Current Version: October 2012

Health Insurance Mandates, Mammography, and Breast Cancer Diagnoses

Marianne P. Bitler and Christopher S. Carpenter*

ABSTRACT

We examine the effects of state health insurance mandates requiring coverage of screening mammograms. These laws vary in the timing of adoption and in the ages of women eligible for different benefits. Using triple difference models, we find that mandates requiring coverage of annual mammograms significantly increased past year mammography screenings by 8 percent. These effects are larger in states that ban deductibles, a policy similar to a provision of federal health reform that bans cost-sharing for preventive care. We also find the mandates significantly shifted breast cancer detection from late stage 'distant' cancers to the earliest stage 'in-situ' cancers.

JEL classification: I1, J8, K32

Keywords: insurance mandates, mammography, breast cancer, quasi-experiment

*Bitler is Associate Professor, Department of Economics, UC Irvine; Research Associate at the NBER, and Research Fellow at IZA; mbitler@uci.edu. Carpenter is Associate Professor, Economics/Public Policy, The Paul Merage School of Business at UC Irvine; Research Associate at the NBER; and Research Fellow at IZA; kittc@uci.edu. We thank Brian Asquith, Charles Hardy, Bhavanna Mannam, Ian Salas, Kathleen Wong, and Melody Yang for excellent research assistance. We are grateful to Kathleen Adams, Laura Argys, Cathy Bradley, David Neumark, Edward Norton, Barak Richman, Lucie Schmidt, Lara Shore-Sheppard, Kosali Simon, Madeline Zavodny, and numerous conference and seminar participants for many useful discussions and comments. Bitler worked on this while visiting the Federal Reserve Bank of San Francisco. We are grateful to the American Cancer Society (Grant #RSGI-11-003-01-CPHPS) and the UCI School of Medicine's Institute for Clinical Translational Science for grant funding. All errors are our own. The views in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Federal Reserve Bank of San Francisco, the Board of Governors of the Federal Reserve System, or the American Cancer Society.

1. Introduction

The recently adopted federal health care reform (the Patient Protection and Affordable Care Act) 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 utilization. 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.[1] Routine mammography rates among adult women are substantially below the recommended levels of both the United States Preventive Services Task Force (USPSTF) and the American Cancer Society (ACS).

Expanding coverage of mammography through federal health care reform therefore has the potential to increase mammography rates and affect breast cancer outcomes, but there is surprisingly very little research showing that adopting more generous insurance coverage will, in fact, increase screening 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 who obtain mammograms.[2] These policies have not been previously studied using quasi-experimental methods and thus their presence

[1] In part this was 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 as well as how frequently screening should occur. All interested parties, however, agree that women age 50 to 75 should have regular mammograms.

[2] 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.

provides researchers a unique opportunity to understand whether mandating insurance coverage and, in some cases, prohibiting cost-sharing for relatively low-cost preventive health services can increase screening utilization and affect breast cancer diagnoses. In so doing, our research also provides valuable insight into the likely effects of federal health reform with respect to mammography and breast cancer outcomes.

To evaluate the effects of state mammography mandates, we draw on data with information about mammography screening 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 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. We supplement these data with information on breast cancer diagnoses from the Surveillance Epidemiology and End Results (SEER) cancer registry system to test for effects of mandates on breast cancer diagnoses using the same triple differences approach.

To preview, we find strong evidence that state mandates requiring insurance coverage for an annual mammogram significantly increased past year mammography rates among women age 25-64 by about 8 percent, representing over 800,000 additional women who were screened from 1987-2000. These effects are 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 these mandates and can be carried out during a typical visit to a general practitioner (GP) or obstetrician/gynecologist (OB/GYN)) or cervical cancer screenings, suggesting that our mandate estimates are not picking up 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—significantly increased mammography screenings among high school dropouts relative to mandates without such limitations on out-of-pocket costs. These 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. Regarding breast cancer diagnoses, we find that the mandates led to a significant shift from late-stage (distant) cancer diagnoses toward increased early stage (in-situ) cancer diagnoses, which is what one would expect if mandate-induced screenings led to cancers being detected and diagnosed earlier and if time to progression from the in-situ stage to the distant stage is short for some cancers.

The paper proceeds as follows: Section 2 outlines institutional details regarding mammography and the insurance mandates under study, and Section 3 describes the relevant literature. We describe the research design, data, and empirical approach in Section 4, and Section 5 presents the results. Section 6 concludes.

2. Breast Cancer Screening and Institutional Details

Breast cancer is both 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. 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 some 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.

Cutler (2008) 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 non-elderly adult 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 health behaviors.

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, occasionally, 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 were not self insured.[3]

These age-based benefits reflect the age-specific mammography frequency recommendations supported by the American Cancer Society (ACS) from 1983 until 1991 for asymptomatic women at average risk of getting breast cancer. 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.[4] In recognition of these changes, some of the mammography mandates

[3] 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.

[4] Notably, 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 2002, 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. We take no stance on which organization's recommendations are the most scientifically or clinically valid, and such discussions are well beyond the scope of this paper. 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.

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.[5] Moreover, a handful of states have used quite 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.

3. Relevant Literature

Our paper is related to a large literature in economics that has used experimental and quasi-experimental methods to identify causal effects of insurance coverage generosity on use of health services and health outcomes, such as the RAND Health Insurance Experiment (HIE) (Manning et al. 1987), the Oregon Health Insurance Experiment (Finkelstein et al. 2011, forthcoming), and the Massachusetts Health Reform (Kolstad and Kowalski, 2010), all of which examined mammography screenings as a key preventive health care outcome.[6]

---

[5] This discussion highlights (and Appendix Figures 1-3 make visually apparent) that the state by year by age group identifying variation in the mandates is only weakly correlated with variation in screening recommendations of ACS and USPSTF. That is, 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 (2011a, b). For an analysis of guideline adherence, see Phillips et al. (1998).

[6] Another related study is Trivedi et al. (2008) who show that voluntary choices by plans to impose cost sharing for screening mammography were associated with reduced screening rates. Unobserved plan characteristics correlated with imposition of cost sharing could have also reduced

The mandate variation we study – where plans were required to cover a specific benefit – is not exactly the same variation as these studies, but is certainly related. The results of those studies are mixed. Manning et al. (1987) found that cost-sharing deterred participants from obtaining preventive care relative to the 'free' plan in the controlled setting of the RAND HIE from 1971 to 1982. Lurie et al. (1987), however, show that mammography rates among women aged 45-64 in the RAND HIE were only around 2 percent, precluding direct tests of cost-sharing on mammography in particular. Regarding a closely related preventive cancer screening – Pap tests for cervical cancer – they found no difference between screening rates for people in the 'free' plan versus people randomized to cost-sharing. Finkelstein et al. (2011, forthcoming) study low-income Medicaid-eligible women and find that participants who took-up Medicaid in the state due to winning a lottery in 2008 (i.e., generally moving from no insurance to public insurance) were significantly more likely to get a mammogram in the first year after the program, an effect on the order of 60 percent relative to the control group mean. Notably, there was no cost-sharing for participants in the Oregon plan. In contrast, Kolstad and Kowalski (2010) find no significant change in mammography rates for women in Massachusetts relative to women in other states after the implementation of the state's mandated health insurance reform in 2006. Thus, the existing quasi-experimental evidence on the role of insurance coverage and cost-sharing in screening mammography is quite mixed.

We complement these studies in the following ways. First, we examine effects of a different type of policy intervention that specifically targets screening mammography and that in some states mimics key provisions in the federal health reform. Second, we examine effects among a much larger share of the female

---

mammography in these groups, and Trivedi et al. (2008) acknowledge this as the "most important limitation" of the paper (p 381).

population (all women 25-64 as opposed to only low-income women in the Oregon case, only 40-64 or 45-64 year old women as in the Oregon and RAND cases, or only women in a single state as in the Oregon and Massachusetts cases). Third, we directly examine effects on cancer diagnoses.

Surprisingly, there is very little research that estimates the effects of state insurance benefit mandates requiring coverage of mammography.[7] Two public health studies find positive associations between mammography mandates and utilization using cross-sectional designs (Mor and Shackleton 2005, Pettibone 2003).[8] 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 while controlling for fixed differences across states or over time.

---

[7] We do not review here an enormous literature in public health that documents associations among demographic characteristics, insurance type, and mammography rates (see, for example, Wang and Pauly 2003, Bastani et al. 1991, and others). These studies are largely descriptive and do not directly address what drives variation across individuals in the presence or type of coverage.

[8] 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. Kadiyala and Strumpf (2012) find a substantial increase in cancer detection at age 65, most of which is among cancers with established screening tests.

The 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.[9] 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 2012; Schmidt 2007; Bundorf, Henne, and Baker 2007; Buckles 2008; and others), mental health parity (Pacula and 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; Almond and Doyle 2011; and others) 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 and subsequent health outcomes. 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.

---

[9] Indeed, public health studies of 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."

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 (Buchmueller et al. 2007, and others). 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. 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. In an alternative calculation, Medical Expenditure Panel Survey (MEPS) data finds that 72% of adults 18–64 had private coverage in 2000, while 8% 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% were at firms which offered health insurance. At firms which offered insurance, 64% of employees were enrolled in health insurance, and of those enrolled, 48% 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-.48) * .64 *.89 = .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 * .72 = .213).

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.[10] Sullivan and Rice (1991), for example, report that the Health Insurance Association of America (HIAA) employer benefits survey 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) coverage increased substantially over the 1990s, such that private insurance mammography benefits were 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)[11]—why weren't all employers and health plans covering these

[10] 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 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).

[11] 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.

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 and the USPSTF recommends biennial screenings for women 50 and older. 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 is screening mammography. And, even though the direct costs of the actual screening are fairly low, the subsequent costs associated with a positive screening—diagnostic mammography, biopsy, chemotherapy, mastectomy, and other cancer treatments—can be much larger. Like many screening tests, mammograms have a high false 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 and 0.7 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.[12]

4. Research Design, Data Description, and Empirical Approach

[12] 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.

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

This DD approach could still be problematic if there were time-varying factors that were correlated with the timing of adoption of mammography mandates across states. For example, HMO penetration increased over this time period in a way that could plausibly be correlated with policy adoption and it is generally believed that HMOs are particularly good at increasing use of preventive services. Alternatively, states could have engaged in public outreach efforts that corresponded with the timing of the mandates. In each of these cases, standard state and year fixed-effects models might still return biased estimates of the effects of mammography mandates on outcomes.

Fortunately, our policy setting 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, the extent to which mammography was being used as a quality measure in health plans, 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. 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.

Our main data on mammography screening 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 tests we focus on the subset of states in a balanced panel.[13] Our analysis focuses on the period 1987-2000; 42 states adopted or changed mandates over this period. We stop our sample in 2000 because there was a significant change in reimbursement by Medicare for digital mammography in 2000 which appears to have led to widespread diffusion of the more expensive technology (Fenton et al., 2010). Also, 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]

---

[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 are: 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 in 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

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 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 and zero otherwise. 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

---

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 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.

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. 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 effects of the mandates 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, 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)$_{ast}$ + $\beta_5 Z_{st} + \beta_6 S_s{*}A_a + \beta_7 T_t{*}A_a + \beta_8 S_s{*}T_t + \varepsilon_{iast}$

[17] One might be concerned that this "any health care coverage" measure is picking up some women who have Medicaid 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 age 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 age 25-64, women with some college age 25-64, college graduates age 25-64, and non-Hispanic white women age 25-64). For non-Hispanic blacks and Hispanics age 25-64, the relevant figure is above 75%. Even for high school dropouts age 25-64, 65% of those with any health coverage had private coverage.

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 dummies for 5-year age groups, race/Hispanic ethnicity, education, and marital status. The first three policy variables reflect the mammography mandates which vary at the age, state, and year level.[18] 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.[19] Thus for a state with the modal mandate, the baseline screening mammogram law dummy would be on for women age 35–39, the biennial screening mammogram law would be on for women age 40–49, and the annual screening mammogram law would be on for women age 50–64. In addition to the specification in equation (1) – which we refer to as the 'expanded mammography mandate' specification – we also estimate an 'any mammography mandate' specification that replaces the three policy variables (for baseline, biennial, and annual screening mandates) with a single policy variable that equals the Share of the Relevant Reference Window Treated by Any Mammography Mandate. This specification is otherwise identical to that reported in equation (1).

---

[18] 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. Note the BRFSS questions introduce a 'reference window' problem as they report use over a period stretching back across time; for details, see the Appendix. Briefly, each variable is the share of the window over which use is measured that the law was in effect.

[19] 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 the actual text of each state's laws by calling up individual records in SCLD. Discrepancies were discussed between the two authors.

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.[20] 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 variation in the laws. For the models without the state

[20] 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).

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 (to proxy for state infrastructure for women's health), 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 (either pilot or full) 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.[21]

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 of the federal health reform law says that mammograms

---

[21] Our information on state participation in the NBCCEDP program comes from personal correspondence with Janet Royalty at the CDC. 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. Our information on direct access laws comes from Baker and Chan (2007). 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.

satisfying the USPSTF guidelines from 2002 (mammograms every 1-2 years for women 40 and older) must be covered for non-grandfathered plans without cost-sharing of any kind. 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 deductibles should be more meaningful for them).

5. 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 targeted 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 increase in recent mammography use for women age 25 to 34 years old. Second, there was a noticeable increase 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 in part 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.

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 – that is, the vertical distance between the lines for 1994 and 2000 at ages 50-64 is large – 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.

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.[22] 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" policy variables that take into account the reference windows for past year outcomes. We find that over half of our sample (50.9

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

percent) is treated by the 'any mammography mandate' for one of 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 (27.8 of the 50.9 percent), and the vast majority of the laws are 'cover' mandates requiring benefits be included and not 'offer' mandates (not shown in table). Finally, we show that a nontrivial proportion of women in our sample are subject to mandates that explicitly prohibit deductibles for obtaining a mammogram; nearly 6 percent (2.8/50.9) of the mandates prohibit deductibles.

We present the first set of regression results in Table 2 for the Mammogram in the Past Year outcome. Each column of each panel is from a separate model. We present coefficient estimates on the key mandate variables of interest, and in each column we add successively more controls. We present results for the 'any mammography mandate' specification in the top panel, and we present results for the 'expanded mammography mandate' specification in the bottom panel. 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 and the state economic and demographic variables, as well as the remaining policies in the Z vector. Column 3 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 4 adds state by age group, year by age group, and state by year fixed effects and is the fully saturated DDD model.

The results in column 1 of Table 2 indicate that there is a strong raw association between mammography mandates (measured either as in the 'any' specification or as in the expanded specification) and the probability that a woman age 25–64 reports having had a mammogram in the past year. For example, we estimate that the presence of any mammography mandate in the top panel of column 1 is associated with a 4.4 percentage point increase in the probability of past year mammography screening. In the bottom panel we find that 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 column 2 we find that these relationships are largely unchanged when we control for other individual and state demographic characteristics and other state policies. In column 3 we control for unrestricted state and year fixed effects (and month fixed effects), and the magnitudes of the coefficient estimates fall substantially for every policy variable in both the top and bottom panels, though the coefficients on the biennial and annual mammography mandates remain statistically significant in the expanded specification in the bottom panel.

Turning to our preferred augmented DDD model in column 4 with a full set of two-way interactions for age, state, and year, we continue to find in the 'any mandate' specification in the top panel that mammography mandates significantly increase the likelihood of reporting a past year mammogram by 1.1 percentage points. For the expanded specification in the bottom panel, we 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.[23] 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

[23] If employers responded to the mandate by expanding insurance generosity for mammograms across women of all ages, not just those explicitly targeted in the laws (due to labor market competitiveness concerns, for example), this could also contribute to the fact that the DDD estimates are smaller than the associated DD-type estimates in column 4 of Table 2. This is an interesting area for future work with employer data.

mammography rates among women whose policies are directly covered by the laws (treatment effect on the treated), then, is closer to 4.5 percentage points. The coefficients on the other mammography mandates are notably substantially smaller and insignificant in the DDD specification.[24]

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.

How much of the increase in screenings over this time period can the mandates explain? 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).

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] We also report results from the preferred 'expanded mammography mandate' specification except when exploring detail about prohibitions on deductibles. These results are shown in Table 3 (which in column 1 reprints the DDD results for past year mammography from column 4 of Table 2). In column 2, we estimate that mandates for annual and biennial mammography screening increase past two-year mammography rates by approximately 2 and 2.4 percentage points, and these

---

[24] Coefficients on the demographic controls for the preferred DDD specification generally have the expected signs. Older women are more likely to be screened. Women with low education are less likely to be screened than those with more education. Married women are more likely than others to be screened. Conditional on all of these things plus the various interactions, Hispanics and black non-Hispanics are more likely than white non-Hispanics to report being screened.

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

effects are statistically significant at the 5% and 10% levels, respectively. 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 2.1 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 whether mammography is a covered insurance benefit. We begin by ruling out a change in health plan coverage, 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 health plan' 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

[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 small share of screenings result in diagnostic mammograms.

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 plan 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 mammography rates of 2.2 percentage points. As expected, we do not find that mandates significantly increased utilization rates among women without a health plan (results in column 3).[28]

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

[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 4 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.

[28] We cannot statistically reject equality of the estimates in columns 2 and 3 of Table 4, however. The p-value is 0.133.

other than mammography screening for breast cancer.[29] 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).[30]

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; and 3) separately considering cover from offer mandates (whereby cover mandates have larger and more precisely estimated effects)[31]. We also performed other

[29] Bitler and Carpenter (2012) examine the effects of similar mandates requiring insurance coverage of Pap tests in a difference-in-differences framework and find evidence that they significantly increased Pap test use, reducing the share of women who had never been screened by 16%. 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. The results discussed here include the full sample of years each outcome was measured.

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

[31] 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 much 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 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 50.9 percent; 46 percent of these are cover mandates.

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. The appendix also contains results by race/ethnicity and by education; we find significant mandate effects for white non-Hispanic women and for women with less than a high school degree. Estimates for other groups are positive but not consistently significant.

Next we present evidence on the effectiveness of provisions in several state mandates that prohibit insurance companies from charging deductibles to women for obtaining mammograms. This type of provision is very similar to one in recently adopted federal health reform, which prohibits all out of pocket costs for eligible individuals obtaining certain preventive health services recommended by the USPSTF, including mammograms. Do mammography mandates that prohibit use of deductibles 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) but also including 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 6 we find evidence that these provisions matter, particularly for women with low levels of education. For the full sample in column 1 we estimate a positive but statistically insignificant main effect and interaction coefficient. In 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 positive but insignificant main effect of mandates for annual mammograms (p=.108), there is also a statistically 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 with a high school degree in column 3 we also estimate positive interaction coefficients, though the coefficient is not statistically significant. In results not reported, these patterns also held when we restricted attention to women with a health plan (and by education) and when we split the mandate variable by frequency of screening covered. These results suggest that similar rules in federal health reform are likely to further increase screening among low-SES women with health insurance coverage.

Finally, we provide evidence on the effects of the mandates on breast cancer diagnoses. If screening of asymptomatic women were effective, we would expect to see that the mandate-induced mammograms led to breast cancers being ‘caught’ or diagnosed at earlier stages than would otherwise occur in the absence of screening. To test this, we examine breast cancer diagnoses at various stages using data from the Surveillance Epidemiology and End Results (SEER) system, which is registry data on the universe of breast cancer diagnoses within nine areas/states that has been collected since 1973. These are the standard cancer diagnosis data used in the field. Returning to the bottom panel in Table 1, we report the overall and age group specific diagnosis prevalence rates per 100,000 women for all diagnoses and for diagnoses by various stages (in-situ, local, regional, and distant). The age gradient in diagnoses is clear from the patterns by age group. While the rate is only 18 per 100,000 for women 25-34, it is 351 per 100,000 for women 50-64.

We use Poisson count data models to estimate similarly specified DDD models of the effects of mandates, assuming a 1 month delay between initial screening and diagnosis, and we control for population as an additional independent variable.[32] These results are presented in Table 7 which follows the format of Table 2 and presents results for both the 'any mammography mandate' specification (top panel) and the 'expanded mammography mandate' specification (bottom panel). We present both the coefficient on the key mandate variables and the relevant marginal effects. The marginal effects for the detailed specifications are calculated setting the other two mandate variables to zero.

The results in Table 7 indicate that the mandates led to significant reductions in diagnoses of the latest-stage 'distant' cancers and an increase in detection and diagnosis of the earliest stage 'in-situ' cancers. For example, in the 'any mandate' specification in the top panel of Table 7 we estimate that a mammography mandate significantly increased early stage 'in-situ' cancer diagnoses by 1.05 off a pre-mandate base of 4.71, or a 22.3 percent increase. We also estimate a corresponding significant decrease in late-stage 'distant' cancers of about 43 percent (.67 reduction off a pre-mandate base of 1.55), and sizable but insignificant negative effects on localized cancers. Results for the expanded mandate specification in the bottom panel produce very similar patterns.[33]

---

[32] Note that we are estimating the Poisson models with a variance covariance matrix that allows arbitrary correlation within state, and thus does not impose the restriction that the mean and variance are the same (e.g., Wooldridge (2010), Chapter 18).

[33] One might wonder why we find an immediate decline in the distant diagnoses, as one would expect the increase in in-situ detection to precede any associated decline in distant diagnoses. However, as long as some share of the distant cancers would have developed relatively quickly from in-situ cancers, this pattern is plausible. Some cancer tumors can double in size in periods as

Notably, the effects of insurance mandates on total cancer diagnoses in column 1 of Table 7 are fairly precisely estimated zeros, suggesting that the mandates induced shifts in timing of diagnoses but no major changes to diagnosis rates overall.[34]

For several reasons, however, the overall welfare implications of these mandate-induced changes in cancer screening and detection are not unambiguous. First, the increase in screenings documented in Tables 2-6 is undoubtedly also associated with some increase in false positives that we cannot track with our BRFSS or SEER data, with associated possible harms. Second, some experts believe that a nontrivial share of the increased detection of in-situ cancers documented in Table 7 may not progress and might be treated unnecessarily.[35] Finally, we note that very few of the mandates that were adopted in the 1980s and 1990s (and that provide our key source of identifying variation) are consistent with the current age-based recommendations of the two leading medical organizations: the American Cancer Society and the United States Preventive Services Task Force (and those that are not consistent require coverage of more

---

short as 90 days. Thus, it is plausible that an increase in earlier screenings can lead to a decline in metastatic disease. See e.g., Michaelson et al. (1999) for a discussion of the tradeoff between screening times and the probability a tumor will become metastatic.

[34] Note that although we estimate significant proportional shifts in cancer detection induced by the mammography mandates, the total number of in-situ cancers that we estimate were detected due to the mandates is very small relative to the number of women who were screened due to the mandates. To see this, note that the pre-mandate rate of in-situ cancer was 15.2 per 100,000 women age 25-64, of which there are approximately 60 million in the United States. This implies there were approximately 9,120 in-situ cancers detected prior to mammography mandates. We estimate that mandates increased the detection of in-situ cancers by 22.3 percent, resulting in 2,034 new in-situ cancers detected due to the mandates. Above we estimated that approximately 960,000 women obtained a mammogram due to the mandates. Thus, the total number of mandate-induced in-situ diagnoses is a very small proportion (2,034/960,000=0.2%) of the total number of mandate-induced screenings.

[35] 'In-situ' refers both to ductal carcimona in situ (DCIS) and to the less common lobular carcinoma in situ (LCIS). For example, Erbas et al. (2006) discuss uncertainty about what share of DCIS tumors will progress to invasive breast cancer. Regarding uncertainty about LCIS, the American Cancer Society's "Breast Cancer Facts and Figures 2011-2012" report indicates that "many oncologists believe … that LCIS is not a true cancer, but an indicator of increased risk for developing invasive cancer in either breast" (p1).

frequent screenings). To the extent that these current recommendations reflect scientific understandings of the clinical appropriateness of mammography screening for asymptomatic women, this is an important consideration in any welfare calculation.

6. Conclusion

Our results suggest that state laws requiring private insurers to cover 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 a mandate requiring coverage of an annual mammogram significantly increased the likelihood a 25-64 year old woman reported getting screened in the past year by 1.6 percentage points. These results hold up to numerous validation checks and robustness analyses. Moreover, we show that mandates specifically prohibiting deductibles were particularly effective at increasing mammography screenings among low-educated women (the group for whom such provisions are most likely to matter). Finally, we demonstrate that the mandate-induced increases in mammography also led to important shifts in cancer detection: the laws significantly increased detection rates of the earliest stage in-situ breast cancers and decreased detection rates of the latest stage 'distant' cancers. These findings are consistent with mandate-induced mammograms catching breast cancers at earlier stages for otherwise asymptomatic women, though as we discuss above the overall welfare implications of these findings require more attention. We leave this important area for future work.

Given that nearly all states have already adopted mammography mandates, what are the public policy implications of our study in general and specifically with respect to the federal health reform? There are several. First, there is still wide variation in the ages of women who are targeted by these laws. Moreover, as noted above, 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. If a greater scientific consensus were to be reached regarding the most appropriate screening frequencies for women of different ages, policies could directly be amended to reflect those understandings.

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 the generosity of insurance coverage for mammography. Also, a minority of state mandates include provisions prohibiting insurance companies from imposing deductibles for obtaining a mammogram. Our estimates suggest that these deductible prohibitions led to an even larger increase in screenings for low-education women. Since federal health reform prohibits these out of pocket costs for any new or substantially revised private insurance plans, this further suggests potential for public policy to increase screening rates among low-SES women (for whom out of pocket costs are likely to be more salient).[36] Finally, it is highly plausible that people may not have

[36] We note that that copays and coinsurance can - and do - exist even in the presence of a provision whereby individuals do not have to meet the deductible before obtaining preventive services (which is true of 75-90 percent of workers with health insurance according to a 2009 Kaiser Family Foundation Annual Survey). Thus, the *total out-of-pocket costs* in a zero deductible plan for preventive health services might still be nontrivial. Since the federal health reform requires

known about the provision in federal health reform requiring no deductibles for preventive care (even if the provision existed), and the federal change (and earlier state changes) may have increased awareness of this coverage due to widespread news coverage about the provision and changes in how plans present information about coverage of preventive care. This too suggests a potential meaningful role for federal health reform to affect mammography screenings and breast cancer diagnosis outcomes, thus speaking to the relevance of this research.

---

zero out-of-pocket costs, not just elimination of deductibles, our results on cost-sharing remain highly relevant for predicting the likely effects of federal reform. For example, the Kaiser Family Foundation Survey for 2011 suggests 23% of workers faced changes in cost-sharing due to ACA, and 31% of workers were in plans which changed what services were considered preventative. This is relevant as ACA in addition to stating that preventive services must be covered without cost-sharing imposed explicit rules as to what services were preventive: those with a grade of B or higher from USPSTF.

REFERENCES

Adams, E., N. Breen, and P. Joski (2006). "Impact of the National Breast and Cervical Cancer Early Detection Program on Mammography and Pap Test Utilization Among White, Hispanic, and African American Women: 1996-2000," *Cancer*, 109(2 Supplement): 348-358.

Adams, E., C. Florence, K. Thorpe, E. Becker, and P. Joski (2003). "Female Cancer Screening, 1996-2000," *American Journal of Preventive Medicine*, 25(4): 301-307.

Albee, S., E. Blount, T. Lee, M. Litow, and M. Sturm. (2000) "Cost Impact Study of Mandated Benefits in Texas: Report # 1." Milliman & Robertson, Inc., for the Texas Department of Insurance. http://www.tdi.state.tx.us/reports/documents/benefits1_00.pdf accessed 3/9/2009.

Almond, D. and J.J. Doyle (2011). "After Midnight: A Regression Discontinuity Design in Length of Postpartum Hospital Stays," *American Economic Journal: Economic Policy*, 3(3): 1-34.

American Cancer Society (2008). "Chronological History of ACS Recommendations of Early Detection of Cancer," available at: http://www.cancer.org/docroot/PED/content/PED_2_3X_Chronological_History_of_ACS_Recommendations_on_Early_Detection_of_Cancer.asp accessed 10/31/2008.

American Cancer Society (2012). "Breast Cancer Facts & Figures 2011-2012." Atlanta, GA. Available at: http://www.cancer.org/acs/groups/content/@epidemiologysurveilance/documents/document/acspc-030975.pdf.

Baker, L. and J. Chan (2007). "Laws Requiring Health Plans to Provide Direct Access to Obstetricians and Gynecologists, and Use of Cancer Screening by Women," *Health Services Research*, 42(3): 990-1006.

Bastani, R., A. C. Marcus, and A. Hollatz-Brown (1991). "Screening Mammography Rates and Barriers to Use: A Los Angeles County Survey," *Preventive Medicine*, 20: 350-363.

Berry, DA, KA Cronin, SK Plevritis, DG Fryback, L Clarke, M Zelen, JS Mandelblatt, AY Yakovlev, DF Habbema, and EJ Feuer . (2005). "Effect of Screening and Adjuvant Therapy on Mortality from Breast Cancer," *New England Journal of Medicine*, 352(17): 1784-1792.

Bertrand, M., E. Duflo, and S. Mullainathan (2004). "How Much Should We Trust Difference-In-Differences Estimates?," *Quarterly Journal of Economics*, 119(1): 249-275.

Bitler, M. (2008). "Utilization of Infertility Treatments: The Effects of Insurance Mandates." Mimeo.

Bitler, M. and C. Carpenter (2012). "Effects of State Cervical Cancer Insurance Mandates on Pap Test Rates," working paper.

Bitler, M. and L. Schmidt (2012). "Utilization of Infertility Treatments: The Effects of Insurance Mandates." *Demography*.

Breen, N. and M. Brown (1994). "The Price of Mammography in the United States: Data from the National Survey of Mammography Facilities," *Milbank Quarterly*, 72(3): 431-450.

Brozan, N. (1986). "Cost of Mammography is a Major Deterrent," *The New York Times*, September 22, 1986.

Buchmueller, T., P. Cooper, M. Jacobson, and S. Zuvekas (2007). "Parity for Whom? Exemptions and the Extent of State Mental Health parity Legislation," *Health Affairs*, 26(4): 483-487.

Buckles, Kasey. (2007). "Stopping the Biological Clock: Infertility Treatments and the Career-Family Tradeoff." Mimeo.

Bundorf, M. Kate, Melinda Henne, and Laurence Baker. (2007). "Mandated Health Insurance Benefits and the Utilization and Outcomes of Infertility Treatments." NBER WP 12820.

Bunce, V. and J. Wieske (2008). "Health Insurance Mandates in the States 2008" report from Council for Affordable Health Insurance available at: http://www.cahi.org/cahi_contents/resources/pdf/HealthInsuranceMandates2008.pdf accessed 10/31/2008.

Butler, P (2000). *ERISA Preemption Manual for State Health Policy Makers*. Washington, DC, Kaiser Family Foundation.

Busch, S. and C. Barry (2008). "New Evidence on the Effects of State Mental Health Mandates," *Inquiry*, 45: 308-322.

Centers for Disease Control (2001). "State Laws Relating to Breast Cancer," available at: http://www.cdc.gov/Cancer/breast/pdf/BCLaws.PDF accessed 10/31/2008.

Cutler, D. (2008). "Are We Finally Winning the War on Cancer?" *Journal of Economic Perspectives*, 22(4): 3-26.

Dans, P. and A. Wright (1996). "Effect of a Legislative Mandate on Mammography Use and Coding Practices in Maryland," *Radiology*, 198: 647-660.

Erbas, B., E. Prevenzano, J. Armes, and D. Gertig (2006). "The Natural History of Ductal Carcinoma In Situ of the Breast: A Review." *Breast Cancer Research and Treatment*, 97(2): 135-44.

Fenton, J., S. Taplin, P. Carney, L. Abraham, E. Sicles, C. D'Orski, E. Berns, G. Cutter, E. Hendrick, W. Barlow, and J. Elmore (2007). "Influence of Computer-Aided Detection on Performance of Screening Mammography," *New England Journal of Medicine*, 356(14): 1399-1409.

Fenton, J., Foote, S., Green, P., and Baldwin, L.-M. (2010). "Diffusion of Computer-Aided Mammography after Mandated Medicare Coverage," *Archives of Internal Medicine*, 170(11): 987-989.

Finkelstein, Amy, Sarah Taubman, Bill Wright, Mira Bernstein, Jonathan Gruber, Joseph P. Newhouse, Heidi Allen, Katherine Baicker, and the Oregon Health Study Group (2011). "The Oregon Health Insurance Experiment: Evidence from the First Year," *Quarterly Journal of Economics*, forthcoming.

Gabel, J. and G. Jensen (1989). "The Price of State Mandated Benefits," *Inquiry*, 26(4): 419-31.

Gruber, J. (1994a). "The Incidence of Mandated Maternity Benefits," *American Economic Review*, 84(3): 622-641.

--- (1994b). "State Mandated Benefits and Employer Provided Insurance," *Journal of Public Economics*, 55(3): 433-464.

Harris, K., C. Carpenter, and Y. Bao (2006). "The Effects of State Parity Laws on the Use of Mental Health Care," *Medical Care*, 44(6): 499-505.

The Henry J. Kaiser Family Foundation and Health Research Educational Trust (1999). "Employer Health Benefits: 1999 Annual Survey" accessed online at: http://www.aone.org/hret/publications/content/1999.pdf.

Jensen, G. and J. Gabel (1992). "State Mandated Benefits and the Small Firm's Decision to Offer Insurance," *Journal of Regulatory Economics*, 4: 379-404.

Jensen, G. and M. Morrissey (1999). "Employer-Sponsored Health Insurance and Mandated Benefits Laws," *Milbank Quarterly*, 77(4): 425-59.

Kadiyala, S. and E. Strumpf (2011a). "How Effective is Population-Based Cancer Screening? Regression Discontinuity Estimates from the U.S. Guideline Screening Initiation Ages," SSRN working paper.

----- (2011b). "Are United States and Canadian Cancer Screening Rates Consistent with Guideline Information Regarding the Age of Screening Initiation?" *International Journal for Quality in Health Care*, 23(6): 611-620.

----- (2012). "How Does Health Insurance Impact Health? The Case of Medicare and Cancer Detection." SSRN working paper.

Kaiser Family Foundation and Health Research & Educational Trust (2011). "Employer Health Benefits: 2011 Annual Survey," available online at: http://ehbs.kff.org/?page=charts&id=2&sn=30&ch=2218.

--- (2009). "Employer Health Benefits: 2009 Annual Survey," available online at: http://ehbs.kff.org/pdf/2009/7936.pdf.

Kelaher, M. and J. Stellman (2000). "The Impact of Medicare Funding on the Use of Mammography Among Older Women: Implications for Improving Access to Screening," *Preventive Medicine*, 31: 658-664.

Kolstad, Jonathan and Amanda Kowalski (2010). "The Impact of Health Care Reform on Hospital and Preventive Care: Evidence from Massachusetts," *NBER Working Paper #16102.*

Liu, Z., W. Dow, and E. Norton (2004). "The Effect of Drive-Through Delivery Laws on Postpartum Length of Stay and Hospital Charges," *Journal of Health Economics*, 23(1): 129-155.

Lurie, Nicole, Willard G. Manning, Christine Peterson, George A. Goldberg, Charles A. Phelps, and Lee Lillard (1987). "Preventive Care: Do We Practice What We Preach?" *American Journal of Public Health*, 77(7): 801-804.

McKinney, M. and K. Marconi (1992). "Legislative Interventions to Increase Access to Screening Mammography," *Journal of Community Health*, 17(6): 333-349.

Manning, Willard, Joseph P. Newhouse, Naihua Duan, Emmett B. Keeler, and Arleen Leibowitz (1987). "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment," *American Economic Review*, 77(June): 251-277.

Michaelson, J., E. Halpern, and D. Kopans (1999). "Breast Cancer: Computer Simulation Method for Estimating Optimal Intervals for Screening." *Radiology* 212, 551-560.

Mor, V., and R. Shackleton (2005). "The Effects of State Mandated Coverage of Mammography," *Abstracts of the AcademyHealth Meetings*, 2005, available at: http://gateway.nlm.nih.gov/MeetingAbstracts/ma?f=103623574.html and through personal correspondence with V. Mor.

National Cancer Institute (2005). "State Laws Requiring Third-Party Payers to Offer or Provide Coverage for Screening Mammograms," table available at http://www.scld-nci.net/Data/mam_6_30_05.pdf accessed 10/31/2008.

Nelson, David, Shayne Bland, Eve Powell-Griner, Richard Klein, Henry Wells, Gary Hogelin, and James Marks, (2002), "State Trends in Health Risk Factors and Receipt of Clinical Preventive Services Among US Adults During the 1990s," *Journal of the American Medical Association*, 287(20): 2659-2667.

Pacula, R. and R. Sturm (2000). "Mental Health Parity Legislation: Much Ado About Nothing?," *Health Services Research*, 35(1Pt2): 263-275.

Pettibone, K. (2003). "Mandating Cancer Screening Reimbursement Coverage: Does it Improve Women's Rates of Breast and Cervical Cancer Screening Use?" *Abstracts of the AcademyHealth Meetings*, 2003, available at: http://gateway.nlm.nih.gov/MeetingAbstracts/ma?f=102275235.html.

Phillips, K. A., K. Kerlikowske, L. Baker, S. W., Chang, and M. L. Brown (1998). "Factors Associated with Women's Adherence to Mammography Screening Guidelines," *Health Services Research*, 33(1): 29-53.

Poplack, Steven, Patricia Carney, Julia Weiss, Linda Titus-Ernstoff, Martha Goodrich, and Anna Tosteson. (2005). "Screening Mammography: Costs and Use of Screening-Related Services." *Radiology* (234): 79–85.

Rathore, S., J. McGreevey, K. Schulman, and D. Atkins (2000). "Mandated Coverage for Cancer-Screening Services: Whose Guidelines Do States Follow?" *American Journal of Preventive Medicine*, 19(2): 71-78.

Schmidt, L (2007). "Effects of Infertility Insurance Mandates on Fertility," *Journal of Health Economics*, 26(3): 431-446.

Sullivan, C. and T. Rice (1991). "The Health Insurance Picture in 1990," *Health Affairs*, Summer (1991): 104-115.

Trivedi, A., W. Rakowski, and J. Ayanian (2008). "Effect of Cost Sharing on Screening Mammography in Medicare Health Plans," *The New England Journal of Medicine*, 358(4): 375-383.

Wang, Y. R., and M. V. Pauly (2003). "Difference in the Use of Preventive Services Between Fee-for-Service Plans and HMOs: Is More Better?" *American Journal of Managed Care*, 9: 293-301.

Warnecke, R., S. Sudman, T. Johnson, D. O'Rourke, A. Davis, and J. Jobe (1997). "Cognitive Aspects of Recalling and Reporting Health-related Events: Papanicolaou Smears, Clinical Breast Exams, and Mammograms," *American Journal of Epidemiology*, 146(11): 982-992.

Wooldridge, Jeffrey (2010). Econometric Analysis of Cross Section and Panel Data, Second Edition. MIT Press: Cambridge.

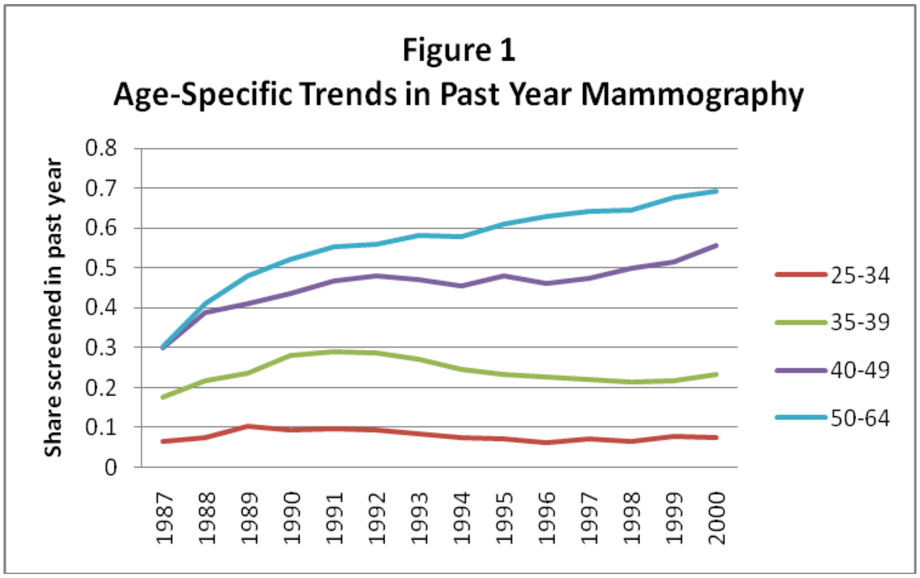

Figure 1 presents weighted mean share of women of various ages in pooled 1987-2000 BRFSS sample who report having had a mammogram in the previous year.

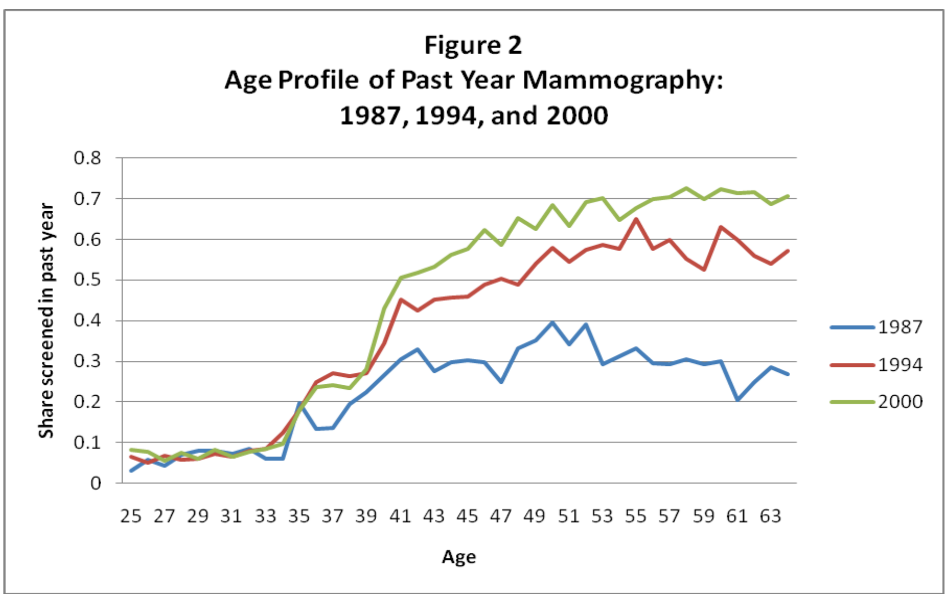

Figure 2 presents share of women of each age in pooled 1987-2000 BRFSS sample who report having had a mammogram in the previous year for survey years 1987, 1994, and 2000.

Table 1:
Descriptive Statistics
Mammogram Outcomes, Mandate Variables, and Breast Cancer Diagnosis Rates, BRFSS and SEER

Variable	All 25–64	Age 25–34	Age 35–39	Age 40–49	Age 50–64
BRFSS – Mammography Data					
Ever had mammogram	.550	.174	.459	.760	.817
Had mammogram w/in past year	.346	.080	.241	.469	.583
Had mamm. w/in past year & most recent was routine	.304	.058	.200	.416	.528
Had mamm. w/in past year & most recent was not routine	.042	.021	.041	.054	.056
Had mammogram w/in past 2 years	.451	.115	.344	.636	.709
Means of policy variables for past year outcomes:					
Share treated by any mandate	.509	.008	.686	.737	.747
Share treated by mandate for baseline screening	.095	0	.609	0	0
Share treated by mandate for biennial screening	.137	0	0	.517	0
Share treated by mandate for annual screening	.278	.008	.077	.220	.747
Share treated by any mandate prohibiting deductibles	.028	.006	.037	.038	.036
N – BRFSS	593737	170352	97610	162580	163195
SEER – Cancer Registry Data					
Diagnoses/100,000 women – all breast cancers with stage	157.7	17.9	70.3	190.6	350.6
In-situ breast cancer diagnosis rate per 100,000 women	27.1	1.6	9.5	37	59.2
Local breast cancer diagnosis rate per 100,000 women	78.4	8.2	32.1	89.5	182.1
Regional breast cancer diagnosis rate per 100,000 women	44.9	7.2	25.5	56.1	92
Distant breast cancer diagnosis rate per 100,000 women	7.4	1	3.2	8	17.2

Notes: Top panel: 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 mammogram w/in past year' does not exactly equal the sum of the variables 'Had mammogram w/in past year & most recent was routine' and 'Had mammogram w/in past year & most recent was not routine' because of a small amount of non-response to the question about the reason for the most recent mammogram. Bottom panel: author calculations from 1985-2000 SEER for 3456 age/race/state/year cells.

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 state policies for women's health	(2) (1) + Individual X's, State Z vector	(3) (2) + State, year, and month fixed effects	(4) (3) + all two-way interactions (DDD)
Any Mandate Specification				
Treated by any mammography	.044***	.042***	.027***	.011*
mandate	(.008)	(.006)	(.006)	(.006)
Adjusted R squared	.20	.21	.21	.22
N	591170	591170	591170	591170
Expanded Specification				
Treated by mandate for baseline	.027***	.019***	.009	-.009
mammogram	(.010)	(.007)	(.007)	(.009)
Treated by mandate for biennial	.044***	.045***	.026***	.018
mammogram	(.010)	(.008)	(.008)	(.011)
Treated by mandate for annual	.053***	.052***	.040***	.016**
mammogram	(.016)	(.011)	(.011)	(.006)
Adjusted R squared	.20	.21	.21	.22
N	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. Columns 2 adds controls for race/ethnicity, education, and marital status and 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 3 adds state, year, and month of interview fixed effects. Column 4 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 Models

Outcome is ➔	(1) Mammogram in past year (Table 2, column 4)	(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	.007	.010	.009
	(.009)	(.009)	(.009)	(.009)
Treated by mandate for biennial mammogram	.018	.024*	.019***	.021*
	(.011)	(.013)	(.007)	(.011)
Treated by mandate for annual mammogram	.016**	.020**	.013**	.021***
	(.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 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. In addition to controls for which coefficients are reported, additional controls in all models include: age groups dummies for being 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64; Pap test mandates; NBCEDPP pilot and full programs; laws mandating access to OB/GYNs; race/ethnicity; education; marital status; 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; share urban; share black; share Hispanic; state, year, and month of interview fixed effects; and 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 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 Models

	(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 (.007)	-.004 (.013)	.001 (.030)
Treated by mandate for biennial mammogram	.004 (.007)	.006 (.011)	-.008 (.020)
Treated by mandate for annual mammogram	.009 (.009)	.022** (.010)	-.017 (.024)
Adjusted R-squared	.11	.25	.11
N	503680	436086	67594

Notes: Each column shows the results from a separate DDD regression model. 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'. In addition to controls for which coefficients are reported, additional controls in all models include: age groups dummies for being 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64; Pap test mandates; NBCEDPP pilot and full programs; laws mandating access to OB/GYNs; race/ethnicity; education; marital status; 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; share urban; share black; share Hispanic; state, year, and month of interview fixed effects; and 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 5:
Mammography Mandates Did Not Affect Clinical Breast Exams (CBE) or Pap Tests
BRFSS 1987–2000, Adult Women 25–64, DDD Models

	(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	-.006	-.008
	(.013)	(.011)
Treated by mandate for biennial mammogram	.007	-.003
	(.008)	(.011)
Treated by mandate for annual mammogram	.007	.003
	(.009)	(.013)
Adjusted R-squared	.04	.05
N	534242	539200

Notes: Each column shows the results from a separate DDD regression model 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. In addition to controls for which coefficients are reported, additional controls in all models include: age groups dummies for being 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64; Pap test mandates; NBCEDPP pilot and full programs; laws mandating access to OB/GYNs; race/ethnicity; education; marital status; 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; share urban; share black; share Hispanic; state, year, and month of interview fixed effects; and 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 6:
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	.010 (.006)	.029 (.018)	.006 (.010)	.010 (.014)	-.002 (.012)
Treated by mandate for annual mammogram * mandate prohibits deductibles	.011 (.010)	.067*** (.016)	.023 (.014)	-.010 (.016)	-.007 (.015)
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. 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. In addition to controls for which coefficients are reported, additional controls in all models include: age groups dummies for being 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and 60–64; Pap test mandates; NBCEDPP pilot and full programs; laws mandating access to OB/GYNs; race/ethnicity; education; marital status; 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; share urban; share black; share Hispanic; state, year, and month of interview fixed effects; and state by age group, year by age group, and state by year fixed effects. 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. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted.

Table 7:
Mammography Mandates Led to Breast Cancers Being Detected at Earlier Stages
SEER9 1985-2000 DDD Poisson Models

	(1)	(2)	(3)	(4)	(5)
Outcome is: ➔	Total incidence	In situ incidence	Localized incidence	Regional incidence	Distant incidence
Any Mandate Specification					
Treated by any mammography mandate	-0.011	0.129**	-0.028	-0.007	-0.302**
	(0.034)	(0.057)	(0.044)	(0.043)	(0.128)
Average marginal effect, any mandate	-0.53	1.05**	-0.67	-0.09	-0.67**
	(1.64)	(0.47)	(1.03)	(0.58)	(0.28)
Pseudo R-squared	.86	.80	.84	.78	.59
N	3456	3456	3456	3456	3456
Expanded Specification					
Treated by mandate for baseline mammogram	0.003	0.144	-0.011	0.005	-0.304*
	(0.074)	(0.105)	(0.069)	(0.099)	(0.184)
Treated by mandate for biennial mammogram	0.041	0.173***	0.030	0.044	-0.225
	(0.049)	(0.052)	(0.061)	(0.054)	(0.183)
Treated by mandate for annual mammogram	-0.043	0.097	-0.062	-0.038	-0.333**
	(0.055)	(0.060)	(0.062)	(0.072)	(0.136)
Average marginal effect, mandate for baseline	0.16	1.10	-0.27	0.06	-0.78
	(3.52)	(0.79)	(1.65)	(1.34)	(0.51)
Average marginal effect, mandate for biennial	1.96	1.36***	0.72	0.60	-0.57
	(2.35)	(0.38)	(1.46)	(0.73)	(0.48)
Average marginal effect, mandate for annual	-2.01	0.75	-1.46	-0.51	-0.79**
	(2.59)	(0.46)	(1.47)	(0.97)	(0.34)
Pseudo R-squared	.86	.80	.84	.78	.59
N	3456	3456	3456	3456	3456

Notes: Each entry shows the coefficient from a separate regression model or the associated marginal effect. The dependent variable is the number of breast cancer diagnoses to women in various age groups using SEER 9 data. Though not shown, all models also include state by age group, state by year, and age group by year fixed effects, dummies for race, relevant populations of women in the age group. * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors throughout are clustered at the state level and estimates are weighted by the population of women. Marginal effects for the expanded specifications are evaluated setting the other mandate policies to zero.