Estimating the Tradeoff Between Risk Protection and Moral Hazard

with a Nonlinear Budget Set Model of Health Insurance

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Motivation: The Tradeoff

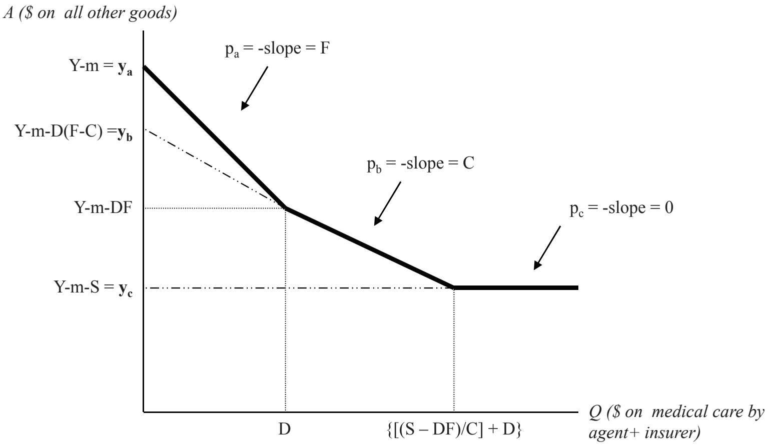
- Expanding insurance increases welfare gain from risk protection and welfare loss from moral hazard
  - Theoretical work: Arrow (1963), Pauly (1968), Zeckhauser (1970), Ehrlich and Becker (1972)
- Sign and magnitude of tradeoff is an empirical question
  - Empirical work considers both sides of the tradeoff separately
  - Moral hazard: Manning et al. (1987), Newhouse (1993), Eichner (1997,1998), Kowalski (2009)
  - Risk protection: Feldstein (1973), Feldman and Dowd (1991), Feldstein and Gruber (1995), Manning and Marquis (1996) Finkelstein and McKnight (2008), Engelhardt and Gruber (2010)
- I develop and estimate a model to examine both sides of the tradeoff simultaneously

Motivation: Nonlinear Budget Set

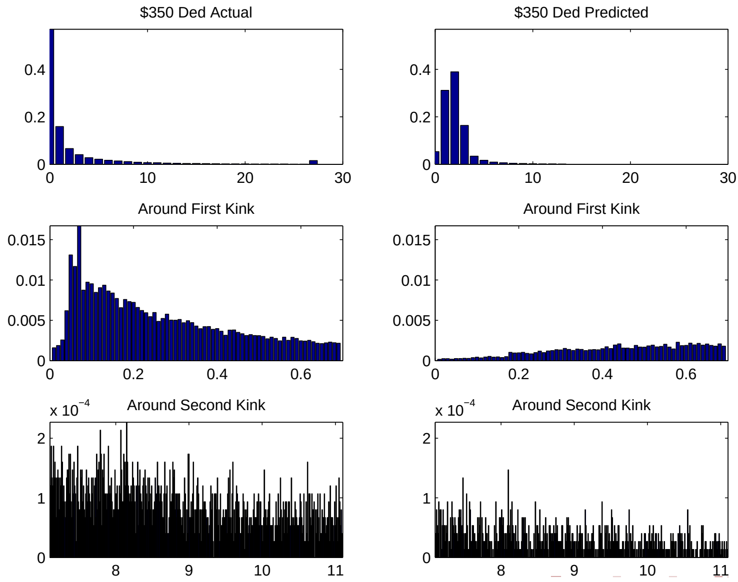
Estimating the Tradeoff Between Risk Protection and Moral Hazard with a Nonlinear Budget Set Model of Health Insurance

- Nonlinearities (deductible, coinsurance, stoploss) affect moral hazard and risk protection
  - Nonlinearities important for policy
    - Medicare Part D "Doughnut hole", discounts added by ACA
    - ACA requires health insurance, many individuals will purchase private plans with nonlinearities
    - Health savings accounts encourage private high deductible plans
    - Feldstein (2006): $1,000 deductible vs. 50% cost sharing to $2,000?
- My estimates inform tradeoff in existing plans and optimal plan structure
- Model builds on Burtless and Hausman (1981) and Hausman (1985). Adds risk protection, more than one nonconvex kink, and new estimator

Graphical Preview of Model



Bunching or Dispersion? Actual and Predicted Spending



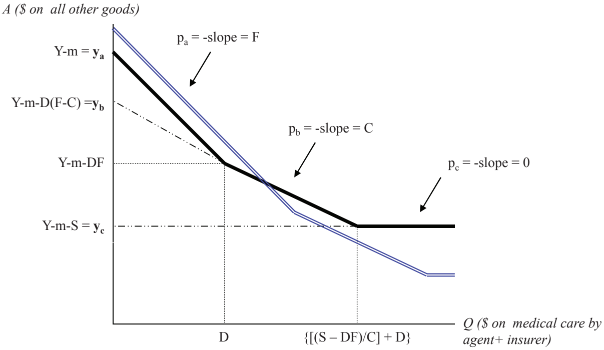
Outline

Two Period Model

- First period: choice of plan, before shock is realized
  - potential gains from risk protection
  - deadweight loss from moral hazard taken into account- “selection on moral hazard”
- Second period: choice of medical consumption, after shock is realized
  - no gains from risk protection
  - deadweight loss from moral hazard
- Solve the model backwards

First Period: Plan Choice

- Choose plan that maximizes expected utility given expect health shock



Second Period: The Agent's Problem

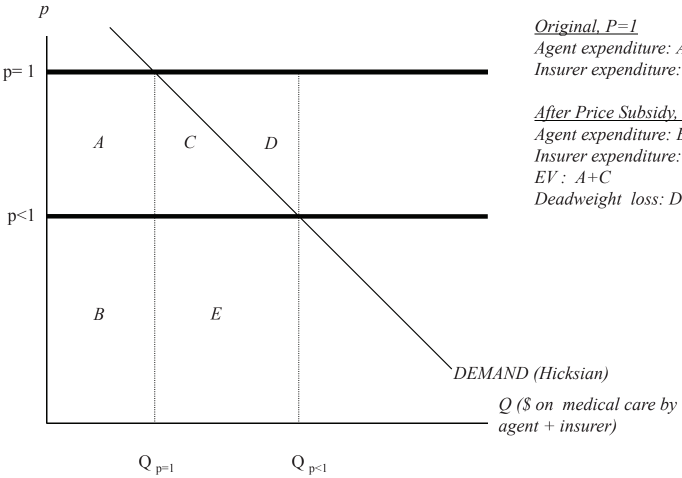
Maximize utility subject to a nonlinear constraint

$$v(y,p) = \max_{Q:pQ \leq y} U(Q,A|Z,\eta_r)$$

- Q total $\$$ on medical care (individual + insurer)
- A total $\$$ on all other goods
- v indirect utility
- U direct utility
- y virtual income
- p marginal price per dollar of medical care
- Z vector of individual characteristics
- η_r realized health shock

Calculating the Tradeoff

DWL from Moral Hazard



Original, P=1
Agent expenditure: A+B
Insurer expenditure: 0

After Price Subsidy, P<1
Agent expenditure: B+E
Insurer expenditure: A+C+D
EV : A+C
Deadweight loss: D

Second period: Indifference between plan j and no insurance for realized shock η_r for each individual i

$$U(Q_{ijr},\ y_{ijr} - p_{ijr}Q_{ijr} - \omega_{ijr}) = U(Q_{i,noins,r},\ Y - Q_{i,noins,r})$$

$$DWL_{ijr} = INS_{ijr} - \omega_{ijr}$$

First period:

$$DWL_{ij} = \int (INS_{ijr} - \omega_{ijr}) f(\eta_i) d\eta_i$$

No insurance is a normalization with a simple interpretation. Could also compare each plan j to a different standard plan.

Calculating the Tradeoff

Risk Protection Premium (RPP) Using Equivalent Variation

First period: Indifference between average utility in plan j and average utility under no insurance

$$\int U(Q_{ijr},\ y_{ijr} - p_{ijr}Q_{ijr} - \pi_{ij})f(\eta_i)d\eta_i =$$

$$\int U(Q_{i,noins,r},\ Y - Q_{i,noins,r})f(\eta_i)d\eta_i$$

$$RPP_{ij} = \pi_{ij} - \int (\omega_{ijr})f(\eta_i)d\eta_i$$

$$DWL_{ij} = \int (INS_{ijr} - \omega_{ijr})f(\eta_i)d\eta_i$$

$$RPP_{ij} - DWL_{ij} = \pi_{ij} - \int (INS_{ijr})f(\eta_i)d\eta_i$$

This tradeoff will vary across individuals.

Specification of Utility *or* Demand

- Need to specify either demand *or* utility
- Roy's identity relates indirect utility to demand:

$$-\frac{\partial v(y_{sj}, p_s)/\partial p_s}{\partial v(y_{sj}, p_s)/\partial y_{sj}} = Q(y_{sj}, p_s)$$

  subject to the Slutsky condition, which requires Hicksian demand to be downward sloping
- I specify a functional form for utility
- Existing literature specifies utility *and* demand, and both functional forms might not be mutually consistent

Specification of Utility/Demand

On a given segment s, given the following specification of the utility function:

$$U(Q_{is}, A_{is}) = \left\{ \begin{array}{c} -\exp(-\gamma A_{is}) + \frac{Q_{is}[\ln(Q_{is}/\alpha_i)-1]}{\ln\beta} \text{ if } (Q_{is} > 0, \alpha_i > 0) \\ -\exp(-\gamma y_{ia}) \text{ otherwise} \end{array} \right\}$$

and the budget set:

$$A_{is} = y_{is} - p_s Q_{is}, \; 0 \le \underline{Q_{is}} \le Q_{is} \le \overline{Q_{is}}$$

Marshallian demand within segment s is given by:

$$Q_{is} = \min(\max(\alpha_i \beta^{\lambda_i p_s}, \overline{Q_{is}})\underline{Q_{is}})$$

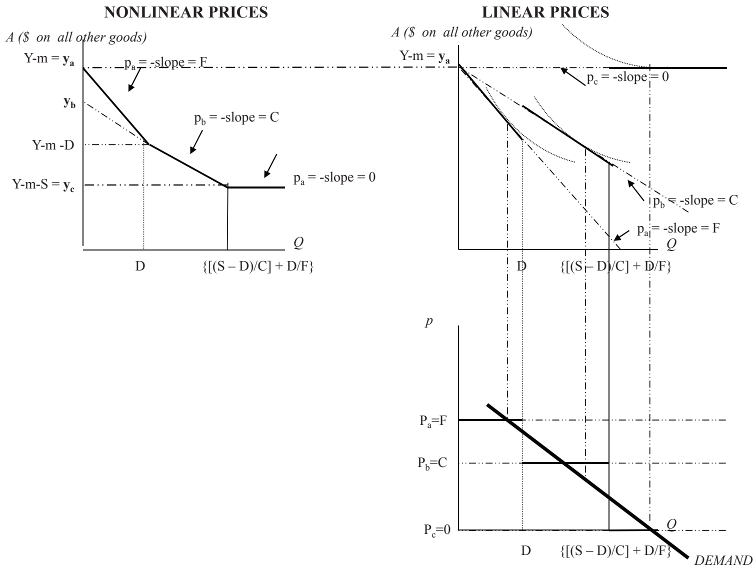
- $\alpha_i = Z_i'\delta + \eta_i$
- $\eta_{ir} \sim N(\mu, \sigma^2)$, μ and σ^2 to be estimated
- $\lambda_i = \gamma \exp(-\gamma A_{is})$ marginal utility of spending on A_{is}

Sources of Identification

- General framework
  - Choice of plan
  - Choice of spending conditional on plan
- Variation in the data
  - Marginal price variation within and across budget sets
  - Observed individual heterogeneity in covariates
  - Variation in medical expenditure across individuals
- Functional form
  - Budget set
  - Utility/Demand
  - Distribution of unobserved individual heterogeneity

Graphical Depiction of Identification

Linearize nonlinear budget segment for each price. Variation in quantities consumed at two or more linear prices identifies Marshallian demand.



Estimation

Simulated Minimum Distance Estimator

- Does not require likelihood
  - Minimizes distance between actual and predicted spending
  - Second nonconvex kink eliminates ordering of likelihood present in traditional NLBS model, making likelihood much more complicated
- Allows for flexible specification of distribution of individual heterogeneity
  - Uses numerical integration

Simulated Minimum Distance Estimator

Estimation Algorithm

Given starting values of θ and the data matrix, which includes actual spending Q_i, the algorithm for the simulated distance estimator is as follows:

1. For each individual i of N, for each plan j of J, for each repetition r of R, draw $\eta_{ir} \sim N(\mu, \sigma^2)$. For each segment $s \in \{a, b, c\}$, predict

$$\widehat{Q_{ijrs}} = \arg\max_{Q_s} U_{ijrs}(Q_s, A_s) : p_{sj} Q_{ijrs} \le y_{ijs}, \underline{Q_{sj}} \le Q_{sj} \le \overline{Q_{sj}}$$

   and the associated $\widehat{U_{ijrs}(Q_s, A_s)}$. Calculate the segment that yields the maximum utility for each i, j, r combination. Retain as $\widehat{Q_{ijr}}$.
2. Calculate the plan j that yields the maximum expected utility over r. Retain as $\widehat{Q}_i$.
3. Solve

$$\widehat{\theta} = \arg\min_{\theta} \sum_{i=1}^{N} \left(\min(Q_i, \psi) - \min(\widehat{Q}_i, \psi) \right)^2 .$$

Data

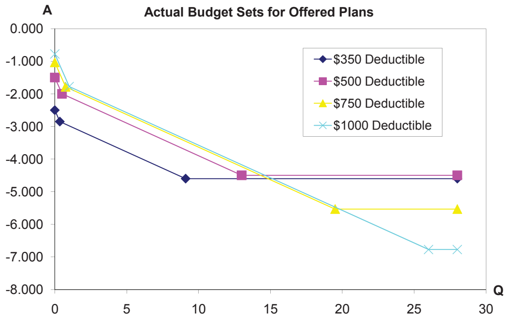
- 2004 Medstat Data
  - One firm in the retail trade industry
  - 4 offered plans, vary only by deductible and stoploss
  - People insured in families of three or fewer
  - 101,343 individuals in estimation sample
  - Limitations
    - Do not observe income - use median income in zip code
    - Do not observe premium - calculate as average expenditure plus 25% loading

Plan Characteristics

Plans		Fraction before Deduct F	Deduct (1000s) D	Coins C	Stoploss (1000s) S
Offered	$350 Deductible	1	0.35	0.2	2.1
	$500 Deductible	1	0.5	0.2	3
	$750 Deductible	1	0.75	0.2	4.5
	$1,000 Deductible	1	1	0.2	6

- Also a family deductible
- Must restrict sample to families of three or fewer because they are not affected by the family deductible

Estimation of Plan Choice
Some Plans Completely Dominated as in Handel (2009)



- Predict plan choice with multinomial logit model, using last year's plan (excluded from demand estimation)
- Produce estimated probabilities $\widehat{prob_{ij}}$ for each individual i for each plan j to be used in simulated minimum distance estimation
- Only consider class of counterfactual simulations in which all agents are in the same plan

Given starting values of θ and the data matrix, which includes actual spending Q_i, the algorithm for the simulated distance estimator is as follows:

1. For each individual i of N, for each plan j of J, for each repetition r of R, draw $\eta_{ir} \sim N(\mu, \sigma^2)$. For each segment $s \in \{a, b, c\}$, predict

$$\widehat{Q_{ijrs}} = \arg\max_{Q_s} U_{ijrs}(Q_s, A_s) : p_{sj} Q_{ijrs} \leq y_{ijs}, \underline{Q_{sj}} \leq Q_{sj} \leq \overline{Q_{sj}}$$

   and the associated $U_{ijrs}\widehat{(Q_s, A_s)}$. Calculate the segment that yields the maximum utility for each i, j, r combination. Retain as $\widehat{Q_{ijr}}$.

2. Solve

$$\hat{\theta} = \arg\min_{\theta} \sum_{i=1}^{N} \left(\min(Q_i, \psi) - \min(\sum_{r=1}^{R} \sum_{j=1}^{J} \widehat{prob_{ij}} \widehat{Q_{ijr}}, \psi)\right)^2.$$

Summary Statistics

Full Sample	All Plans	By Deductible $350	$500	$750	$1,000
Spending/1,000	2.335	2.637	1.779	1.412	1.147
Income/1,000	40.824	40.876	40.836	40.545	40.538
Virtual Income/1,000	37.900	37.491	38.764	39.068	39.405
Price	0.650	0.598	0.731	0.815	0.872
Male	0.373	0.336	0.443	0.464	0.532
Salary	0.077	0.072	0.101	0.089	0.087
Census Division 2 - Middle Atlantic	0.032	0.031	0.028	0.033	0.038
Census Division 3 - East North Central	0.151	0.144	0.176	0.176	0.164
Census Division 4 - West North Central	0.101	0.089	0.143	0.138	0.128
Census Division 5 - South Atlantic	0.264	0.281	0.215	0.222	0.215
Census Division 6 - East South Central	0.139	0.147	0.124	0.117	0.107
Census Division 7 - West South Central	0.206	0.206	0.210	0.196	0.202
Census Division 8 - Mountain	0.067	0.062	0.070	0.080	0.093
Census Division 9 - Pacific	0.023	0.023	0.020	0.019	0.033
Age	42.187	42.943	41.072	39.327	39.110
Missing 2003	0.475	0.436	0.566	0.598	0.604
2003 Spending*Nonmissing 2003	0.989	1.187	0.551	0.388	0.297
$350 Deductible in 2003*Nonmissing 2003	0.427	0.556	0.050	0.079	0.070
$500 Deductible in 2003*Nonmissing 2003	0.052	0.005	0.374	0.037	0.019
$750 Deductible in 2003*Nonmissing 2003	0.014	0.001	0.004	0.276	0.009
$1,000 Deductible in 2003*Nonmissing 2003	0.033	0.002	0.006	0.010	0.297
In Family of 2	0.189	0.170	0.240	0.247	0.244
In Family of 3	0.085	0.070	0.119	0.130	0.131
N	101,343	74,933	12,095	4,140	10,175
Share of N	1.000	0.739	0.119	0.041	0.100

- "Positive correlation test"
  - Positive correlation between plan generosity and spending
  - Following Chiappori and Salanie (2000)
  - Evidence of MH and/or AS
- "Unused observables test"
  - Positive correlation between observable characteristic and plan generosity AND
  - Positive correlation between observable characteristic and spending
  - Following Finkelstein and Poterba (2004)
  - Evidence of AS (with or without MH)
- Limitations
  - These tests do not give magnitudes of MH or AS
  - Cannot predict spending in counterfactual nonlinear plans
  - Do not give welfare impact of interventions aimed at reducing MH and/or AS

Model will address these limitations.

Reduced Form Examination of Moral Hazard and Adverse Selection

Positive Correlation Test

Positive Correlation Test (Null Hypothesis: No Moral Hazard or Adverse Selection)

Dependent Variable:	Spending			
Variable	**Estimate**		**95% confidence**	
Deductible	-2.46	***	-2.73	-2.18

Regression includes constant (coefficient not reported).
N=101,343 R Squared = 0.0030.
***p<0.01, **p<0.05,*p<0.1

- We see positive correlation between deductible and generosity (lower deductible is higher generosity)
- Mean spending in each plan tells the same story

Unused Observables Test

Unused Observables Test (Null Hypothesis: No Adverse Selection, With or Without Moral Hazard)

Dependent Variable:	Spending			Deductible		
	Separate Regressions			Separate Regressions		
Variable	**Estimate**	**95% confidence**		**Estimate**	**95% confidence**	
Income/1,000	0.0007	-0.0026	0.0041	-0.0001 **	-0.0002	0.0000
Male	-1.0535 ***	-1.1702	-0.9369	0.0559 ***	0.0533	0.0585
Salary	-0.5603 ***	-0.7717	-0.3488	0.0179 ***	0.0132	0.0226
Census Division 2 - Middle Atlantic	-0.7758 ***	-1.0993	-0.4524	0.0129 ***	0.0057	0.0201
Census Division 3 - East North Central	0.3405 ***	0.1827	0.4983	0.0132 ***	0.0097	0.0167
Census Division 4 - West North Central	0.0888	-0.0983	0.2760	0.0340 ***	0.0299	0.0382
Census Division 5 - South Atlantic	0.1035	-0.0246	0.2317	-0.0247 ***	-0.0276	-0.0219
Census Division 6 - East South Central	-0.1932 **	-0.3567	-0.0297	-0.0228 ***	-0.0264	-0.0191
Census Division 7 - West South Central	0.0151	-0.1246	0.1549	-0.0021	-0.0053	0.0010
Census Division 8 - Mountain	-0.3339 ***	-0.5599	-0.1080	0.0312 ***	0.0262	0.0362
Census Division 9 - Pacific	0.0325	-0.3432	0.4082	0.0227 ***	0.0143	0.0310
Age	0.0801 ***	0.0755	0.0846	-0.0017 ***	-0.0018	-0.0016
Age Squared/100	0.0971 ***	0.0918	0.1025	-0.0021 ***	-0.0022	-0.0020
Age Cubed/1,000	0.1445 ***	0.1366	0.1524	-0.0032 ***	-0.0034	-0.0030
Missing 2003	-0.1399 **	-0.2657	-0.0141	0.0376 ***	0.0348	0.0404
2003 Spending*Nonmissing 2003	0.3058 ***	0.2963	0.3153	-0.0021 ***	-0.0023	-0.0019
2003 Spending*Nonmissing 2003 Squared/1,000	0.6806 ***	0.6233	0.7379	-0.0019 ***	-0.0032	-0.0007
2003 Spending*Nonmissing 2003 Cubed/1,000,000	0.6628 ***	0.5055	0.8200	-0.0013	-0.0048	0.0022
$500 Deductible in 2003*Nonmissing 2003	-0.4816 ***	-0.6878	-0.2753	0.0754 ***	0.0708	0.0799
$750 Deductible in 2003*Nonmissing 2003	-0.8903 ***	-1.2689	-0.5117	0.2898 ***	0.2816	0.2980
$1,000 Deductible in 2003*Nonmissing 2003	-1.0796 ***	-1.3325	-0.8267	0.5254 ***	0.5207	0.5300
In Family of 2	0.3858 ***	0.2414	0.5302	0.0357 ***	0.0325	0.0389
In Family of 3	-0.5806 ***	-0.7835	-0.3778	0.0566 ***	0.0521	0.0611

All regressions include constants (coefficients not reported).

N=101,343 for all regressions. R squared =0.0444 in spending single regression. R squared=0.3217 in deductible single regression.

***p<0.01, **p<0.05,*p<0.1

Estimated Coefficients

		Simulated Minimum Distance			
Interpretation	Parameter	Estimate		95% confidence	
Mean of unobserved heterogeneity	mu	-1.0005	***	-1.2174	-0.7836
Male	delta1	-0.5568	***	-0.6088	-0.5048
Salary/1,000	delta2	-0.1129	***	-0.1819	-0.0438
Census Division 2 - Middle Atlantic	delta3	-0.1290	**	-0.2575	-0.0004
Census Division 3 - East North Central	delta4	0.4612	***	0.3576	0.5648
Census Division 4 - West North Central	delta5	0.2246	***	0.1184	0.3308
Census Division 5 - South Atlantic	delta6	0.2912	***	0.2019	0.3806
Census Division 6 - East South Central	delta7	0.2277	***	0.1327	0.3227
Census Division 7 - West South Central	delta8	0.2511	***	0.1616	0.3405
Census Division 8 - Mountain	delta9	0.0389	**	0.0068	0.0710
Census Division 9 - Pacific	delta10	-0.0456		-0.1018	0.0107
Age	delta11	0.1049	***	0.0943	0.1155
Age Squared/100	delta12	-0.2102	***	-0.2350	-0.1854
Age Cubed/1,000	delta13	0.2066	***	0.1781	0.2351
Missing 2003	delta14	0.7034	***	0.6422	0.7645
2003 Spending*Nonmissing 2003	delta15	0.3661	***	0.3436	0.3886
2003 Spending*Nonmissing 2003 Squared/1,000	delta16	-3.0281	***	-3.6727	-2.3835
2003 Spending*Nonmissing 2003 Cubed/1,000,000	delta17	1.4863		-1.1997	4.1722
In Family of 2	delta18	0.0873	**	0.0145	0.1602
In Family of 3	delta19	-0.0551	**	-0.0991	-0.0110
Standard deviation of unobserved heterogeneity	sigma	0.0371	**	0.0080	0.0662
Coefficient of Absolute Risk Aversion	gamma	0.0769	**	0.0157	0.1380
Price parameter	beta	0.3319	***	0.1431	0.5207
N (observations)		101,343			
R (draws of ind. het.)		5			
stepsize (in thousands)		0.001			

***p<0.01, **p<0.05,*p<0.1

Confidence intervals obtained by subsampling. See text for details.

Estimated Elasticities

- Price Elasticity of Expenditure

$$arc = \frac{Q_I - Q_{II}}{Q_I + Q_{II}} \div \frac{p_I - p_{II}}{p_I + p_{II}}$$

  - -0.0015 from .25 to .95
    - Compare to Rand -.22
  - -0.0021 from .20 to 1
    - Compare to Kowalski (2009)

Will also show plan-specific measures of moral hazard.

Regression of Actual Spending on Mean Predicted Spending Over All Draws

Variable	Estimate	95% confidence	
Mean predicted spending	0.99	0.98	1.01
Constant	0.02	-0.03	0.06
N	101,343		
R Squared	0.09		

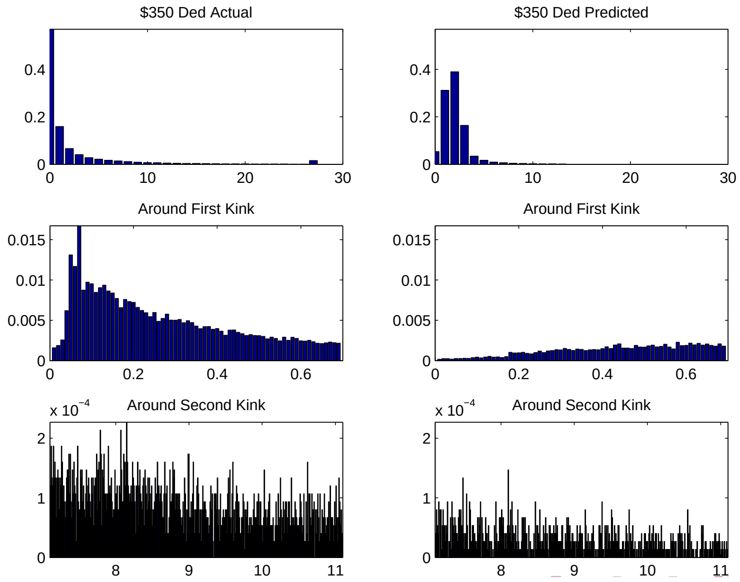
Model Fit

Predicted Shares of Each Segment (Not Matched by Model)

Percent of Sample by Actual and Predicted Budget Segment in Actual Plan

Actual *Mean Predicted* *One Draw Predicted*	**All**	**By Deductible** **$350**	**$500**	**$750**	**$1,000**
Zero Spending	30.88	27.39	35.92	41.30	46.37
	0.21	*0.20*	*0.19*	*0.17*	*0.30*
	0.30	*0.29*	*0.30*	*0.19*	*0.48*
Before Deductible	26.73	24.01	31.17	35.87	37.78
	6.29	*2.69*	*6.99*	*15.89*	*28.06*
	6.25	*2.65*	*6.82*	*15.97*	*28.12*
At Deductible	0.01	0.01	0.01	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
	0.00	*0.00*	*0.00*	*0.00*	*0.00*
Between Deductible and Stoplos	36.99	41.90	30.18	21.69	15.15
	92.80	*96.17*	*92.76*	*83.94*	*71.64*
	92.75	*96.13*	*92.82*	*83.84*	*71.40*
At Stoploss	0.00	0.00	0.00	0.00	0.00
	0.00	0.00	0.00	0.00	0.00
	0.00	*0.00*	*0.00*	*0.00*	*0.00*
After Stoploss	5.39	6.70	2.72	1.14	0.71
	0.70	*0.94*	*0.06*	*0.00*	*0.00*
	0.70	*0.93*	*0.07*	*0.00*	*0.00*
N	101,343	74,933	12,095	4,140	10,175

Bunching or Dispersion?
Actual and Predicted Spending



Counterfactual Simulation

Place all agents in single existing or counterfactual plan

Plans		**Fraction before Deductible** ***F***	**Deductible** ***D***	**Coinsurance** ***C***	**Stoploss** ***S***
Offered	$350 Deductible	1	350	0.2	2,100
	$500 Deductible	1	500	0.2	3,000
	$750 Deductible	1	750	0.2	4,500
	$1,000 Deductible	1	1,000	0.2	6,000
Hypothetical	50% Frac to $2,000 Deduct	0.5	2,000	0.2	6,000
	0% Frac (Full Insurance)	0	NA	NA	NA
	20% Frac	0.2	NA	NA	NA
	40% Frac	0.4	NA	NA	NA
	50% Frac	0.5	NA	NA	NA
	60% Frac	0.6	NA	NA	NA
	80% Frac	0.8	NA	NA	NA
	100% Frac (No Insurance)	1	NA	NA	NA
	$1,000 Deductible/Stoploss	1	1,000	NA	1,000
	$5,000 Deductible/Stoploss	1	5,000	NA	5,000
	$10,000 Deductible/Stoploss	1	10,000	NA	10,000
	$20,000 Deductible/Stoploss	1	20,000	NA	20,000

Calculate DWL and RPP

Counterfactual: Place All Agents in Single Plan

Effects on Spending

		Agent + Insurer Q_{ij} Mean	Insurer INS_{ij} Mean	Agent $INS_{ij}-Q_{ij}$ Mean
Counterfactual Without Model*				
Offered	$350 Deductible	1,963.20	1,383.19	580.01
	$500 Deductible	1,963.20	1,259.05	704.16
	$750 Deductible	1,963.20	1,106.00	857.21
	$1,000 Deductible	1,963.20	998.54	964.66
Hypothetical	50% Frac to $2,000 Deduct	1,963.20	854.10	1,109.10
	0% Frac (Full Insurance)	1,963.20	1,963.20	0.00
	50% Frac	1,963.20	981.60	981.60
	100% Frac (No Insurance)	1,963.20	0.00	1,963.20
	$1,000 Deductible/Stoploss	1,963.20	1,536.89	426.31
	$5,000 Deductible/Stoploss	1,963.20	836.90	1,126.30
	$10,000 Deductible/Stoploss	1,963.20	451.37	1,511.83
Counterfactual Using Model				
Offered	$350 Deductible	1,956.20	1,291.80	664.40
	$500 Deductible	1,956.00	1,174.10	781.90
Hypothetical	50% Frac to $2,000 Deduct	1,954.50	1,105.90	848.60
	0% Frac (Full Insurance)	1,958.70	1,958.70	0.00
	50% Frac	1,951.80	975.90	975.90
	100% Frac (No Insurance)	1,943.10	0.00	1,943.10
	$1,000 Deductible/Stoploss	1,957.90	1,030.00	927.90
	$5,000 Deductible/Stoploss	1,946.00	84.20	1,861.80
	$10,000 Deductible/Stoploss	1,944.10	9.90	1,934.20

Values in dollars.
*Agent+Insurer censored above $27,500 for each agent for comparison to model.
Censoring affects 1,311 agents (approximately 1.3% of sample).

Counterfactual: All Agents in Single Plan

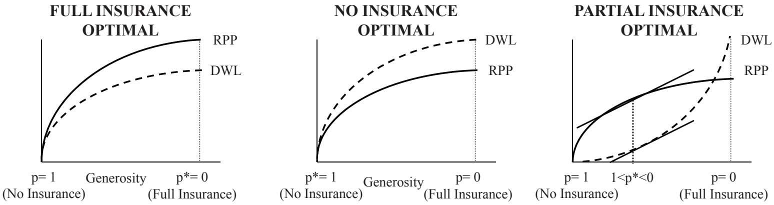
Effects on DWL and RPP *Across Distribution*

			Quantiles					Mean as
DWL $_{ij}$	**Plan *j***	**Min**	**25**	**Median**	**75**	**Max**	**Mean**	**% of *MAS***
Offered	$350 Deductible	0.00	1.04	2.81	6.08	600.82	5.52	0.284
	$500 Deductible	0.00	0.98	2.79	6.06	476.15	5.36	0.276
	$750 Deductible	0.00	0.80	2.71	5.99	474.55	5.23	0.269
	$1,000 Deductible	0.00	0.38	2.48	5.87	472.95	5.04	0.259
Hypothetical	50% Frac to $2,000 Deduct	0.00	0.50	1.46	4.33	474.55	4.35	0.224
	0% Frac (Full Insurance)	0.00	1.61	4.23	9.04	600.82	7.82	0.403
	50% Frac	0.00	0.44	1.19	2.60	248.31	2.41	0.124
	100% Frac (No Insurance)	0.00	0.00	0.00	0.00	0.00	0.00	0.000
	$1,000 Deductible/Stoploss	0.00	0.58	3.78	8.88	600.82	7.39	0.380
	$5,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	600.82	1.44	0.074
	$10,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	600.82	0.49	0.025
	$20,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	0.00	0.00	0.000
RPP $_{ij}$								
Offered	$350 Deductible	0.00	0.02	0.03	0.05	0.27	0.04	0.002
	$500 Deductible	0.00	0.02	0.03	0.05	0.27	0.04	0.002
	$750 Deductible	0.00	0.01	0.03	0.05	0.27	0.04	0.002
	$1,000 Deductible	0.00	0.01	0.03	0.05	0.27	0.03	0.002
Hypothetical	50% Frac to $2,000 Deduct	0.00	0.02	0.03	0.05	0.29	0.03	0.002
	0% Frac (Full Insurance)	0.00	0.02	0.03	0.06	0.39	0.04	0.002
	50% Frac	0.00	0.02	0.03	0.04	0.29	0.03	0.002
	100% Frac (No Insurance)	0.00	0.00	0.00	0.00	0.00	0.00	0.000
	$1,000 Deductible/Stoploss	0.00	0.01	0.03	0.05	0.29	0.03	0.002
	$5,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	0.22	0.00	0.000
	$10,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	0.28	0.00	0.000

Counterfactual: All Agents in Single Plan
Effects on DWL and RPP *By Covariates*

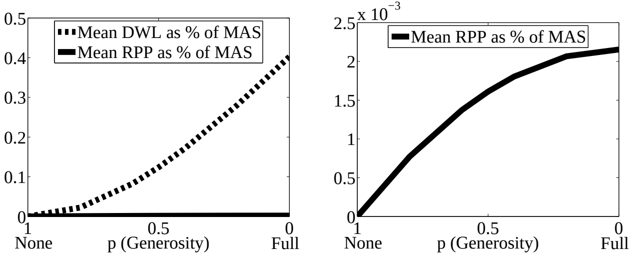
			Mean By Gender		Mean By Type		Mean By Income Quartile				Mean By Age	
DWL $_{ij}$	**Plan *j***	**Mean**	**Male**	**Female**	**Salary**	**Hourly**	**1 (Low)**	**2**	**3**	**4 (High)**	**Age< med**	**Age> med**
Offered	$350 Deductible	5.52	3.58	6.68	4.08	5.64	12.43	5.70	2.96	0.80	3.32	7.84
	$500 Deductible	5.36	3.42	6.52	3.96	5.48	12.07	5.54	2.88	0.78	3.23	7.61
	$750 Deductible	5.23	3.21	6.44	3.80	5.36	11.78	5.41	2.81	0.76	3.07	7.52
	$1,000 Deductible	5.04	2.90	6.32	3.53	5.17	11.34	5.22	2.70	0.74	2.75	7.45
Hypothetical	50% Frac to $2,000 Deduct	4.35	2.40	5.51	2.81	4.48	9.77	4.51	2.34	0.63	2.03	6.80
	0% Frac (Full Insurance)	7.82	5.16	9.41	5.95	7.98	17.64	8.05	4.18	1.14	4.93	10.87
	50% Frac	2.41	1.55	2.92	1.76	2.46	5.40	2.49	1.30	0.35	1.43	3.44
	100% Frac (No Insurance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$1,000 Deductible/Stoploss	7.39	4.26	9.26	5.26	7.57	16.66	7.63	3.95	1.08	4.13	10.83
	$5,000 Deductible/Stoploss	1.44	0.91	1.76	0.79	1.50	3.18	1.54	0.78	0.21	0.48	2.45
	$10,000 Deductible/Stoploss	0.49	0.36	0.57	0.17	0.51	1.07	0.53	0.27	0.07	0.11	0.89
RPP $_{ij}$												
Offered	$350 Deductible	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
	$500 Deductible	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Hypothetical	50% Frac to $2,000 Deduct	0.03	0.03	0.04	0.03	0.04	0.03	0.03	0.04	0.04	0.03	0.04
	0% Frac (Full Insurance)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
	50% Frac	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
	100% Frac (No Insurance)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$1,000 Deductible/Stoploss	0.03	0.02	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04
	$5,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	$10,000 Deductible/Stoploss	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Values in dollars.
Median age is 43. Income first quartile: $30,208; median: $37,222; third quartile: $49,113.


FULL INSURANCE OPTIMAL
RPP
DWL
p= 1
(No Insurance)
Generosity
p*= 0
(Full Insurance)
NO INSURANCE OPTIMAL
DWL
RPP
p*= 1
(No Insurance)
Generosity
p= 0
(Full Insurance)
PARTIAL INSURANCE OPTIMAL
DWL
RPP
p= 1
(No Insurance)
1<p*<0
p= 0
(Full Insurance)

Implications of Estimates for Optimal Linear Insurance

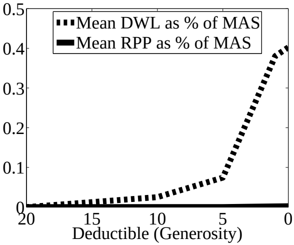
Figure: Estimates of Optimal Insurance with Varying Linear Price



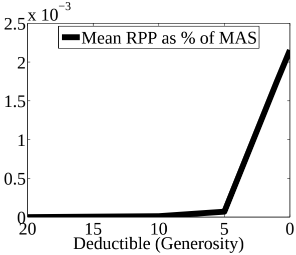
(a) DWL and RPP (b) RPP Only (Different Scale)

Implications of Estimates for Optimal Deductible-Only Insurance

Figure: Estimates of Optimal Insurance with Varying Deductible



(a) DWL and RPP



(b) RPP Only (Different Scale)

Summary of Findings

Tradeoff Between Moral Hazard and Risk Protection in NLBS model

- On average, DWL» RPP in existing plans
- Substantial variation across agents
  - Top 1% of agents have welfare *gain* 100x smaller than loss at mean
  - Bottom 1% of agents have net loss from insurance 10x larger than loss at mean
  - Considerable variation across observable characteristics
- Implications for optimal linear insurance
  - Partial linear insurance not necessarily optimal
    - As generosity increases, DWL always increases faster than RPP
    - Considering DWL and RPP only, no insurance is optimal
    - If society considers other factors, results can inform magnitude of nonzero optimal linear insurance
  - Specific application: counterfactual Feldstein plan yields higher welfare than similar high deductible plan

Discussion of Findings

Tradeoff Between Moral Hazard and Risk Protection in NLBS model

- On average, DWL» RPP in existing plans
  - Entire sample is insured
  - Sample not subject to large expenditure shocks
- Implications for optimal linear insurance
  - Optimal *linear* insurance might not be relevant for policy
- Specific application: counterfactual Feldstein plan yields higher welfare than similar high deductible plan
  - Potentially more relevant for policy
  - Cannot get to this finding without a model

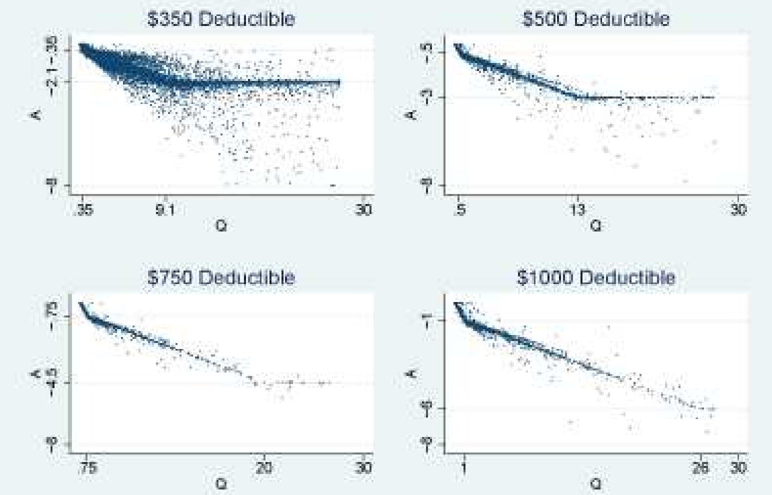
Strengths and Limitations of NLBS Model

As Applied to Health Insurance

- Strengths
  - Directly models several aspects of decision problem
    - Joint choice of price, quantity, and income
    - Decision to consume zero care
  - Estimates tied closely to model
  - Allows for counterfactual simulations
    - Expenditure/welfare response to nonlinear price change
  - Advances NLBS Methodology
    - Adds risk protection
    - Extends NLBS model to case with more than one nonconvex kink
    - New estimator
    - Application to health insurance has advantages over labor application

- Limitations
  - Does not include some aspects of decision problem
    - No dynamics within or across years
    - Does not distinguish between doctor and insurer decisions
    - Abstracts away from supply side considerations
  - Requires nonlinear plan structure and detailed data

Empirical Budget Set by Plan

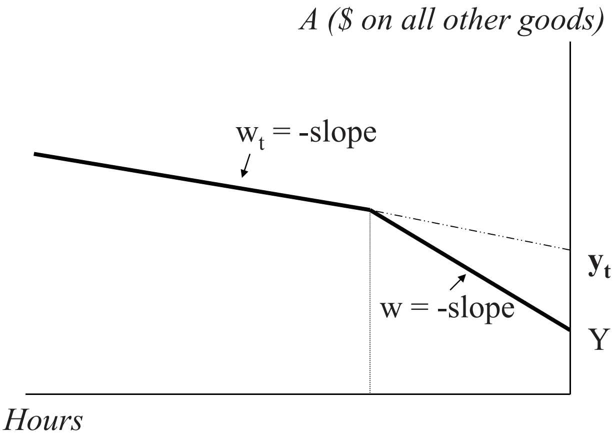


Depicts 98.7% of observations with Q<27.5 and A>-8.

Intuition for Slutsky Condition

- If and only if the indifference curve is convex, the second derivative with respect to Q_{sj} will be positive.
- This condition is satisfied when the Slutksy condition holds.
- Alternative intuition: from the Slutsky equation, the Slutsky condition must hold for Hicksian demand to be downward sloping.

Nonlinear Budget Set from Labor



Comparison to Kowalski (2009)

- Quick recap of Kowalski (2009):
  - CQIV estimates of the price elasticity of expenditure on medical care
  - -2.3 estimated price elasticity of expenditure, which is constant across the upper quantiles of the distribution
  - Relies on IV strategy using family interactions in cost-sharing and injuries
- Kowalski (2009) vs. this paper
  - Data from same firm
  - Different population
  - Family size >=4 vs. Family size <=3
  - People with family injuries vs. entire population