	.561	.507	0
Share treated by mandate for biennial screening	.139	0	0	.507	0
Share treated by mandate for annual screening	.255	.016	.041	.180	.707
Share treated by any cover mandate	.444	.016	.544	.627	.647
Share treated by any offer mandate	.047	.000	.065	.066	.068
Share treated by any mandate prohibiting deductibles	.046	.016	.056	.060	.058
N	593737	170352	97610	162580	163195

Notes: Author calculations from 1987–2000 BRFSS adult females 25–64. Statistics are weighted. N is maximum possible N; a small number of observations are missing for various measures (e.g., individuals who did not answer questions about the timing of their last mammogram are not asked why they had it). Past year outcomes are the share of the prior calendar year (relative to the respondent's interview date) that a law has been in effect, assuming it first impacted health insurance policies as of January 1 of the year after it was passed. The variable 'Had a mammogram w/in 1 year' does not exactly equal the sum of the variables 'Had a routine mammogram w/in 1 year' and 'Had a non-routine mammogram w/in 1 year' because of a small amount of non-response to the question about the reason for the most recent mammogram. The variable 'Share treated by any mandate' does not exactly equal the sum of the 'share treated by any cover mandate' and the 'share treated by any offer mandate' because of 2575 observations from Ohio for 1993 to 1997. For these observations we could not reliably differentiate cover from offer status; these observations are therefore coded as both cover and offer.

Table 2:
Mammography Insurance Mandates Significantly Increased Past Year Mammography
BRFSS 1987-2000, Adult Women 25-64, Incremental Controls

Controls for:	(1) Age group dummies and policies related to screening/access to OB/GYNs	(2) (1) + Individual X's	(3) (2) + State X's and relevant public policies in Z vector	(4) (3) + State, year, and month fixed effects	(5) (4) + state* age, year *age, and state*year fixed effects (DDD Model)
Treated by mandate for baseline	.027**	.026**	.019***	.009	-.009
mammogram	(.010)	(.010)	(.007)	(.007)	(.009)
Treated by mandate for biennial	.044***	.043***	.044***	.025***	.018
mammogram	(.010)	(.009)	(.008)	(.008)	(.011)
Treated by mandate for annual	.053***	.052***	.052***	.040***	.016**
mammogram	(.016)	(.015)	(.011)	(.011)	(.006)
Adjusted R squared	.20	.21	.21	.21	.22
N	591170	591170	591170	591170	591170

Notes: Each panel within each column shows selected coefficients from one regression. The dependent variable for all models in Table 2 is equal to one if the woman had a mammogram in the past year. Mandate variables control for share of last calendar year the law was in effect. In addition to controls for which coefficients are reported, additional controls are included as indicated in the column label. Age groups dummies for being 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64 are included in all regressions, as are controls for Pap test mandates, NBCEDPP pilot and full programs, and laws mandating access to OB/GYNs. Individual Xs added in column 2 include controls for race/ethnicity, education, and marital status. Column 3 adds controls for the following variables for each state and year: share of women 15–44 with private health insurance; share of women who work or who have a husband who works at a firm with 24 or fewer employees, 25–99 employees or 100 or more employees; the unemployment rate; welfare reform; the level of HMO penetration (as a share of the population); the number of obstetric beds per 100 women 15–44, the eligibility threshold for Medicaid eligibility for a pregnant woman in the state as a share of the FPL; and the share urban, share black, and share Hispanic in the state. Column 4 adds state, year, and month of interview fixed effects. Column 5 adds state by age group, year by age group, and state by year fixed effects. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 3:
Mammography Insurance Mandates and Other Mammography Screening Outcomes
BRFSS 1987-2000, Adult Women 25-64, DDD

Outcome is ➔	(1) Mammogram in past year (Table 2, column 5)	(2) Mammogram in past two years	(3) Ever had a mammogram	(4) Mammogram in past year and most recent one was routine
Treated by mandate for baseline mammogram	-.009	.008	.010	.009
	(.009)	(.009)	(.009)	(.009)
Treated by mandate for biennial mammogram	.018	.025*	.019***	.021*
	(.011)	(.013)	(.007)	(.011)
Treated by mandate for annual mammogram	.016**	.020**	.013**	.020**
	(.006)	(.008)	(.006)	(.006)
Adjusted R squared	.22	.29	.34	.21
N	591170	591170	592468	589799

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2 but a different dependent variable. The dependent variable in column 1 is mammogram in past year, that in column 2 is mammogram in past 2 years, that in column 3 is any mammogram ever, and that in column 4 is mammogram in past year and most recent one was routine screening mammogram. Relevant mandate variables for the specification in columns 1 and 4 account for the share of the last calendar year the law was in effect. Relevant mandate variables for the specification in column 2 account for the share of the last two calendar years the law was in effect. Relevant mandate variables for the specification in column 3 accounts for whether a mandate has been implemented as of January of the survey year. See notes to Table 2 for description of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 4:
Mandates Not Related to Probability a Woman Has a Health Plan and Mandate Effects Driven by Women with a Health Plan
BRFSS 1987–2000, Adult Women 25–64, DDD

	(1)	(2)	(3)
Outcome is ➔	Has a health plan	Mammogram in past year, among women with a health plan	Mammogram in past year, among women without a health plan
Treated by mandate for baseline mammogram	.008	-.003	-.001
	(.007)	(.013)	(.031)
Treated by mandate for biennial mammogram	.003	.006	-.009
	(.007)	(.011)	(.019)
Treated by mandate for annual mammogram	.008	.023**	-.018
	(.009)	(.010)	(.024)
Adjusted R-squared	.11	.25	.11
N	503680	436086	67594

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2. Column 1 shows specifications with the dependent variable 'has a health plan', columns 2 and 3 show specifications with the dependent variable 'mammogram within the last year'. Sample in column 2 is women with a health plan, and that in column 3 is women without a health plan. Mandate controls are for share of last year mandate was in effect. Sample size in column 1 is smaller than in Tables 2 and 3 because the variable 'has a health plan' is only available from 1990 onward and because we drop the observations who are missing a response for 'has a health plan'. See notes to Table 3 for list of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 5:
Mammography Mandates Did Not Affect Clinical Breast Exams (CBE) or Pap Tests
BRFSS 1987–2000, Adult Women 25–64, DDD

	(1)	(2)
Outcome is ➔	CBE in past year	Pap test in past year
Sample is ➔	1990–2000 (when CBE questions asked)	1988–2000 (when Pap test questions asked)
Treated by mandate for baseline mammogram	-.007	-.009
	(.013)	(.011)
Treated by mandate for biennial mammogram	.006	-.003
	(.008)	(.011)
Treated by mandate for annual mammogram	.007	.002
	(.009)	(.013)
Adjusted R-squared	.04	.05
N	534242	539200

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2 but estimated for a different sample. The sample in column 1 includes the set of states and years in which questions about clinical breast exams were asked. The samples in column 2 includes the set of states and years in which questions about Pap tests were asked. See notes to Table 2 for list of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 6:
Effects of Mandates by Age Group and Adherence Status
Outcome in all models is had a mammogram last year
BRFSS 1987-2000, DDD Models

	(1)	(2)	(3)	(4)
Sample is ➔	25-44 year olds	45-64 year olds	25-64 year olds	25-64 year olds
Treated by mandate for baseline mammogram	-.010 (.009)	--	--	--
Treated by mandate for biennial mammogram	.015 (.014)	.030 (.025)	--	--
Treated by mandate for annual mammogram	.001 (.011)	.033* (.019)	--	--
Mandate is adherent to ACS guideline in effect at time of interview for baseline	--	--	.008 (.010)	--
Mandate is not adherent to ACS guideline in effect at time of interview for baseline	--	--	-.022* (.012)	--
Mandate is adherent to ACS guideline in effect at time of interview for biennial	--	--	.017 (.011)	--
Mandate is not adherent to ACS guideline in effect at time of interview for biennial	--	--	.024 (.015)	--
Mandate is adherent to ACS guideline in effect at time of interview for annual	--	--	.019*** (.007)	--
Mandate is not adherent to ACS guideline in effect at time of interview for annual	--	--	.011 (.007)	--
Mandate is adherent to USPSTF guideline in effect at time of interview for baseline	--	--	--	--
Mandate is not adherent to USPSTF guideline in effect at time of interview for baseline	--	--	--	-.009 (.009)
Mandate is adherent to USPSTF guideline in effect at time of interview for biennial	--	--	--	.018* (.011)
Mandate is not adherent to USPSTF guideline in effect at time of interview for biennial	--	--	--	--
Mandate is adherent to USPSTF guideline in effect at time of interview for annual	--	--	--	.014* (.007)
Mandate is not adherent to USPSTF guideline in effect at time of interview for annual	--	--	--	.019* (.011)
Adjusted R-squared	.14	.06	.22	.22
N	354389	236781	591170	591170

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2, with exception that mandate controls in columns 3 and 4 interact the mandate with indicators for whether or not the mandate was adherent to the guidelines of the time. Sample in columns 1 and 2 is women 25-44, and 45-64 respectively. See notes to Table 3 for list of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 7:
Mandates that Prohibit Deductibles Further Increased Screenings Among High School Dropouts
Outcome is past year mammogram
BRFSS 1987-2000, Adult Women 25-64, DDD Models

	(1)	(2)	(3)	(4)	(5)
Sample is ➔	All women	High school dropouts	High school degree	Some college	College degree or more
Treated by mandate for annual mammogram	.014**	.038*	.002	.010	.015
	(.006)	(.020)	(.012)	(.017)	(.019)
Treated by mandate for annual mammogram * mandate prohibits deductibles	.019	.074***	.011	.005	.026
	(.012)	(.023)	(.016)	(.030)	(.021)
Adjusted R-squared	.22	.13	.20	.23	.28
N	591170	59541	197322	168298	165303

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2, with addition that interactions of mandate prohibiting deductibles with the main mandate variables are also included. Though not shown, all models also include controls for the baseline and biennial mandate variables, as well as their interactions with the indicator for laws that prohibit deductibles. See notes to Table 2 for list of additional control variables. Column 1 sample is all women, column 2 sample is women with less than a high school degree; column 3 sample is women with exactly a high school degree; column 4 sample is women with some college education; and column 5 sample is women with at least a bachelor's degree. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Appendix

Appendix Table 1 presents descriptive statistics of the key demographic variables as well as for the other screening outcomes used in this analysis for adult women in the BRFSS. Column 1 presents results for all women, while the remaining columns present associated descriptive statistics for age-specific samples of interest: 25 to 34 year old women, 35 to 39 year old women, 40 to 49 year old women, and 50 to 64 year old women. (As in Figure 2, these age groups reflect the modal laws.) We present basic demographic characteristics (e.g., age, race/ethnicity, education, marital status) as well as the fraction of women in each group who had a past year Pap test or clinical breast exam (CBE), neither of which should have been affected by the mammography mandates and thus serve as placebo tests below. The patterns of demographic characteristics across groups indicates that most of the sample for each age group is white non-Hispanic, while about ten percent of the sample is black non-Hispanic, and nine percent of the sample is Hispanic. Educational attainment is predictably higher for younger women compared to the women age 50–64. Over two-thirds of the sample is married and over 85 percent of women report that they have a health care plan. Finally, note that other non-mammography screening levels (past year Pap tests and clinical breast exams) are fairly regularly high across age groups—much higher than the associated mammography rates in Table 1 (in text)—and show the opposite age patterns (i.e., younger women are more likely to obtain these screenings).

In Appendix Table 2 we show that the relationship between mandates for annual mammograms and past year mammography is robust to restricting attention to the sampled years in which we observe outcomes related to clinical breast exams and Pap tests (addressed in Table 5 in the text). In column 1 of Appendix Table 2 we show that over the period 1990–2000 (when questions about clinical breast exams were asked), mammography mandates for annual screenings significantly increased past year mammography rates, and in column 2 we show that the main finding is similarly robust over the period 1988–2000 (when Pap test questions were asked).[35]

In Appendix Table 3 we provide further evidence on the robustness of our estimated effects of insurance mandates on past year mammography rates. First, we address issues about the unbalanced panel nature of the BRFSS data. Recall that states began participating throughout the late 1980s and early 1990s. Column 1 shows that restricting attention to all states

[35] All of the models in Appendix Table 2 include the full set of controls in the triple difference specification.

observed continuously from 1989–2000 produces similar estimates to those reported in Table 2.[36] Column 2 of Appendix Table 3 shows that when we replace the 5-year age group dummy variables with single year of age dummy variables (as well as all of the relevant single-year-of-age-based interaction terms), we obtain very similar results. Column 3 of Appendix Table 3 shows that our consistent findings of significant increases in screenings attributable to mandates for annual mammograms is larger and more precisely estimated for the much more common "cover" mandates than for the small number of "offer" mandates, as expected. Finally, column 4 of Appendix Table 3 shows that our main result also obtains if we ignore the baseline/biennial/annual distinctions among the various mammography benefits and simply control for an indicator variable equal to one if the woman is covered by any type of mammography mandate. Thus, columns 3 and 4 show that more and less involved ways of defining mandates return consistent evidence that the insurance mandates increased mammography use, particularly mandates requiring coverage of annual screenings.

In Appendix Table 4 we provide evidence on the effects of mandates for various subgroups of women in the fully saturated DDD models. Column 1 shows that among white women there were statistically significant increases in past year mammography rates associated with mandates for annual mammograms. Coefficient estimates also indicate meaningful increases in past year mammography associated with these same mandates for non-Hispanic black and Hispanic women, though these estimates are not statistically precise given the smaller sample sizes and are smaller in magnitude if the samples are restricted to non-Hispanic black or Hispanic women with a health plan. In column 4 of Appendix Table 4 we find that the mandates for annual mammograms are estimated to significantly increase past year mammography rates for high school dropouts, although again, not statistically significantly if restricted to the sample of high school dropouts with a health plan. Coefficient estimates on the annual mammogram mandate variable for the other groups of women in columns 5-7 are all positive though none is statistically significant at conventional levels. Notably, however, we also found positive and statistically significant effects of mammography mandates for annual screenings for college

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[36] The same is true when we restricted attention to states in a balanced panel from 1987-2000 or using the balanced panel of states observed in 1987 and 1989-2000 (keeping in mind that the questions were asked to a very small subset of women in 1988).

graduates (coefficient is 0.046) when we restricted attention to women who had a health plan (the group who should have been most directly affected by the policies).[37]

[37] These additional results are available upon request. In Appendix Table 4 we estimate that mandates for biennial mammograms significantly increased past year screenings: non-Hispanic white women, non-Hispanic black women, and women with a high school degree. The statistical significance of these findings, however, goes away when we restricted attention to women with a health plan.

Appendix Table 1
Descriptive Statistics, BRFSS Females

Variable	All ages 25–64	Age 25–34	Age 35–39	Age 40–49	Age 50–64
White non-Hispanic	.762	.722	.749	.769	.806
Black non-Hispanic	.105	.114	.106	.104	.095
Other race non-Hispanic	.035	.040	.037	.036	.027
Hispanic	.094	.120	.105	.086	.068
Less than high school degree	.118	.093	.093	.099	.177
HS degree	.339	.315	.319	.328	.386
Some college	.272	.290	.289	.281	.235
Bachelors degree or more	.270	.301	.298	.290	.199
Married	.679	.636	.710	.709	.681
Widowed/Divorced/Separated	.195	.121	.169	.212	.275
Never married	.103	.204	.095	.061	.037
Living with a partner	.021	.038	.023	.015	.005
Has any health care plan (1990-00)	.859	.824	.856	.874	.882
Had Pap test last year (from 1988)	.695	.774	.703	.674	.624
Had clinical breast exam last year (from 1990)	.697	.723	.680	.683	.691
N	593737	170352	97610	162580	163195

Notes: Author calculations from 1987–2000 BRFSS adult females 25–64 who completed interviews by December 2000. Some of the variables are not defined in some of the years (e.g., health insurance is not asked until 1990). Statistics are weighted. Between 0.1% and 0.3% of observations are missing values for education, marital status, employment status, or health insurance. A larger share is missing household income. Questions about Pap tests and clinical breast exams not asked for all years and all states, and thus are reported for a smaller number of observations than the reported N.

Appendix Table 2:
Mammography Mandate Effects Observed in Same Sample as Available for CBE and Pap "Falsification" Tests
BRFSS 1987–2000, Adult Women 25–64, DDD

	(1)	(2)
Outcome is ➔	Mammogram in past year	Mammogram in past year
Sample is ➔	1990–2000 (when CBE questions asked)	1988–2000 (when Pap test questions asked)
Treated by mandate for baseline mammogram	-.007	-.002
	(.012)	(.008)
Treated by mandate for biennial mammogram	.011	.017
	(.010)	(.011)
Treated by mandate for annual mammogram	.018**	.019***
	(.008)	(.007)
Adjusted R-squared	.23	.22
N	535890	571817

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2 (in text) but estimated for a different sample. The sample in column 1 includes the set of states and years in which questions about clinical breast exams were asked. The samples in column 2 includes the set of states and years in which questions about Pap tests were asked. See notes to Table 2 (in text) for list of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Appendix Table 3:
Robustness Checks – Outcome is mammogram in past year
BRFSS 1987-2000, Adult Women 25-64, DDD Models

	(1) Balanced panel (no 87/88)	(2) Single year of age controls	(3) Cover vs. Offer Specification	(3) Any mandate specification
Treated by mandate for baseline mammogram	-.005 (.009)	-.008 (.009)	--	--
Treated by mandate for biennial mammogram	.015 (.010)	.017 (.011)	--	--
Treated by mandate for annual mammogram	.018** (.007)	015** (.006)	--	--
Treated by cover mandate for baseline mammogram	--	--	-.008 (.009)	--
Treated by offer mandate for baseline mammogram	--	--	.006 (.013)	--
Treated by cover mandate for biennial mammogram	--	--	.014 (.011)	--
Treated by offer mandate for biennial mammogram	--	--	.020* (.011)	--
Treated by cover mandate for annual mammogram	--	--	.015*** (.005)	--
Treated by offer mandate for annual mammogram	--	--	.009 (.015)	--
Treated by any mammography mandate	--	--	--	.011* (.006)
Adjusted R squared	.22	.22	.22	.22
N	562002	591170	591170	591170

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2 (in text), with the exception that the specification in column 2 includes single year of age dummies and interactions; the mandate variables are split into cover and offer for column 3; and the mandate variables are collapsed into a single any mandate variable for column 4. The dependent variable in each model is equal to one if the woman had a mammogram in the past year. Relevant mandate variables account for the share of the last calendar year the law was in effect. See notes to Table 2 (in text) for description of additional control variables. Sample in column 1 is a balanced set of state year cells (and excludes 1987 and 1988). Columns 2-4 use the full sample of women. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Appendix Table 4:
Results by Demographic Group: Mammography in Past Year
BRFSS 1987-2000, Adult Women 25-64, DDD Models

	(1) White, non-Hispanic	(2) Black, non-Hispanic	(3) Hispanic	(4) Less than high school degree	(5) High school degree	(6) Some college	(7) College degree or more
Treated by mandate for	-.006	-.021	-.013	.0005	-.019	.010	-.022
baseline mammogram	(.010)	(.036)	(.040)	(.024)	(.021)	(.015)	(.015)
Treated by mandate for	.020**	.054*	.031	.021	.037**	.003	-.007
biennial mammogram	(.009)	(.032)	(.045)	(.023)	(.017)	(.018)	(.018)
Treated by mandate for	.019**	.024	.061	.041**	.002	.010	.017
annual mammogram	(.007)	(.019)	(.049)	(.020)	(.012)	(.017)	(.019)
Adjusted R-squared	.23	.18	.18	.13	.20	.23	.28
N	473842	58011	34891	59541	197322	168298	165303

Notes: Each column shows the results from a separate DDD regression model with the specification in column 5 of Table 2 (in text) but estimated for a different sample. Column 1 sample is non-Hispanic white women; column 2 sample is non-Hispanic black women; and column 3 sample is Hispanic women. Column 4 sample is women with less than a high school degree; column 5 sample is women with exactly a high school degree; column 6 sample is women with some college education; and column 7 sample is women with at least a bachelor's degree. See notes to Table 2 (in text) for list of additional control variables. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.