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DOES HIGH COST-SHARING SLOW THE LONG-TERM GROWTH RATE OF HEALTH SPENDING? EVIDENCE FROM THE STATES

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ABSTRACT

Multiple studies have shown that high-deductible health plans lower spending levels, however, less is known about whether such plans have an effect on spending growth. We begin with a model of the relationship between levels of insurance coverage and both spending levels and spending growth, highlighting the role of new technology adoption in the latter. Next, we leverage cross-sectional variation in private deductibles across states (and over time) to estimate whether areas with relatively higher deductibles experience lower spending growth. We use publicly available data from the Centers for Medicare and Medicaid Services and the Agency for Healthcare Research and Quality from 2002-2016, a period during which deductibles among privately insured employees more than tripled in magnitude and real spending growth exceeded 40%. Consistent with prior empirical work, we find that current period spending growth is significantly lower in states with higher deductible levels but non-responsive to changes in such levels over time. We observe these relationships in models of both private and total spending (including that on behalf of publicly insured and uninsured individuals), suggestive of potential spillovers. Future work should explore the role of other plan benefit characteristics in explaining spending growth and mechanisms underlying any observed effects.

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1 Introduction

Many empirical studies of health insurance establish that, when an individual or a population moves from a private health plan with moderate cost sharing to one with a high deductible, spending falls, compared to what would have happened had people remained in the original plan. This reduction in spending has been tracked over at most one or two additional years. However, evidence on what happens to spending growth rates for populations with longer-term persistence of high cost sharing plans is scant. No one knows whether such insurance can bend the cost curve for an extended period. If we assume that a major reason for growth in spending per capita over time is not demographic change but rather is the adoption and diffusion of more beneficial but more costly technologies, the potential impact of insurance coverage on that choice is of primary interest.

This long-term spending growth question has only been explored using the time series of national aggregated data, comparing growth in national health expenditures (NHE) or personal health expenditures (PHE) to the level of out of pocket spending (across public and private insurance) (Newhouse 1978, 1988, 1992, 1993; Peden and Freeland, 1998). Not only do these older analyses concern forms of cost sharing that have been eclipsed by others (namely, the federally-regulated high deductible health plan [HDHP] that can be linked to a tax shielded spending account), the necessarily small number of observations with nationally aggregated data and likely changing environmental characteristics in a time series limit the power of such analyses.

In this paper, we leverage cross-sectional variation across states (as well as over time) in the proportion of privately insured people covered by plans with high deductibles. We relate that variation to the growth of total spending (across the entire population), thus capturing any spillover effects of changes in plan generosity for a large segment of the population on spending growth for the entire population. We also focus on the direct effect of private insurance deductibles on privately insured spending growth, to provide an estimate of spending and private premium growth reduction linked to high deductible plans.

We find that current period medical spending growth, both over all persons and for the privately insured, is significantly lower in states with higher deductible *levels* than in those with lower levels. In contrast, as in Peden and Freeland (1998; henceforth PF), we do not find a significant negative effect of *changes* in deductibles on contemporaneous spending growth. These findings are robust despite the absence of a positive correlation between the level of high-deductible insurance penetration and the rate of growth in that penetration, and the lack of a correlation between the level of spending and the rate of growth of spending.

2 Conceptual Issues

2.1 Coverage Levels and Spending Levels

It is well established that, at the individual- or insurance plan-level, raising out of pocket (OOP) payments (by increasing an annual deductible) will lower spending levels for a time period or two after the change, relative to what they were before the change. In empirical studies, a high deductible treatment group is typically compared to a (usually low deductible) control group that experienced no change in cost sharing provisions in their insurance plan (for a recent example, see Haviland et al., 2016).

This finding of lower levels of spending after switching to a HDHP is consistent with the standard theory of moral hazard: the higher average user price reduces the quantity demanded (Pauly, 1968). This prediction and this analysis are simplest under the assumption that the set of services available (the technology) is unchanged from period to period. To see this, consider the following example.

Suppose that the initial distribution of medical expenses, x, in the population has the density $f(x)$, and both consumers and actuaries believe that the distribution in the following period will remain the same. In other words, any change in coverage does not change spending in any state of health (there is no moral hazard). The actuarial value (AV) of benefits under an initial deductible, e.g. $500, takes the form:

$$AV = \int_{500}^{\infty} f(x - 500)dx$$

It follows that the actuarially fair premium is as shown below, where λ is a positive proportional loading cost:

$$P = (1 + \lambda) \times AV$$

If the deductible were to increase to $2500 and there is no moral hazard, the AV expression becomes:

$$AV = \int_{2500}^{\infty} f(x - 2500)dx$$

If there is no moral hazard, the expected OOP payments for a consumer with medical expenses x remains the lesser of $500 and x for x up to $500, increases to the lesser of $2500 and x for x between $500 and $2500, and increases from $500 to $2500 for x in excess of $2500. If there is a moral hazard response to the coverage change, there should be no change in spending for the first range just described, but the value of x and the expected benefits and OOP payments will decline for at least some values of x above $500. Thus, a test of the moral hazard hypothesis is whether the expected benefits (or premiums) fall by more than the decline in AV that would be expected with the original distribution of spending, $f(x)$.

2.2 Coverage Levels and Spending Growth

Note that the theory above is a static theory: it does not consider changes in either unit prices or products over time. Such evidence as we have on spending growth in the US and in all other countries is consistent with the accounting identity– that it is composed of changes in unit prices and changes in quantity. However, the primary component of change in quantity comes from the introduction and use of new technologies, not from changes in volumes per capita of existing services using current technology (Weisbrod, 1991; Chandra and Skinner, 2012). The impacts of demographic changes on quantity are small, while per capita rates of use of specific existing services ebb and flow, but on average change little (Papanicolas et al., 2018). It is also important to note that technology itself is not wholly exogenous and may be endogenous to income growth, changes in tastes, changes in insurance, or prices.

Hence, any relationship of insurance coverage *levels* to spending *growth* depends on whether the level of coverage affects the adoption and utilization rates of new technology, and the rate of growth in unit prices. On the former point, it is plausible (but so far unproven) that higher cost sharing (compared to lower) will deter the rate of use of new and beneficial but (incrementally) costly new technologies, the extent depending on the level and distribution of value-added by that technology. It is less clear whether there should be an insurance relationship with growth of unit prices because it is unclear what causes prices to increase. Monopoly power causes price levels to be high relative to perfect competition, but not to increase; price increases require increasing monopolization or some change in marginal cost of production (in excess of economy wide inflation). It is also plausible that higher cost sharing (compared to lower) will increase the average consumer's demand elasticity and thus deter price increases in response to increases in marginal cost, but in a study of one high deductible plan, Brot-Goldberg et al. (2017) found no evidence of increased price shopping. To reiterate, a higher demand elasticity alone will only mean that price levels are lowered when elasticity changes, not that they increase less rapidly.

Treating the increase in availability of new technology as both exogenous and constant over time, we can then predict in the aggregate time series that spending growth should be lower with higher levels of cost sharing (e.g. higher deductibles). Figure 1 shows how to combine these insurance effects to generate a predicted pattern of spending growth over time when a high deductible plan is introduced. The top solid line shows the time path of total spending and the bottom solid line shows the amount of spending on new technology. Prior to Period 4, total spending is increasing at a rate of two units per period. At the beginning of Period 4, coverage for the population changes to a higher deductible, which reduces spending on both existing and new technology by half. This reduces spending on existing technology by three units (two in Period 4 and one in Period 5) and slows the adoption of new technology to from two units to one unit per period. The corresponding path of spending growth reflects an absolute reduction in spending in Period 4, a constant level in Period 5 (i.e. zero growth), and then growth by one spending unit per time period thereafter. This pattern of absolute decline, zero or very low growth during a period of adjustment, and a low but constant amount of growth thereafter, is what would be predicted by this model. The actual pattern depends on the effect of lower spending on both existing and new technology (which does not have to be a uniform change or elasticity) and the pattern and time of adjustment for the reduction in old technology. Empirically, the pattern in this illustration would show up as a large reduction in spending growth (compared to low deductible coverage) in the two periods after the deductible is increased, and then a smaller but persistent reduction in relative spending growth tied to the new higher deductible after that. If total spending instead tracked the dashed line after Period 3, with no drop in spending after the change in coverage but a new change in long-term growth, that would be consistent with the hypothesis that the higher deductible only affected spending on new technology.

Note that in this example it is the absolute amount of change rather than the percentage rate of change that is assumed to be affected. We could also add, as many have, that there should be feedback from lower demand to lower investment in new technology. However, with state cross section data, it is most reasonable to assume that access to any new technology will be roughly similar across states and any reduction in coverage in a given state will have a negligible effect on that access - any provider in any state can buy or order the latest piece of equipment or new drug.

One unknown, however, is whether new technology is made available nationwide (or worldwide) at a constant amount or rate per year. Probably there is variation in the rate of introduction - we certainly know that is true for the number of new drugs FDA approved each year - but beyond random fluctuation there is no developed model of the determinants of supply of new technology. Since the assumption of nationally uniform availability of technology implies that there should be no cross-state differences in spending growth related to innovation, we cannot test the hypothesis that technology influences spending growth in the cross section, and we have few years for a national aggregate time series.

One way to think about these kinds of effects of changes in cost sharing is to imagine that they raise the user price of existing services rendered using old technology and would imply a decrease in spending even if no new technology was supplied. That is, the level of deductible affects the rate of addition or diffusion of new technology, while the change in deductible (conditional on the starting level) reflects reductions in spending on old technology.

3 Methods

3.1 Data and Measures

The advent of high deductibles has been primarily limited to employment-based group insurance, though the Bronze and Silver exchange plans often require high dollar amounts to be paid up front. However, the most accurate state-level data on spending (and its growth rate) reflect spending financed from all sources. For those with group insurance, there is instead data on the amount of benefits paid per insured person per year. We will show that these data can be used to provide estimates of the growth in group insured spending. However, our baseline empirical model is one that uses growth in total spending per person in a state (including those with public, other private coverage, and no coverage) as the dependent variable, and looks for a relationship with group insurance deductibles and other factors. Since private group insurance covers more than half of all Americans, we might expect to find some relationship.

For this spending data, we rely on the State Health Expenditure Accounts (SHEA), an extension of the National Health Expenditure Accounts (NHEA), which are maintained by the US Centers for Medicare and Medicaid Services (CMS) and considered to be the official estimates of total health care spending in the country. The SHEA are estimated at the "Personal Health Care (PHC)" level and capture the consumption of all health care goods and services in all states across the country. Administrative costs associated with insurance provision, public health activities, and health investment funds are excluded. The SHEA estimates of PHC spending are available by payer (all-source, Medicare, Medicaid, private) and by disaggregated service categories (e.g. hospital care, prescription drugs).

The 1991-2014 SHEA are publicly available and can be found online along with detailed documentation of the methodology behind the data. Of note, private health insurance (PHI) expenditures in the SHEA are derived from information on premium payments, where net cost ratios[1] are applied to derive PHI spending (or benefits). That is, the SHEA contain a measure of benefits paid by private insurers for spending on insured services but no separate measure of the insured's out of pocket spending on those services and hence no measure of *total* spending on privately insured services nor its rate of change. For the purposes of this study, we utilized the 2002-2014 SHEA; summary statistics for select spending measures are provided in Table 1, including both total spending and spending per capita/enrollee. With the exception of Medicaid spending per capita, all spending measures increased considerably over the data window, with the greatest growth observed in private spending.

[1]Net costs include administrative expenses, changes in reserves, and profit margins.

Our other primary data source, for details of private insurance coverage by state over time, is the Medical Expenditure Panel Survey (MEPS). The MEPS is a national, annual, large-scale survey administered by the Agency for Healthcare Research and Quality (AHRQ). It includes two major and separate components: the household component (HC) and the insurance component (IC). The HC collects data from families and individuals across the country on their health care utilization and costs, and the IC collects data from about 40,000 public and private sector employers on the health benefits offered to employees. For this study, we use the 2002-2016 MEPS IC and focus on those data provided by private-sector employers only. Data were not collected for the MEPS IC in 2007, so we impute such data with means of 2006 and 2008 values for relevant variables. We construct measures of average premiums and deductibles by state-year using enrollment-weighted means of such measures for single-person and family coverage. In the case of deductibles, we construct both conditional and unconditional averages. The conditional measure is the average deductible among those with a positive deductible; the unconditional measure multiplies that by the proportion of individuals with a positive deductible. The unconditional average deductible is our preferred summary measure of private insurance generosity for a given state-year.

Summary statistics for our measures from the MEPS IC can be found in Table 2. Of note, the proportion of employees with a positive deductible increased from 52% to 88% from 2002 to 2016. Average conditional deductibles also increased substantially from $395 to $1,443 for single coverage and from $848 to $2,663 for family coverage.

We also draw upon the Current Population Survey (CPS) for state-year-level data on health insurance coverage rates. The CPS is conducted by the US Census Bureau for the Bureau of Labor Statistics, with data used in official reports of uninsured rates through 2012. The CPS health insurance questions were redesigned in 2013 and the Census Bureau advises against naively combining both versions of the data. Due to this data limitation, models with controls from the CPS only use data from 2002-2012.

Finally, we elected to create two groups of small states (due to populations below 1 million) for purposes of analysis. We combined Delaware, the District of Columbia and Vermont into an eastern group, and North Dakota, South Dakota and Wyoming into a western group and generated a weighted average deductible with weights based on the relative size of the state's employee population in the MEPS IC each year. We also exclude Alaska due to the large share of government spending on behalf of the states Native American population. This results in a total of 46 observations per data year (44 states plus two state groups), with the exception of the 2002 MEPS IC, where the effective sample size is 43 due to missing data for a subset of states.[2] The total number of observations is thus 598 for the 2002-2014 spending data (13 * 46) and 687 for the 2002-2016 MEPS IC data (15 * 46 3). Models relying on measures from both datasets will naturally use the years of overlap.

All dollar measures (spending, deductibles, and premiums) are adjusted for inflation using the Gross Domestic Product (GDP) index from the Bureau of Economic Analysis, a part of the US Department of Commerce. Dollar amounts reported throughout the tables are in 2014 US Dollars. Percent changes are calculated using the difference in natural logs.

One advantage of looking at data at the market aggregated level (as in an entire state) is that doing so attenuates the problem of self-selection bias present in individual insurance data (Van de Ven and Van Praag, 1981), whether the potential cause of changes in spending is the level or change in deductible. While HDHPs may be chosen more frequently by those who are lower risk or who expect to have smaller levels of spending next period, market data will reflect the overall "intent to treat" effect of increasing the average deductible over all insureds with group coverage. Even if some people switch coverage in anticipation of unusually high or low future spending (while others remain in high or growing deductible plans), any impact of the average change will be present in the aggregated data. Another advantage of looking

[2]The 2002 MEPS IC has missing data for eight states: AK, AR, DC, ID, ND, RI, SD, and VT. Missing data for Alaska is irrelevant as the state is dropped from all analyses. Four other states DC, ND, SD, and VT are in groups with another state that has non-missing data and is used to represent the entire group for 2002. Thus, we effectively lose three observations from the ideal 46 (AR, ID and RI).

at data at the state rather than national level is that any potential influence of feedback from future expected cost-sharing on industry R&D investment in new products (an issue raised by PF) should be minimized, since providers in all states presumably have the same access to current technology. Finally, any time series effects should be uniform across states.

3.2 Regression Model

To derive an empirical regression equation to estimate based on the above model, we first posit that health spending in state i in year t is equal to the sum of spending on old and new technology. Formally, let "old" technology be technology introduced *prior* to the data window (i.e. before $t = 1$) and let "new" technology refer to technology introduced *within* the data window:

$$x_{it} = \text{old}_{it} \ + \ \text{new}_{it}$$

Next, we specify spending on old technology to be equal to a constant plus an additional amount that depends linearly on the deductible in state i in year t, denoted d_{it}:

$$\text{old}_{it} = \alpha + \beta \ d_{it} \tag{1}$$

We hypothesize that a state's spending on new technology introduced in period t is equal to a fraction θ_{it} of the constant per-period amount of new technology available, F. We further hypothesize that this fraction adopted is a function of the state's average deductible in that year. It follows that a state's spending on new technology introduced since $t = 1$ can be expressed as:

$$\text{new}_{it} = \sum_{t=1}^{t} \theta_{it} \cdot F \tag{2}$$

Together, Equations (1) and (2) imply the following equation for spending levels:

$$x_{it} = \alpha + \beta\ d_{it} + \sum_{t=1}^{t} \theta_{it} \cdot F \tag{3}$$

Before proceeding, it is worth noting that Figure 1 (and the accompanying discussion) considers "new" technology to be exclusively that introduced in the current period, while "existing" technology is any technology introduced prior to the current period. We can easily re-express Equation (3) to be consistent with this terminology:

$$x_{it} = \underbrace{\alpha + \beta\ d_{it}\ +\ \Sigma_{t=1}^{t-1}\theta_{it} \cdot F}_{Existing}\ +\ \underbrace{\theta_{it} \cdot F}_{New}$$

Returning to the derivation of our estimating equation, we difference Equation (3) to obtain:

$$\Delta \mathrm{x}_{it} = \beta\ \Delta d_{it} + \theta_{it} F$$

Next, consider the following specification for θ_{it}, where δ is sufficiently small to ensure $\theta_{it} \in [0, 1]$:

$$\theta_{it} = 1 - \delta\ d_{it}$$

Substituting the above expression for γ_{it} into equation (3):

$$\begin{aligned}
\Delta \mathrm{x}_{it} &= \beta\ \Delta d_{it} + (1 - \delta\ d_{it})F \\
&= \beta\ \Delta d_{it} + (1 - \delta\ d_{it})F \\
&= \beta\ \Delta d_{it} + F - (\delta \cdot F)\ d_{it} \\
&= \alpha' + \beta\ \Delta d_{it} - \delta'\ d_{it}
\end{aligned}$$

The final equation above is our preliminary estimating equation, where $\alpha' = F$ and $\delta' = \delta \cdot F$.

Accounting for other possible time-varying influences on spending (vector Z) and an econometric error yields the complete estimating equation:

$$\Delta \mathrm{x}_{it} = \alpha' + \beta \ \Delta d_{it} - \delta' \ d_{it} + \gamma Z_{it} + \epsilon_{it} \tag{4}$$

In our models, we operationalize $\Delta \mathrm{x}_{it}$ as the change in a spending category or in private group insurance premiums since the previous year, measured as either a percent or dollar change. Spending categories include different payers (privately insured, all payers) as well as different service types (e.g. hospital, drug), and we consider both aggregate and per capita spending. As overall spending should respond to changes in OOP payment from public plans, largely driven by growth in Medicaid coverage and corresponding reductions in the uninsured rate, we include as controls both the level and the change in the state's proportion with Medicaid and proportion uninsured. We do not include as controls measures corresponding to influences that are uniform nationwide such as NIH spending or Medicare coverage and reimbursement.

In all models we utilize robust standard errors clustered by state to account for potential heteroscedasticity and intra-state correlations over time.[3]

4 Results

4.1 All-Source Spending Growth

We begin with an analysis intended to replicate the PF model in Table 3. In Columns 1-5, we relate deductible levels and changes in deductibles in private insurance to changes in spending per capita over all payers, in the spirit of PF. We find a significant negative effect

[3]We explored adding state fixed-effects to our models in the event that there are unobserved time-invariant factors that influence state spending over time (e.g. propensity to adopt new innovations despite uniform availability nationwide, as documented by Skinner and Staiger, 2005). Their inclusion primarily improves model fit statistics (F, R-squared), with negligible to modest effects on point estimates.

of the level of that deductible on overall spending, but a positive or insignificant sign on the change in deductible using both absolute dollar changes and percentage changes (Columns 1 and 2, respectively). This result is consistent with the hypothesis that the most significant effects of higher private deductibles is on the rate of growth in spending on costly new technology but that deductibles have no significant effects on spending on services based on existing technology. Given the qualitatively similar results, we employ percentage changes for all other models in the table.

We add the Medicaid and uninsured controls to the regression in Column 3. We find both the change in the proportion of the population with Medicaid and (anomalously) the change in the proportion uninsured to be associated with greater spending growth. Conversely, greater Medicaid enrollment is associated with lower spending growth. Medicare enrollment (and its change) was not significant, nor did it affect other coefficients, so is not included in these regressions. We retain these additional insurance controls for the remaining models in the table.

Columns 4 and 5 disaggregate growth in total spending into hospital and drug spending, respectively. The level of deductibles slows drug spending to a much greater extent than hospital spending (where it is negative but non-significant), consistent with the hypothesis that new technology is both more prevalent and more subject to consumer incentives in the former. We also consider the relationship between private plan deductibles and growth in aggregate spending in public (non-private) plans in Column 6. Here we find evidence of a significant spillover from high levels of private deductibles to public spending growth, and also an effect of the uninsured level, Medicaid level and Medicaid growth.

In summary, the main takeaway from Table 3 is that the explanatory variable with a consistent and significant association with lower overall state spending growth is the (log of) the average level of deductible among those with group insurance in the state. The change in the average deductible and the change in the proportion uninsured do not appear to significantly reduce spending growth. The absence of a significant negative effect for the change in coverage generosity (as measured by deductibles), controlling for the level of that coverage, is the same result as was found by PF.

4.2 Premiums and Benefits per Capita for those with Private Group Insurance

If we consider the effect of instituting a deductible or increasing an existing deductible, the change will lower expected benefits if the mean and distribution of insured spending remains constant; in other words, a higher deductible will lower the actuarial value of coverage all else equal. If per capita premiums bear a proportional relationship to per capita benefits, those reductions in the actuarial value of benefits should translate into proportional reductions in premiums. However, if an increase in deductibles reduces moral hazard applied to old or existing technologies, for which a portion of spending falls above the deductible, the level of total spending will fall. In this case, the fall in premiums should be greater than the fall in the actuarial value of benefits.

The results of regressions relating changes in premiums per person (from the MEPS IC) to the levels and changes in unconditional deductibles are shown in the first four columns of Table 4. The first two columns use percent changes in premiums and deductibles while the second two columns use dollar changes. Columns 1 and 3 show the change in the unconditional deductible, and Columns 2 and 4 show the result of breaking that variable into its component parts, the change in proportion with a positive deductible and the change in deductible conditional of having an initial positive deductible. In all four columns, the level of the deductible is highly significant. When the deductible changes, all four models indicate a negative impact on premiums, though only the models with changes expressed in dollars achieve statistical significance.[4] However, the coefficient on the change in conditional

[4]Note that this significant result is not robust to shortening the data window from 2002-2016 to 2002-2014.

deductible (in either specification) is not large enough relative to the change in actuarial value of benefits to indicate a moral hazard effect on current technology spending at the levels of deductible that commonly prevailed.

The final two columns of Table 4 show analogous results with estimated percent changes in private spending per capita (from the SHEA data) as the dependent variable. Recall that this measure is estimated from data on PHI premiums (and assumptions about insurer markups and coverage) and is not based on the same sample underlying the MEPS-based measures of deductibles and premiums. This measure still displays a significant coefficient on the unconditional level of deductibles, but now the contemporaneous change in deductibles is not significant regardless of how it is measured. We also explored using a measure of change in actuarial value based on a distribution of spending observed in a single year of the MEPS HC (instead of the change in deductible) and explored adding multiple lags of the change in deductible (results not shown). In both cases, we found no evidence of impact.

5 Discussion

These results strongly confirm the main PF hypothesis - that high levels of cost sharing (in this case in the form of deductibles) are associated with lower rates of growth of spending. This finding is an interesting combination of the static and dynamic behavior, in that the level of one variable affects the rate of change of anotherbut that is what our model of new and old technology implies. In contrast, the change in cost sharing as measured by the change in deductible levels does not have a significant effect on total spending or on spending by group insureds. However, it does sometimes have the expected significant negative effect on the growth of private insurance benefits, but the small magnitude of the change is consistent with a hypothesis of no significant effect on spending on old technology.

Given that the annual changes in deductibles were relatively modest during this period (about 11% per year on a base of about $1120), it is perhaps not surprising that we did not find a statistically significant effect for those changes, consistent with the view of both PF and Chernew and Newhouse (2011). Moreover, the RAND experiment had shown that the bulk of the negative effects of deductibles on spending arise from moving from zero deductible to relatively small positive deductibles, again not surprising because at higher deductible levels, any increase in that level affects a smaller and smaller fraction of total spending (that above the previous deductible).

Our results could also be due to other causes. If there are statewide differences in the rate of adoption of high deductible plans related to statewide differences in responsiveness to coverage, there could be "(adverse) selection on moral hazard" (Einav et al., 2013). If so, the absence of a response to changes over time in deductibles would imply that less responsive (to cost-sharing) individuals were moving to higher deductible plans, which may or may not be a plausible story. Finally, it is possible that other types of changes in plan generosity, such as increases in copayments and coinsurance rates, might have a larger or stronger effect on the growth in spending.[5] Future work should explore these relationships further, including other features of plan benefit design, such as cost-sharing arrangements for specific services.

[5]Additional measures of office visit copayments are also available within the MEPS IC. In exploratory analyses, we related levels and changes in such measures to spending growth, controlling for deductible levels and changes. We did not observe meaningful nor significant relationships to private spending growth, and suggestive evidence that total spending growth is lower in areas with higher office visit copay levels.

References

Brot-Goldberg, Z. C., Chandra, A., Handel, B. R., & Kolstad, J. T. (2017). What does a deductible do? The impact of cost-sharing on health care prices, quantities, and spending dynamics. *Quarterly Journal of Economics*, 132(3), 1261-1318.

Chandra, A., & Skinner, J. (2012). Technology growth and expenditure growth in health care. *Journal of Economic Literature*, 50(3), 645-80.

Chernew, M. E., & Newhouse, J. P. (2011). Health care spending growth. In *Handbook of Health Economics* (Vol. 2, pp. 1-43). Elsevier.

Einav, L., Finkelstein, A., Ryan, S. P., Schrimpf, P., & Cullen, M. R. (2013). Selection on moral hazard in health insurance. *American Economic Review*, 103(1), 178-219.

Haviland, A. M., Eisenberg, M. D., Mehrotra, A., Huckfeldt, P. J., & Sood, N. (2016). Do "consumer-directed" health plans bend the cost curve over time?. *Journal of Health Economics*, 46, 33-51.

Newhouse, J. P. (1978). The erosion of the medical marketplace. Santa Monica, CA: Rand Corporation.

Newhouse, J. P. (1988). Has the erosion of the medical marketplace ended?. *Journal of Health Politics, Policy and Law*, 13(2), 263-278.

Newhouse, J. P. (1992). Medical care costs: how much welfare loss?. *Journal of Economic Perspectives*, 6(3), 3-21.

Newhouse, J. P. (1993). An iconoclastic view of health cost containment. *Health Affairs*, 12(suppl 1), 152-171.

Pauly, M. V. (1968). The economics of moral hazard: comment. *American Economic Review*, 531-537.

Papanicolas, I., Woskie, L. R., & Jha, A. K. (2018). Health care spending in the United States and other high-income countries. *JAMA*, 319(10), 1024-1039.

Peden, E. A., & Freeland, M. S. (1998). Insurance effects on US medical spending (19601993). *Health Economics*, (8), 671-687.

Skinner, J., & Staiger, D. (2005). Technology adoption from hybrid corn to beta blockers. NBER Working Paper No. 11251.

Van de Ven, W. P., & Van Praag, B. M. (1981). The demand for deductibles in private health insurance: A probit model with sample selection. *Journal of Econometrics*, 17(2), 229-252.

Weisbrod, B. A. (1991). The health care quadrilemma: an essay on technological change, insurance, quality of care, and cost containment. *Journal of Economic Literature*, 29(2), 523-552.

Tables and Figures

Figure 1: Spending Growth Following a Coverage Change

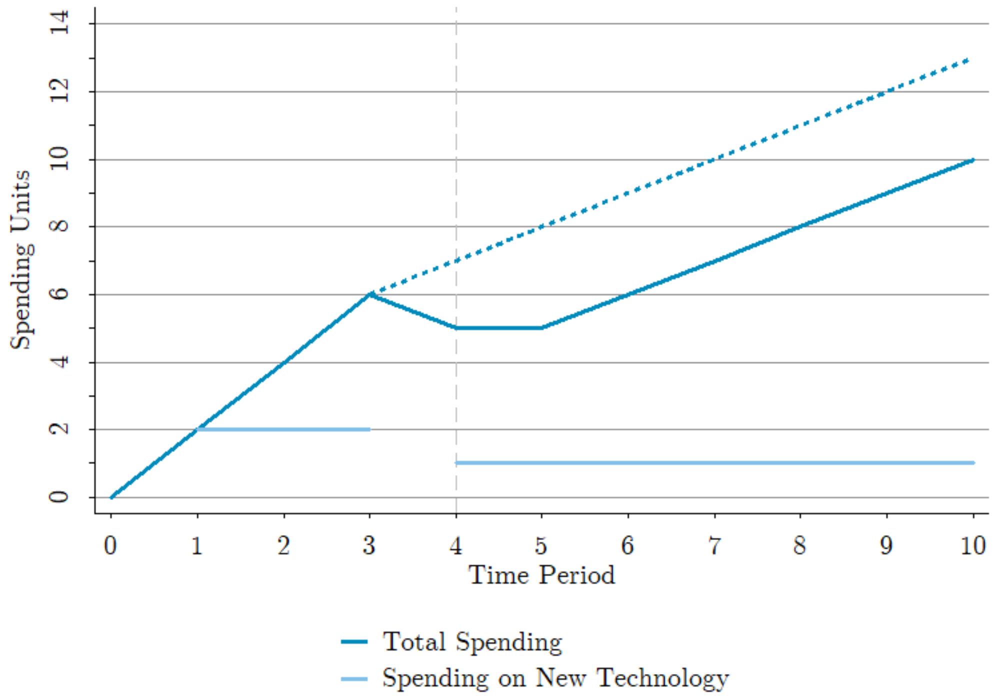

Table 1: Average Spending across States by Category and Year

	All Payer	Private	Medicaid	Medicare	Hospital	Drug†
Total Spending ($ Millions)						
2002						
N	46	46	46	46	46	46
Mean	37,550	13,387	6,309	7,071	13,327	5,267
Std. Dev.	38,106	13,221	8,055	7,567	13,288	5,063
2014						
N	46	46	46	46	46	46
Mean	54,915	18,751	9,578	12,497	20,970	7,631
Std. Dev.	56,974	19,702	11,799	13,221	21,005	7,935
2002-2014						
N	598	598	598	598	598	598
Mean	47,043	16,387	7,776	10,075	17,300	6,648
Std. Dev.	48,269	16,573	9,688	10,875	17,278	6,671
Spending per Capita/Enrollee ($)						
2002						
N	46	46	46	46	46	46
Mean	6,072	3,095	7,740	7,743	2,180	857
Std. Dev.	735	303	2,364	1,025	272	129
2014						
N	46	46	46	46	46	46
Mean	8,142	4,442	7,156	10,383	3,202	1,115
Std. Dev.	1,102	576	1,470	1,124	528	198
2002-2014						
N	598	598	598	598	598	598
Mean	7,269	3,918	7,683	9,674	2,741	1,020
Std. Dev.	1,146	656	2,002	1,554	549	178

Source: CMS State Health Expenditure Accounts; †Additionally includes other non-durable medical products

Table 2: Average Premiums and Deductibles across States by Year

	Premiums ($)			Deductibles ($)			
	Single	Family	Average	% With	Single	Family	Average
2002							
N	43	43	43	43	43	43	43
Mean	4,066	10,715	6,880	0.520	395	848	458
Std. Dev.	255	665	397	0.173	184	382	208
2016							
N	46	46	46	46	46	46	46
Mean	5,930	17,043	9,558	0.881	1,443	2,663	1,885
Std. Dev.	328	892	488	0.100	308	574	400
2002-2016							
N	687	687	687	687	687	687	687
Mean	5,086	14,145	8,539	0.757	884	1,711	1,121
Std. Dev.	656	2,162	1,006	0.177	391	710	523

Source: Medical Expenditure Panel Survey Insurance Component; Single and family deductible values are conditional on a positive deductible.

Table 3: Models of All Source and Public Spending Growth

	All-Source Spending Per Capita					Public
	Total ($)	Total	Total	Hospital	Drug†	Spending
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Uncond Avg Deductible)	-92.67***	-0.0138***	-0.0133***	-0.00652	-0.0396***	-0.0154***
	(19.68)	(0.00265)	(0.00287)	(0.00332)	(0.00525)	(0.00388)
Change in Uncond Avg Deductible	0.0422	0.0119*	0.0126*	0.0104	0.0150	-0.00988
	(0.0448)	(0.00485)	(0.00562)	(0.00757)	(0.0114)	(0.00909)
Percent Uninsured			0.000204	-0.000445	0.00108	0.00131***
			(0.000257)	(0.000365)	(0.000660)	(0.000312)
Change in Percent Uninsured			0.00117**	0.00222**	0.00164*	0.00154
			(0.000386)	(0.000727)	(0.000709)	(0.000834)
Percent Medicaid			-0.000701*	-0.000626	-0.00133	-0.00154***
			(0.000306)	(0.000376)	(0.000683)	(0.000403)
Change in Percent Medicaid			0.00145**	0.00175*	0.000630	0.00419***
			(0.000427)	(0.000681)	(0.00102)	(0.00116)
Constant	801.8***	0.117***	0.120***	0.0910***	0.287***	0.149***
	(137.3)	(0.0186)	(0.0187)	(0.0224)	(0.0326)	(0.0221)
Observations	549	549	457	457	457	457
Adjusted R^2	0.125	0.165	0.208	0.0583	0.246	0.126
F	11.12	17.19	14.67	6.617	22.68	14.89

Standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; †Additionally includes other non-durable medical products

All spending outcomes measured as percent changes unless otherwise specified with ($) in the column header

Table 4: Models of Private Group Insurance Premiums and Spending per Capita

	Private Premiums				Private Spending	
	Percent Change		Dollar Change		Percent Change	
	(1)	(2)	(3)	(4)	(5)	(6)
Ln(Uncond Avg Deductible)	-0.0227***	-0.0230***	-139.1***	-141.8***	-0.0257***	-0.0259***
	(0.00326)	(0.00346)	(24.36)	(27.99)	(0.00358)	(0.00383)
Change in Uncond Avg Deductible	-0.0122		-0.270*		0.00163	
	(0.0137)		(0.116)		(0.0223)	
Change in Percent with Deductible		-0.0260		-88.32		-0.0187
		(0.0400)		(316.8)		(0.0690)
Change in Cond Avg Deductible		-0.00825		-0.258*		0.00464
		(0.0153)		(0.125)		(0.0231)
Constant	0.182***	0.185***	1185.1***	1205.4***	0.206***	0.207***
	(0.0235)	(0.0250)	(171.0)	(198.5)	(0.0258)	(0.0278)
Observations	641	641	641	641	549	549
Adjusted R^2	0.0689	0.0682	0.0605	0.0591	0.0541	0.0526
F	24.55	15.51	21.90	14.34	27.13	17.90

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$