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The Long Term Effects of “Consumer-Directed” Health Plans on Preventive Care Use¹

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Abstract

“Consumer-Directed” Health Plans (CDHPs), those with high deductibles and personal medical accounts, have been shown to reduce health care spending. The impact of CDHPs on preventive care is unclear. On the one hand CDHPs might increase use of preventive care as such care is exempt from the deductible. However, CDHPs also decrease visits to physicians which might result in less screening. Prior research has found conflicting results. In this study, using data from 37 employers we examine the effects of CDHPs on the use of cancer screenings up to three years after the initial CDHP offering with ITT and LATE approaches. Being offered a CDHP or enrolling in a CDHP had little or no effect on cancer screening rates but individuals increase screenings prior to enrolling in a CDHP. Our findings suggest the importance of examining CDHP effects on periodic care over the longer-term and carefully controlling for anticipatory stockpiling.

1. Introduction

Enrollment in consumer-directed health plans (CDHPs), health plans with high deductibles and tax-advantaged medical savings accounts, is increasing rapidly. In 2015 20 percent of workers with employer-sponsored insurance were enrolled in CDHPs and CDHPs are the dominant type of plan offered on the federal health insurance exchange (KFF & HERT 2016). While CDHPs have been shown to reduce health care costs and some attribute the recent slowdown in health care cost growth in part to increasing popularity of CDHPs

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(Cutler et al. 2013; Haviland et al. 2012) the mechanism by which CDHPs decrease spending remains controversial (Haviland et al. 2016; Sinaiko et al. 2016; Sood et al. 2013; Haviland et al. 2011).

The concern is that those who enroll in CDHPs indiscriminately use less care, avoiding care that is unnecessary (low-value care) but also reducing care that is beneficial (high-value care). Among the range of high-value services, there has been particular interest in the impact of CDHPs on use of preventive care (Maciosek et al. 2006). To deter the negative impact of cost sharing on preventive care, CDHPs exempt preventive care from the deductible and therefore CDHP enrollees face no out-of-pocket costs for preventive screening, even prior to the Affordable Care Act (ACA) mandate. However, many beneficiaries do not understand the nuance of their CDHP benefit design (Reed et al. 2012) and thus might erroneously think that they will pay for preventive services. Also, the out-of-pocket costs of office visits are higher for CDHP enrollees. Fewer office visits might translate into fewer physician referrals for preventive services. Additionally, the longer-term impacts of CDHPs on preventive care might differ from short-term effects. Over time CDHP enrollees might better understand their benefit design—specifically, that preventive services are not subject to the deductible. In this scenario, any negative impact of CDHPs on preventive care may be mitigated over time.

This study estimates the effects of CDHPs on cancer screenings over three years. We use 2004–2007 data from 37 large US firms, 12 of which offered a CDHP in 2005 and 25 which never offered a CDHP during this time period. We estimate changes in cancer screenings among firms that began offering a CDHP in 2005 to other firms only offering traditional plans. On the one hand, the CDHPs in our sample cover preventive services without cost sharing, unlike most traditional plans during this time period. On the other hand, CDHP enrollees must pay the full price of doctor visits before reaching the deductible where traditional plan enrollees may just be responsible for a copayment, which may reduce screenings. We add to this literature in several important ways. First, we study a large number of employers, with varying degrees of CDHP takeup, who offered hundreds of different plans from many insurance carriers. We believe our results are more broadly generalizable than prior studies that focused on a single firm or carrier. Second, in contrast to prior studies which have focused on just one or two year effects, we estimate effects up to three years post CDHP offer. These longer-term estimates are key to understanding how consumers interact with preventive care when enrolled in CDHPs given that most screenings are not recommended every year.

The key empirical challenge in this study is selection into CDHPs. While we are able to establish that CDHP offer is plausibly orthogonal to preventive care demand, it is possible that enrollees are still endogenously choosing to enroll into these plans. To minimize the impact of this unobservable bias on our estimates, we estimate the effect of being *offered* a CDHP (exogenous intent-to-treat effect) (Haviland et al. 2016) and the *causal effect of enrolling* in a CDHP (exogenous local average treatment effect) (Finkelstein et al. 2012) by instrumenting CDHP enrollment in at least one of the three post years with CDHP offer.

A second empirical challenge in this literature is dealing with the impact of anticipatory care prior to CDHP enrollment. Individuals know of the impending switch into a CDHP and may be wary about the out-of-pocket costs associated with preventive care. In the face of this uncertainty, these individuals may schedule and complete their preventive care directly before they enroll in the CDHP. This “stockpiling of care” before CDHP enrollment has been observed for outpatient care (Brot-Goldberg et al. 2017) and chronic illness prescription drugs (Huckfeldt et al. 2015). To understand how the stockpiling of care affects our estimate of a treatment effect, we take three different approaches. First, we investigate the effect of *actual enrollment* in a CDHP, by examining differences in screening rates after the CDHP takes effect. Second, we investigate changes in behavior *prior* to enrollment in a CDHP (consistent with stockpiling), by examining differences in screening rates after the enrollment decision is made in the fourth quarter of the pre-year. Third, we estimate the effects of CDHP enrollment on screening rates adjusting for potential stockpiling, by examining differences in screening rates starting in the second quarter of the first post year.

In contrast to prior literature, we find little evidence that CDHP enrollment is associated with decreased cancer screenings three years after CDHP offer. This result is robust to various specifications, alternative measures of CDHP exposure, definitions of appropriate post period, alternative patient inclusion criteria, and alternative firm inclusion criteria. We find significant reductions among similar, non-preventive care utilization that was not subject to deductible carve outs. To investigate the null-result, we explore three possible sub group analyses: differences among those less likely to see any physician, differences among those with larger deductible changes, and differences across age. The remainder of this paper proceeds as follows: in section two we briefly summarize the prior literature, in section three, we describe our data, section four outlines our econometric specifications, section five reports the results, and section six concludes.

2. Related Literature

The evidence on the effects of CDHPs on use of preventive care is decidedly mixed and excellently summarized in two recent research syntheses (Bundorf 2016; Bundorf 2013). Here, we will briefly summarize the relevant work from Bundorf’s reviews.

A number of prior papers has found no difference among CDHP enrollees in cancer screening rates (Rowe et al. 2008; Wharam et al. 2008; Wharam et al. 2012). Fronstin et al. (2013) found a decrease in the first year after enrollment, but no effect after year two. The majority of studies have found a sustained decrease in cancer screening rates (Buntin et al. 2011; Haviland et al. 2011; Charlton 2011; Wharam et al. 2011; Brot-Goldberg et al. 2017). No studies, to our knowledge, have found an increase in cancer screening rates after CDHP enrollment, with the exception of Wharam et al. (2011) which found a slight increase in fecal occult blood testing. Fecal occult blood testing is an alternative to colonoscopy for colon cancer screening and the authors believe the increase in fecal occult blood testing is a substitution away from colonoscopy.

There are several potential reasons for these mixed results. One is that most of these studies use data from a single treatment employer (Fronstin et al. 2013; Brot-Goldberg et al. 2017)

or a single insurance carrier (Wharam et al. 2008; Wharam et al. 2011; Wharam et al. 2012; Fronstin et al. 2013; Brot-Goldeberg et al. 2017; Rowe et al. 2008; Charlton et al. 2011). Because of the small number of treated units, idiosyncratic changes may drive the results. For example, some studies (e.g. Charlton et al. 2011) included CDHP plans without preventive care carve outs and this first-dollar coverage of preventive care can increase utilization (Meeker et al. 2010).

Another explanation for the mixed literature is variation in identification strategies. All studies used a difference-in-difference specification but the plausible exogeneity of treatment differed across studies. About half used firms that fully replaced an existing traditional plan with a CDHP (Wharam et al. 2008; Wharam et al. 2011; Wharam et al. 2012; Fronstin et al. 2013; Brot-Goldeberg et al. 2017). While using a full replacement firm eliminates bias from individual-level selection into a CDHP, it does not account for firm level selection. Firms that choose to switch all their employees to CDHP might be unobservably different. Other studies used firms with a variety of take-up into a CDHP (Rowe et al. 2008; Buntin et al. 2011; Haviland et al. 2011; Charlton et al. 2011). Propensity score methods were used to mitigate bias from individual-selection into CDHPs but such methods cannot control for selection on unobservables.

A third explanation is variation in time horizons. Most studies examined screening differences after one or two years of CDHP enrollment (Wharam et al. 2008; Wharam et al. 2011; Wharam et al. 2012; Buntin et al. 2011; Haviland et al. 2011; Charlton et al. 2011; Brot-Goldeberg et al. 2017). Rowe et al. (2008) followed enrollees for three years, but lacked a baseline pre-year for CDHP enrollees. Fronstin et al. (2013) studied individuals up to four years after enrollment but included only one treatment firm. Given that many preventive screenings are only recommended on a periodic basis (and that enrollees may learn about benefit design over time), it is important to consider a longer period following enrollment. Furthermore, most studies (except Brot-Goldeberg et al. 2017) do not account for any anticipatory stockpiling of care in the period immediately prior to CDHP enrollment.

We contribute to this literature in four key ways. First, we include individuals from many large U.S. firms, with a variety of CDHP designs, representing hundreds of different health plan products from multiple carriers. Second, we estimate the intent-to-treat and local average treatment effects, avoiding some of the identification challenges outlined above. Third, we analyze enrollee screening behavior for three years after CDHP offer, with alternate definitions of what constitutes the post period to examine anticipatory effects. Lastly, we investigate subgroup analyses driving the effects any effects we observe.

3. Data

The data was constructed specifically to study CDHPs across a range of employers with different plan types and geographic areas. The data is described in detail in previous work (Haviland et al. 2016). The 37 employers were chosen in two ways. The first group includes 12 employers that were identified and recruited to join the study because they reported offering a CDHP for the first time in 2005. These employers continued to offer a CDHP through the end of the study period. These employers were clients of Towers Watson and

were selected to include a range of CDHP benefit designs, proportions of employees enrolling in those CDHPs, geographic regions, and industries. Not all employees in the treatment sample enrolled in a CDHP. For those that are enrolled in a CDHP, the sample includes some individuals with health savings accounts (HSA) and others with health reimbursement accounts (HRA). HSAs, the more commonly used accounts in current CDHPs (KFF and HERT 2015) are similar to a 401(k) retirement plan. The enrollee owns the account balance and can roll it over from year to year. Health reimbursement accounts (or HRAs) are set up and owned by the employer and may not roll over from year to year. The remaining 25 employers were selected from employers contributing to the MarketScan data product produced then by Thomson Reuters, now maintained by Truven Health Analytics, and represent a variety of geographic regions, employer size, and industries.

Across all 37 employers in our sample, the data include enrollment and claims data from 2004 through 2007 supplemented by detailed information on insurance benefit design and geocoded socio-demographic information.

We make two key sample restrictions. First, in order to study preventive care utilization over a longer time frame, we restrict our sample to those individuals who are continuously employed by the same firm for four years. Given that the screenings we are studying are not recommended every year (USPSTF 2014), it is imperative that we observe the same individuals over time. While this might introduce a source of bias if employee turnover is in some way correlated with firm level CDHP adoption and preventive care utilization, we do not believe it is an issue in this analysis as those continuously employed for one year versus four years do not have significantly different observable characteristics (Appendix Table A1). The second sample restriction is limiting to those who, based on age and gender, are recommended for the screening in a given year. We use the Healthcare Effectiveness Data and Information Set (HEDIS) definitions (NCQA 2008) to identify populations that are eligible for each type of screening and there was no change in these HEDIS measures during our study period. The breast and cervical cancer screening samples are restricted to females and the breast, cervical, and colon cancer screening samples are restricted to those aged 40 and over, 18 and over, and 50 and over, respectively. After these restrictions, the sample includes all individuals employed at one of these firms, regardless of which plan they enroll in.

Our independent variables revolve around firm-level CDHP offer and individual enrollment. We define a CDHP as having a \$1,000 or greater deductible and a medical savings account). \$1,000 was chosen as it is the minimum statutory deductible for an HSA in the first year of our treatment data (2005). Our analyses use two key independent variables, one for the intent-to-treat (ITT) analysis and one for the local average treatment effect (LATE) analysis. When estimating the ITT effect, we use an indicator variable equal to one if the firm offered a CDHP in that year. All treatment employers have this indicator variable equal to one in 2005 and all years after 2005. Control employers have this variable equal to zero in all years. We define a firm as offering a CDHP in a given year if the firm reported offering a CDHP and more than 5% of their employees enrolled in a CDHP, following previous literature (Haviland et al. 2016). We use this cutoff to eliminate firms with very low take up (less than 3%) where a CDHP might not have been a genuine offering. In the LATE analysis, our key

independent variable is an indicator variable equal to one if the individual enrolls in a CDHP in at least one of the three post years (1st, 2nd, and/or 3rd). We focus on those who enroll in at least one of the three post years in order to minimize selection bias arising from plan switching during the post period. We instrument for this endogenous variable with the indicator variable for CDHP offer (more details on this instrumental variables strategy is detailed below in Section 4.3).

The dependent variables used were the receipt of three types of cancer screening among those in three analysis samples; those eligible for breast cancer, cervical cancer, and colon cancer screenings. We operationalize screening with an indicator for at least one screening in any of the three post years. We chose this binary outcome (instead of how many times screened in post period) because it provided a more straightforward measure and because the HEDIS measures capture screening once every three years for breast cancer, once every two years for cervical cancer, and once every ten years for colon cancer (if using colonoscopy which is the most common form of colon cancer screening) (USPSTF 2014; CDC 2013). Therefore, the vast majority of patients will only be eligible for screening once during the post period. In our sample, all CDHP enrollees had this first-dollar coverage.

We constructed individual level control variables from the enrollment and claims data, including: age (in the pre year), gender, family type, zip code level demographic and socio-economic characteristics, census region, and indicators for being in an MSA, employer industry, and indicator variables for having each of twenty five major diagnostic categories (MDC) (in the pre-year).

4. Methods

4.1 Overview of Methods

Our empirical strategy focuses on estimating the effect of CDHPs on preventive care utilization. The sample includes four years of data for each individual: one pre-year and three post years. In order to examine differences in screening rates across all three post years, the control group must exhibit the trend in the post period that the treatment group would have exhibited, absent treatment. We check this assumption by examining pre-year differences in screening rates in quarter one through quarter three (i.e. an identification check). Then, we examine the effect of CDHPs on post-year screening rates using intent-to-treat (ITT) and local average treatment effect (LATE) strategies. Last, we examine pre-year differences in quarter four screening rates (i.e. a check on anticipatory stockpiling) and then re-estimate the ITT and LATE while controlling for any anticipatory stockpiling. This section proceeds as follows: first we discuss the ITT and LATE estimation strategies, including identification checks, next we discuss the approach for dealing with anticipatory stockpiling, and last, we describe a variety of sensitivity analyses and subgroup analyses.

4.2 The Intent-to-Treat (ITT) Effect of CDHPs on Preventive Care Utilization

In our first model, we seek to identify the average effect of a new CDHP offering (ITT) over the first three years of that offering. We use a difference-in-differences (in spirit) approach using the following baseline specification:

$$y_i = f(\beta_0 + \beta_1 CDHPOFFER_i + X_i \beta_2 + \varepsilon_i) \quad (1)$$

where, y is screening at least once in any of the three post years, $CDHPOFFER$ is an indicator identifying that individual i was in a traditional plan in the pre-year and *offered* a CDHP in all three of the post years, and X is a vector of individual level covariates, including age (in the pre year), gender, family type, zip code level demographic and socio-economic characteristics, census region, and indicators for being in an MSA, employer industry, and having each of twenty five major diagnostic categories (MDC) (in the pre-year). The unit of analysis is person. Standard errors are clustered at the firm level. We estimate this model separately for each cancer screening (breast, cervical, and colon). We report estimates from OLS models to aid in interpretation, but the results are robust to alternative specifications (Appendix Table A4). $CDHPOFFER (\beta_1)$ is the main coefficient of interest, and gives the average difference in means between the treatment group and the control group. It can be interpreted as the impact of being offered a CDHP from the individual's firm on the individual's likelihood of obtaining a screening in any of the three post years.

We estimate this ITT effect because healthier individuals may differentially opt into CDHPs while patients who are sicker or have more chronic conditions may choose to remain in traditional plans (McDevitt et. al. 2014). By analyzing the impact of CDHP *offer* at the firm level rather than enrollment at the individual level, we mitigate any selection bias from an individual's choice of enrollment among offered plans.

In order for the ITT effect to be identified, the firm's decision to offer a CDHP must be orthogonal to an individual's decision to screen. Though we are unable to test directly for exogeneity of firm offer, observable characteristics between the treatment and control cohort are not significantly different (Table 1; Appendix Table A1).

The second necessary condition for identification is that the treatment and control cohorts must have similar pre-trends in screening behavior prior to CDHP offer. With only one pre-year of data, we are unable to conduct a traditional identification check and directly test the similarity of pre-trends in utilization between the treatment and control group. One way to control for differing screening behaviors in the pre-period between the treatment and control group in this setting would be to estimate separate models for those who screen in the pre-year versus those who did not². However, this approach would not account for anticipatory stockpiling of care prior to CDHP enrollment. Instead, we establish similar pre-year screening rates by re-estimating (1) on screening in quarter one to quarter three in the pre-year.

²While potentially sub-optimal because of anticipatory stockpiling, we do analyses stratified by pre-year screening status as a robustness check, described in Section 4.7.

4.3 The Local Average Treatment Effect (LATE) of CDHPs on Preventive Care Utilization

In addition to estimating the ITT effect of offering a CDHP, we are also interested in the effect of enrolling in a CDHP. Since CDHP enrollment is endogenous (individuals choose whether or not to enroll in a CDHP), we also estimate local average treatment effect (LATE). This is done via a two-step procedure where we estimate an instrumental variables model with treatment offer as an instrument for enrollment. This approach is similar to Finkelstein et al. (2012), where the authors instrumented Medicaid enrollment with being offered Medicaid. For this approach, we estimate the following two-stage model:

$$CDHPENROLL_i = f(\pi_0 + \pi_1 CDHPOFFER_i + X_i \pi_2 + \varepsilon_i) \quad (2)$$

$$y_i = f(\delta_0 + \delta_1 \widehat{CDHPENROLL}_i + X_i \delta_2 + \varepsilon_i) \quad (3)$$

where $CDHPENROLL$ is an indicator for enrolling in a CDHP in at least one of the three post years, $\widehat{CDHPENROLL}_i$ is the predicted CDHP enrollment calculated from the first stage estimated in (2), and all other variables are defined as in (1). The unit of analysis is person. Standard errors are clustered at the firm level and account for the two-stage nature of the estimation procedure. We estimate this model separately for each cancer screening (breast, cervical, and colon). We report estimates from 2SLS models to aid in interpretation, but the results are robust to alternative specifications (Appendix A4). In (3), our main coefficient of interest is the effect on $\widehat{CDHPENROLL}_i (\delta_1)$, which we interpret as a local average treatment effect of being in a CDHP, or LATE (Imbens and Angrist 1994).

In order for this 2SLS model to be identified, the instrument must satisfy two conditions. First, the instrument (offering a CDHP), must be predictive of the endogenous regressor (enrolling in a CDHP). This condition is easily testable and the coefficient on firm offer in the first stage of the model is statistically significant ($p < 0.001$) with a F-statistics greater than 10 in all three cancer samples (first stage results are available in Appendix Table A3). The second condition is that CDHP offer must be uncorrelated with the error term in the second stage of the model. This exogeneity assumption is similar to the assumption needed for identification in our prior ITT model described above in Section 4.2. As above, this assumption is not directly testable but the observable characteristics between the treatment and control cohorts are not significantly different (Table 1; Appendix Table A1) and quarter one through quarter three screening rates in the pre-year are similar (Table 3).

A key issue with this LATE approach is plan switching during the post-period. One possible method would be to restrict the sample to those who do not switch plans during the post period. However, this plan switching would be likely endogenous and introduce selection bias into our estimates. Instead, we define $CDHPENROLL$ as enrolling in a CDHP in at least one of any of the three post years. Additionally, we run sensitivity analyses, where we examine the effect of enrolling in a CDHP in at least two of the three post years and the effect of enrolling in a CDHP in all three post years.

4.4 Anticipatory Stockpiling

Individuals might anticipate their forthcoming CDHP enrollment and may be wary about increases in out-of-pocket costs. Furthermore, since individuals often do not understand their health plan benefits in a CDHP (Reed et al. 2012), they may not be aware of deductible carve outs for preventive care. In the face of this uncertainty, these individuals may schedule and complete their preventive care directly before they enroll in the CDHP.

To understand how the stockpiling of care affects our estimate of the ITT effect and LATE, we first document stockpiling by re-estimating the models (1)–(3) on quarter four of the pre-year. These estimates will tell us if significant anticipatory stockpiling is occurring. Next, we re-estimate the models on the post period using two alternative measures of the post period. First, we estimate changes in screening rates *prior* to actual offer and enrollment in a CDHP (consistent with stockpiling), by examining differences in screening rates after the enrollment decisions are made in the fourth quarter of the pre-year. Alternatively stated, this model considers the fourth quarter of the pre-year to be part of the post period. Second, the stockpiling of care in the fourth quarter of the pre-year may lead to artificially low screening rates in the first quarter of the first post year. To examine this possibility, we examine the effects of CDHP enrollment on screening rates adjusting for potential stockpiling, by examining differences in screening rates starting in the second quarter of the first post year. (i.e. omit the first quarter of the first post year from the analysis).

4.5 Utilization of non-preventive care services

To better understand the impact of CDHPs on preventive care, we examine utilization of services that are similar to the preventive screenings but, unlike cancer screening, are not carved out from the deductible and therefore subject to the increased cost sharing associated with the CDHP. Specifically, we compare breast cancer screening with all advanced imaging as both are radiologic tests, cervical cancer screenings with all gynecological spending due to the gynecological aspect of cervical cancer screening, and colon cancer screenings with upper endoscopies due to the similarity of the procedures. The advanced imaging and upper endoscopy alternative utilization measures are defined by their respective BETOS codes, an aggregation of CPT codes developed by CMS (CMS 2014). Gynecological spending is identified as all claims billed by an obstetrician/gynecologist. Our hypothesis was that CDHPs would have a larger negative effect on the utilization of these non-preventive care services compared to preventive services as they are subject to the deductible and thus had higher patient cost-sharing. We estimate the two-stage model in (2) and (3) using the alternative service utilization as the outcome measures.

4.6 Learning over time

We take two approaches to examine differing CDHP effects over time. First, we vary the definition of the main independent variable in the LATE models, specifically requiring at least one year, two years, or all three years of CDHP enrollment during the post period. These models allow us to examine if enrolling in a CDHP for a longer period of time corresponds to a stronger demand response. Second, we estimate the ITT models at the person-quarter level, with a full set of quarter, CDHP offer, and quarter by CDHP offer fixed effects. We then calculate the marginal treatment effect for each quarter and how that

estimated marginal treatment effect changes over time. These estimated marginal treatment effects allow us to test for differences in the treatment effect in each of the 16 quarters in the study period. We plot these effects in a series of figures to illustrate both any stockpiling effects found as well as any treatment effects.

4.7 Sensitivity Analyses

We estimate several sensitivity analyses to test the robustness of our results. First, as mentioned above, we re-estimate our OLS models with Probits and our 2SLS models with recursive Bivariate Probits. Second, we re-estimate our main models but leave one treatment employer out at a time to test if our results are being driven by a single employer. Third, we re-estimate our main models, stratifying by pre-period screening, to control for different pre-period levels of screening.

4.8 Subgroup Analyses

We examine three possible subgroup analyses to explore if there is an effect among certain key subgroups even if there was no effect in the main estimation: differences among those less likely to see any physician, differences among those with larger deductible changes, and differences across age. First, those that are more likely to see a physician for a general office visit are more likely to receive recommendations for screening. Therefore, we would expect any CDHP effect to be blunted among high utilization individuals. To test for this, we estimate our main 2SLS models, stratifying by the predicted number of post year office visits. Since the number of post year office visits is, in of itself, endogenous, we instead estimate a model where we predict the number of post year office visits based on the pre-year characteristics in X_i . We stratify based on the median number of predicted office visits (9 visits for the breast and cervical cancer sample, 10 for the colon cancer sample).

Second, it is possible that the CDHP effect differs across those who experienced greater changes in their deductible after CDHP offer or enrollment. Our main models might mask this effect if CDHPs are only affecting screenings among those who experience large deductible changes. To test for this, we estimate our main 2SLS models, stratifying by the median deductible change from the pre to post year (\$1,400). We calculate the deductible change by comparing the mean deductible, at the firm level, in the pre-year to the mean post-year deductible among CDHP enrollees.

Lastly, CDHP effects are likely to differ across age groups as the risk of breast and colon cancer increase significantly with age (McPherson et al. 2000; Haggard et al. 2009). It is possible that CDHP effects might be concentrated in those that are closer to the cut off for a screening recommendation and, as age increases, individuals are likely to screen, regardless of their sensitivity to deductible spending. To test for this, we estimate our main 2SLS models, stratifying by five-year age bands after the cutoff for a screening recommendation. We estimate these models only for the breast cancer and colon cancer samples, as cervical cancer screenings are recommended for all 18+ age groups.

4.9 Limitations

We note three major limitations in our analyses. First, we only include employees with four years of continuous employment at the same employer and therefore our results may not generalize to individuals who switch employers more frequently and individuals who obtain insurance on an exchange (though observable characteristics are not very different, Appendix Table A1). Second, as for all observational studies, there is no random assignment into our treatment group. The treatment individuals that select to enroll in a CDHP might be categorically different from those in the control sample who were never offered a CDHP. While we mitigate this bias by estimating a 2SLS model with firm offer as an instrument for individual enrollment, and we show that quarter one to quarter three screening rates in the pre-year are not significantly different, we are unable to conclusively show that firm's offer decision is exogenous. Last, in the models that control for pre-year stockpiling, we omit the first quarter of the post period. Our solution may not be accurate because cancer screenings are recommended over a long period and if stockpiling is contaminating the post-period, it might do so for years and not just in the first quarter. While we note this limitation, it would lead us to overestimate a CDHP effect and given additional credence to any null results.

5. Study Results

5.1 Sample Description

Our dataset includes 209,062 individuals in the breast cancer sample 332,871 in the cervical cancer sample, and 154,027 in the colon cancer sample (Table 1). Pre-year screening rates are higher in the offered group than control group (48% vs 47.4% for breast cancer, 52% vs 47% for cervical cancer, and 22.0% vs 21.9% for colon cancer) but the difference is statistically significant only for cervical cancer screenings ($p < 0.001$). On average, members of the control cohort are slightly older and less healthy than those that were offered a CDHP. A comparison of additional patient characteristics can be found in the appendix (Table A1).

During the pre-offer year deductibles are slightly higher in the control cohort vs. treatment cohort, but the pre-year differences are not statistically significant at the 5% level (Table 2). In all three samples, the deductibles among members of the control cohort during the study period are steadily increasing by ten to fifteen dollars per year. In the treatment samples, we observe small deductibles for treatment individuals prior to CDHP offer and then a large ($> \$400$ in each of the three samples) increase in the mean deductible after CDHPs are offered. We also find a drop in the actuarial value of the plan after CDHP offer (approximately a five percentage point drop in each of the three samples) as opposed to the actuarial value of the control plans, which remain constant around 90%.

In Appendix Table A2, we report plan descriptives for those who choose to enroll in a CDHP. The treatment sample contains mostly enrollees with HRAs (80%, 84%, and 75% in the breast cancer, cervical cancer, and colon cancer sample, respectively) with the remaining CDHP enrollees having HSAs. The amount of money employers contribute to savings accounts is also stable over time and across the three samples (approximately \$450).

5.2 Pre-Year Screening

Table 3 presents the impact of future CDHP offer (ITT) and enrollment (LATE) on pre-year screening behavior, stratified by quarter of year. Columns (1) and (2) show that there are no statistically significant differences in screening rates from quarter one to quarter three of the pre-year. Columns (3) and (4) show significant increases in all three screenings in the last quarter of the year prior to CDHP offer providing evidence of the anticipatory stockpiling of care. Based on a base of 10.8% in a given quarter, the 1.6 percentage point change is a 14.8 percent higher rate of breast cancer screening in this quarter. Similar increases were seen for cervical and colon cancer screening.

5.3 The Impact of CDHPs on Post-Year Screening

Table 4 presents the results from our main ITT and LATE specifications with Breast Cancer in Panel A, Cervical Cancer in Panel B, and Colon Cancer in Panel C. First stage results and F-stats for the 2SLS LATE models are presented in Appendix Table A3. We do not observe any significant differences in cancer screening rates between control individuals and those who were offered (Columns 1, 3 and 5) and/or enrolled (Columns 2, 4, and 6) in a CDHP. The estimated effects do not differ appreciably regardless of how the post period is defined and is robust to including the fourth quarter of the pre year and omitting the first quarter of the first post year. While the sign of the coefficients fluctuates for cervical cancer screenings, the sign is consistently positive for breast cancer and colon cancer screenings.

5.4 Utilization of Non-Preventive Comparison Services

We also assess the impact of CDHP enrollment on a set of comparison non-preventive care services (Table 5). As discussed above in Section 4.5, these comparison services do not come with first dollar coverage and are subject to the deductible. In this table, we only estimate the LATE 2SLS models. Column 1 repeats the non-significant estimates found for cancer screenings in Table 3, and column 2 presents the CDHP effect on advanced imaging, gynecological services, and upper endoscopies. CDHP enrollment is associated with significant decreases in spending for all three comparison services, in magnitudes that are similar when compared to other studies looking at overall decreases in outpatient spending (e.g. Haviland et al. 2016).

5.5 Effect Over Time

In Table 6 and Figure 1, we present models looking at CDHP effects over time. Table 6 shows how the estimated LATE differs with the definition of the main independent variable, specifically requiring at least one year, two years, or all three years of CDHP enrollment during the post period. While the coefficients increase in absolute value as the number of years of CDHP enrollment is increased, the estimates are never statistically significant from zero.

In Figure 1, we look for learning over time by estimating ITT models at the person-quarter level. In all three samples, significant stockpiling of cancer screenings is observed in the quarter immediately prior to CDHP offer, similar to the findings presented in Table 3. In the cervical cancer group, we do not observe any significant effects for any quarters after CDHP offer. In the breast cancer and colon cancer groups, we find that significant stockpiling of

screenings continues in the fourth quarter of each of the three years after CDHP offer for the treatment group relative to the control group.

5.6 Sensitivity checks

To test the robustness of our results, we run several sensitivity analyses. First, Appendix Table A4 presents results from Probit (ITT) and Bivariate Probit (LATE) models for our main specification. The results are similar to those presented in Table 4, with no statistically significant CDHP effects. Appendix Table A5 presents ITT and LATE results, stratified by the individual's pre-year screening status, in order to control for differing pre-year utilization. Like in the combined models, we see no statistically significant CDHP effects. In Appendix Figures A6, we re-estimate our main specification (equations (3)–(4)) and leave out one treatment employer at a time to determine if the CDHP impact estimates are driven by a single employer. For all three cancer screenings, in no case did the exclusion of a single employer lead to a result with a negative impact of CDHPs on screening suggesting that our results are not sensitive to which firms are included in the sample.

5.7 Subgroup Analyses

One possible explanation for the null result is that while patients fully understand the preventive care carve-outs, screening reductions are limited to those with fewer office visits with primary care physicians. To examine this, we estimate the LATE models, stratifying by the predicted number of post-year office visits (below and above median). We present results from this stratification in columns (1) and (2) of Table 7. The high and low office visit coefficients are not significantly different. In columns (3) and (4), we present results from models where we stratify individuals based on the size of the deductible change from the pre to post years to examine if CDHP effects might be larger among those experiencing large deductible changes. We observe no statistically significant differences. Columns (4), (5), and (6) presents stratification models based on the age where models present an increasingly older population and thus at a higher risk of breast and colon cancer. In all 12 of these models, we find no statistically significant differences between the treatment and control group suggesting that cancer risk is not correlated with any CDHP effect.

6. Discussion

To our knowledge this is the first study to look at the longer-term effects of CDHPs on preventive care use using data that span multiple employers and multiple insurers. We find evidence of increased cancer screening in the last quarter before the CDHP was offered. Additionally, we find that this stockpiling behavior continues in the years after CDHP offer for the breast cancer and cervical cancer groups. This result is consistent with economic theory as the threat of high cost sharing that leads individuals to stockpile in the year prior to CDHP offer continues in the years after. We find no effect of CDHP offer or enrollment on breast, cervical, or colon cancer screening rates over the entire post period. These null results are fairly precise with narrow confidence intervals for the estimates $[-0.019, 0.034]$, $[-0.027, 0.018]$, $[-0.017, 0.021]$ for breast cancer, cervical cancer, and colon cancer screening, respectively). The results do not differ appreciably when estimating the ITT effect or the LATE. Similarly, the results do not change regardless how we define the window

associated with the post period. In models where we estimate the effect of CDHPs on similar non-screening procedures that are subject to the deductible, we find significant decreases. In analyses that seek to uncover differences across subgroups, we similarly find no statistically significant differences.

Our results differed from some prior studies that find that CDHPs lower the use of preventive services. The difference with prior work appears to be limited to the area of preventive care, as analyses using similar data to the present study (e.g. Haviland et al. 2016) find estimates that are broadly consistent with the CDHP literature. Although some of the differences are due to differences in study sample and methods, the difference might also be due to the time horizon of the study. We used data three years post while prior studies used a shorter time horizon. This extended time horizon is critical when studying cancer screenings, as they are not clinically recommended every year (USPTF 2014).

The findings from this study have several important policy implications. First, they suggest that anticipatory stockpiling of care is not limited to prescription drugs but can be found in care settings where stockpiling is not necessarily intuitive, like cancer screenings. The anticipatory spending suggests poor benefit design comprehension given that all CDHP enrollees in our sample received deductible carve outs for preventive care. Second, the results suggest that CDHPs do not negatively impact receipt of recommended cancer screenings in the post period. This null result might be due to the fact that the CDHPs in this study exempt cancer screenings from the deductible, as all plans under the ACA now do, and that it takes several years for enrollees to learn the details associated with their benefit design. Third, these results suggest that just reducing the out-of-pocket costs might not be enough to increase utilization of recommended cancer screenings. Additional research on the effects of out-of-pocket costs on high value care utilization is needed.

Overall, our results suggest that broad based reductions in preventive care by CDHP enrollees at large employers are not occurring and hence worries about a resulting spending rebound in the future may not be well founded. However, more needs to be done to understand what strategies may be effective in boosting use of preventive and other high value care in CDHPs as well as investigating whether these findings hold in other settings (exchanges, small employers).

Appendix List

Appendix A1-1

Enrollee Characteristics in the pre-year, Breast Cancer Sample

	N	Control Mean	SD	N	Offered CDHP Mean	SD
Pre-year Screening	196,201	0.474	0.499	12,861	0.480	0.500
Age	196,201	47.35	5.405	12,861	46.30	8.123
Female	196,201	1	0	12,861	1	0
MDC Count	196,201	3.667	2.344	12,861	3.414	2.196
Northeast	196,201	0.182	0.386	12,861	0.152	0.359

	N	Control Mean	SD	N	Offered CDHP Mean	SD
Midwest	196,201	0.382	0.486	12,861	0.447	0.497
South	196,201	0.353	0.478	12,861	0.294	0.456
West	196,201	0.0837	0.277	12,861	0.106	0.308
d(MSA)	196,201	0.868	0.338	12,861	0.828	0.378
Median HH Inc (Zip)	196,201	47,199	23,737	12,861	51,454	20,759
Fraction Unemployed (Zip)	196,201	0.0421	0.0296	12,861	0.0410	0.0263
Fraction College (Zip)	196,201	0.254	0.175	12,861	0.281	0.169
Fraction HS (Zip)	196,201	0.514	0.200	12,861	0.539	0.153
Fraction Hispanic (Zip)	196,201	0.0617	0.112	12,861	0.0632	0.103
Fraction Black (Zip)	196,201	0.0869	0.156	12,861	0.0733	0.137
Fraction White (Zip)	196,201	0.711	0.309	12,861	0.777	0.250
Oil/Manufacturing Industry	196,201	0.368	0.482	12,861	0.341	0.474

Notes: Descriptive statistics are in the pre-year (prior to CDHP offer). Other covariates included in the model but not in this table are a six level family type, dummy for missing zip code level demographics, and MDC dummies.

Appendix A1-2

Enrollee Characteristics in the pre-year, Cervical Cancer Sample

	N	Control Mean	SD	N	Offered CDHP Mean	SD
Pre-Year Screening	312,200	0.471	0.499	20,671	0.520	0.500
Age	312,200	41.47	9.208	20,671	40.53	10.68
Female	312,200	1	0	20,671	1	0
MDC Count	312,200	3.510	2.250	20,671	3.291	2.133
Northeast	312,200	0.176	0.381	20,671	0.144	0.351
Midwest	312,200	0.380	0.485	20,671	0.461	0.498
South	312,200	0.357	0.479	20,671	0.294	0.455
West	312,200	0.0868	0.282	20,671	0.102	0.303
d(MSA)	312,200	0.878	0.327	20,671	0.839	0.368
Median HH Inc (Zip)	312,200	47,668	23,257	20,671	51,093	20,449
Fraction Unemployed (Zip)	312,200	0.0425	0.0298	20,671	0.0415	0.0273
Fraction College (Zip)	312,200	0.259	0.175	20,671	0.279	0.168
Fraction HS (Zip)	312,200	0.514	0.195	20,671	0.541	0.153
Fraction Hispanic (Zip)	312,200	0.0662	0.118	20,671	0.0641	0.106
Fraction Black (Zip)	312,200	0.0896	0.158	20,671	0.0765	0.143
Fraction White (Zip)	312,200	0.709	0.305	20,671	0.773	0.253
Oil/Manufacturing Industry	312,200	0.341	0.474	20,671	0.325	0.469

Notes: Descriptive statistics are in the pre-year (prior to CDHP offer). Other covariates included in the model but not in this table are a six level family type, dummy for missing zip code level demographics, and MDC dummies.

Appendix A1-3

Enrollee Characteristics in the pre-year, Colon Cancer Sample

	N	Control Mean	SD	N	Offered CDHP Mean	SD
Pre-year Screening	145,664	0.219	0.414	8,363	0.220	0.414
Age	145,664	53.57	2.786	8,363	53.06	6.337
Female	145,664	0.475	0.499	8,363	0.532	0.499
MDC Count	145,664	3.456	2.360	8,363	3.290	2.240
Northeast	145,664	0.176	0.381	8,363	0.142	0.349
Midwest	145,664	0.418	0.493	8,363	0.457	0.498
South	145,664	0.325	0.468	8,363	0.287	0.452
West	145,664	0.0808	0.273	8,363	0.113	0.317
d(MSA)	145,664	0.851	0.356	8,363	0.794	0.405
Median HH Inc (Zip)	145,664	46,072	22,923	8,363	50,495	20,424
Fraction Unemployed (Zip)	145,664	0.0428	0.0295	8,363	0.0411	0.0256
Fraction College (Zip)	145,664	0.245	0.171	8,363	0.274	0.169
Fraction HS (Zip)	145,664	0.521	0.200	8,363	0.542	0.157
Fraction Hispanic (Zip)	145,664	0.0576	0.108	8,363	0.0636	0.103
Fraction Black (Zip)	145,664	0.0814	0.147	8,363	0.0673	0.127
Fraction White (Zip)	145,664	0.724	0.306	8,363	0.780	0.248
Manufacturing Industry	145,664	0.394	0.489	8,363	0.387	0.487

Notes: Descriptive statistics are in the pre-year (prior to CDHP offer). Other covariates included in the model but not in this table are a six level family type, dummy for missing zip code level demographics, and MDC dummies.

Table A2

Plan Characteristics by Treatment Year

	Treatment						Control	
	Offered			Enrolled			Deductible (\$)	Actuarial Value of Plan (Fraction)
	Deductible ¹ (\$)	Actuarial Value of Plan ² (Fraction)	Deductible ¹ (\$)	Actuarial Value of Plan ² (Fraction)	HRA ³ (Fraction)	Account Contribution ⁴ (\$)		
Breast Cancer								
Pre	46.44 (83.12)	0.87 (0.03)	19.21 (57.66)	0.85 (0.02)	– –	– –	52.75 (94.67)	0.90 (0.05)
1 st Post	512.5 (580.0)	0.82 (0.07)	1163 (233.5)	0.74 (0.02)	81 (0.39)	449.7 (145.3)	65.17 (103.5)	0.90 (0.05)
2 nd Post	631.1 (563.4)	0.81 (0.07)	1162 (230.7)	0.75 (0.02)	0.81 (0.39)	451.4 (138.2)	85.85 (121.2)	0.89 (0.06)
3 rd Post	808.9 (597.9)	0.79 (0.08)	1172 (249.9)	0.74 (0.03)	0.81 (0.39)	436.7 (109.5)	107.68 (132.78)	0.85 (0.02)
Cervical Cancer								
Pre	42.25	0.87	15.25	0.85	–	–	52.37	0.88

	Treatment						Control	
	Offered			Enrolled				
	Deductible ¹ (\$)	Actuarial Value of Plan ² (Fraction)	Deductible ¹ (\$)	Actuarial Value of Plan ² (Fraction)	HRA ³ (Fraction)	Account Contribution ⁴ (\$)	Deductible (\$)	Actuarial Value of Plan (Fraction)
1 st Post	(81.29)	(0.03)	(48.36)	(0.02)	–	–	(94.05)	(0.05)
	539.6	0.82	1149	0.74	0.84	440.5	65.19	0.90
2 nd Post	(580.2)	(0.07)	(224.3)	(0.02)	(0.36)	(134.2)	(102.9)	(0.05)
	653.9	0.81	1151	0.75	0.84	440.4	85.44	0.90
3 rd Post	(561.4)	(0.07)	(223.9)	(0.02)	(0.36)	(128.8)	(120.7)	(0.05)
	830.6	0.79	1160	0.74	0.84	427.9	106.5	0.89
	(595.6)	(0.07)	(239.7)	(0.02)	(0.36)	(103.2)	(133.5)	(0.06)
Colon Cancer								
Pre	52.02	0.87	24.41	0.85	–	–	58.90	0.88
	(85.00)	(0.03)	(61.92)	(0.02)	–	–	(92.48)	(0.53)
1 st Post	435.3	0.83	1188	0.74	0.76	454.5	68.51	0.90
	(564.5)	(0.07)	(263.5)	(0.02)	(0.43)	(159.0)	(101.7)	(0.05)
2 nd Post	563.5	0.82	1188	0.75	0.76	459.9	99.30	0.90
	(566.3)	(0.07)	(263.2)	(0.02)	(0.43)	(147.9)	(127.5)	(0.05)
3 rd Post	738.9	0.80	1200	0.74	0.76	444.1	117.3	0.89
	(608.3)	(0.08)	(277.4)	(0.03)	(0.43)	(111.3)	(144.6)	(0.06)

Notes: Table contains summary statistics of plan characteristics during study period for those enrolled in a CDHP (treatment) and those who were not offered nor enrolled in a CDHP (control). Plan characteristics were calculated from the claims by Watson Wyatt (now Towers Watson). We report means with standard deviations in parentheses.

¹ Deductible is defined as the individual plan deductible.

² Actuarial value of the plan is not inclusive of the employer contribution to the plan.

³ HRA is the fraction of respondents in a health reimbursement account (HRA) versus a health savings account (HSA).

⁴ Account contribution is the average amount the employer contributed to the account (individual, not family).

Table A3

First Stage Results for Table 3, The Effect of CDHP Offer on CDHP Enrollment in At Least 1 Post Year

(1) Enrollment in at least 1 Post Year	
Panel A: Breast Cancer	
CDHP Offer	0.49833 *** (0.08994)
Observations	209,062
F-Stat	1177
R-squared	0.516
Panel B: Cervical Cancer	
CDHP Offer	0.53083 ***

(1) Enrollment in at least 1 Post Year	
	(0.02108)
Observations	332,871
F-Stat	1287
R-squared	0.556
Panel C: Colon Cancer	
CDHP Offer	0.42974 ***
	(0.07545)
Observations	154,027
F-Stat	903.0
R-squared	0.429

Notes: Unit of observation is person.

p<0.01,

**

p<0.05,

*

p<0.1. Standard errors are clustered at the firm level. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Table A4

Impact of CDHP Offer and Enrollment On Screening in Any of the Three Post Years, Probits and Bivariate Probits

	(1)	(2)	(3)	(4)	(5)	(6)
	3 Post Years		Q4 is Post		Q1 is Omitted	
	Offer Probit	Enrollment BiProbit	Offer Probit	Enrollment BiProbit	Offer Probit	Enrollment BiProbit
Panel A: Breast Cancer						
CDHP	0.00693	0.0422	0.00869	0.0551	0.00689	0.0410
	(0.0136)	(0.0821)	(0.0128)	(0.0797)	(0.0143)	(0.0847)
Observations	209,062	209,062	209,062	209,062	209,062	209,062
Dependent Variable Mean	0.666	0.666	0.682	0.682	0.647	0.647
Panel B: Cervical Cancer						
CDHP	-0.00451	-0.0307	-0.00289	-0.0200	0.00706	0.0460
	(0.0111)	(0.0764)	(0.0103)	(0.0746)	(0.0138)	(0.0900)
Observations	332,871	332,871	332,871	332,871	332,871	332,871
Dependent Variable Mean	0.765	0.765	0.777	0.777	0.727	0.727
Panel C: Colon Cancer						
CDHP	0.00201	0.0125	0.00620	0.0390	0.00379	0.0242
	(0.00989)	(0.0623)	(0.0116)	(0.0718)	(0.0101)	(0.0644)
Observations	154,027	154,027	154,027	154,027	154,027	154,027
Dependent Variable Mean	0.387	0.387	0.409	0.409	0.363	0.363

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,
**
p<0.05,
*
p<0.1. Standard errors are clustered at the firm level. In columns 1, 3, and 5 marginal effects from probit models are presented. The independent variable is being *offered* a new CDHP. In columns 2, 4, and 6 second stage marginal effects from a two-stage bivariate probit model is presented where CDHP offer is the instrument for CDHP enrollment in at least one of the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Table A5

Impact of CDHP Offer and Enrollment On Screening in Any of the Three Post Years,
Stratified by Pre-Year Screening

	(1)	(2)	(3)	(4)
	Did not screen in Pre-Year		Screened in Pre-Year	
	Offer OLS	Enrollment 2SLS	Offer OLS	Enrollment 2SLS
Panel A: Breast Cancer				
CDHP	0.00683 (0.0132)	0.0140 (0.0272)	0.00860 (0.00938)	0.0168 (0.0176)
Observations	109,904	109,904	99,158	99,158
R-Squared	0.067	0.067	0.029	0.029
Dependent Variable Mean	0.521	0.521	0.825	0.825
Panel B: Cervical Cancer				
CDHP	-0.0155 (0.0196)	-0.0304 (0.0351)	-0.000562 (0.00685)	-0.00102 (0.0123)
Observations	175,483	175,483	157,388	157,388
R-Squared	0.088	0.088	0.016	0.016
Dependent Variable Mean	0.634	0.634	0.911	0.911
Panel C: Colon Cancer				
CDHP	0.00300 (0.00871)	0.00702 (0.0201)	-0.00319 (0.0139)	-0.00728 (0.0320)
Observations	120,241	120,241	33,786	33,786
R-Squared	0.036	0.036	0.084	0.084
Dependent Variable Mean	0.344	0.344	0.539	0.539

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,
**
p<0.05,
*
p<0.1. Standard errors are clustered at the firm level. In columns 1 and 3 coefficients from OLS models are presented. The independent variable is being *offered* a new CDHP. In columns 2, and 4 second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment in at least one of the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Figure A6-1. Results for Breast Cancer Screening Leaving Out One Employer at a Time

Notes: Dots are point estimates and lines represent 95% confidence intervals. Model corresponds to column (2) from Table 4. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment. Control group is those who were not offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and pre-year MDC indicator variables.

Figure A6-2. Results for Cervical Cancer Screening Leaving Out One Employer at a Time

Notes: Dots are point estimates and lines represent 95% confidence intervals. Model corresponds to column (2) from Table 4. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment. Control group is those who were not offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and pre-year MDC indicator variables.

Figure A6-3. Results for Colon Cancer Screening Leaving Out One Employer at a Time

Notes: Dots are point estimates and lines represent 95% confidence intervals. Model corresponds to column (2) from Table 4. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment. Control group is those who were not offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and pre-year MDC indicator variables.

References

- Brot-Goldberg ZC, Chandra A, Handel BR, Kolstad JT. What does a deductible do? The impact of cost-sharing on health care prices, quantities, and spending dynamics. *Quarterly Journal of Economics*. 2017 forthcoming.
- Bundorf, MK. Research Synthesis Report 24. The Robert Wood Johnson Foundation; 2012. The Synthesis Project. Consumer-Directed Health Plans: Do They Deliver?. Available at <http://www.rwjf.org/content/dam/farm/reports/reports/2012/rwjf402405>
- Bundorf MK. Consumer-directed health plans: a review of the evidence. *The Journal of Risk and Insurance*. 2016; 83(1):9–41.
- Buntin M, Haviland A, McDevitt R, Sood N. Health care spending and preventive care in high-deductible and consumer-directed health plans. *American Journal of Managed Care*. 2011; 17(3): 222–30. [PubMed: 21504258]
- CDC. Vital Signs: Colorectal Cancer Screening Test Use- United States, 2012. 2013. <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6244a4.htm> Accessed October 1, 2014
- CMS. Berenson-Eggers Type of Service (BETOS). 2014. <https://www.cms.gov/Medicare/Coding/HCPSCReleaseCodeSets/BETOS.html> Accessed October 1, 2014

- Charlton ME, Levy T, High RR, Schneider JE, Brooks JM. Effects of health savings account eligible plans on utilization and expenditures. *American Journal of Managed Care*. 2011; 17(1):79–86. [PubMed: 21348571]
- Cutler D, Sahni NR. If slow rate of health care spending growth persists. *Health Affairs*. 2013; 32(5): 841–50. [PubMed: 23650316]
- Fronstin P, Sepulveda MJ, Martin J, Roebuck MC. Consumer-directed health plans reduce the long-term use of outpatient physician visits and prescription drugs. *Health Affairs*. 2013; 32(6):1126–1134. [PubMed: 23733988]
- Haggar FA, Boushey RP. Colorectal cancer epidemiology: incidence, mortality, survival, and risk factors. *Clinics in Colon and Rectal Surgery*. 2009; 22(4):191–197. [PubMed: 21037809]
- Haviland A, Eisenberg M, Mehrotra A, Huckfedlt P, Sood N. Do ‘consumer-directed’ health plans bend the cost curve over time? *Journal of Health Economics*. 2016; 46:33–51. [PubMed: 26851386]
- Haviland A, Marquis MS, McDevitt RD, Sood N. Growth of consumer directed health plans to one-half of all employer-sponsored insurance could save \$57 billion annually. *Health Affairs*. 2012; 31(5):1009–15. [PubMed: 22566440]
- Haviland A, Sood N, McDevitt R, Marquis SM. How do consumer directed health plans affect vulnerable populations. *Forum for Health Economics & Policy*. 2011; 14(2):1558–9544. (Online).
- Huckfeldt P, Haviland A, Mehrotra A, Wagner Z, Sood N. Patient Responses to Incentives in Consumer-Directed Health Plans: Evidence from Pharmaceuticals. 2015NBER Working Paper
- KFF, HRET. Employer health benefits: 2015 summary of findings. The Kaiser Family Foundation and Health Research and Education Trust; 2016.
- Kozhimannil KB, Law MR, Baluer-Patterson C, Zhang F, Wharam JF. The impact of high deductible health plans on men and women: an analysis of emergency department care. *Medical Care*. 2013; 51(8):639–45. [PubMed: 23685403]
- Maciosek M, Coffield A, Edwards N, Flottemesch T, Goodman M, Solberg L. Priorities among effective clinical preventive services: results of a systematic review and analysis. *American Journal of Preventive Medicine*. 2006; 31:52–61. [PubMed: 16777543]
- Meeker D, Joyce G, Malkin J, Teutsch S, Haddix A, Goldman D. Coverage and preventive screening. *Health Services Research*. 2010; 46(1):173–184. [PubMed: 21029084]
- McDevitt R, Haviland A, Laudenberg L, Lore R, Eisenberg M, Sood N. Risk selection into consumer-directed health plans: an analysis of family choices within large employers. *Health Services Research*. 2014. 2014; 49(2):609–27.3.
- McPherson J, Steel CM, Dixon JM. Breast cancer—epidemiology, risk factors, and genetics. *BMJ*. 2000:321–624.
- National Committee for Quality Assurance. HEDIS 2008: volume 2: technical specifications. <http://www.ncqa.org/tabid/536/Default.aspx> Accessed October 1, 2014
- Rowe JW, Brown-Stevenson T, Downey RL, Newhouse JP. The effect of consumer-directed health plans on the use of preventive and chronic illness services. *Health Affairs*. 2008; 27(1):113–20. [PubMed: 18180485]
- Reed ME, Graetz I, Fung F, Newhouse JP, Hsu J. In consumer-directed health plans, a majority of patients were unaware of free or low-cost preventive care. *Health Affairs*. 2012; 31(12):2641–2648. [PubMed: 23213148]
- Sinaiko AD, Mehrotra A, Sood N. Cost-sharing obligations, high-deductible health plan growth, and shopping for health care: enrollees with skin in the game. *JAMA Internal Medicine*. 2016; 176(3): 395–7. [PubMed: 26784644]
- Sood N, Wagner Z, Huckfedlt P, Haviland A. Price shopping in consumer directed health plans. *Forum for Health Economics and Policy*. 2013; 16(1):101–122.
- Wharam JF, Galbraith AA, Klienman KP, Soumerai SB, Ross-Degnan D, Landon BE. Cancer screening before and after switching to a high-deductible health plan. *Annals of Internal Medicine*. 2008; 148(9):647–655. [PubMed: 18458277]
- Wharam JF, Graves AJ, Landon BE, Zhang F, Soumerai SB, Ross-Degnan D. Two-year trends in colorectal cancer screening after switch to a high-deductible health plan. *Med Care*. 2011 Sep; 49(9):865–71. [PubMed: 21577162]

Wharam JF, Graves AJ, Zhang F, Soumerai SB, Ross-Degnan D, Landon BE. Two-year trends in cancer screening among low socioeconomic status women in an HMO-based high-deductible health plan. *J Gen Intern Med.* 2012 Sep; 27(9):1112–9. [PubMed: 22544705]

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Figure 1. Marginal Treatment Effect of CDHP Offer Over Time

Notes: Marginal treatment effects are presented with points with 95% confidence bounds. Standard errors are clustered at the firm level. The y-axis represented the marginal treatment effect of CDHP offer. The x-axis represents quarter of time. The red vertical line represents the initiation of CDHP offer. Estimates are calculated from ITT models estimated at the person-quarter level, with a full set of quarter, CDHP offer, and quarter by CDHP offer fixed effects. Estimates are adjusted for age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median

HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and pre-year MDC indicator variable.

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Table 1

Pre-period Characteristics

	Control		Offered CDHP	
	Mean	SD	Mean	SD
Panel A: Breast Cancer				
Pre-year Screening	0.474	0.499	0.480	0.500
Age	47.35	5.405	46.30	8.123
Female	1	0	1	0
MDC Count	3.667	2.344	3.414	2.196
Northeast	0.182	0.386	0.152	0.359
Midwest	0.382	0.486	0.447	0.497
South	0.353	0.478	0.294	0.456
West	0.0837	0.277	0.106	0.308
d(MSA)	0.868	0.338	0.828	0.378
N	196,201		12,861	
Panel B: Cervical Cancer				
Pre-Year Screening	0.471	0.499	0.520	0.500
Age	41.47	9.208	40.53	10.68
Female	1	0	1	0
MDC Count	3.510	2.250	3.291	2.133
Northeast	0.176	0.381	0.144	0.351
Midwest	0.380	0.485	0.461	0.498
South	0.357	0.479	0.294	0.455
West	0.0868	0.282	0.102	0.303
d(MSA)	0.878	0.327	0.839	0.368
N	312,200		20,671	
Panel C: Colon Cancer				
Pre-year Screening	0.219	0.414	0.220	0.414
Age	53.57	2.786	53.06	6.337
Female	0.475	0.499	0.532	0.499
MDC Count	3.456	2.360	3.290	2.240
Northeast	0.176	0.381	0.142	0.349
Midwest	0.418	0.493	0.457	0.498
South	0.325	0.468	0.287	0.452
West	0.0808	0.273	0.113	0.317
d(MSA)	0.851	0.356	0.794	0.405
N	145,664		8,363	

Notes: Table contains characteristics during the pre-period. "Offered" includes all individuals who will be offered a CDHP in the post period. Control includes all individuals who will not be offered nor enroll in a CDHP in the post years. Full patient characteristics, stratified by those that did and did not screen in the pre-year, are available in Appendix A1.

Table 2

Plan Characteristics by Treatment Year

	Treatment		Control	
	Deductible ¹ (\$)	Actuarial Value of Plan ² (Fraction)	Deductible (\$)	Actuarial Value of Plan (Fraction)
Breast Cancer				
Pre	46.44 (83.12)	0.87 (0.03)	52.75 (94.67)	0.90 (0.05)
1 st Post	512.5 (580.0)	0.82 (0.07)	65.17 (103.5)	0.90 (0.05)
2 nd Post	631.1 (563.4)	0.81 (0.07)	85.85 (121.2)	0.89 (0.06)
3 rd Post	808.9 (597.9)	0.79 (0.08)	107.68 (132.78)	0.85 (0.02)
Cervical Cancer				
Pre	42.25 (81.29)	0.87 (0.03)	52.37 (94.05)	0.88 (0.05)
1 st Post	539.6 (580.2)	0.82 (0.07)	65.19 (102.9)	0.90 (0.05)
2 nd Post	653.9 (561.4)	0.81 (0.07)	85.44 (120.7)	0.90 (0.05)
3 rd Post	830.6 (595.6)	0.79 (0.07)	106.5 (133.5)	0.89 (0.06)
Colon Cancer				
Pre	52.02 (85.00)	0.87 (0.03)	58.90 (92.48)	0.88 (0.53)
1 st Post	435.3 (564.5)	0.83 (0.07)	68.51 (101.7)	0.90 (0.05)
2 nd Post	563.5 (566.3)	0.82 (0.07)	99.30 (127.5)	0.90 (0.05)
3 rd Post	738.9 (608.3)	0.80 (0.08)	117.3 (144.6)	0.89 (0.06)

Notes: Table contains summary statistics of plan characteristics during study period for those offered a CDHP (treatment) and those who were not offered nor enrolled in a CDHP (control). Plan characteristics were calculated from the claims by Watson Wyatt (now Towers Watson). We report means with standard deviations in parentheses.

¹ Deductible is defined as the individual plan deductible.

² Actuarial value of the plan is not inclusive of the employer contribution to the plan.

³ Proportion HRA, HSA, account contributions, and statistics on enrolled population can be found in Appendix Table A2.

Table 3

Impact of Future CDHP Offer and Enrollment on Pre-Year Screening

	(1)	(2)	(3)	(4)
	Q1–Q3		Q4	
	Offer OLS	Enrollment 2SLS	Offer OLS	Enrollment 2SLS
Panel A: Breast Cancer				
CDHP	–0.0104 (0.00954)	–0.0208 (0.0187)	0.0165 ** (0.00652)	0.0330 *** (0.0107)
Observations	209,062	209,062	209,062	209,062
R-squared	0.144	0.144	0.045	0.046
Dependent Variable Mean	0.293	0.293	0.108	0.108
Panel B: Cervical Cancer				
CDHP	0.0199 (0.0338)	0.0375 (0.0627)	0.0234 ** (0.00926)	0.0440 ** (0.0174)
Observations	332,871	332,871	332,871	332,871
R-squared	0.212	0.212	0.060	0.060
Dependent Variable Mean	0.349	0.349	0.117	0.117
Panel C: Colon Cancer				
CDHP	0.000340 (0.00942)	0.000792 (0.0215)	0.00694 ** (0.00297)	0.0162 *** (0.00592)
Observations	154,027	154,027	154,027	154,027
R-squared	0.140	0.140	0.046	0.046
Dependent Variable Mean	0.152	0.152	0.0537	0.0537

Notes: Unit of observation is person. Analysis is run in the year prior to CDHP offer.

p<0.01,**
p<0.05,

*
p<0.1. Standard errors are clustered at the firm level. In columns 1 and 2, coefficients from OLS models are presented. The independent variable is being *offered* a new CDHP in the future. In columns 2 and 4, second stage coefficients from a two-stage least squares model is presented where future CDHP offer is the instrument for future CDHP enrollment in at least one of the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Table 4

Impact of CDHP Offer and Enrollment On Screening in Any of the Three Post Years

	(1)	(2)	(3)	(4)	(5)	(6)
	3 Post Years		Q4 is Post		Q1 is Omitted	
	Offer OLS	Enrollment 2SLS	Offer OLS	Enrollment 2SLS	Offer OLS	Enrollment 2SLS
Panel A: Breast Cancer						
CDHP	0.00736 (0.0135)	0.0148 (0.0266)	0.00885 (0.0127)	0.0178 (0.0251)	0.00730 (0.0142)	0.0146 (0.0281)
Observations	209,062	209,062	209,062	209,062	209,062	209,062
R-squared	0.109	0.109	0.122	0.122	0.108	0.108
Dependent Variable Mean	0.666	0.666	0.682	0.682	0.647	0.647
Panel B: Cervical Cancer						
CDHP	-0.00458 (0.0116)	-0.00863 (0.0211)	-0.00319 (0.0108)	-0.00600 (0.0196)	0.00689 (0.0138)	0.0130 (0.0262)
Observations	332,871	332,871	332,871	332,871	332,871	332,871
R-squared	0.124	0.124	0.136	0.136	0.118	0.118
Dependent Variable Mean	0.765	0.765	0.777	0.777	0.727	0.727
Panel C: Colon Cancer						
CDHP	0.00199 (0.00985)	0.00463 (0.0223)	0.00616 (0.0115)	0.0143 (0.0258)	0.00374 (0.0101)	0.00871 (0.0227)
Observations	154,027	154,027	154,027	154,027	154,027	154,027
R-squared	0.050	0.050	0.062	0.063	0.047	0.047
Dependent Variable Mean	0.387	0.387	0.409	0.409	0.363	0.363

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,

**

p<0.05,

*

p<0.1. Standard errors are clustered at the firm level. In columns 1, 3, and 5 coefficients from OLS models are presented. The independent variable is being *offered* a new CDHP. In columns 2, 4, and 6 second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment in at least one of the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Table 5

Impact of Different Years of CDHP Enrollment On Screening and Comparison Services

	(1)	(2)
	3 Post Years	
	P(Screening)	Ln(Comparison Costs)
Panel A: Breast Cancer vs Advanced Img.		
CDHP in at Least 1 Post Year	0.0148	-0.396**
	(0.0266)	(0.199)
Observations	209,062	209,062
R-squared	0.109	0.112
Dependent Variable Mean	0.666	456.9
Panel B: Cervical Cancer vs Gynecology		
CDHP in at Least 1 Post Year	-0.00863	-0.274**
	(0.0211)	(0.142)
Observations	332,871	332,871
R-squared	0.124	0.189
Dependent Variable Mean	0.765	513.2
Panel C: Colon Cancer vs Upper Endoscopy		
CDHP in at Least 1 Post Year	0.00463	-0.231***
	(0.0223)	(0.0664)
Observations	154,027	154,027
R-squared	0.050	0.039
Dependent Variable Mean	0.387	55.92

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,**
p<0.05,

*
p<0.1. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment in the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

Table 6

Impact of Different Years of CDHP Enrollment On Screening in Any of the Three Post Years

	(1)	(2)	(3)
	3 Post Years Enrollment 2SLS		
Panel A: Breast Cancer			
CDHP in at Least 1 Post Year	0.0148 (0.0266)		
CDHP in at Least 2 Post Years		0.0226 (0.0435)	
CDHP in All 3 Post Years			0.0301 (0.0582)
Observations	209,062	209,062	209,062
R-squared	0.109	0.109	0.109
Dependent Variable Mean	0.666	0.666	0.666
Panel B: Cervical Cancer			
CDHP in at Least 1 Post Year	-0.00863 (0.0211)		
CDHP in at Least 2 Post Years		-0.0132 (0.0299)	
CDHP in All 3 Post Years			-0.0178 (0.0389)
Observations	332,871	332,871	332,871
R-squared	0.124	0.124	0.124
Dependent Variable Mean	0.765	0.765	0.765
Panel C: Colon Cancer			
CDHP in at Least 1 Post Year	0.00463 (0.0223)		
CDHP in at Least 2 Post Years		0.00721 (0.0342)	
CDHP in All 3 Post Years			0.00996 (0.0481)
Observations	154,027	154,027	154,027
R-squared	0.050	0.050	0.050
Dependent Variable Mean	0.387	0.387	0.387

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,**
p<0.05,*
p<0.1. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment in the three post years. Control group is those who are never offered a CDHP and had deductibles

lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variables.

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Impact of CDHP Enrollment On Screening in Any of the Three Post Years, Stratified by Predicted Number of Post Year Office Visits, Shift in Deductible, and Age

Table 7

	(1) Low OV	(2) High OV	(3) Low Deductible Change	(4) High Deductible Change	(5) Age 40–44	(6) Age 45–49	(7) Age 50+
Panel A: Breast Cancer							
CDHP in at Least 1 Post Year	0.00744 (0.0229)	0.0236 (0.0322)	0.0354 (0.0247)	−0.0384 (0.0345)	0.0217 (0.0263)	0.0219 (0.0285)	0.00963 (0.0286)
Observations	104,531	104,531	204,200	202,944	60,867	62,628	85,490
R-squared	0.134	0.050	0.109	0.108	0.091	0.104	0.125
Dependent Variable Mean	0.595	0.734	0.666	0.664	0.640	0.661	0.687
Panel B: Cervical Cancer							
CDHP in at Least 1 Post Year	0.00344 (0.0208)	−0.0239 (0.0216)	−0.00282 (0.0242)	−0.0274 (0.0316)			
Observations	166,436	166,435	325,597	323,103			
R-squared	0.149	0.082	0.124	0.124			
Dependent Variable Mean	0.718	0.811	0.766	0.765			
Panel C: Colon Cancer							
CDHP in at Least 1 Post Year	0.0249 (0.0232)	−0.0235 (0.0207)	−0.00586 (0.00880)	0.0374 (0.0313)	50–54 0.00353 (0.0154)	55–59 −0.00357 (0.0367)	60+ 0.0495 (0.0773)
Observations	77,014	77,013	150,463	150,278	83,287	60,922	9,792
R-squared	0.051	0.029	0.051	0.050	0.053	0.049	0.054
Dependent Variable Mean	0.328	0.444	0.387	0.387	0.385	0.389	0.387

Notes: Unit of observation is person. Analysis is run for the three years after CDHP offer.

p<0.01,

**
p<0.05,

*
p<0.1. Standard errors are clustered at the firm level. Second stage coefficients from a two-stage least squares model is presented where CDHP offer is the instrument for CDHP enrollment in the three post years. Control group is those who are never offered a CDHP and had deductibles lower than \$500. Controls include age, gender (where appropriate), family type indicators, an indicator for being in the oil or manufacturing industry, zip code characteristics (median HH income, % unemployed, % college, % HS, % Hispanic, % black, % white), 5 level census region, an indicator for being in an MSA, and MDC indicator variable.