Published in final edited form as:

Womens Health Issues. 2017 ; 27(6): 692–699. doi:10.1016/j.whi.2017.08.005.

When Guidelines Conflict: A Case Study of Mammography Screening Initiation in the 1990s

Mireille Jacobson and

Associate Professor Economics/Public Policy, Director Center for Health Care Management and Policy, UC Irvine, Paul Merage School of Business, Irvine, CA 92697

Srikanth Kadiyala

Full Economist, Rand Corporation, 1776 Main St., Santa Monica, CA 90401

I. Introduction

Background

In 2009, the United States Preventive Services Task Force (USPSTF) changed the recommended age to initiate mammogram screening in women of average risk from age 40 to age 50. Many high-profile organizations such as the American Cancer Society (ACS), American Medical Association, and the National Comprehensive Cancer Network continued to recommend screening initiation at age 40, leaving many women ages 40 to 49 confused about how to process the new recommendation. Adding further to the confusion, in 2016 The American Cancer Society switched its recommendation to age 45 while further recommending that women have the opportunity to start screening at age 40 if they so choose (Oeffinger, Fontham, Etzioni et al. 2015).

How might women respond to conflicting guidelines and recommendations from well-known, influential organizations such as the American Cancer Society and the United States Preventive Services Taskforce? One possibility is that patients with the aid of physicians weigh the tradeoffs between benefits (e.g., information on underlying disease status, reduction in anxiety and survival benefits) and harms (e.g. anxiety from false positives, the costs and negative health effects of additional testing due to false positives and overdiagnosis) at different ages. Then average-risk women who prefer earlier testing might converge on the age-40 or age-45 thresholds while those who prefer later testing might converge on the age-50 threshold. Such differentiation would generate multiple discrete increases in mammography test use, one at age 40, another at age 45 and yet another at age 50.

Alternatively, physicians, patients and policy-makers might decide that one recommendation is clearly superior, resulting in a single-age testing equilibrium: initiation at age 40, 45 or 50.

Both authors contributed equally to the manuscript

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Structural factors, such as malpractice standards, age-based cost-sharing rules, state guideline-based insurance mandates (Bitler and Carpenter 2016; Rathore et al. 2000) or public screening programs such as the National Breast and Cervical Cancer Early Detection Programs (NBCCEDP) (Bitler and Carpenter 2015) and individual factors such as income, may also contribute to convergence towards a single guideline.

While several recent papers have found that mammography patterns in women ages 40 to 49 have been relatively unchanged since the new USPSTF guidelines (Pace et al. 2013; Wang et al. 2014; Dehkordy et al. 2015; Wharam et al. 2015), these papers at most use data from 3 years after the guideline change.¹ The extent to which physicians and younger women will comply with the USPSTF's age 50 guideline in the future remains an open question. To provide insight into the question of longer-run responses to conflicting mammography screening recommendations and to better understand the results from these initial studies, we analyze another period of conflicting guidelines in the United States. Between 1984 and 2002, the mammography screening initiation age was hotly debated and, guidelines from organizations such as the ACS and USPSTF conflicted. During this period, the ACS and other organizations recommended initiating mammography screening at age 40 while the USPSTF recommended initiating at age 50.

Why might analyses of data from the earlier period be informative? First, clinicians' beliefs about the effectiveness of mammography screening for women in their 40s have changed relatively little over time. In a 1989 survey of physicians, nearly 72% of physicians reported agreement with the ACS mammography guidelines (ACS 1990). Data from the mid-1990s found that relatively few surveyed physicians (8%) changed their practice in response to an NCI Statement of Evidence recommending against routine screening between the ages of 40–49 (Klabunde, O'Malley and Kaluzny 1997). More recently, a survey of internal medicine (IM), family medicine (FM) and gynecology (GYN) physicians found that physicians in these specialties are more likely to recommend screening initiation at age 40 (65% IM, 64% FM, 92% GYN) than age 50 (Corbelli et al. 2014). And a 2014 survey of physicians found that 50.6% of physicians “strongly agree” and 44% of physicians “agree” that mammography screening is “effective” for women ages 40–49 (Miller et al. 2014).

These findings are important because clinicians' beliefs affect recommendations to patients, which in turn affect a patient's willingness to be tested (Schueler et al. 2008). A survey of women ages 40 to 49 about the pre-2002 guideline conflict found that most women viewed their personal physician as their primary source of information on mammography; about three quarters of women had discussed mammograms with their physician (Woloshin et al. 2000). Another survey found that despite the early guideline controversy, women reported that their physicians did not recommend delaying initiation to age 50 and that they themselves supported screening in their 40s (Aiken, Jackson, Lapin 1998).

Second, although physician beliefs have changed little, structural factors have increased over time to reinforce an age 40 testing equilibrium for insured women. Nearly all states currently

¹The most recent year of nationally representative data included in these set of papers is from the 2012 Behavioral Risk Factor Social Survey. Interestingly, Jiang et al. (2015) find that the 2009 USPSTF guideline led to a ~5% to 9% reduction in screening mammography utilization in the age 65+ Medicare population.

mandate that private insurers offer a mammography screening benefit, with the modal state requiring coverage of screening mammograms beginning at age 40 (Bitler and Carpenter 2016). The Affordable Care Act's exchange subsidies and individual health insurance mandate have served to increase the bite of these mammography screening mandates by increasing the uptake of private health insurance. Moreover, since September 23, 2010 the Affordable Care Act has required all non-grandfathered insurance plans cover screening mammograms with no cost-sharing for women beginning at age 40 (Mehta et al. 2015). In addition, many organizations, such as the Susan G. Komen Foundation and the American Breast Cancer Foundation routinely tout the benefits of mammography.

For these reasons, we hypothesize that lessons from the prior period of guideline conflict will be informative, particularly for insured women. Since insured women faced greater conflict among screening guidelines in the past, with fewer structural factors (such as the no cost-sharing requirement) to resolve this conflict compared to today, the pre-2002 period should have been ripe for multiple testing equilibria. To the extent that mammography screening among insured women was unresponsive during this earlier period, we hypothesize that it will be even less sensitive to conflicting guidance today. In other words, the early period should provide an upper bound on how age-based mammography initiation rates among insured women respond to current guideline conflicts.

In contrast, structural factors have been more stable for uninsured women. Since 1996, $\frac{3}{4}$ of federal funds for mammography screening of the uninsured have been directed to women ages 50 to 64 (Bitler and Carpenter 2015; Lee et al. 2014). Thus, we hypothesize that the test initiation response among uninsured women to the prior period of conflict should provide a good reflection of the likely response today.

Two important changes add some uncertainty to our comparisons over the two time periods. First, in contrast to the early to mid 1990s, a consensus currently exists regarding the positive mortality benefits from screening women in their 40s (Fletcher et al. 1993; Nelson et al. 2009). The widely accepted positive mortality benefit from initiating screening at age 40 should increase test use at younger ages compared to mammography utilization patterns in the 1990s. At the same time, there is currently more concern about the tradeoffs between the mortality benefits and the anxiety and unnecessary care due to false positives and overdiagnosis in women under age 50. Attention to these negative features of screening, might reduce test use. Despite this uncertainty, for the reasons described, the pre-2002 data should offer some insight into future responses to the current mammography testing debate and provide a greater understanding of the prior conflict period.

Mammography Screening Recommendations and Policies during the 1980s and 1990s

Numerous organizations have published recommended ages for the initiation of mammography screening since the 1980s. Arguably the two most important organizations are the American Cancer Society and the United States Preventive Services Task Force. We focus on recommendations from these organizations to understand the state of knowledge during the 1980s and 1990s. As shown in Table 1, the American Cancer Society (ACS) has been remarkably consistent in its age-based screening recommendations. As early as 1983 and continuing until quite recently, ACS recommended initiating mammography screening

for breast cancer for women at age 40 (ACS 1982; ACS 1983; ACS 1990). Only in October 2015 did the ACS switch its recommendation for screening initiation from age 40 to age 45, with the important caveat that women should have the opportunity to begin screening between the ages of 40 and 44 if they so choose. From 1982 to 1992 the ACS also recommended a baseline mammogram for women between the ages of 35–39².

The USPSTF first released its screening recommendations in 1989. Initially it recommended “mammography every one to two years... for all women beginning at age 50” but made no mention regarding the efficacy of mammography screening for younger women of average-risk. In 1996, the USPSTF again recommended routine mammography screening initiation at age 50 and specifically stated that there was “insufficient evidence to recommend for or against routine mammography... for women aged 40–49.” In 2002, the USPSTF changed their recommendation, lowering the mammography screening age threshold for average women from 50 to 40.

During the 1980s and 1990s, much like today, there was substantial public debate regarding the optimal age to begin regular mammography screenings. Notable events during this period include a National Cancer Institute (NCI) recommendation in 1993 against universal mammography screening beginning at age 40 (Eastman 1997) and an NIH consensus statement recommending informed decision-making as the correct course of action for mammography screening for women in their 40s (Ernster 1997). In 1997, the NCI modified its policy position, recommending mammogram screening for women ages 40–49 (ACS 1990; Eastman 1997). From 2002 to 2008, both the ACS and the USPSTF recommended mammography screening initiation at age 40.

State Policies and Programs Related to Mammograms during the 1980s and 1990s

We identified two state level policies during the 1990s that likely affected age-specific initiation of mammography screenings: state mandated private insurance cost-sharing rules and the National Breast and Cervical Cancer Early Detection Program (NBCCEDP). State health insurance mandates are binding for employees in non-self-insured plans, which in 1998 covered approximately 41 percent of employed workers (Fronstin 2012). In the 1990s forty-four states had mandates related to breast cancer screening, and as describe in detail in Rathore et al. (2000) 34 of these states based their mandate rules directly on the age 40 guideline set by the ACS. No states at the time set mandate rules similar to the USPSTF guidelines. Given the predominance of routine coverage at age 40 in mandates it is likely that non-mandated coverage also centered on age 40. To our knowledge, however, a comprehensive understanding of mammography cost-sharing policies in private health insurance plans that are not bound by state mandates (e.g., self-insured plans) is not available³.

Overall the implication of state coverage mandates is that, at a minimum, women in health insurance plans bound by state mandates experience a substantial reduction in

²ML Finkel (2005) notes that 10 other national organizations also recommended a baseline mammogram in the 1980s.

³Health insurance coverage thus serves as an imperfect marker for mammography coverage at age 40. Individuals with health insurance will still be significantly more likely to be covered for mammography than individuals without health insurance.

mammography cost-sharing precisely at age 40. This, in turn, suggests that guidelines conflicts as in 1989 and 2009, likely will have differential effects for women with and without health insurance.⁴ Adding to this possibility, in 1996, after the USPSTF reiterated its recommendation for biennial mammography screening beginning at age 50, the NBCCEDP program instituted its “75/25 rule”, requiring that 75% of its mammography funding be for women ages 50 and older and no more than 25% be directed at women ages 40 to 49 (Bitler and Carpenter 2015; Ryerson et al. 2002; Lee et al. 2014). In short, conflicting screening guidelines in the 1990s led to conflicting coverage and funding requirements for insured versus uninsured women.

II. Methods

Study Data

We use data from the 1991–2008 Behavioral Risk Factor Social Surveys (BRFSS) to understand mammography behavior among women in the United States during and after the time period when there were dissenting recommendations.⁵ The BRFSS data ask individuals whether they ever received a mammogram and if so, the timing of their last mammogram (last year, last 2 years, etc.). We combine this test-use data with individual age to examine the relationship between age and mammography utilization rates within the past year. We weight the data to be representative of the population at the state level and aggregate data from each state by year to identify national estimates.⁶

Analyses

We start with graphical analyses of mammography utilization by age, plotting mean rates of mammography by age and time-period. We then formalize the graphical results via regression discontinuity analyses as in prior work in the academic literature (Kadiyala and Strumpf 2011; Dehkordy et al. 2015). The regression analyses test for a discrete increase in mammography testing at the guideline recommended initiation ages (GRIA) (age 40 and age 50) while allowing for a smooth age trend in test use that can vary across the recommended initiation ages. Specifically, we use the following simple regression discontinuity model (Lee and Lemieux, 2010):

$$Y_i = \alpha_0 + \alpha_1 \text{GRIA}_i + \alpha_2 \text{GRIA}_i * (\text{age}_i) + \alpha_3 (1 - \text{GRIA}_i) * (\text{age}_i) + \alpha_4 \text{Year}_i + e_i \quad (1)$$

⁴The size of the reduction of course depends on the particular health insurance plan someone is enrolled in. In a typical fee-for-service plan women can be expected to see an ~80% reduction in cost-sharing precisely at age 40. Comparatively individuals without health insurance, unless they receive aid from a program such as the NBCCEDP, will continue to pay the full price of the mammogram at age 40.

⁵Mammography questions are asked in the BRFSS starting in 1987, but health insurance status is only asked of respondents starting in 1991. For consistency across analyses, some of which focus on insurance status, we exclude the pre-1991 BRFSS data. Results (available upon request) that include the earlier years are nearly identical to those presented here.

⁶We use the yearly BRFSS weights as is for all the analyses. When combining BRFSS data years for analysis some BRFSS documentation suggests that BRFSS weights should be modified by the contribution of a given year's un-weighted observations to the total analysis sample. We tested the robustness of the results to this alternative weighting method, as well as without weighing. The results, which are reported in the appendix, are almost identical in magnitude and levels of statistical significance irrespective of the approach to three different weighting procedures: as is, modified based on unweighted sample contribution or unweighted.

where Y_i is a categorical variable that equals 1 if individual i received a mammogram in the last year and zero otherwise. $GRIA_i$ is a categorical variable that equals 1 if the age of the individual is equal to or greater than the recommended initiation ages and zero otherwise. The key two remaining two terms in the regression equation – $GRIA_i \cdot (age_i)$ and $(1 - GRIA_i) \cdot (age_i)$ – capture linear age-trends in mammography testing that are allowed to vary on either side of the GRIA⁷. In the above equation, α_1 is the key coefficient of interest and identifies any discrete increases in mammography testing for individuals in the GRIAs.

We estimate equation (1) using linear probability models; results from logistic regression models are virtually identical. We estimate separate regressions for the age-40 and age-50 guideline increase. In each case, we include all individuals within 5 years of the GRIA (35–44 or 45–54). The results are identical using larger bandwidths (e.g., 30–49 and 40–49) around the GRIAs. As an additional robustness check we adjust for individual characteristics including an individual's race (white-non Hispanic, black non-Hispanic, Hispanic, other), marital status (married, never married, divorced, widowed, couple), education level (less than high school, high school graduate, more than high school) and income (less than \$50,000, \$50,000–\$74,999, $\geq$ 75,000, Refused/Don't Know). A-priori, since individuals immediately on either side of the age thresholds should be similar on observable (and unobservable) characteristics that might be related to mammography utilization, one would expect that covariate adjustment to have no effect on the main coefficient of interest (α_1), although it should still increase the precision of the estimates. In all cases, we cluster the standard errors on age to account for any within group correlation in the error term (Lee and Lemieux, 2010).

We also examine whether lack of convergence among recommendations leads to multiple-age testing equilibria by insurance status. Price and mandate effects for the insured might lead to one testing equilibrium for the insured at age 40 since most state mandates require private insurers cover routine screening beginning at age 40 (Rathore et al. 2000; Bitler and Carpenter 2016). The NBCCEDP program may generate another testing equilibrium for the uninsured at age 50 given funding guidelines that favor women ages 50 and over (Bitler and Carpenter 2015). For the initial analyses, we combine all of the available data from 1991 to 2001 BRFSS data, the BRFSS data years in which there was disagreement regarding the age of screening initiation. We then examine the data separately by insurance status for the time period ranging from 1991 to 2001, the years in which information on insurance status is available. We also use the 2002–2008 BRFSS data to identify any potential responses to convergence in the ACS and USPSTF mammography screening recommendations. Finally, we analyze the data from the two time-periods together and formally test for any differential changes in test use at the guideline recommend ages over the two time periods.

III. Results

Figure 1 plots mammography test rates by age for all women ages 25 to 60, using the BRFSS data from 1991 to 2000.⁸ Over this time period, mammography test rates are

⁷In actuality the variable age is measured as a deviation from the GRIA (40 or 50), allowing us to interpret α_1 as the discontinuous change in outcome Y_i at the GRIA and makes the comparison between the RD graphs and tables easier.

relatively smooth between ages 25 to 34 but increase discretely at age 35, the age at which the ACS recommended baseline mammograms from 1982–1992, i.e., a prior period that, with the exception of 1992, is not in our sample period.⁹ Another smaller discrete jump in use appears at age 36, which given the 1-year look back period for the survey question likely captures an increase in baseline testing at age 35. Mammography rates continue to increase gradually until age 40, at which point they show the largest, discrete increase over the age 25 to 60 range. After another, smaller discrete increase at age 41, which again likely reflects the survey look-back period, mammography test use increases smoothly until age 50. At age 50, test use increases again by a small amount, after which point testing rates plateau.

We estimate the magnitude of these changes at the key age thresholds using equation 1. These results, which are shown in Table 2, are based on separate analyses of the age 40 and 50 GRIAs using 1991–2000 BRFSS data for the 35–44 and 45–54 age ranges, respectively. After adjusting for smooth increases in test use by age, the results show that test use increases discretely by 8.7 percentage points (Panel A, column 1) at the age 40 GRIA. By comparison, test use increases at the age 50 GRIA by only 1.6 percentage points (Panel B, column 1). Both of these estimates are statistically significant at the 5% level and statistically different from each other ($p < 0.001$). Regression models adjusting for race, marital status, income and education do not have any affect on the main coefficients of interest (column 2 in each panel). Based on these analyses of a period of conflicting guidelines, we conclude that physicians and patients converged primarily on the age 40 screening initiation guideline. We also find evidence that physicians and individuals are using the age 50 testing initiation recommendation in their decision-making, but the change in test utilization at age 50 is clearly dominated, in both absolute and relative terms, by the change at age 40.

Health Insurance

We next examine the age-mammography testing relationship, by insurance status. Figure 2 illustrates the age-mammography testing relationship separately for insured and uninsured individuals for the 1991–2000 BRFSS data years, and also plots the age-mammography relationship for the population as a whole. At every age after age 40, mammography test use for the uninsured is significantly lower than mammography test use for the insured. This gap is attributable primarily to the larger increase in test use for the insured at age 40. Interestingly, there is evidence of compliance with both age-based screening recommendations among uninsured individuals, as test use increases discretely at both ages 40 and 50 in the uninsured population. A similar, large increase at age 50 is not apparent for the insured group.

Estimating separate regression models by insurance status, we find a discontinuity of approximately 9.3 percentage points at age 40 and 1.4 percentage points at age 50 for the insured group (Table 2, column 3). Both of these estimates are statistically significant at the 5% level. For the uninsured group, we estimate large comparable discontinuities at both

⁸Starting in 2000 the BRFSS only asks questions regarding mammography every other year. Thus, the 2002–2008 analyses only include data from the 2002, 2004, 2006 and 2008 BRFSS data.

⁹We explore historical and current patterns in baseline mammogram use in greater detail in other work.

GRIAs, specifically a 4.3 percentage point increase in test use at age 40, which is less than 50% of the change for the insured, and a 6.3 percentage point increase at age 50 (Table 2, column 5). Both of these estimates are also statistically significant at the 5% level. Again, covariate adjustment has little to no effect on the main coefficients of interest (Table 2, columns 4 and 6).

Convergence of Recommendations in 2002

If divergence of recommendations leads to multiple-age testing equilibria, then one might expect that mammography discontinuities at age 50 for the uninsured and insured might decrease once recommendations converged to age 40 in 2002. In particular, if some of the uninsured discontinuity at age 50 is due to the NBCCDEP program and some due to the earlier age 50 USPSTF guideline, then this discontinuity should decrease in the 2002–2008 period.

Figure 3 plots test use from the BRFSS 2002–2008 data by age and separately for the uninsured, insured and both groups combined. In contrast to Figure 2, the increase in mammography utilization for the uninsured at age 50 is less striking. Mammography testing after age 50 barely rises above the pre-50 rate. Estimating a regression model (equation 1) using the 2002–2008 BRFSS data years (Table 3, column 5), we no longer find a discontinuity at age 50 for the uninsured (Coefficient = $-.001$); the estimated discontinuity at age 40 for the uninsured rises from 4.3 percentage points to 8.6 percentage points. Similarly, the mammography discontinuity at age 40 for the insured rises from 9.3 percentage points to 15.8 percentage points. Interestingly, we continue to find a small discontinuity in test use for the insured at age 50 (2 percentage points) suggesting that a small number of women are still responsive to the age 50 threshold even after the convergence of recommendations. As before, covariate adjustment has little impact on these estimates.

We can also explicitly test for convergence by analyzing information from all the BRFSS years (1991–2008) together using the following regression equation:

$$Y_i = \alpha_0 + \alpha_1 \text{GRIA}_i + \alpha_2 \text{Convergence}_i + \alpha_3 \text{GRIA}_i * \text{Convergence}_i + \alpha_4 \text{GRIA}_i * (\text{age}_i) + \alpha_5 (1 - \text{GRIA}_i) * (\text{age}_i) + \alpha_6 \text{Year}_i + e_i$$

(2)

In the above regression equation Convergence_i is a dummy variable for whether or not an observation is from the 2002 to 2008 period and the $\text{GRIA}_i * \text{Convergence}_i$ term captures the interaction between being in the convergence time period and being in the guideline recommended initiation age.¹⁰ Year represents a vector of year dummy variables. We analyze both the 35–44 samples and the 45–54 sample using the above regression equation separately and again by health insurance status. Convergence of recommendations should at

¹⁰Alternatively one can also include year as a linear term in the regression model. The α_3 coefficient is identical regardless of how the year variable is specified in the regressions.

a minimum imply a positive coefficient on the interaction term for the ages 35–44 sample and a negative coefficient on the interaction term for the ages 45–54 sample.

Table IV presents the results from the analyses of all the years combined. Consistent with analyses of the two separate time periods, we identify a substantial increase in the mammography discontinuity at age 40 over time. Specifically, we find an almost 9 percentage point increase in the discontinuity in the post convergence time period relative to the pre-2002 period. Similarly, we find an approximately 3 percentage point decline in the discontinuity at age 50 over time, implying that women moved away from testing at age 50. The magnitude of the decline at age 50 is similar for the insured and uninsured groups, although the uninsured coefficients (Table IV, Panel B, Columns 5,6) are only statistically significant at the 10% level. We also find large increases for the both the insured and uninsured in the mammography discontinuity at age 40 in the 2002–2008 time period relative to the 1991–2000 time period. While the changes for both groups are substantial, the change in the discontinuity for the insured group is again approximately 50% larger than the change in the discontinuity for the uninsured group, likely reflecting differences in the cost of screening at age 40 for the insured versus the uninsured.

IV. Discussion

What choices do physicians and patients make when recommendations regarding the age of screening initiation conflict? In the case of mammography during the 1990s, we find that despite conflicting recommendations, age 40 was the primary age for initiating routine mammography testing. In the period from 1991 to 2000, we find a large discrete 8.7 percentage point increase in mammography test use precisely at age 40 and a much smaller discrete 1.6 percentage point increase in mammography test utilization at age 50.

In contrast to a dominant single population-wide age-40 screening equilibrium, we found multiple-age testing equilibria among the uninsured population. From 1991 to 2000, rates of mammography testing among uninsured women increased discretely by 4.3 and 6.3 percentage points at both ages 40 and 50. An increase in testing at age 40 for the uninsured is consistent with physician offers and patient demand for testing being responsive to guideline age information; not simply to price. An increase in testing at age 50 for the uninsured is consistent with the NBCCDEP program's directing of funds to women ages 50 and over and also with physician and patient compliance with the age 50 GRIA.

Implications for Policy

What are the implications of these historical results for the current mammography debate and for future changes to mammography screening patterns in the U.S.? Data from a prior time period in which guidelines conflicted indicate that physicians and women preferred the age 40 screening recommendation. This preference can be seen most clearly in patterns for the uninsured, who increased mammography test use significantly at age 40, despite financial incentives favoring delay. Given changes in the structural factors that influence screening, the past experience described here and persistent policy factors suggest a continuation of screening initiation at ages below age 50, and specifically at age 40, all else equal.

The reasoning behind this conclusion is threefold. First, the large differential increase in mammography testing at age 40 for the insured relative to the uninsured in the 1990s suggests that for many women prices matter for take-up.¹¹ When the generosity of insurance coverage or the availability of public funds is age-based, the age of mammography screening initiation in the population will reflect this. Currently, all state insurance mandates from the 1990s remain in effect, with most requiring coverage of routine (biennial) screening starting at age 40. Thus, insured individuals continue to face a substantial price decrease precisely at age 40. A key unknown relates to the likelihood that the existing mandates are repealed or amended, which in turn might lead to insurers changing their cost-sharing policies for mammography. Historical experience suggests that state mandates and insurance benefits, once granted, are difficult to revoke. As a point of comparison, the ACS withdrew their recommendation for a baseline mammogram in 1992 and to our knowledge none of the state mandates calling for private insurers to cover a baseline mammogram at age 35 have been repealed.

Second, the recent increase in U.S. health insurance coverage, due largely in part to the Affordable Care Act's (ACA's) health insurance exchange subsidies (Carman, Eibner and Paddock, 2015), individual mandate and Medicaid expansions¹², will reduce the price of mammography at the age-40 GRIA for a large set of individuals and thus reinforce the existing age-40 equilibrium. Estimates indicate that approximately 1 million women in their 40s will have health insurance due to the ACA (Garrett and Gangopadhyaya 2016).

Third, the ACA's elimination of cost sharing in private insurance for screening mammograms beginning at age 40 is likely to further increase take up at age 40 (US DHHS 2010).¹³ All of these factors favor a continuation of initial screening at age 40 and, all else equal, a potential increase in screening at the age-40 GRIA.

V. Conclusion

How will age-mammography screening patterns evolve in a world where organizations such as the USPSTF and ACS disagree regarding the age of mammography initiation? Several research papers evaluating mammography patterns after the USTPSTF guidelines find few changes in mammography test use in younger women after 2009 (Pace et al. 2013; Wang et al. 2014; Dehkordy et al. 2015; Wharam et al. 2015). We provide further insight into this question and shed more light on these prior null findings by analyzing age and mammography testing patterns from an earlier time-period in U.S. history during which a nearly identical guideline conflict existed (1991–2000), as well as after guidelines converged (2002–2008). This earlier period of conflict is particularly interesting because fewer structural factors (e.g., the ACA's cost-sharing provisions) pushed women to a given testing

¹¹Trivedi et al. (2008) also find decreases in mammography screening due to cost-sharing in Medicare managed care plans.

¹²Under the ACA, states can receive a federal Medicaid match increase for covering USPSTF recommended screenings. Unlike private insurers, however, state Medicaid programs can choose to cover mammography beginning at age 40 or age 50. See <https://www.medicaid.gov/affordable-care-act/provisions/downloads/4106-faqs-clean.pdf>

¹³To compare, prior to 2010 a transition from being uninsured to fee-for-service health insurance plan reduced cost-sharing for a mammogram by approximately 80% at age 40. Given the existing mammography state health insurance mandates, the 2010 ACA provision will typically reduce cost-sharing for insured women who turn 40 by an additional 20%.

guideline. Thus, to the extent we find multiple testing equilibria in the early time period, it should serve as an upper bound on multiple testing equilibria in the future.

Mammography data from the earlier time period reveals that physicians and patients converged primarily on the age-40 screening guideline. We find more evidence for multiple-age testing equilibria in the uninsured population, possibly due to a NBCCEDP requirement that $\frac{3}{4}$ of all mammography funding go to women ages 50 and over. The much larger age-40 mammography testing discontinuity for the insured relative to uninsured women is consistent with the sharp reduction in insured plan cost-sharing at age 40, as well as the higher implicit price for uninsured women at age 40 relative to age 50 and above due to NBCCEDP funding. Data on the evolution of physician beliefs about the effectiveness of mammography in younger women, existing state mammography mandates, health insurance expansions under the ACA and prevention cost-sharing policy in the ACA further reinforce age 40 as the focal age of mammography screening initiation, despite guidelines that recommend otherwise. In short, the prior period suggests that despite the current conflict, age 40 will remain the modal age for mammography screening initiation.

Acknowledgments

We thank the referees for detailed feedback on the paper. This work was made possible by a grant from the National Cancer Institute, 1R01CA152043-01. All mistakes are our own.

References

- Aiken LS, Jackson KM, Lapin A. Mammography screening for women under 50: women's response to medical controversy and changing practice guidelines. *Women's Health*. 1998; 4(3):169–97. [PubMed: 9787648]
- American Cancer Society. Mammography 1982: A Statement of the American Cancer Society. *CA: a Cancer Journal for Clinicians*. 1982; 32(4):226–230. [PubMed: 6805868]
- American Cancer Society. Mammography guidelines 1983: background statement and update of cancer-related checkup guidelines for breast cancer detection in asymptomatic women age 40 to 49. *CA: a Cancer Journal for Clinicians*. 1983; 33(4)
- American Cancer Society. 1989 survey of physicians' attitudes and practices in early cancer detection. *CA: a Cancer Journal for Clinicians*. 1990; 40(2)
- Benard VB, Saraiya MS, Soman A, et al. Cancer Screening Practices Among Physicians in the National Breast and Cervical Cancer Early Detection Program. *J Women's Health*. 2011; 20(11): 1479–1485.
- Bitler MP, Carpenter C. Health Insurance Mandates, Mammography, and Breast Cancer Diagnoses. *AEJ: Economic Policy*. 2016; 8(3):39–68.
- Bitler, MP., Carpenter, C. New Evidence on the Effects of the National Breast and Cervical Cancer Early Detection Program. 2015 Aug. Working Paper
- Carman KG, Eibner C, Paddock SM. Trends in Health Insurance Enrollment, 2013–15. *Health Affairs*. 2015; 34(6):1–5.
- Corbelli J, Borrero S, Bonnema R, et al. Physician Adherence to U.S. Preventive Services Task Force Mammography Guidelines. *Women's Health Issues*. 2014; 24(3):e313–e319. [PubMed: 24794545]
- Dehkordy SF, Hall KS, Roach AL, et al. Trends in Breast Cancer Screening: Impact of U.S. Preventive Services Task Force Recommendations. *Am J Prev Med Online* April. 2015; 1
- Eastman P. NCI adopts new mammography screening guidelines for women. *J Natl Cancer Inst*. 1997; 89:538–9. [PubMed: 9106638]

- Ernster VL. Mammography screening for women aged 40 through 49—a guidelines saga and a clarion call for informed decision making. *Am J Public Health*. 1997; 87(7):1103–1106. [PubMed: 9240097]
- Finkel, ML. Understanding the mammography controversy. Westport, CT: Praeger; 2005.
- Fletcher SW, Black W, Harris R, Rimer BK. Report of the International Workshop on Screening for Breast Cancer. *J Natl Cancer Inst*. 1993; 85(20):1644–56. [PubMed: 8105098]
- Fronstin P. Self-Insured Health Plans: State Variation and Recent Trends by Firm Size. EBRI. 2012; 33(11)
- Garret, B., Gangopadhyaya, A. ACA Implementation-Monitoring and Tracking. Urban Institute; 2016. Who Gained health Insurance Coverage Under the ACA, and Where Do they Live?.
- Jiang M, Hughes DR, Duszak R. Screening Mammography Rates in the Medicare Population before and after the 2009 U.S. Preventive Services Task Force Guideline Change: An Interrupted Time Series Analysis. *Women's Health Issues*. 2015; 25(3):239–245. [PubMed: 25965155]
- Kadiyala S, Strumpf E. Are U.S. and Canadian Cancer Screening Rates Consistent with Guideline Recommendations with Respect to the Age of Screening Initiation? *International Journal for Quality in Health Care*. 2011; 23(6):611–620. [PubMed: 21890706]
- Klabunde CN, O'Malley MS, Kaluzny AD. Physicians' Reactions to Change in Recommendations for Mammography Screening. *Am J Prev Med*. 1997; 13(6):432–8. [PubMed: 9415788]
- Lee NC, Wong FL, Jamison PM, et al. Implementation of the National Breast and Cervical Cancer Early Detection Program. *Cancer*. 2014; 120(16):2540–2548. [PubMed: 25099896]
- Mehta SJ, Polsky D, Zhu J, et al. ACA-Mandated Elimination of Cost Sharing for Preventive Screening Has Had Limited Early Impact. *The American Journal of Managed Care*. 2015; 21(7): 511–517. [PubMed: 26247741]
- Miller JW, Baldwin LM, Matthews B. Physicians' beliefs about effectiveness of cancer screening tests: A national survey of family physicians, general internists, and obstetrician–gynecologists. *Preventive Medicine*. 2014; 69:37–42. [PubMed: 25038531]
- Nelson, HD., Tyne, K., Naik, A., et al. Screening for Breast Cancer: Systematic Evidence Review Update for the US Preventive Services Task Force. Rockville (MD): Agency for Healthcare Research and Quality (US); 2009 Nov. Evidence Syntheses, No 74 Available from: <http://www.ncbi.nlm.nih.gov/books/NBK36392/>
- Oeffinger KC, Fontham ETH, Etzioni R, et al. Breast Cancer Screening for Women at Average Risk: 2015 Guideline Update from the American Cancer Society. *JAMA*. 2015; 314(15):1599–1614. [PubMed: 26501536]
- Pace LE, He Y, Keating NL. Trends in mammography screening rates after publication of the 2009 US Preventive Services Task Force recommendations. *Cancer*. 2013; 119(14):2518–23. [PubMed: 23605683]
- Rathore SS, McGreevey JD 3rd, Schulman KA, Atkins D. Mandated coverage for cancer-screening services: whose guidelines do states follow? *American Journal of Preventive Medicine*. 2000; 19(2):71–8. [PubMed: 10913895]
- Ryerson, AB., Benard, VB., Major, AC. National Breast and Cervical Cancer Early Detection Program: 1991–2002 National Report. CDC US Department of Health and Human Services; 2002.
- Schueler KM, Chu PW, Smith-Bindman R. Factors associated with mammography utilization: a systematic quantitative review of the literature. *J Women's Health*. 2008; 17(9):1477–1498.
- Trivedi AN, Rakowski W, Ayaniana JZ. Effect of Cost Sharing on Screening Mammography in Medicare Health Plans. *N Engl J Med*. 2008; 358:375–383. [PubMed: 18216358]
- U.S. Dept of Health and Human Services. Sep 23. 2010 <http://www.hhs.gov/healthcare/facts-and-features/fact-sheets/preventive-services-covered-under-aca/> Web Accessed. 14 May 2016
- Wang AT, Fan J, Van Houten HK, et al. Impact of the 2009 US Preventive Services Task Force Guidelines on Screening Mammography Rates on Women in Their 40s. *PLOS One*. 2014
- Wharam FJ, Landon B, Zhang F, et al. Mammography Rates 3 Years After the 2009 US Preventive Services Task Force Guidelines Changes. *Journal of Clinical Oncology*. 2015; 33(9):1067–1079. [PubMed: 25667290]

Woloshin S, Schwartz LM, Byram SJ, Sox HC, Fischhoff B, Welch HG. Women's Understanding of the Mammography Screening Debate. *Archives of Internal Medicine*. 2000; 160:1434–1440. [PubMed: 10826455]

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Figure 1.
Age Profile of Past Year Mammography Testing (1991–2000)

Figure 2.

Age Profile of Past Year Mammography Testing by Insurance Status: 1991–2000

Figure 3.
Age Profile of Past Year Mammography Testing by Insurance Status: 2002–2008

Table 1

Age-based Recommendations for Initiating Routine Mammography Screening

	American Cancer Society	USPSTF
1983–2001	Age 40 (1983)	Age 50 (1989)
2002–2008	Age 40	Age 40 (2002)
2009–2014	Age 40	Age 50 (2009)
2015	Age 45 *	Age 50

Note:

* Although the ACS recommends that routine mammography screening start for women at age 45, they also recommend that women have the opportunity to be screened between the ages of 40–44 if they so choose.

Table 2

Mammography Testing in the Last Year at Age 40 and Age 50 (BRFSS Years 1991–2000)

Panel A. Increase at the Age 40 GRIA: Women Ages 35 to 44					
	All		Insured		Uninsured
Age 40 GRIA	0.087** (.014)	0.086** (.015)	0.093** (.017)	0.091** (.017)	0.043** (.015) 0.038** (.016)
Age Trend Below	0.02** (.004)	0.021** (.004)	0.023** (.004)	0.023** (.005)	0.007** (.004) 0.009 (.005)
Age Trend Above	0.026** (.004)	0.026** (.004)	0.028** (.004)	0.027** (.005)	0.014** (.004) 0.014** (.003)
Covariates Included	No	Yes	No	Yes	No Yes
N	160051	158704	138964	137841	20938 20727
Panel B. Increase at the Age 50 GRIA: Women Ages 45 to 54					
	All		Insured		Uninsured
Age 50 GRIA	0.016** (.005)	0.017** (.005)	0.014** (.004)	0.015** (.004)	0.063** (.010) 0.050** (.010)
Age Trend Below	0.016** (.001)	0.017** (.001)	0.016** (.001)	0.017** (.001)	0.007** (.001) 0.009** (.001)
Age Trend Above	0.009** (.001)	0.012** (.001)	0.011** (.001)	0.013** (.001)	−0.005 (.006) −0.002 (.007)
Covariates Included	No	Yes	No	Yes	No Yes
N	119480	118328	105564	104577	13821 13666

Notes: Data are for female respondents from the 1991–2000 BRFSS. All regression models contain dummy variables for year of data. Standard errors are clustered by age and provided in the parentheses. The covariates included in the regression models in columns 2, 4, and 6 are described in the text.

** signifies $p < .05$.

Table 3

Mammography Testing in the Last Year at Age 40 and Age 50 (BRFSS Years 2002–2008)

Panel A. Increase at the Age 40 GRIA: Women Ages 35 to 44				
	All	Insured	Uninsured	
Age 40 GRIA	0.148** (.020)	0.158** (.021)	0.159** (.022)	0.086** (.017)
Age Trend Below	0.022** (.004)	0.022** (.004)	0.024** (.005)	0.009** (.002)
Age Trend Above	0.039** (.006)	0.038** (.006)	0.041** (.006)	0.018** (.006)
Covariates Included	No	Yes	No	Yes
N	136679	135371	117102	19431
Panel B. Increase at the Age 50 GRIA: Women Ages 45 to 54				
	All	Insured	Uninsured	
Age 50 GRIA	0.015** (.004)	0.016** (.004)	0.020** (.004)	0.019** (.005)
Age Trend Below	0.009 (.001)	0.008** (.001)	0.007** (.002)	0.006** (.002)
Age Trend Above	0.007 (.001)	0.008** (.001)	0.007** (.0002)	0.008** (.0004)
Covariates Included	No	Yes	No	Yes
N	158732	156857	138222	20348
				20023

Notes: Results based on BRFSS data for female respondents from 2002–2008. All regression models contain dummy variables for survey. Standard errors are clustered by age and provided in the parentheses. The covariates included in the regression models in columns 2, 4, and 6 are described in the text.

** signifies $p < .05$.

Table IV

Mammography Testing in the Last Year at Age 40 and Age 50 (BRFSS Years 1991–2008)

Panel A. Increase at the Age 40 GRIA: Women Ages 35 to 44				
	All	Insured	Uninsured	
Age 40 GRIA	0.079** (.014)	0.084** (.016)	0.039** (.011)	0.034** (.012)
Age 40 GRIA * Converge	0.088** (.011)	0.096** (.012)	0.098** (.012)	0.055** (.013)
Covariates Included	No	Yes	No	Yes
N	296730	294075	40369	39919
Panel B. Increase at the Age 50 GRIA: Women Ages 45 to 54				
	All	Insured	Uninsured	
Age 50 GRIA	0.025** (.005)	0.027** (.006)	0.029** (.006)	0.044** (.009)
Age 50 GRIA * Converge	−0.027** (.007)	−0.030** (.008)	−0.037** (.009)	−0.031 (.017)
Covariates Included	No	Yes	No	Yes
N	278212	275185	241270	33689

Notes: Data are for female respondents from the 1991–2008 BRFSS. All regression models contain dummy variables for year of data. Standard errors are clustered by age and provided in the parentheses. The covariates included in the regression models in columns 2, 4, and 6 are described in the text.

**
*** signifies $p \leq .05$.