What Does a Deductible Do? The Impact of Cost-Sharing on Health Care Prices, Quantities, and Spending Dynamics

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Medical Care Price Responsiveness

- Price elasticity of demand for health care services ("moral hazard") is a crucial input into many important policy decisions
  - Insurance menu offerings (e.g. ACA, large employer)
  - Design of payment structure within contract
  - National health system priorities / methods for cost control
- Recent trends:
  - 82% of employers offer HDHPs, 30% in 2015 will only offer an HDHP (up from 16% in 2014), and five year change in HDHP enrollment from 15% to 33% at employers
  - Regulation of cost sharing on ACA exchanges

Our Environment

- Study health care utilization of 160,000 employees and dependents of large self-insured firm
  - Relatively high income (Median income $125,000-150,000)
  - Approx. 70% of employees in one state / location
- The firm discontinued primary health insurance option at end of 2012, forcing most employees into high-deductible plan (HDHP)
  - Shift motivated by (i) ACA Cadillac Tax (ii) Health spending trends
  - Shift from *zero* cost-sharing to HDHP
  - Income effect compensated for
- Use shift together with detailed data to study many aspects of consumer price responsiveness

Key Questions

- Question 1: What are the effects of different marginal prices on health care spending?
  - Forced HDHP switch causes 16.5% reduction in total spending for 2013 ($123 Million)
  - *Spending reductions from sickest quartile of consumers (ex ante)*
- Question 2: How do sick/well off consumers reduce spending?
  - Provider price changes (+1.7%)
  - Consumer price shopping (+4.3%)
  - Consumer quantity reductions (-22.4%)
- Question 3: Are sicker consumers responding to true expected marginal prices or spot prices (short-run)?
  - Reductions from ex ante sick consumers when under deductible
  - Consumers reduce under deductible spending by 27%, controlling for true end of year price
  - Related work: Part D, broadband, electricity

Overview

Administrative Data

- Large firm with approximately 60,000 US employees (yearly) covering roughly 160,000 lives
- Detailed administrative data from both the insurer and HR department of the firm, covering the years 2009-2013
  - Insurance choices / design features
  - Demographic data
  - Health claims
  - Linked HR files (income, job description, etc.)
  - ACG medically relevant predictive metrics
  - Linked survey data for subset of consumers
- A lot of money at stake–firm's total health care spending in 2012 over $750 million

Policy Change

From 2009-2012 the firm had two primary insurance options:

- PPO:
  - Broad provider network
  - *Zero employee cost-sharing*
  - 80-85% market share
- HDHP:
  - Same providers
  - Linked health savings account *with direct subsidy*
  - Non-linear cost-sharing contract: consumers pay 22% on average
  - 10-15% market share
- Firm discontinued PPO option for 2013, effectively moving all employees enrolled in the PPO into the HDHP
  - First announcement October 2010, many subsequent
  - Handel & Kolstad (2015)

Insurance Options

Health Plan Characteristics **Family Tier**	PPO	HDHP
Premium	$0	$0
Health Savings Account (HSA)	No	Yes
HSA Subsidy	-	$3,750*
Max. HSA Contribution	-	$6,250**
Deductible	$0***	$3,750*
Coinsurance (IN)	0%	10%
Coinsurance (OUT)	20%	30%
Out-of-Pocket Max.	$0***	$6,250*

* These values apply to the employee-only coverage tier. Employees with no (one) dependent have 0.4x (0.8x) the values given in this table.
**Single employees have a legal maximum contribution of $3,100. Employees over 55 can contribute an extra $1,000 in 'catch-up' contribution. This maximum includes the employer subsidy.
***For out-of-network spending, the PPO has a deductible of $100 per person (up to $300) and an out-of-pocket max. of $400 per person (up to $1200).

Primary Sample

- Primary sample uses employees and dependents present over entire five-year sample 2009-2013
- Includes only those who were (i) in PPO 2009-2012 (ii) in HDHP 2013
- Internal selection concerns very limited:
  - 85% in PPO in pre-period, more than 95% of expenses
  - Robustness to different pre-horizons removes duration selection
  - Limited differential attrition
  - Much of literature relies on structural assumptions to separate AS/MH
- Excludes those enrolled in HMO option (stable 4%)

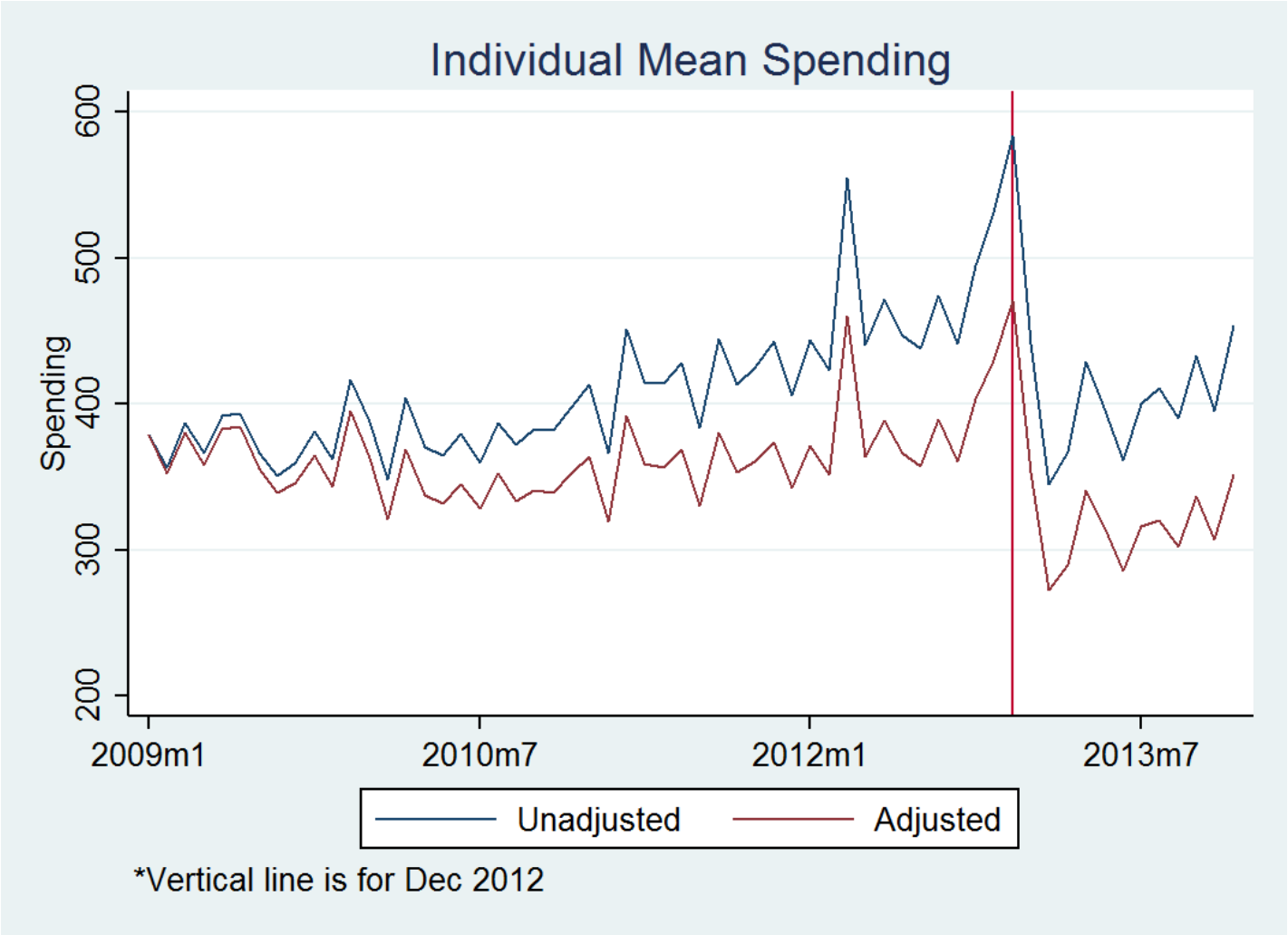
Primary Sample

	PPO or HDHP in 2012	PPO in 2012	Sample in 2012
N - Employees	52,445	44,711	31,293
N - Emp. & Dep.	147,388	129,183	97,022
Age - Emp.& Dep.			
$<$ 18	34.5%	35.3%	36.8%
18-29	12.3%	11.5%	9.8%
30-54	50.1%	50.1%	50.1%
$\geq$ 55	3.1%	3.1%	3.3%
Income			
Tier 1 ($<$ \$75K)	1.8%	1.8%	2.0%
Tier 2 (\$75K-\$100K)	6.6%	6.4%	6.2%
Tier 3 (\$100K-\$125K)	30.1%	29.8%	30.5%
Tier 4 (\$125K-\$150K)	34.9%	35.1%	35.3%
Tier 5 (\$150K-\$175K)	15.5%	15.6%	15.2%
Tier 6+ (\$175K+)	11.2%	11.3%	10.8%
Family Size			
1	23.7%	21.4%	17.8%
2	19.6%	19.1%	18.3%
3+	56.7%	59.5%	64.0%
Individual Spending, 2012			
Mean	\$5,020	\$5,401	\$5,811
25th Percentile	\$609	\$687	\$722
Median	\$1,678	\$1,869	\$1,978
75th Percentile	\$4,601	\$5,036	\$5,219
95th Percentile	\$18,256	\$19,367	\$20,201
99th Percentile	\$49,803	\$52,872	\$56,624

Overview

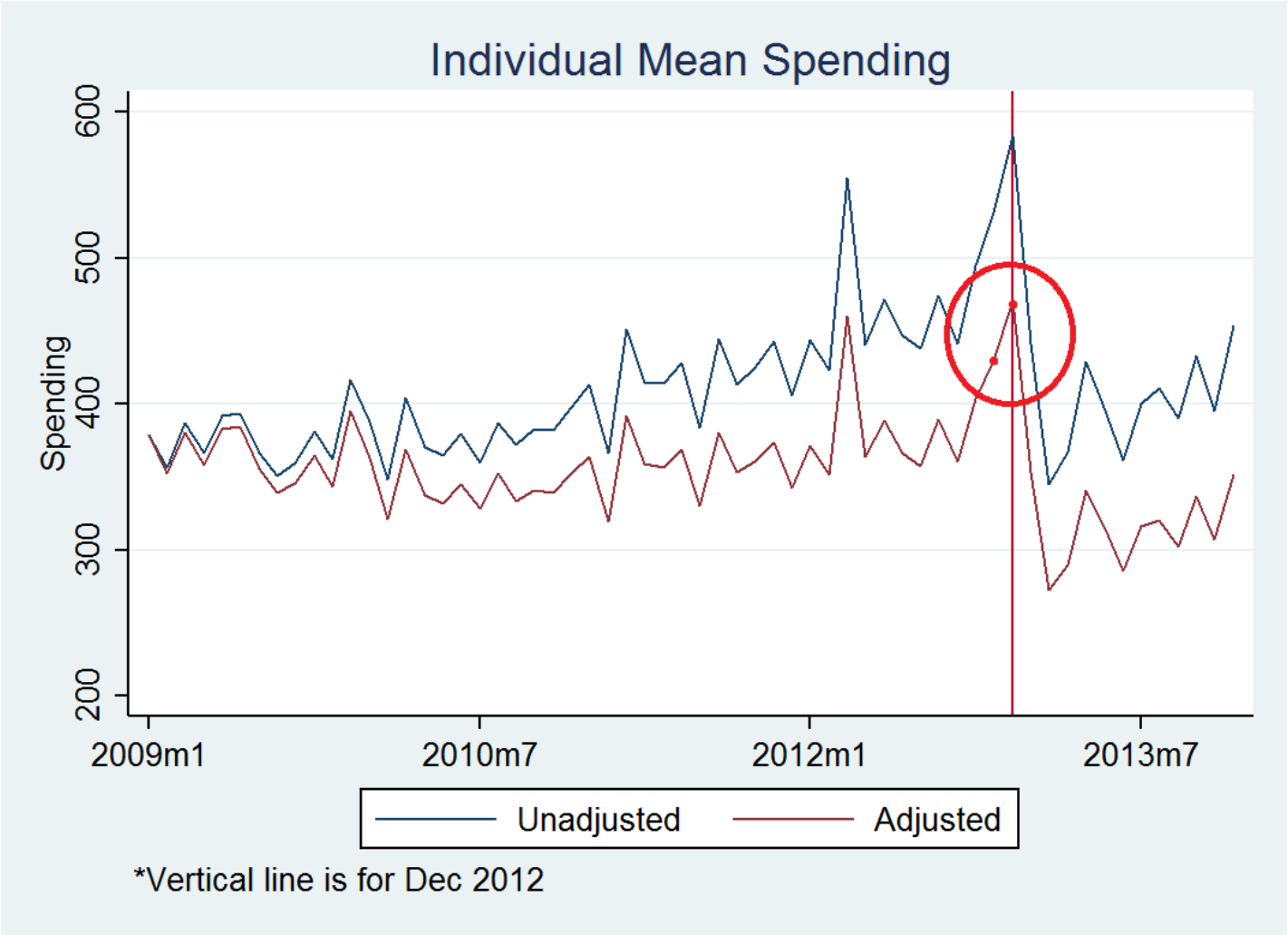
Spending Trends

19.6% drop in nominal spending, 22.9% drop in age and CPI adjusted spending



Anticipatory Spending

Anticipatory intertemporal substitution of claims is apparent, even more apparent in member *median* spending



Anticipatory Spending

Correction for Causal Estimates

- Estimate model on months from January 2009 to December 2011:

$$\bar{y}_t = \alpha + \beta t + \lambda_{month} + \bar{\epsilon}_t \quad (1)$$

- Measure anticipatory spending as deviation from predicted values

$$(y_{Nov2012} - \hat{y}_{Nov2012}) + (y_{Dec2012} - \hat{y}_{Dec2012}) \quad (2)$$

- Limited, insignificant excess mass in prior months
- Deviations from trend include anticipatory spending and idiosyncratic shock $\bar{\epsilon}$
- 95%CI for November-December 2012 'excess mass' of **[$122.57, 212.21]**, point estimate of **$167.38**

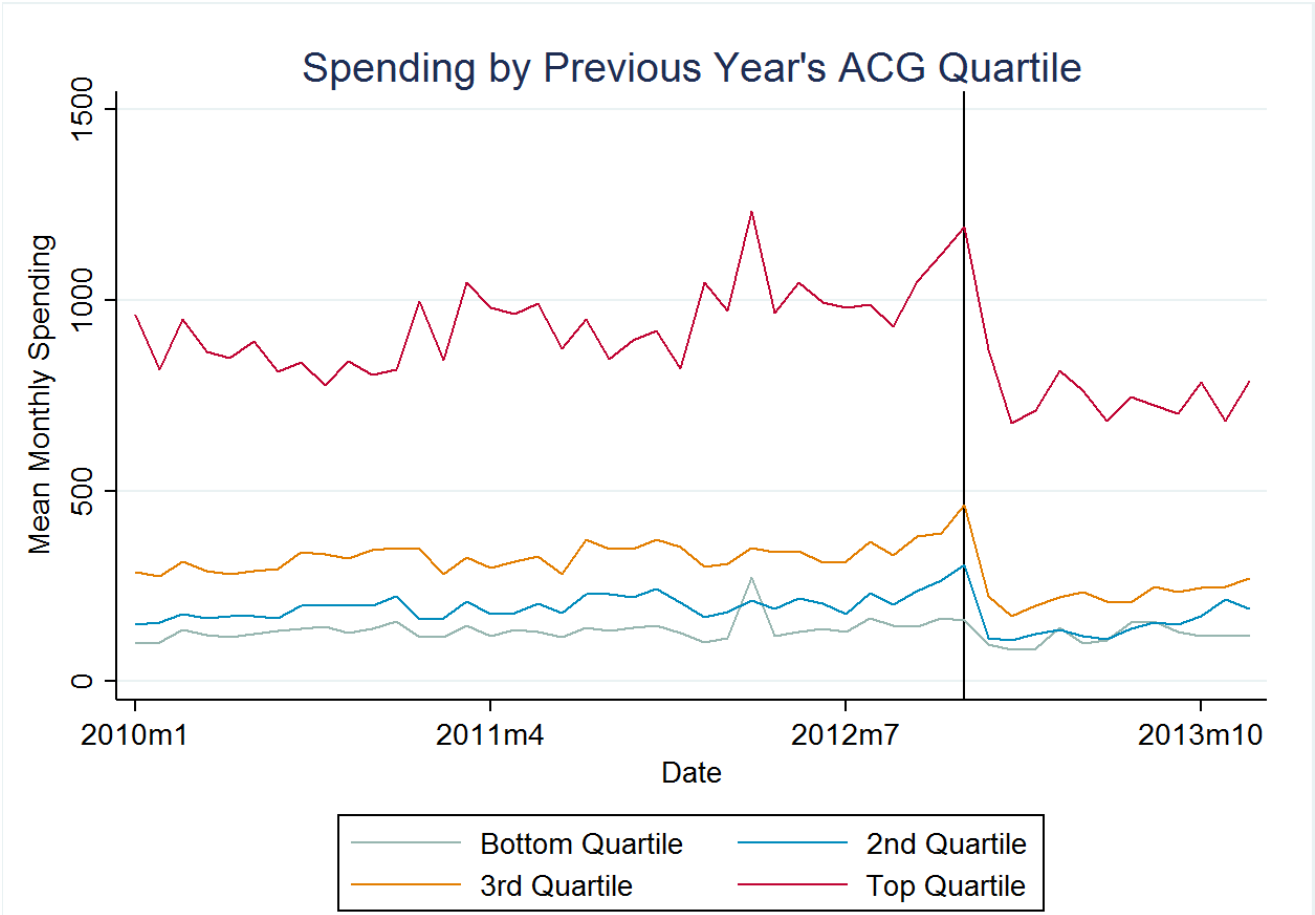
Treatment Effect of Policy Change

- Calculate 'treatment effect' taking % change in mean spending between 2012 and 2013, with adjustments
- Use treatment effect, extrapolated to whole firm, to compute % total medical savings from forced HDHP switch

HDHP Switch Spending Impact	Model			
Year	(1) –	(2) CPI	(3) Intertemp. Substitution	(4) Early Switcher Diff-in-Diff
2009	4372.54	4244.68	4244.68	–
2010	4709.95	4273.05	4273.05	–
2011	5159.41	4434.72	4434.72	–
2012	5811.48	4764.97	4597.58	–
2013	4671.73	3673.75	3841.14	–
% Decrease, 2012-2013	-19.61%	-22.90%	-16.45%	-20.12%
$ Impact (million)	-$147.09	-$171.76	-$123.40	–

Heterogeneity: Health Status

- Classify consumers into ex ante health status quartiles at beginning of each year
- Sickest consumers reduce spending by large magnitude (26%)
- Why do rich / sick consumers reduce spending?



Heterogeneity: Medical Services

Heterogeneous HDHP Spending Impact	Group %	Spending %	2012 Mean Spending	Treatment Effect (1) Nominal Spending	(2) CPI	(3) Intertemp. Substitution
Inpatient		19.20	1115.71	-0.14	-0.17	-0.09
Outpatient Hosp.		17.67	1026.84	-0.18	-0.22	-0.12
ER		2.92	169.41	-0.27	-0.30	-0.29
Office Visit		7.02	407.99	-0.19	-0.22	-0.17
RX		12.25	712.14	-0.22	-0.25	-0.22
RX-Brand		11.70	679.94	-0.20	-0.23	-0.20
RX-Generic		3.87	224.88	-0.19	-0.23	-0.21
Mental Health		9.02	524.21	-0.09	-0.13	-0.16
Preventive		8.87	515.32	-0.11	-0.15	-0.11
Other		23.06	1339.86	-0.31	-0.33	-0.24

- Relationship to income, dependants, chronic conditions

Overview

Prices vs. Quantities in Reduced Utilization

- Significant reduction in total utilization, especially for sick
- We analyze whether drop in utilization is from:
  - Providers reducing prices (potential equilibrium effects)
  - Price shopping by consumers
  - Quantity reductions by consumers
- Decompose different effects by holding prices or quantities constant (in the spirit of Oaxaca (1973), Blinder (1973))
- Analysis leverages detailed data on procedure-provider combinations to investigate
  - Over 15 observations in 2012 / 2013 (90% spending)
- Short-run analysis: 2014 coming as well

Provider Price Changes

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- Compute mean price for provider-procedure combinations in 2012 and in 2013
- Compare the following statistics:
  - Total spending for 2012 choices at 2012 prices: $TS_{2012,2012}$
  - Total spending for 2012 choices at 2013 prices: $TS_{2013,2012}$
- Provider price changes equal:

$$\frac{TS_{2013,2012} - TS_{2012,2012}}{TS_{2012,2012}} \tag{3}$$

- Not saying why prices changes happened, just that they did

Price Shopping

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- The extent to which HDHPs induce price shopping is an important policy question [e.g. Lieber (2014)]
- We compute this effect as follows:

$$PS_{m,t+1,t} = \frac{\mathbf{P}_{m,Q,t+1} \cdot \mathbf{C}_{m,Q,t+1} - \mathbf{P}_{m,Q,t+1} \cdot \mathbf{C}_{m,Q,t}}{\mathbf{P}_{m,Q,t+1} \cdot \mathbf{C}_{m,Q,t}}$$

$$PS_{t+1,t} = \Sigma_{m=1}^{M} \frac{Y_{m,t}}{Y_t} PS_{m,t+1,t}$$

- m is procedure, Q providers offering procedure
- First step is, for each class of procedures compare:
  - Mean provider-procedure prices for 2012 choices at 2013 prices
  - Mean provider-procedure prices for 2013 choices at 2013 prices
- Second step computes aggregate price-shopping effect across all procedures, holding procedure-specific revenue share constant

Price Shopping

Interpretation

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- Approach nets out provider price changes and focuses on incremental sorting given 2013 prices
  - If prices re-order over time, will bias coefficient towards more price shoping
- Our approach is *conditional on procedure*
- Could also do *conditional on episode of illness*
- Example: in our case, substitution to different procedures, that are lower price, enters through quantity impact
- With episode of illness, proecedure substitution in price shopping
- E.g. Surgery vs. management, brand vs. generic

Quantity Reductions

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- We compute % decrease from quantity reductions as remainder of total effect taking out other two mechanisms
- Compute year to year % change in total spending as:

$$\Delta TS_{t+1,t} = \frac{\mathbf{P}_{t+1} \cdot \mathbf{C}_{t+1} - \mathbf{P}_t \cdot \mathbf{C}_t}{\mathbf{P}_t \cdot \mathbf{C}_t}$$

- Effect of quantity reduction:

$$QE_{t+1,t} = \Delta TS_{t+1,t} - PPI_{t+1,t} - PS_{t+1,t}$$

- Remember: this incorporates procedure substitution
- Also compute directly, with very similar results

Results Decomposition

- Change for 2013 is large departure from trend of increasing health expenditures, and increasing service quantities

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Total Spending Change Decomposition

	$\Delta TS_{t+1,t}$	$PPI_{t+1,t}$	$PS_{t+1,t}$	$QE_{t+1,t}$
2009-2010	11.3%	3.7%	-0.8%	8.4%
2010-2011	11.9%	3.5%	2.2%	6.2%
2011-2012	10.2%	0.4%	0.0%	9.8%
2012-2013	-16.4%	1.7%	4.3%	-22.4%

- Also, for new employees (approx. 2,000):
  - Quantity reduction of 22.3%
  - Price index rises by 2.7%
  - Price shopping gives 1.7% higher spend

Decomposition: Sickest Consumers

- Surprising that sick and high income consumers reduce spending by quite a bit, and that all of reduction from reduced service quantities

Specific Effects
Spending Decomposition

	% Tot. Spend	$\Delta TS_{t+1,t}$	$PPI_{t+1,t}$	$PS_{t+1,t}$	$QE_{t+1,t}$
Sickest Quartile					
2009-2010	52.1%	18.4%	3.9%	-1.4%	15.9%
2010-2011	57.3%	25.1%	4.0%	1.1%	20.0%
2011-2012	54.7%	-7.2%	-0.5%	-1.1%	-5.6%
2012-2013	47.3%	-23.1%	0.6%	5.1%	-28.8%

Decomposition: Imaging Services

- Imaging services (e.g.MRIs / CT scans) thought to be one source of 'moral hazard'

Specific Effects
Spending Decomposition

	% Tot. Spend	$\Delta TS_{t+1,t}$	$PPI_{t+1,t}$	$PS_{t+1,t}$	$QE_{t+1,t}$
Imaging					
2009-2010	10.5%	9.3%	5.8%	1.5%	2.0%
2010-2011	9.9%	6.2%	4.1%	-1.1%	3.2%
2011-2012	10.5%	12.0%	0.7%	1.7%	9.6%
2012-2013	11.5%	-20.6%	0.1%	0.9%	-21.6%
Preventive Always					
2009-2010	7.0%	5.9%	3.5%	-1.6%	4.0%
2010-2011	7.3%	5.0%	-1.8%	8.2%	-1.4%
2011-2012	7.5%	1.4%	6.7%	-2.6%	-2.7%
2012-2013	8.7%	-3.0%	8.6%	4.4%	-16.0%

Decomposition: Top 30 Procedures

- Reproduce decomposition analysis for:
  - 30 top procedures by revenue
  - 30 top procedures by count
- Substantial difference in changes for 2013 for these top 30 procedures, relative to earlier years

Total Spending Change Decomposition High Spend Procedures

	% Total Spend	$\Delta TS_{t+1,t}$	$PPI_{t+1,t}$	$PS_{t+1,t}$	$QE_{t+1,t}$
No. top 30 w/ Positive Value					
2010-2011	-	26	23	15	22
2011-2012	-	24	19	17	23
2012-2013	-	4	13	17	7

Overview

Consumer Responses to Non-Linear Contracts

- Switching to the HDHP not only increases prices, but forces employees to respond to multi-part non-linear contract
- Non-linear contracts are more complicated than typical price (e.g. Aaron-dine, et al., 2013). Are consumers responding to:
  - Marginal price (expected EOY)
  - Spot price
  - Average price

Coverage Tier	Avg. HDHP Price	% Under Deductible	% Over Ded., Under OOP Max.	% Over OOP Max.	Actuarial Value
0 Dependents	0.428	37.92% (< $1,500)	49.16% ($1,500 - $11,500)	12.92% (> $11,500)	78.31%
1 Dependent	0.293	23.22% (< $3,000)	61.08% ($3,000 - $23,000)	15.70% (> $23,000)	76.59%
2+ Dependents	0.201	13.30% (< $3,750)	68.40% ($3,750 - $28,750)	18.30% (> $28,750)	78.24%
All Tiers	0.249	18.42%	64.46%	17.12%	78.05%

Advantage of Our Setting

- Our setting is uniquely well-suited to answer this question:
  - Same large population of consumers over five years
  - First four years in free plan, last in non-linear contract
- Key assumption: Constant population health

$$F_{2013}[s_t|H,X] = F_{2011}[s_t|H,X], \forall t 1....12$$

- H is ex ante health status, X is demographics, s_t is health status for month t
- Key Feature: Dynamics in health status from lower spending bias *against* incremental spending reductions for low spending consumers
  - Will bring in 2014 data to assess longer run

Approach

- Mapping from H to monthly spending at each point in time:

$$G[M_{t+1} - M_t | s_t, H, X, Ins_t]$$

- Ins_t can be decomposed into non-linear contract prices
- We observe everything except for s_t
- Consider distribution of incremental spending, based on observables, at date t for duration x:

$$G(M_{t+x} - M_t | H, X, Ins_t)$$

- For any (H, X), look at incremental behavior for people in given position in contract in month t, and compare to incremental spending of *associated quantiles* in 2011

Prices

Spot vs. Marginal vs. Average

- Reduce contract position conditional on (H,X) to three prices
- Spot price P_t^s: Either 1, 0.1, or 0 depending on NLC arm
- Expected EOY price P_t^e: $E_t[P_t^s | M_{t-1}, H, X, Ins_t]$
- Average price P_t^a: Ex ante expectation of expected price at beginning of year, conditional on (H, X)
- Other things coming.....

Expected EOY Marginal Price

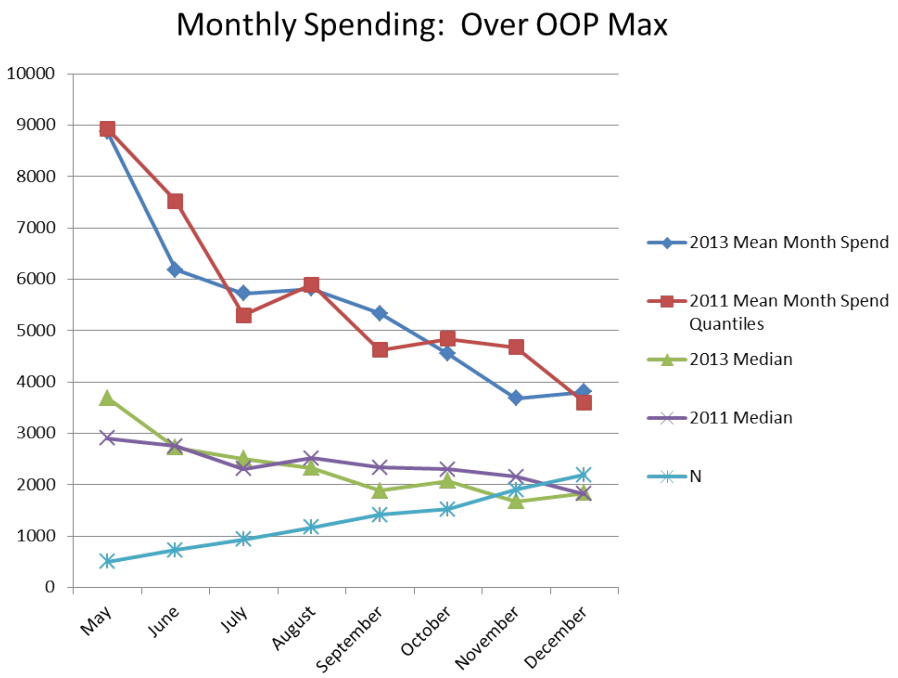
- Use minimal assumptions to get expected EOY marginal price
  - Rational expectations is benchmark, in essence testing this
- Step 1: For each individual i and each point in time t define cell by triple (H, X, M_{t-1})
- Step 2: Form non-parametric distribution of EOY spending $f_i(M_{i,T}|H, X, M_{i,t-1})$
- Step 3: Combine individual distributions within family:

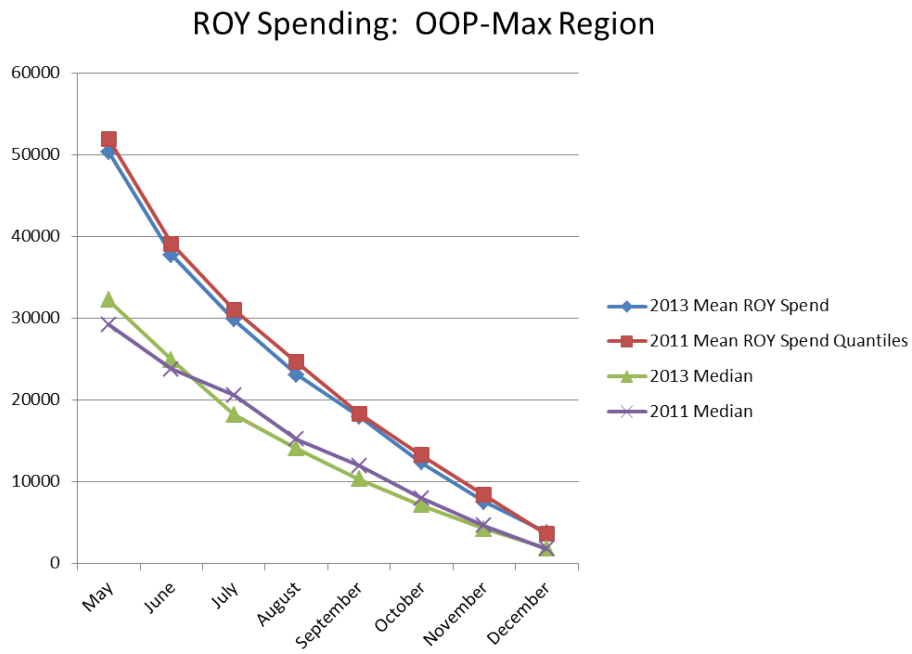
$$f_{J(i)}(M_T) = \Sigma_{\Sigma_{M_{i,t}=M_T}} \Pi_i^{J(i)} f_i(M_T) \tag{4}$$

- Step 4: Form expected EOY marginal price:

$$P_{j,t}^e = \int_{R_+^{J(i)}} P_{J(i)}^s(M_T) dF_{J(i)}(M_t)$$

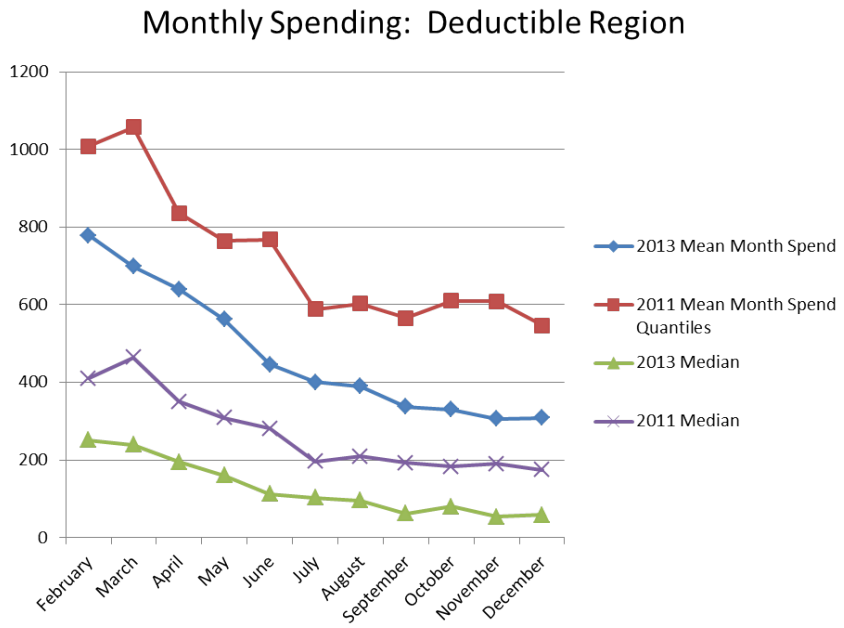
Incremental Spending Above OOP Max

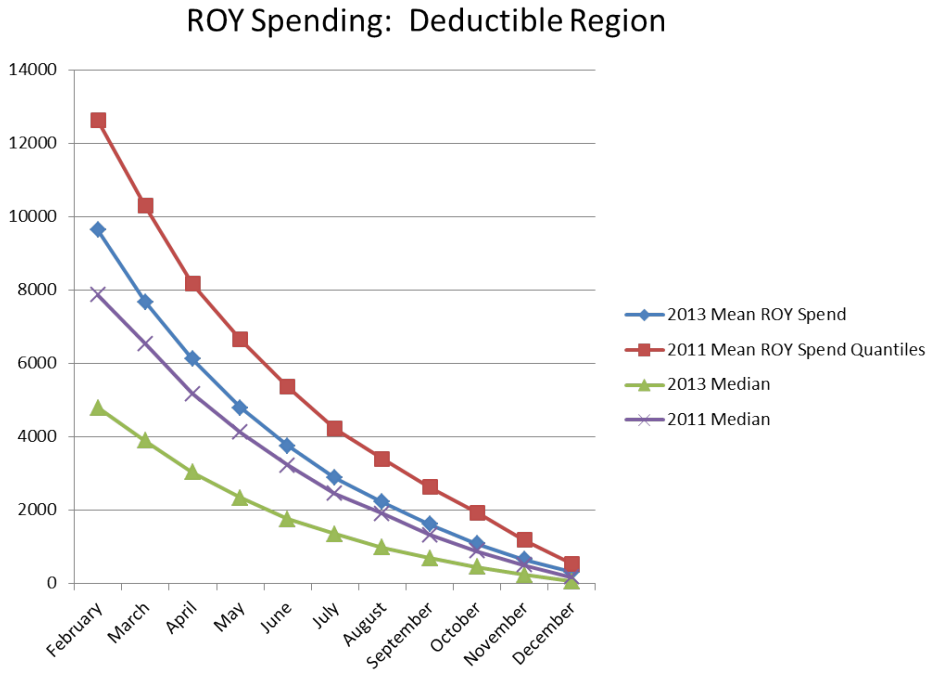




- Good test of average vs. combined margin and spot price
- Charts for families

Incremental Spending: Deductible Region

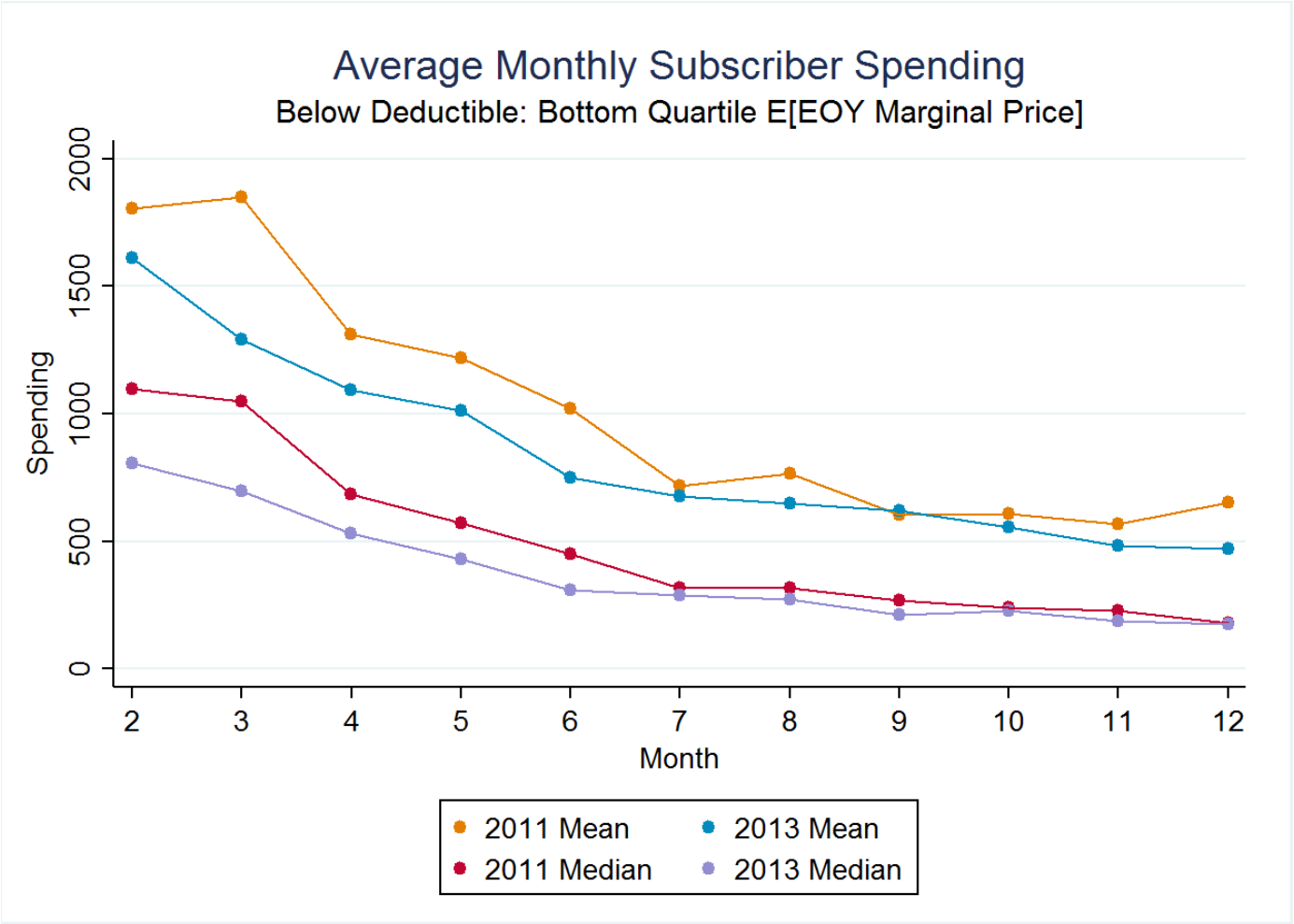




- Very large and meaningful decrease in ROY spending, suggestive of dynamic effects of economizing now and then being under deductible later

Incremental Spending: Deductible Region

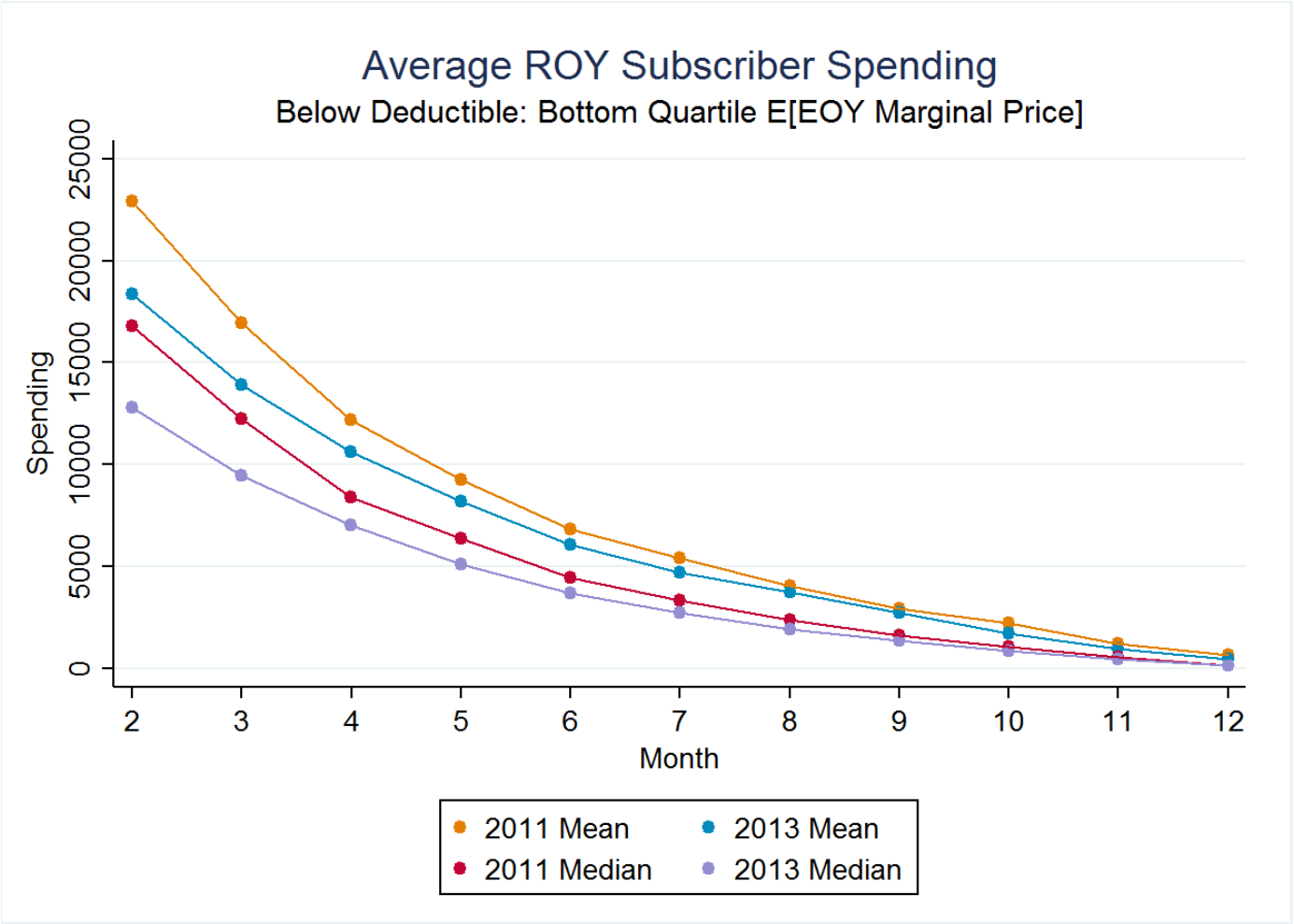
Spot vs. Expected EOY Price



- Average expected EOY marginal price in February is 0.09
- Average expected EOY marginal price in March is 0.10

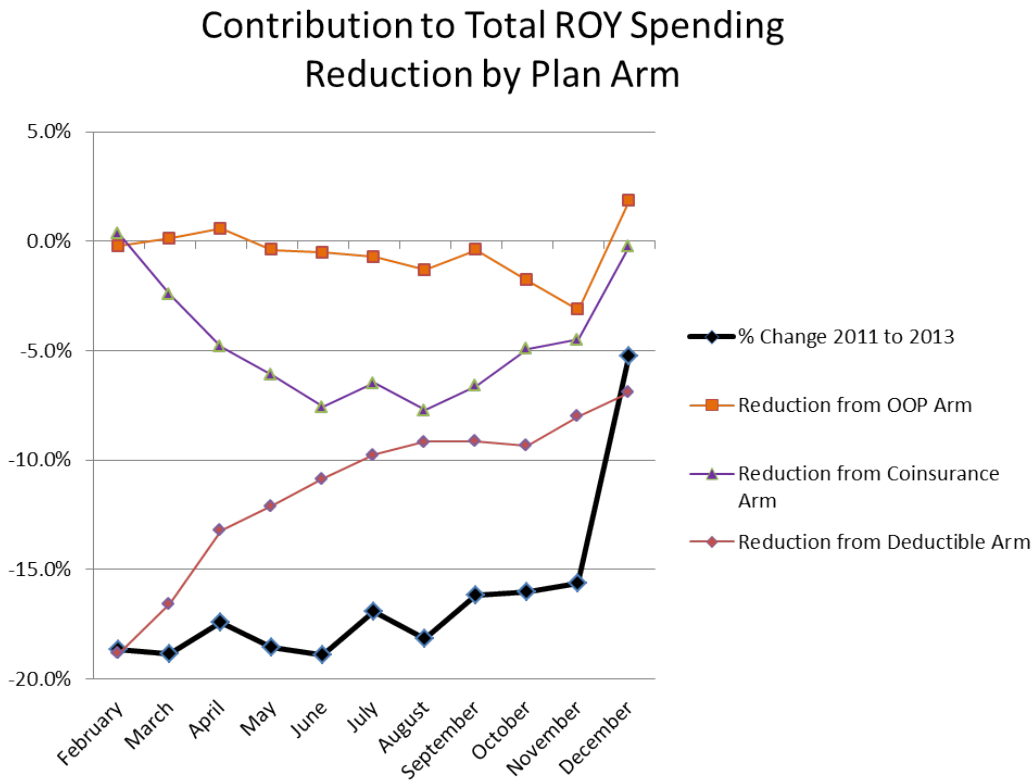
Incremental Spending: Deductible Region

Spot vs. Expected EOY Price



- Drop in ROY spending of approximately 20%, despite fact that they are very likely to spend a lot!

Contribution to ROY Spending Changes by Contract Arm



- Primary reduction due to individuals under the deductible, particularly early in year

NLC Analysis: Regressions Analysis

- Regressions that decompose effects of three potentially different prices that consumer respond to:

$$log(Y_{i,t}) = \alpha_{2013} I_{2013} + \alpha_t I_t + [\theta_s P^s_{i,t} + \theta_e P^e_{i,t}] I_{2013} + [\beta_s P^s_{i,t} + \beta_e P^e_{i,t}] + \gamma_h H_i + \gamma_X X_i + \gamma_L log(Y_{i,t-1}) + \epsilon_{i,t}$$

- $Y_{i,t}$: Log total incremental spending for next month
- Independent variables: Prices faced at beginning of month, health status, demographics, spending to date / recent spending
- Construct counterfactual prices for 2011 consumers to control for history dependent unobserved heterogeneity
- Current specification *for July only*. Coming:
  - Pooled regression over all months
  - ROY spending

Impact of Specific Pricing Components

VARIABLES	(1) Includes all Controls	(2) Excludes Previous Spending Controls	(3) Excludes Health Controls
2013	0.0562	0.0183	0.0434
	(0.0936)	(0.0962)	(0.0966)
(Spot MP = 1) x 2013	-0.266**	-0.333**	-0.251*
	(0.136)	(0.140)	(0.141)
(Spot MP = 0.1) x 2013	-0.137	-0.174	-0.148
	(0.104)	(0.107)	(0.107)
2nd quantile E[EOY MP] x 2013	-0.113*	-0.167**	-0.169**
	(0.0644)	(0.0661)	(0.0664)
3rd quantile E[EOY MP] x 2013	-0.104	-0.140	-0.195**
	(0.0902)	(0.0926)	(0.0930)
4th quantile E[EOY MP] x 2013	-0.0568	-0.149	-0.196*
	(0.110)	(0.113)	(0.113)
Top quantile E[EOY MP] x 2013	0.0220	-0.00252	-0.0511
	(0.110)	(0.113)	(0.114)
Log Spending Last Month	0.170***	-	-
	(0.00568)	-	-
Log Spending 2 Mths. Ago	0.123***	-	-
	(0.00686)	-	-
Observations	60,407	60,408	60,408
R-squared	0.368	0.333	0.326

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- Other controls have intuitive / predictive power / signs
- Clear emphasis on spot prices

Overview

Conclusion

- Overall causal impact of HDHP equal to 16.45% reduction in spending, off spending base of $750 Million
  - Important to account for anticipatory spending
  - Meaningful spending drop for for high income, compensated pop.
  - Sickest consumers reduce spending by over 20%
- Decomposition into quantity effects vs. price shopping
  - Large quantity implications, with potentially meaningful implications for welfare
  - Limited to no price shopping effect in short run (2014 coming)
  - Sickest consumers substantially reduce quantities
- Consumers substantially reduce spending when under deductible (30%), somewhat when in coinsurance arm, not at all above OOPMax
  - Sick consumers reduce spending a lot under deductible, *even when expected EOY price is low!!*

Next Steps

- Optimal menu design depending on:
  - Consumer price response heterogeneity
  - Heterogeneity in medical services responses
  - Dynamic responses to non-linear contracts
  - Leverage machine learning algorithms
- Welfare a la Baicker et al. (2015):
  - Informed consumers vs. uninformed consumers
  - Rational price responses
  - Categorization of services
- Mechanism underlying dynamic responses
  - Beliefs about health risk
  - Knowledge of contract
  - Myopia
  - Learning
- Long-term price shopping and offsets