Endogenous Information Acquisition and Insurance Choice

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Abstract

Insurance contracts are complicated and individuals may choose how much time and effort to put into understanding potential out-of-pocket costs and comparing plans. We develop a parsimonious discrete choice model that incorporates both endogenous information acquisition and preference heterogeneity. The framework generates stark predictions about how individuals appear to trade off premiums and out-of-pocket costs, as well as how choices are affected when the stakes change. Using prescription drug insurance data, we exploit within-individual variation and show that the framework provides an explanation for behavior that is inconsistent with standard demand models. In ongoing work, we estimate a structural model explicitly incorporating endogenous information acquisition, recovering individuals' cost of acquiring and processing information in addition to standard demand parameters. We argue that rational inattention has important implications for counterfactuals and welfare, in addition to supply-side incentives.

Keywords: insurance, information frictions, rational inattention
JEL Classification: L15, I13, D83

1 Introduction

When individuals shop for insurance plans, it is straight-forward to compare premiums. In contrast, out-of-pocket costs can be difficult to predict given the complexity of insurance contracts. In order to predict out-of-pocket costs for each plan, individuals must know the total price and cost sharing for every type of claim, as well as the probability of each claim type. Individuals may spend considerable time and effort trying to compare insurance contracts and still not fully understand how contract terms map into expected out-of-pocket cost. Moreover, the amount of time and effort that individuals spend comparing plans is likely endogenous. If the stakes are low, individuals may choose an insurance plan with very limited information. If the stakes are high, individuals may incur significant cost to acquire information. Depending on the cost of information and who has incentive to acquire it, some individuals may choose dominated insurance plans, with important implications for adverse selection, competition, and regulation of insurance markets.

We develop a theoretical framework for examining choices in the presence of an information acquisition cost for a subset of product characteristics. We focus on insurance choice, although the model can be applied more broadly. We build on theoretical work incorporating rational inattention in discrete choice models (Matějka and McKay 2015; Fosgerau et al. 2017). In the model, the amount of information acquired by individuals depends on the stakes. In particular, individuals with small consequences from choosing the wrong plan, such as those expecting few claims, acquire less information than individuals with large consequences. We show that this generates a non-monotonic relationship between the stakes and the quality of decisions that individuals make. In addition, the model implies that the relative weight that individuals place on premiums versus out-of-pocket cost depends on the stakes.

We show that reduced-form results are consistent with the model. We leverage administrative data from Medicare prescription drug insurance, also known as Medicare Part D. Focusing on individuals that are forced to make an active choice (i.e. new enrollees and those who had a previous plan that was discontinued), we find that the quality of decision making is affected by the stakes. Importantly, we show that the empirical results are robust to exploiting within-individual variation in the stakes. In other words, when an individual needs more expensive medical services and faces higher stakes, we find evidence that she acquires more information. We argue that these results are not consistent with standard models of insurance demand that have been previously used in the literature.

We will estimate a structural model directly based on the theoretical framework. This will allow us to recover the cost of information, which we argue is a key policy-invariant parameter. With the results in hand, we will be able to examine a variety of policy-relevant counterfactuals including changing the cost of information, number of plans, and cost sharing. We also plan to examine the supply-side implication of endogenous information acquisition, including the incentive for insurers to compete on premiums versus compete on expected out-of-pocket costs. In addition, insurers may have incentive to price discriminate based on individuals' sophistication, i.e. cost of information.

1.1 Related Literature

There is an influential literature documenting that individuals choose dominated health insurance plans, often overpaying significantly (e.g. Abaluck and Gruber 2011; Kling et al. 2012; Heiss et al. 2013; Handel and Kolstad 2015; Bhargava et al. 2017). It has been argued that this is due to the complexity of health insurance plans and resulting information frictions. For instance, Handel and Kolstad (2015) survey individual's beliefs about health care plans and find that individuals do not fully understand the insurance plans, making it difficult to choose correctly. These beliefs are then used to estimate a structural model.

We build on the previous literature by developing the first model of insurance choice that endogenizes individuals' acquisition of information about contract terms that determine out-of-pocket cost. In addition to explaining why individuals may choose dominated options, we also provide new evidence that choices depend on the stakes in a manner inconsistent with standard demand models. The model leverages theoretical results that link rational inattention models to discrete choice demand (Matějka and McKay 2015; Fosgerau et al. 2017). There is very limited work incorporating the rational inattention framework into structural models.

A related literature also examines consumer inertia in insurance plan choice (e.g. Ho et al. 2017; Polyakova 2016; Abaluck and Adams 2018). Our empirical results currently focus on individuals forced to switch, thus abstracting from switching costs, however we also argue that our model of endogenous information acquisition can provide a micro-foundation for endogenous switching costs. In particular, individuals may not wish to shop for insurance plans every year due to an information acquisition cost.

The remainder of this paper is as follows. Section 2 presents the basic framework. Section

3 discusses background and data. Section 4 presents reduced-form evidence consistent with the model. Section 5 presents an empirical framework. Section 6 concludes.

2 Theoretical Framework

In this section, we present a basic version of the discrete choice model in which individuals minimize expected total cost when part of the cost, i.e. out-of-pocket costs, are initially unobserved unless individuals acquire information. We leverage theoretical results linking the rational inattention framework with discrete choice models (Matějka and McKay 2015; Fosgerau et al. 2017), deriving a straightforward expression for insurance choice probabilities. The model is useful for clarifying how demand with endogenous information acquisition differs from standard demand models. We examine the implications of the model, motivating our reduced-form analysis. In Section 5, we present a richer empirical framework that accounts for individual risk aversion, preferences over non-cost characteristics, and idiosyncratic taste shocks.

Individual i chooses between N alternatives indexed by j. Each alternative has cost p_j, which is initially observed, and v_{ij}, which is initially unobserved unless the individual acquires costly information. The vector of payoffs, $\mathbf{u}_i \in \mathbb{R}^N$, is determined by the vector of observed cost, $\mathbf{p} \in \mathbb{R}^N$, and initially unobserved cost, $\mathbf{v_i} \in \mathbb{R}^N$. Specifically,

$$u_{ij} = \underbrace{-p_j}_{\substack{\text{Initially}\\\text{Observed}\\\text{Cost}}} \quad \underbrace{-v_{ij}}_{\substack{\text{Initially}\\\text{Unobserved}\\\text{Cost}}} \tag{1}$$

In the case of insurance choice, p_j is the premium and v_{ij} is expected out-of-pocket costs. Information on plan premiums is readily available, often listed on websites or in published material. Conversely, individual-specific expected out-of-pocket costs are difficult to observe as it requires forming expectations about claims and mapping those claims to out-of-pocket costs via complicated insurance contracts that potentially involve deductibles, copays, coinsurance, and catastrophic coverage.

Following Matějka and McKay (2015), we can consider the decision problem having two stages. In the first stage, individuals have a prior and rationally choose how much information to acquire about v_{ij}, forming posterior beliefs about the total cost of each option. In the second stage, individuals maximize expected utility given beliefs that were formed in the first stage.

We start with the second stage decision. After acquiring the chosen amount of information, the individual has beliefs $B_i \in \Delta(\mathbb{R}^N)$ about the expected payoff of each option where the set of all probability distributions is given by $\Delta\mathbb{R}^N$. The individual chooses the option that solves

$$\max_{j \in J} \left[-p_j - \mathbb{E}_{B_i}[v_{ij}] \right] \tag{2}$$

In the first stage, the individual chooses what signals to receive based on the expected payoff, the cost of information, and the prior. The individual's potential information acquisition strategies are unconstrained—any information about any of the options can be acquired in any manner, subject to the cost of information. In particular, individuals may wish to become partially informed about options, e.g. receive vector of signals, $\mathbf{s}_i$, with limited information content. The information strategy can be expressed as a joint distribution of signals and payoffs, $F(\mathbf{s}_i, \mathbf{v}_i) \in \Delta(\mathbb{R}^{2N})$. Given the individual's prior, G_i, the individual chooses the conditional distribution $F(\mathbf{s}_i|\mathbf{v}_i)$. This results in posterior belief $F(\mathbf{v}_i|\mathbf{s}_i)$.

Given unit cost of information λ, total cost of information takes the form

$$c(F) = \lambda \left(-\int_{v_i} g(\mathbf{v}_i) \log g(\mathbf{v}_i) d\mathbf{v}_i + \mathbb{E}_{\mathbf{s}_i}[\int_{\mathbf{v}_i} f(\mathbf{v}_i|\mathbf{s}_i) \log f(\mathbf{v}_i|\mathbf{s}_i) d\mathbf{v}_i] \right) \tag{3}$$

where $g(\mathbf{u}_i)$ is the pdf of the prior and $f(\mathbf{u}_i|\mathbf{s}_i)$ is the pdf of the joint distribution of signals and payoffs.

As is standard in the rational inattention literature, the cost of information is proportional to the change in entropy between the prior and signal, often referred to as the mutual information. This can be thought of as a measure of the reduction in uncertainty after signals are received. This cost function has attractive properties and is meant to reflect the time and cognitive load necessary to acquire and process information. In particular, the cost function is consistent with an individual asking a series of yes-no questions with a fixed cost per question.[1]

The individual chooses an information acquisition strategy that solves

$$\max_{F(\mathbf{s}_i, \mathbf{v}_i) \in \Delta(\mathbb{R}^{2N})} \int_{\mathbf{v}_i} \int_{\mathbf{s}_i} \max_{j \in J} \left[-p_j - \mathbb{E}_{B_i}[F(\cdot|\mathbf{s}_i)] F(d\mathbf{s}_i|\mathbf{v}_i) G(d\mathbf{v}_i) \right] - c(F) \tag{4}$$

[1]See discussion in Cabrales et al. (2013), Matějka and McKay (2015), and ...

$$\text{s.t.} \quad \int_{\mathbf{s}_i} F(d\mathbf{s}_i, \mathbf{u}_i) = G(\mathbf{u}_i) \ \forall \mathbf{u}_i \in \mathbb{R}$$

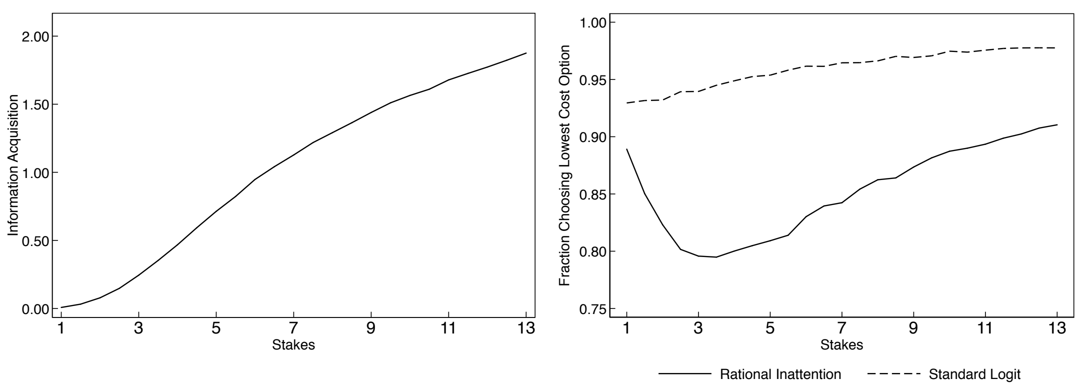
Matějka and McKay (2015) show that this problem can be reformulated in a way that abstracts from the specific information acquisition strategy and resulting signals. Expected utility given beliefs can be expressed as

$$\mathbb{E}_{B_i}[u_{ij}] = \underbrace{p_j + v_j}_{\text{Actual Utility}} + \underbrace{\lambda \log P^0_{ij}}_{\text{Contribution of Prior}} + \underbrace{\lambda e_{ij}}_{\text{Belief Error}} \tag{5}$$

where e_{ij} is distributed EV1 and P^0_j is the initial choice probability based on the individual's prior but before the realization of signals. The distribution of the belief error is not an assumption, but rather a natural consequence of the rational inattention framework. Initial choice probabilities based on the prior, $P^0_1, .., P^0_N$, are obtains from solving

$$\max_{P^0_{i1}, .., P^0_{iN}} \int_{\mathbf{v}} \lambda \log \Sigma_j P^0_{ij} e^{(p_j + v_{ij})/\lambda} G(d\mathbf{v}) \text{ s.t. } \sum_j P^0_{ij} = 1, P^0_{ij} \geq 0 \ \forall j \tag{6}$$

Figure 1
Predicated Information Acquisition and Fraction Choosing Lowest Cost Plan
By Stakes



a. Information Acquisition by Stakes   b. Fraction Choosing Lowest Cost Plan by Stakes

Notes: Charts show mean fraction of individuals choosing lowest cost option from simulations with

We assume that individuals know the variance of v_{ij} across alternatives, σ^2, and this used to form their prior G. The prior is the same for all alternatives, an assumption we relax in

Section 5.[2]

We derive a closed-form expression for expected utility given that the variance of the prior for each alternative is σ^2,

$$\mathbb{E}_{B_i}[u_{ij}] = -\underbrace{\frac{l}{\lambda(l-1)}}_{\substack{\text{Premium}\\ \text{Weight}}} p_j - \underbrace{\frac{1}{\lambda}}_{\substack{\text{OOP}\\ \text{Weight}}} v_{ij} + \underbrace{e_{ij}}_{\substack{\text{Normalized}\\ \text{Belief Error}}} \tag{7}$$

where $l^2 = \frac{6\sigma^2}{\pi^2\lambda^2} + 1$. The derivation, which is presented in Appendix Section A, makes use of a distributional assumption on the prior that emits a closed-form expression for P_j^0. In Appendix Section A we conduct a Monte Carlo exercise to assess the importance of this assumption.

Even though payoffs are deterministic in this simple version of the model, it is as if choices are the result of a random utility model. Rather than an idiosyncratic taste shock, the error is due to endogenous information frictions.

The rational inattention framework implies belief errors that are distributed EV1, yielding straight-forward choice probabilities that are similar to a standard logit. Choice probabilities are given by

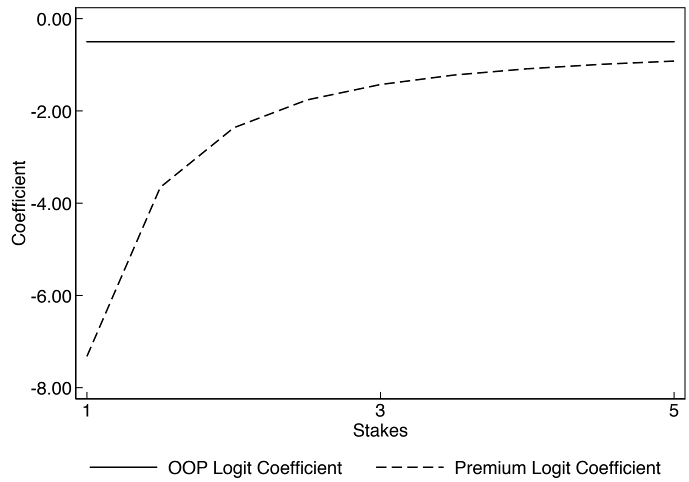
$$P_{ij} = \frac{e^{(p_i l/(l-1)+v_{ij})/\lambda}}{\sum_k e^{(p_k l/(l-1)+v_{ik})/\lambda}} \tag{8}$$

The model implies that choices depend on the stakes. To see this, note that σ can be interpreted as a measure of the stakes. In the case of insurance, σ is low when when expected out-of-pocket costs are similar across plans, perhaps because the individual is likely to have few claims. In this case, individuals acquire little information. When individuals are highly exposed to out-of-pocket costs, the variance across plans may be high. In this case, individuals have more incentive to acquire information given that there is more scope for accidentally choosing an expensive plan. This is depicted graphically in Figure 1 Panel a. In the figure, information acquisition is simulated for different values of the stakes using Equation 3.

Endogenous information acquisition has important implications for overspending. Figure 1 Panel b shows the fraction of individuals choosing the lowest cost plan as a function of the stakes. A key implication of the model is that there is a non-monotonic relationship

[2] Note that the mean of the prior is inconsequential since it is assumed to be the same for every option and there is no outside option.

Figure 2
Predicted Logit Coefficient on Premium and Out-of-Pocket cost by Stakes



Notes: Chart shows implied logit coefficient on annual out-of-pocket cost and annual premium from simulations with..

between the stakes and overspending. When the stakes are low, comparing plans is relatively simple. Despite the fact that individuals choose to acquire little information, they often choose correctly. As the stakes grow and comparisons become more complex, it becomes more difficult for individuals to choose the lowest cost plan despite the fact that they are acquiring more information. This implies a positive relationship between stakes and overspending. However, once the stakes are large enough, individuals become highly informed given the strong incentive to acquire information. In this range, there is a negative relationship between stakes and overspending.

The model with endogenous information acquisition can be contrasted with standard demand models assuming full information. If utility is only a function of the cost, as in Equation 1, the stakes will have no effect on choices. In a logit demand model with a fixed taste shock, there is a monotonic relationship between stakes and probability of choosing the least expensive plan. As the stakes grow, the taste shock becomes less important, generating a positive relationship. This can be seen in Figure 1 Panel b.

Moreover, the model has stark predictions for the effective weight that decision makers place on q_j and v_{ij}. Under full information, a change in q_j affects choices the same as an equivalent change in v_{ij}. However, in the demand model with endogenous information acquisition where v_{ij} is initially unobserved, the weight that individuals appear to place on characteristics is endogenous and differs for q_j and v_{ij}. In Equation 7, the coefficient on v_{ij} is solely a function of the cost of information, however the coefficient on q_j depends on both the cost of information and the stakes. As shown in Figure 2, the magnitude of the the coefficient on q_j , e.g. the premium, decreases when the stakes increase. As individuals acquire more information about v_{ij}, the weight on q_j and v_{ij} converge.

In Section 4 we test the predictions of the model using data on Medicare prescription drug insurance choice. In particular, we ask whether choices are affected by the stakes in a manner consistent with the model presented in this section.

3 Background and Data

When individuals choose a Medicare Part D plan, premiums are easily compared either on the Medicare website or in printed material. There are a number of reasons why out-of-pocket costs are more difficult to observe, potentially requiring costly effort. First, individuals must know their likely drug usage over the coming year, including dosage and frequency. Then individuals must understand how this maps into out-of-pocket costs. Given the complexity of deductibles, copayments, coinsurance, the donut hole, and catastrophic coverage this may require significant time and effort, especially for older individuals eligible for Medicare Part D. The Medicare website provides an online tool, PlanFinder, that helps compare out-of-pocket costs across plans after individuals enter information about drug usage. However, the tool is still difficult to use, especially for older patients that may not be familiar with the internet (cites). The difficulty in comparing out-of-pocket costs is highlighted by Kling et al. (2012), who find that individuals would choose less expensive plans with easier to use information.

In the context of our model, we wish to construct a measure of out-of-pocket costs that reflects the beliefs of individuals as the cost of information goes to zero (or information acquisition goes to infinity). Following the previous literature, we construct two measures of expected out-of-pocket cost. The primary measure, based on the rational expectations assumption, is constructed by binning individuals into groups based on similarity in the year prior, constructing out-of-pocket costs for each individual with each plan, then averaging across individuals in the group to obtain an estimate of expected out-of-pocket cost. There is concern about measurement error, and therefore we also construct a measure based on a perfect foresight assumption. In this approach, we assume that, with full information,

Table 1
Summary of Insurance Choice for Forced Switchers

	Mean	SD
Demographics:		
Age	76.6	7.3
Female	0.61	0.49
Chosen option:		
Annual premium	504.9	165.0
Out-of-pocket cost (RE)	681.5	978.1
Out-of-pocket cost (PF)	673.3	1379.7
Total spending	1178.2	1396.3
Relative to least expensive option:		
Difference (RE)	425.5	531.6
Percent difference (RE)	0.32	0.16
Difference (PF)	459.4	1217.2
Percent difference (PF)	0.34	0.20
Number of individuals	64,071	
Choice situations	84,193	

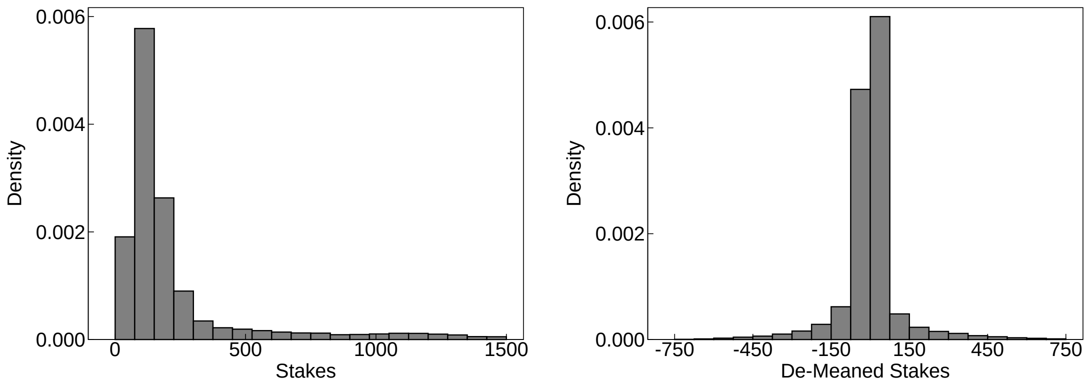
Notes: Sample includes all forced switchers from 2011 to 2015.

individuals would know their future utilization exactly. Therefore, each individual's realized claims is used to construct out-of-pocket costs. This approach abstracts from moral hazard.

In order to construct out-of-pocket costs, we use a 20 percent sample of Medicare Part D beneficiaries from 2010 to 2015, 13.9 million individuals . The large sample size allows us to construct more precise estimates of expected out-of-pocket costs. For the analysis, we limit the sample to 5 percent of the 20 percent sample, 379,316 choice situations. The previous literature has documented the importance of consumer inertia in plan choice (cites). In this project, we focus on individuals that are forced to switch due to the fact that their previous plan was not available. We discuss the implications of the model for inertia in plan choice.

Motivated by the theoretical model, we define the stakes as the standard deviation in out-of-pocket costs across plans in an individual's choice set. It is important to note that the stakes are not always higher when individuals face higher out-of-pocket costs. For instance, if individuals face very high out-of-pocket costs, they may hit the catastrophic coverage portion of Medicare Part D plans, leading to low variance in costs across plans. In this case, the individual would face relatively low stakes.

Figure 3
Variation in Stakes



a. Variation in stakes b. Within-individual variation in stakes

Notes: Stakes are defined as the standard deviation in annual out-of-pocket cost across plans in an individual's choice set.

4 Reduced-Form Evidence

Motivated by the results of the model in Section 2, we now examine how insurance plan choice is affected by the stakes. We use individual-level data on Medicare prescription drug plan choice and exploit within-individual variation, i.e. the same individual who is forced to make choices under different circumstances.

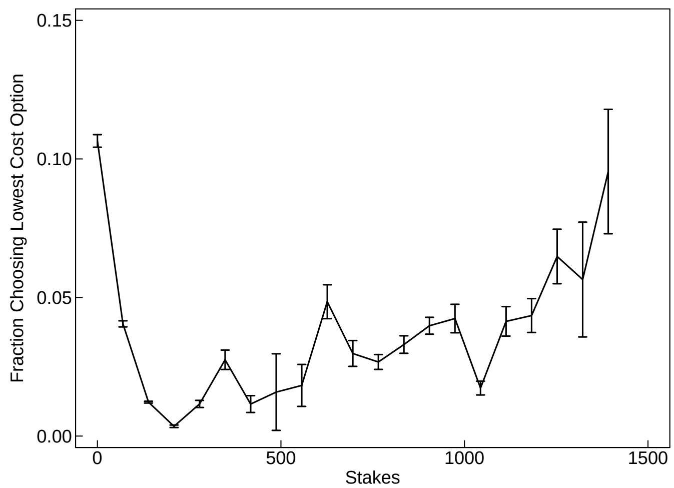
Stakes and Overspending

We start by examining the relationship between the fraction of individuals choosing the lowest cost plan and the stakes. Figure 4 shows that there is a non-monotonic relationship. As in Figure 1 Panel b, the relationship is U-shaped. We interpret this as initial evidence in support of the model, however there are concerns that individuals facing high stakes have different preferences than individuals facing low stakes.

In order to examine the causal effect of stakes on the fraction of individuals choosing the lowest cost plan, we exploit within-individual variation. For individual i in year t, we estimate the following linear probability model

$$y_{it} = \beta_0 + \alpha_1 Stakes_{it} + \alpha_2 Stakes_{it}^2 + \beta X_{it} + \gamma_i + \theta_t + \varepsilon_{it} \tag{9}$$

Figure 4
Fraction Choosing Lowest Cost Plan by Stakes



Notes: Chart shows mean fraction of individuals choosing lowest cost option. Standard error bars show 95% confidence interval for the mean.

where γ_i are individual fixed effects, θ_t are year fixed effects, and X_{it} are average plan characteristics.[3] By including individual fixed effects, Identification of α_1 and α_2 exploits within-individual variation in the stakes. Year fixed effects control for changes in plans offered over the period. The dependent variable, y_{it}, is an indicator for whether individual i chose the option with the lowest total cost, defined as the sum of the annual premium plus and the annual expected out-of-pocket cost calculated using rational expectations assumption. The primary hypothesis is that there is a U-shaped relationship between stakes and the dependent variable, i.e. $\alpha_1 < 0$ and $\alpha_2 > 0$.

Estimates are presented in Table 2. Across specifications including different controls and fixed effects, we consistently find that $\alpha_1 < 0$ and $\alpha_2 > 0$, implying a U-shaped relationship. The preferred specification, presented in column 5, includes both individual and year fixed effects. The coefficients imply that individuals are initially less likely to choose the lowest cost plan as the stakes increase. However, once the stakes are higher than $333, individuals are more likely to choose the lowest cost plan as the stakes increase.

One concern is that there is measurement error stemming from the fact that each individual's out-of-pocket costs are predicted based on a group of individuals. As a robustness check, we use individual's actual utilization to predict out-of-pocket costs, e.g. a perfect fore-

[3] We include controls for star quality, deductible, generic coverage, coverage in the donut hole, and cost sharing. In addition, we control for within-plan out-of-pocket cost variance to account for risk-aversion.

Table 2
Non-Monotonic Effect of Stakes on Choice of Lowest Cost Insurance Plan

	(1)	(2)	(3)	(4)	(5)
Stakes (100s)	-2.443^{***}	-1.969^{***}	-0.448^{***}	-0.521^{***}	-0.392^{***}
	(0.055)	(0.055)	(0.078)	(0.078)	(0.079)
Stakes Squared	0.222^{***}	0.184^{***}	0.064^{***}	0.071^{***}	0.059^{***}
	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)
Plan Characteristic Controls	No	Yes	No	Yes	Yes
Individual FEs	No	No	Yes	Yes	Yes
Year FEs	No	No	No	No	Yes
Implied minimum	551.1	534.0	351.2	369.1	333.0
Adjusted R2	0.010	0.034	0.396	0.399	0.400
Observations	200,701	200,701	200,701	200,701	200,701

Notes: Estimates from linear probability model where dependent variable is percent choosing lowest cost plan. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

sight assumption. The regression results are presented in Appendix Table A-1. All of the specification also imply a U-shaped relationship, although the standard errors are slightly larger.

Another concern is that the simple linear probability model does not fully account for preferences over non-price characteristics. In particular, there are reasons why individuals may not choose the lowest cost plan even under full information. This includes preferences related to risk aversion, plan quantity, and other plan characteristics. While the linear probability model allows us to control for year fixed effects and average plan characteristics, the logit framework used in the following section incorporate characteristics for each plans in individuals' choice set.

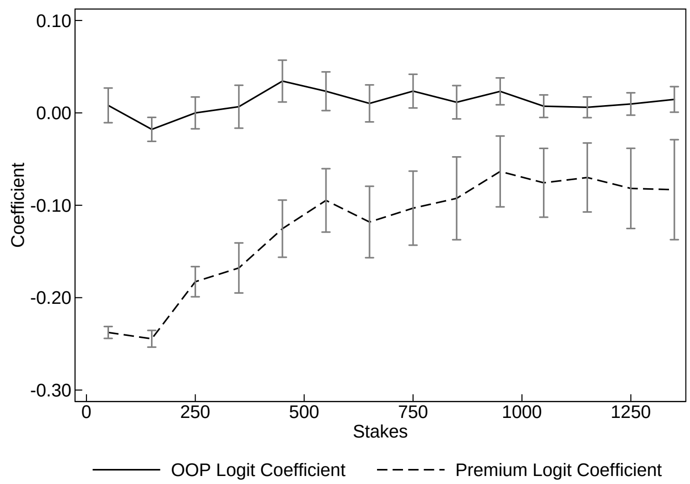
Stakes and Logit Coefficients

In order to examine the relative weight that individuals place on out-of-pocket cost and premiums, and how this varies according to the stakes, we estimate a model based on the standard logit framework. We use the model to further test the theoretical predictions in Section 2. The model is "reduced-form" in the sense that we do not incorporate the cost of information. In Section 5 we estimate a model that is directly based on the rational inattention framework.

We start by considering the following specification for observable utility of plan j

$$\nu_{ijt} = \alpha_1 p_{jt} + \alpha_2 p_{jt} Stakes_{it} + \gamma_1 v_{ijt} + \gamma_2 v_{jt} Stakes_{it} + \theta \tilde{\sigma}^2_{ijt} + \beta X_{ijt} \tag{10}$$

Figure 5
Logit Coefficient on Premium and Expected Out-of-Pocket Cost by Stakes



Notes: Chart shows logit coefficient on annual out-of-pocket cost and annual premium interacted with indicators for the stakes. Logit specification includes controls for risk aversion (OOP variance), plan quality rating, deductible, generic coverage, coverage in the donut hole, and cost sharing. Standard error bars show 95% confidence interval.

The specification controls for risk aversion by including $\tilde{\sigma}^2_{ijt}$, the variance of out-of-pocket costs for plan j.[4]. We also include other plan characteristics, X_{ijt}. Given additive i.i.d. EV1 error, choice probabilities are $P_{ijt} = \exp[\nu_{ijt}] / \left(\sum_k \exp[\nu_{ikt}]\right)$.

If the assumptions of the standard logit model hold, we would expect $\alpha_1 = \gamma_1$ since both coefficients should be equal to the negative marginal utility of income. The stakes do not affect decisions in the standard model, therefore $\alpha_2 = \gamma_2 = 0$. In contrast to the standard logit model, the model presented in Section 2 predicts $\alpha_1 < \gamma_1$ and $\alpha_2 > 0$ since individuals acquire more information about out-of-pocket costs when the stakes are high.

Figure 5 presents the results in graphical form by interacting stake bins with coefficients on premium and out-of-pocket cost.[5] When the stakes are low, individuals appear to place a high value on reducing premiums relative to the value that they place on reducing out-of-pocket cost, i.e. the coefficient on premium is low relative to the coefficient on out-of-pocket cost. This is consistent with the idea that individuals do not have incentive to become informed about out-of-pocket costs. As the stakes rise, the relative weight that individuals

[4]Starting from CARA utility, this can be derived by considering a first-order Taylor series expansion.

[5]Formally, the logit specification assumes observable utility $v_{ijt} = \sum_g \alpha_g p_{jt} D_{ijtg} + \sum_g \gamma_g v_{jt} D_g + \theta \tilde{\sigma}^2_{ijt} + \beta Z_{ijt}$ where $Stakes_{it}$ is divided into groups indexed by g and $D_{ijtg} = 1$ if $Stakes_{it}$ is in group g and $D_{ijtg} = 0$ otherwise.

Table 3
Interaction of Stakes and Price Coefficient in Standard Logit Model

	(1)	(2)	(3)	(4)	(5)	(6)
Premium (100s)	-0.233^{***}	-0.276^{***}	-0.477^{***}	-0.291^{***}	-0.477^{***}	-0.477^{***}
	(0.003)	(0.003)	(0.020)	(0.003)	(0.021)	(0.021)
Premium × Indiv. avg stakes				0.019^{***}	0.017^{***}	0.017^{***}
				(0.001)	(0.001)	(0.001)
Premium × Stakes		0.020^{***}	0.017^{***}	0.008^{***}	0.007^{***}	
		(0.001)	(0.001)	(0.001)	(0.001)	
Premium × Stakes × $\mathbb{1}(\Delta\text{Stakes} > 0)$						0.005^{***}
						(0.001)
Premium × Stakes × $\mathbb{1}(\Delta\text{Stakes} < 0)$						0.011^{***}
						(0.001)
Out-of-Pocket Cost (100s)	-0.017^{***}	0.018^{***}	0.011	0.020^{***}	0.011	0.005
	(0.002)	(0.005)	(0.014)	(0.004)	(0.014)	(0.014)
OOP × Indiv. avg stakes				0.000	0.000	0.000
				(0.000)	(0.000)	(0.000)
OOP × Stakes		−0.000	−0.000	−0.000	-0.001^{**}	
		(0.000)	(0.000)	(0.000)	(0.000)	
OOP × Stakes × $\mathbb{1}(\Delta\text{Stakes} > 0)$						-0.001^{**}
						(0.000)
OOP × Stakes × $\mathbb{1}(\Delta\text{Stakes} < 0)$						−0.000
						(0.000)
Premium × Z_i	No	No	Yes	No	Yes	Yes
OOP × Z_i	No	No	Yes	No	Yes	Yes
Log Likelihood	-114,187	-113,814	-113,391	-113,654	-113,251	-113,230
Observations	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674

Notes: Stakes in hundreds of dollars. All specifications include controls for risk aversion (OOP variance), plan quality rating, deductible, generic coverage, coverage in the donut hole, and cost sharing. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

appear to place on premiums declines, consistent with the model predictions depicted in Figure 2.

The results using the specification described in Equation 10 are presented in Table 3 Column 2. Consistent with the model, the interaction of premium and stakes is positive and statistically significant. The interaction of out-of-pocket cost and stakes is very small and statistically insignificant, also consistent with the model.

The primary concern is that the results reflect heterogeneity in preferences that are correlated with the stakes rather than endogenous information acquisition. We address this in a few ways. First, we allow for heterogeneity in the price coefficients by including separate coefficients on observable individual characteristics interacted with the stakes. Observable individual characteristics include age, gender, race indicators, average chronic conditions, zip code income and education, and an indicator for rural locality. The results, presented in Table 3 Column 3, are qualitatively the same.

To address the concern that there still may be unobserved preference heterogeneity, we include a separate coefficient on the interaction between premium and an individual's average stakes during the period. We also include out-of-pocket cost interacted with an individual's average stakes during the period. Therefore, within-individual variation in the stakes identified the coefficient on $p_{jt}Stakes_{it}$ and $v_{jt}Stakes_{it}$. The results, with and without the interaction of observable characteristics, are presented in Table 3 Column 4 and 5. The coefficient on premium interacted with the within-individual stakes remains positive and statistically significant in both specifications, although smaller in magnitude. The interaction of out-of-pocket cost and within-individual stakes remains small in magnitude.

Finally, we examine whether the magnitude of the effect is different for an increase in the stakes compared to a decrease in the stakes. The results, which exploit the same within-individual variation, are presented in Table 3 Column 6. Focusing on how the stakes affect the weight that individuals put on premiums, the results imply a statistically significant and positive effect for both an increase and a decrease. However, the effect of a decrease in the stakes is larger in magnitude.

5 Empirical Model

To be completed.

6 Conclusion

To be completed.

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APPENDIX

A Model Derivation

B Appendix Tables

Table A-1
Non-Monotonic Effect of Stakes on Insurance Choice
Robustness Check with Perfect Foresight Assumption

	(1)	(2)	(3)	(4)	(5)
Stakes (100s)	-2.268^{***}	-1.766^{***}	-0.143	-0.315^{***}	-0.210^{**}
	(0.061)	(0.062)	(0.090)	(0.090)	(0.091)
Stakes Squared	0.198^{***}	0.159^{***}	0.032^{***}	0.046^{***}	0.036^{***}
	(0.006)	(0.005)	(0.008)	(0.008)	(0.008)
Plan Characteristic Controls	No	Yes	No	Yes	Yes
Individual FEs	No	No	Yes	Yes	Yes
Year FEs	No	No	No	No	Yes
Implied minimum	571.4	554.1	223.0	339.1	288.9
Adjusted R2	0.007	0.028	0.347	0.351	0.353
Observations	200,701	200,701	200,701	200,701	200,701

Notes: Dependent variable is percent choosing lowest cost plan, where lowest cost plan is defined using a perfect foresight assumption. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-2
Interaction of Stakes and Price Coefficient in Standard Logit Model
Robustness Check with Random Coefficients

	(1)	(2)	(3)	(4)	(5)	(6)
Premium (100s)	-0.309^{***}	-0.348^{***}	-0.621^{***}	-0.376^{***}	-0.638^{***}	-0.637^{***}
	(0.004)	(0.004)	(0.030)	(0.004)	(0.030)	(0.030)
sd	0.211^{***}	0.205^{***}	0.205^{***}	0.206^{***}	0.206^{***}	0.205^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Premium × Indiv. avg stakes				0.023^{***}	0.021^{***}	0.021^{***}
				(0.001)	(0.002)	(0.002)
Premium × Stakes		0.023^{***}	0.022^{***}	0.009^{***}	0.010^{***}	
		(0.001)	(0.001)	(0.001)	(0.001)	
Premium × Stakes × $\mathbb{1}$(Stakes > 0)						0.008^{***}
						(0.002)
Premium × Stakes × $\mathbb{1}$(Stakes < 0)						0.012^{***}
						(0.002)
Out-of-Pocket Cost (100s)	0.048^{***}	0.063^{***}	0.161^{***}	0.082^{***}	0.175^{***}	0.178^{***}
	(0.005)	(0.007)	(0.035)	(0.008)	(0.035)	(0.035)
sd	-0.107^{***}	-0.108^{***}	-0.109^{***}	0.099^{***}	-0.101^{***}	-0.103^{***}
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
OOP × Indiv. avg stakes				-0.001	-0.001	-0.001
				(0.001)	(0.001)	(0.001)
OOP × Stakes		0.001	0.001	-0.001	-0.001	
		(0.001)	(0.001)	(0.001)	(0.001)	
OOP × Stakes × $\mathbb{1}$(Stakes > 0)						-0.000
						(0.001)
OOP × Stakes × $\mathbb{1}$(Stakes < 0)						-0.001
						(0.001)
Premium × Z_i	No	No	Yes	No	Yes	Yes
OOP × Z_i	No	No	Yes	No	Yes	Yes
Log Likelihood	-112,168	-111,912	-111,493	-111,781	-111,384	-111,380
Observations	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674

Notes: Stakes in hundreds of dollars. All specifications include controls for risk aversion (OOP variance), plan quality rating, deductible, generic coverage, coverage in the donut hole, and cost sharing. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

C Appendix Figures

Table A-3
Interaction of Stakes and Price Coefficient in Standard Logit Model
Robustness Check with Perfect Foresight Assumption

	(1)	(2)	(3)	(4)	(5)	(6)
Premium (100s)	-0.234^{***}	-0.279^{***}	-0.492^{***}	-0.294^{***}	-0.489^{***}	-0.486^{***}
	(0.003)	(0.003)	(0.021)	(0.003)	(0.021)	(0.022)
Premium × Indiv. avg stakes				0.019^{***}	0.018^{***}	0.017^{***}
				(0.001)	(0.001)	(0.001)
Premium × Stakes		0.020^{***}	0.018^{***}	0.008^{***}	0.008^{***}	
		(0.001)	(0.001)	(0.001)	(0.001)	
Premium × Stakes × $\mathbb{1}(\text{Stakes} > 0)$						0.005^{***}
						(0.001)
Premium × Stakes × $\mathbb{1}(\text{Stakes} < 0)$						0.013^{***}
						(0.001)
Out-of-Pocket Cost (100s)	-0.023^{***}	-0.020^{***}	-0.057^{***}	-0.013^{***}	-0.049^{**}	-0.046^{**}
	(0.002)	(0.005)	(0.019)	(0.005)	(0.019)	(0.019)
OOP × Indiv. avg stakes				0.003^{***}	0.002^{***}	0.002^{***}
				(0.001)	(0.001)	(0.001)
OOP × Stakes		0.003^{***}	0.003^{***}	0.001^{**}	0.001^{*}	
		(0.000)	(0.000)	(0.000)	(0.000)	
OOP × Stakes × $\mathbb{1}(\text{Stakes} > 0)$						0.000
						(0.000)
OOP × Stakes × $\mathbb{1}(\text{Stakes} < 0)$						0.001^{***}
						(0.000)
Premium × X_i	No	No	Yes	No	Yes	Yes
OOP × X_i	No	No	Yes	No	Yes	Yes
Log Likelihood	-114,144	-113,804	-113,329	-113,652	-113,196	-113,179
Observations	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674

Notes: Stakes in hundreds of dollars. All specifications include controls for risk aversion (OOP variance), plan quality rating, deductible, generic coverage, coverage in the donut hole, and cost sharing. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A-4
Interaction of Stakes and Price Coefficient in Standard Logit Model
Robustness Check with Random Coefficients and Perfect Foresight Assumption

	(1)	(2)	(3)	(4)	(5)	(6)
Premium (100s)	-0.310^{***}	-0.349^{***}	-0.625^{***}	-0.377^{***}	-0.641^{***}	-0.640^{***}
	(0.004)	(0.004)	(0.029)	(0.004)	(0.029)	(0.029)
sd	0.210^{***}	0.204^{***}	0.204^{***}	0.204^{***}	0.204^{***}	0.203^{***}
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Premium × Indiv. avg stakes				0.023^{***}	0.021^{***}	0.021^{***}
				(0.001)	(0.002)	(0.002)
Premium × Stakes		0.023^{***}	0.021^{***}	0.009^{***}	0.009^{***}	
		(0.001)	(0.001)	(0.001)	(0.001)	
Premium × Stakes × $\mathbb{1}$(Stakes $>$ 0)						0.008^{***}
						(0.002)
Premium × Stakes × $\mathbb{1}$(Stakes $<$ 0)						0.011^{***}
						(0.002)
Out-of-Pocket Cost (100s)	0.017^{***}	0.007	0.061^{**}	0.004	0.055^{*}	0.056^{*}
	(0.003)	(0.004)	(0.029)	(0.006)	(0.029)	(0.029)
sd	-0.086^{***}	-0.087^{***}	0.083^{***}	0.084^{***}	-0.083^{***}	-0.085^{***}
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
OOP × Indiv. avg stakes				0.004^{***}	0.004^{***}	0.004^{***}
				(0.001)	(0.001)	(0.001)
OOP × Stakes		0.004^{***}	0.004^{***}	0.001^{**}	0.001^{**}	
		(0.001)	(0.001)	(0.001)	(0.001)	
OOP × Stakes × $\mathbb{1}$(Stakes $>$ 0)						0.002^{***}
						(0.001)
OOP × Stakes × $\mathbb{1}$(Stakes $<$ 0)						0.001
						(0.001)
Premium × X_i	No	No	Yes	No	Yes	Yes
OOP × X_i	No	No	Yes	No	Yes	Yes
Log Likelihood	-112,179	-111,938	-111,509	-111,821	-111,409	-111,405
Observations	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674	1,025,674

Notes: Stakes in hundreds of dollars. All specifications include controls for risk aversion (OOP variance), plan quality rating, deductible, generic coverage, coverage in the donut hole, and cost sharing. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.