Behavioral Hazard in Health Insurance

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Abstract

A fundamental implication of economic models of health insurance is that insurees overuse low-value medical care because the copay is lower than cost, i.e., because of moral hazard. There is ample evidence, though, that people misuse care for a different reason: behavioral errors. For example, many highly beneficial drugs end up being under-used; and some useless care is bought even when the price equals cost. We refer to this kind of misuse as “behavioral hazard” and its presence changes the welfare calculus. With only moral hazard, demand elasticities alone can be used to make welfare statements, a fact many empirical papers rely on. In the presence of behavioral hazard, welfare statements derived only from the demand curve can be off by orders of magnitude and can even be of the wrong sign. Highly elastic demand suggests increasing copays when the care is low-value but suggests decreasing copays when the care is high-value. Making welfare statements requires knowing the health response as well as the demand elasticity. We derive optimal copay formulas when both moral and behavioral hazard can be present, providing a theoretical foundation for value-based insurance design. Our framework also provides a way to interpret behavioral interventions ("nudges"), suggests different implications for market equilibrium, and shows how health insurance does not just provide financial protection, but can also create incentives for more efficient treatment decisions.

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1 Introduction

Moral hazard is central to how we understand health insurance. Because the insured pay less for health care than it costs, they may overuse it (Arrow 1963; Pauly 1968; Zeckhauser 1970; Cutler and Zeckhauser 2000). One feature of the standard moral hazard model has proven especially important for empirical analysis and policy work: the demand curve alone is enough to quantify the inefficiency generated by insurance (see Finkelstein 2014 for a review). When looking at a change in copays, we can draw welfare conclusions without ever measuring the health impacts because we infer such impacts: if people optimize perfectly, health benefits equal copays at the margin. A large body of empirical work relies on this “sufficient statistic” property to derive welfare calculations and make policy recommendations (Newhouse 1993; Manning et al. 1987; Feldstein 1973). Yet, when it comes to health care choices, people may fail to optimize so perfectly. In this paper, we develop a richer model of health insurance that allows people to make mistakes and suggest that relying on the demand data alone can lead to highly misleading welfare calculations and optimal copay prescriptions.

Many important health care choices are hard to reconcile with a world in which moral hazard alone drives misutilization. First, there are many examples of people underusing rather than overusing care, such as patients failing to use care whose health benefits substantially exceed costs (even accounting for possible side-effects or other non-monetary costs). Diabetes medications, for example, have clear and large benefits—they increase life span, reduce the risk of limb loss or blindness, and improve the quality of life. Yet people fail to take them consistently: adherence rates for these medications is estimated at only 65% (Bailey and Kodack 2011). Diabetes is not the exception: we see low adherence for beneficial medications that help manage chronic conditions, as well as for treatments such as prenatal and post-transplant care (van Dulmen et al. 2007; Osterberg and Blaschke 2005). Second, even when people over-use care, moral hazard is not always the reason: patients sometimes demand care that does not benefit at them or at times even harms them. For example, patients seek out antibiotics with clear risks and unclear benefits for often self-limiting conditions such as ear infections (Spiro et al. 2006). It is hard to explain this kind of overuse with a model based on private benefits exceeding private costs.

This evidence is consistent with a simple narrative. People do not misuse care only because the

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1In principle, it is possible to argue that unobserved costs of care, such as side effects, drive what seems to be underuse. However, in practice, this argument is difficult to make for many of the examples we review. The underuse we focus on is very different from the underuse that can arise in dynamic moral hazard models. In such models, patients may underuse preventive care that generates monetary savings for the insurer (Goldman and Philipson 2007; Ellis and Manning 2007). Here, we focus on the underuse of care whose benefits outweigh costs to the consumer. For example, though the underuse of diabetes medications does generate future health care costs, the uninsurable private costs to the consumer alone (e.g. higher mortality and blindness) make non-adherence likely to be a bad choice even if she is fully insured against future health care costs. We also abstract from underuse due to health externalities (e.g. the effect of vaccination on the spread of disease).
price is below the social marginal cost: they also misuse it because of behavioral biases—because they make mistakes. We call this kind of misutilization behavioral hazard. Many psychologies contribute to behavioral hazard. People may overweight salient symptoms such as back pain or underweight non-salient ones such as high blood pressure or high blood sugar. They may be present-biased (Newhouse 2006) and overweight the immediate costs of care, such as copays and hassle-costs of setting up appointments or filling prescriptions. They may simply forget to take their medications or refill their prescriptions. Or they may have false beliefs about the efficacy of care (Pauly and Blavin 2008). Section 2 introduces a model of behavioral hazard that nests such behavioral biases, as well as others within a large class.  

Behavioral hazard means that welfare calculations can no longer be made from demand data alone. Consider the “marginal” insurees—those who respond to a copay change. In the standard model, these consumers are trading off the health benefits against the copay. Because they are perfectly optimizing, their indifference means the health benefits must roughly equal the copay. But Section 3 shows that with behavioral hazard this inference fails exactly because insurees may be misvaluing care. For example, we would not want to falsely conclude that diabetes medications are ineffective because a modest copay reduces adherence (e.g., Lohr et al. 1986), or that breast cancer patients place little value on conserving their breasts because a modest copay induces them to switch from equally-effective breast-conserving lumpectomy to breast-removing mastectomy (e.g., Einav, Finkelstein, and Williams 2015). In these cases, the care is likely very effective: behavioral hazard means agents can be marginal in their choices even when the health benefits are much larger than the copay.

Empirical work suggests that this is more than an abstract concern. First, we look at cases where we understand the health benefits. Instead of seeing that low-value care is highly elastic and high-value care is inelastic, we find very similar elasticities for both. Second, we reexamine the results of a large-scale field experiment that eliminated copays for certain drugs for recent heart attack victims (Choudhry et al. 2011). Looking only at the demand response—a substantial increase in drug use—would suggest significant moral hazard. Looking at the health outcomes,

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2Of course, differentiating between these biases could help in designing non-price or behavioral interventions, but our focus is largely on the role of more standard price levers. Chetty (2009a) proposes a model of salience and taxation in a similar way: he derives empirically implementable formulas for the incidence and efficiency costs of taxation that are robust across positive theories for why agents may fail to incorporate taxes into choice. Our approach more closely follows that of Mullainathan, Schwartzstein, and Congdon (2012). More broadly, our analysis is in the spirit of the “sufficient statistics” approach to public finance (Chetty 2009b), which develops formulas for the welfare consequences of various policies that are functions of reduced-form elasticities.

3Technically, we can only equate the marginal private utility benefit with the copay, but presumably much of this benefit derives from the health effects.

4Indeed, there is evidence that providing decision aids to inform breast cancer patients about the relevant trade-offs increases demand for the less invasive option (Waljee et al. 2007). One possibility is that patients may start from a false mental model that the more invasive procedure works better.
however, shows substantial reductions in mortality and improvements in health. Thus, while traditional analysis implies a welfare cost, taking behavioral hazard into account implies a much larger welfare gain.

The failure of the demand curve to serve as a sufficient statistic also has implications for the optimal design of insurance. We show in Section 4 that the optimal copay formula now depends on both demand and health responses, not just the demand response (Zeckhauser 1970). This provides a formal foundation for “value-based insurance design” proposals that argue for lower cost-sharing for higher value care (Chernew, Rosen, and Fendrick 2007; Liebman and Zeckhauser 2008; and Chandra et al. 2010), and our model nests a more specific result of Pauly and Blavin (2008) that applies to the case of uninformed consumers. Perhaps surprisingly, we show that the health value of treatment should be taken into account even when behavioral hazard is unsystematic and averages to zero across the population, so long as it is variable. We further show that health insurance now does not just provide financial protection: it can also create incentives for more efficient treatment decisions.

Because it has qualitatively different implications, factoring in behavioral hazard can have a large effect. In Section 5 we compare the optimal copay to the copay a “neo-classical analyst” who ignores behavioral hazard would think is optimal. The neo-classical analyst underestimates the optimal copay whenever behavioral hazard is systematically positive, driving people to overuse, and overestimates the optimal copay whenever behavioral hazard is systematically negative, driving people to underuse. In fact, we show that when behavioral hazard is really positive or really negative, the situations where a neo-classical analyst believes that copays should be particularly low are precisely those situations where copays should be particularly high and vice versa. When behavioral hazard is extreme, the neo-classical optimal copay is exactly wrong.

In addition to changing the calculus around optimal copays, our framework also has implications for the optimal use of nudges (Thaler and Sunstein 2009)—such as defaults and reminders—to mitigate overuse and underuse, as well as to calibrate the degree of behavioral hazard. Section 6 discusses this as well as other extensions of the basic analysis, including what we might expect the market to deliver in equilibrium. Proofs are in the Online Appendix, as are further model extensions and a case study applying the model to treatment of hypertension. Section 7 concludes with a brief discussion of directions for future work.

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5Spinnewijn (2014) analyzes the optimal design of unemployment insurance when job-seekers have biased beliefs and similarly predicts that policies implementing standard sufficient statistics formulas become suboptimal when agents make errors.

6The idea that the optimal copay is below the neo-classical optimal copay when behavioral hazard drives systematic underuse parallels findings on self-commitment devices for present-biased agents. For example, DellaVigna and Malmendier (2004) show that sophisticated present-biased agents value gym memberships that reduce the price of going to the gym below the social marginal cost, since this reduction counteracts internalities that result from the overweighting of immediate costs relative to long-term benefits.
2 A Model of Behavioral and Moral Hazard

2.1 Moral Hazard

We begin with a stylized model of health insurance. Consider an individual with wealth $y$. Insurance has price, or premium, $P$. When healthy, she has utility $U(y - P)$ if she buys insurance. With probability $q \in (0, 1)$, she can fall sick with a specific condition with varying degree of severity $s$ that is private information on the part of the individual. For example, individuals may be afflicted with diabetes that varies in how much it debilitates. Assume $s \sim F(s)$, where $F$ has support on $S = [\underline{s}, \overline{s}] \subset \mathbb{R}^+$ and $\underline{s} < \overline{s}$. Assume further that $F(s)$ has strictly positive density $f(s)$ on $S$. Severity is measured in monetary terms so that when sick, absent treatment, the agent receives utility $U(y - P - s)$.

Treatment can lessen the impact of the disease. Treatment costs society $c$, and its benefit $b(s; \gamma)$ depends on severity, where $\gamma \in \mathbb{R}$ is a parameter that allows for heterogeneity across people in treatment benefits conditional on disease severity, and is also private information.\(^7\) The more severe the disease, the greater the benefits: $b_s > 0$. We assume $b(0; \gamma) = 0$ for all $\gamma$ (the unaffected get no benefit) and $b_s \leq 1$ (the treatment cannot make people better off than not having the disease). The benefits are put in monetary terms. It is efficient for some but not all of the sick to get treated: $b(\underline{s}; \gamma) < c < b(\overline{s}; \gamma)$ for all $\gamma$. We assume that the insured individual pays price or “copay” $p$ for treatment. Notice that while the copay implicitly depends on the disease and treatment, it is independent of $s$ and $\gamma$; we assume that both disease severity and treatment benefits cannot be contracted over because the insurer cannot perfectly measure these variables. The interpretation is that the copay is conditional on all information known to the insurer, but the individual may have some residual private information.\(^8\) In this way, we nest the traditional moral hazard model. An insured individual who receives treatment for his disease gets utility $U(y - P - s + b(s; \gamma) - p)$.

We evaluate insurance contracts from the perspective of a benevolent social planner ranking contracts based on social welfare.\(^9\) Welfare as a function of the copay and the premium equals

\(^7\)As standard in the literature, we implicitly assume that, without insurance, consumers would face the social marginal cost of treatment, which abstracts from another rationale for why insurance coverage can be welfare-improving even for risk-neutral consumers: when treatment suppliers have market power, subsidizing treatment can bring copays closer to the social marginal cost of care (Lakdawalla and Sood 2009).

\(^8\)We focus on a single specific condition for presentational simplicity, but the analysis is qualitatively similar if the person can fall sick with different conditions and the specific condition she falls sick with is observable and verifiable to the insurer, so the insurer can set different copays across conditions.

\(^9\)We take the policy-maker’s welfare function as given. See Bernheim and Rangel (2009) for a discussion of a choice-based approach to recovering consistent welfare functions from inconsistent choice behavior. In effect, we are assuming in Bernheim and Rangel’s framework that there is some (unmodeled in our framework) ancillary condition that the policy-maker uses to infer a consistent preference for the agent and that the objective of the welfare problem is to maximize this preference.
expected utility:

$$W(p, P) = (1 - q)U(y - P) + q\mathbb{E}[U(y - P - s + m(p)(b - p))|\text{sick}],$$

(1)

where $m(p) \in \{0, 1\}$ represents an individual’s demand for care at a given price and equals 1 if and only if the person demands treatment. The first term is the utility if individuals do not get sick with a specific condition: they simply pay the premium. The second term is the utility if they do get sick: the expected utility (depending on disease severity and other stochastic parameters, described in more detail below) which includes the loss due to being sick ($-s$) as well as the benefits of care net of costs to individuals ($b - p$) for the times they choose to use care ($m(p) = 1$). We assume that insurance must be self-funding: $P = P(p) = M(p)(c - p)$, where $M(p) = \mathbb{E}[m(p)]$ equals the per-capita aggregate demand at a given copay. As a result, we can re-write welfare solely as a function of the copay: with some abuse of notation, $W(p) \equiv W(p, P)$.

In this simple setup, the choice to receive treatment when insured is easy: the rational person gets treated whenever benefits exceed price, or $b > p$. This decision is the source of moral hazard. While the insurance value in insurance comes from setting price below true cost, or $p < c$, this subsidized price means that while individuals should efficiently get treated whenever $b > c$ (benefits exceed social costs), they get treated whenever $b > p$ (benefits exceed private costs), generating inefficient utilization when $p < b < c$. Figure 1 illustrates this. Individuals are arrayed on the line according to treatment benefits. Those to the right of the cost $c$ should receive treatment and do so. Those to the left of the price $p$ should not receive treatment and do not. The middle region represents the problem: those individuals should not receive treatment but they do. The price subsidy inherent to insurance is the source of misutilization: Raising the price individuals face would diminish overutilization, but come at the cost of diminished insurance value.\(^\text{10}\)

2.2 Behavioral Hazard

There is, however, ample evidence of misutilization that is difficult to interpret as a rational person’s response to subsidized prices. We incorporate behavioral hazard through a simple modification of the original model. Instead of decisions being driven by a comparison of true benefits to price, evaluating whether $b(s; \gamma) > p$, people choose according to whether $b(s; \gamma) + \varepsilon(s; \theta) > p$, where $\varepsilon$ is positive in the case of positive behavioral hazard (for example, seeking an ineffec-

\(^{10}\)For simplicity, we are assuming away income effects or issues of affordability. In a standard framework, insurance could lead to more efficient decisions insofar as it makes high-value, high-cost procedures affordable to consumers (Nyman 1999). However, in this framework, insurance cannot lead consumers to make more efficient decisions on the margin. Abstracting from income effects serves to highlight this well-known fact (Zeckhauser 1970). Also, many of the examples we focus on involve low cost treatments such as prescription drugs where any income effects are likely to be small.
tive treatment for back pain) and negative in the case of negative behavioral hazard (for example, not adhering to effective diabetes treatment). The parameter $\theta \in \mathbb{R}$ allows for heterogeneity across people in the degree of behavioral hazard and is not observable to the insurer. We assume that $b(s; \gamma) + \varepsilon(s; \theta)$ is differentiable and strictly increasing in $s$ for all $(\gamma, \theta)$. The parameters $(\gamma, \theta)$ are distributed independently from $s$, according to joint distribution $G(\gamma, \theta)$. We let $Q(s, \gamma, \theta) = F(s)G(\gamma, \theta)$ denote the joint distribution of all the possibly stochastic parameters. All expectations are taken with respect to this distribution unless otherwise noted. When $U$ is non-linear, it will be useful to consider a “normalized” version of the behavioral error, $\varepsilon'(s; \theta) = \frac{U(y-P-s) - U(y-P-s-\varepsilon(s; \theta))}{\mathbb{E}[U'(C)]}$, which essentially puts $\varepsilon$ in utility units. (Note that $\varepsilon = \varepsilon'$ for linear $U$, so we have the approximation $\varepsilon \approx \varepsilon'$ if we take $U$ to be approximately linear).

This formulation builds on Mullainathan, Schwartzstein and Congdon (2012) and implicitly captures a divide between preference as revealed by choice and utility as it is experienced, or between “decision utility” and “experienced utility” (Kahneman et al. 1997). In our framework $b - p$ affects the experienced utility of taking the action. Individuals instead choose as if $b + \varepsilon - p$ affects this utility. We focus on behavioral models that imply a clear wedge between these two objects – in other words, models where people have a propensity to misbehave due to mistakes and feature non-zero $\varepsilon$ terms, or “internalities”– rather than models of non-standard preferences.\footnote{For example, anticipation and anxiety may alter how individuals experience benefits (Koszegi 2003): benefits will vary depending on whether taking the action (such as getting an HIV test) leads to anxiety in anticipating the outcome. In these kinds of situations it may be wrong to model the behavioral factor as a bias affecting $\varepsilon$, but rather as a force that affects the mapping between outcomes (such as getting a diagnostic test) and benefits $b$.}

This simple formalization captures a variety of behavioral phenomena. Three examples are presented here and summarized in Table 1: present-bias, symptom salience, and false beliefs.

Present-bias can be important because the benefits of medical care are often in the distant future while its costs appear now (Newhouse 2006). Take the canonical $(\beta, \delta)$ model of present-bias (Laibson 1996, O’Donoghue and Rabin 1999), where, for simplicity, $\delta = 1$. Suppose each treatment is associated with an immediate cost but a delayed benefit. Specifically, $b(s; \gamma) =$
Table 1: Examples of Biases Underlying Behavioral Hazard

<table>
<thead>
<tr>
<th>Present-Bias</th>
<th>Symptom Salience</th>
<th>False Beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>(-k(s; \gamma) + v(s) &gt; p)</td>
<td>(b(\alpha v + \mu n + o; \gamma) &gt; p)</td>
<td>(\hat{b}(s; \gamma, \theta) &gt; p)</td>
</tr>
</tbody>
</table>

\(-k(s; \gamma) + v(s)\), where \(k(s; \gamma)\) represents immediate costs, for example side effects, which can vary across the population even conditional on disease severity, and \(v(s)\) represents delayed benefits, which for simplicity are assumed to only depend on disease severity. The notation and language suggests that \(v > 0\) and \(k > 0\), but we also allow for \(v < 0\) and \(k < 0\), with benefits of treatment in the present and costs delayed. For example, taking a medication may lead to immediate benefits and more delayed side effects. While standard agents (for simplicity) are assumed not to discount future benefits, present-biased agents discount these benefits by factor \(\beta \in (0, 1)\). Instead of getting treated whenever \(b(s; \gamma) = -k(s; \gamma) + v(s) > p\), present-biased agents get treated whenever \(-k(s; \gamma) + \beta v(s) > p \iff b(s; \gamma) - (1 - \beta) v(s) > p\), where here \(\theta\) allows for heterogeneity in the degree to which people are present biased. Defining \(\varepsilon_{PB}(s; \theta) \equiv - (1 - \beta) v(s)\), the present-biased agent has a propensity to underuse treatment relative to what is privately optimal whenever \(\varepsilon_{PB}(s; \theta) < 0\) (corresponding to delayed treatment benefits, \(v > 0\)) and overuse whenever \(\varepsilon_{PB}(s; \theta) > 0\) (corresponding to delayed costs, \(v < 0\)).

Symptom salience can be important. Individuals appear to overweight salient symptoms and underweight less salient ones (Osterberg and Blaschke 2005), driving overuse or underuse. For example, diabetics’ symptoms of elevated glucose levels are often not salient (Rubin 2005), and it is easy to undervalue the health benefits of taking a pill whose effects cumulate slowly over time. Patients at the symptomatic stages of HIV/AIDS are more likely to be adherent to their treatment regimens than are patients at the asymptomatic stage (Gao et al. 2000). Most tuberculosis treatment regimens are at least six months long, but effective therapy leads to improved symptoms after the first four weeks and a concurrent drop-off in adherence. Pain, on the other hand, is clearly highly salient, and patients may overweight the current pain and seek expensive treatments with potential adverse effects in the future. Stories in the popular press highlight the role of symptom salience: a recent report noted the death of an uninsured patient with a tooth infection who was prescribed an antibiotic and a painkiller and who spent his limited resources to fill the painkiller prescription rather than the potentially life-saving antibiotic (Gann, ABC News 2011).

Economists in recent years have introduced rich models to study the impact of salience on behavior (e.g., Bordalo, Gennaioli and Shleifer 2012, 2013; Koszegi and Szeidl 2013). We use a modified version of DellaVigna’s (2009) empirical model of limited attention. Suppose the severity of symptoms is the sum of three components: the severity of highly visible or painful symptoms,
below, this may be attributable to a combination of patient and physician psychology.

where an antibiotic would not be helpful, such as for a viral infection (Gonzales et al. 2001)—although, as discussed combination of factors are at play.

Section 6.1 highlights ways that distinguishing between such factors can be helpful, though we suspect that often a faulty mental models; they may not interpret evidence as Bayesians; they may be inattentive to available evidence. 

instead of getting treated when \( b(s; \gamma) > p \), agents with false beliefs get treated when \( \hat{b}(s; \gamma, \theta) > p \) \( \iff b(s; \gamma) + [\hat{b}(s; \gamma, \theta) - b(s; \gamma)] > p \), where \( \hat{b} \) is the decision benefit to getting treated.

Defining \( \varepsilon^{FB}(s; \theta) = b(s; \gamma, \theta) - b(s; \gamma) \), which for simplicity we assume is constant in \( \gamma \), the person with false beliefs has a propensity to underuse treatment whenever \( \varepsilon^{FB}(s; \theta) < 0 \), where they undervalue treatment \( \hat{b}(s; \gamma, \theta) < b(s; \gamma) \), and has a propensity to overuse treatment whenever \( \varepsilon^{FB}(s; \theta) > 0 \), where they overvalue treatment \( \hat{b}(s; \gamma, \theta) > b(s; \gamma) \).
2.3 Misutilization with Behavioral Hazard

No matter the psychological micro-foundation, behavioral hazard changes how we think about the demand for treatment. We illustrate this in Figure 2. We have now added a second axis to form a square instead of an interval, where the vertical axis represents $b+\varepsilon$, which can vary by individual. The horizontal line separates the region where $b+\varepsilon > p$, while the vertical line separates the region where $b > c$. We see the ranges of misutilization are no longer clear. The people in the bottom left corner (where $b+\varepsilon < p$ and $b < c$) are efficient non-users. Those in the top right corner (where $b+\varepsilon > p$ and $b > c$) are efficient users. But there are now three other regions.

![Figure 2: Model with Behavioral Hazard](image)

The bottom right area is a region of underutilization. People fail to consume care in this region because $b+\varepsilon < p$, but the actual benefits exceed social cost. When there is behavioral hazard underutilization is a concern, not just overutilization due to moral hazard. Examples such as the lack of adherence to drugs treating chronic conditions, like diabetes, hypertension, and high cholesterol, illustrate such underutilization, and Online Appendix Table 1 provides further examples and references.\footnote{Underuse is of course not restricted to prescription drug non-adherence. Patients do not receive recommended care across a wide range of categories, with only 55 percent receiving recommended preventive care including screenings (e.g., colonoscopies) and follow-up care for conditions ranging from diabetes and asthma management to post-hip-fracture care (McGlynn et al. 2003; Denberg et al. 2005; Ness et al. 2000).}
The top left area illustrates overutilization. In this area, benefits of care are below cost so \( b < c \), and the efficient outcome is for the individual not to get treated. Yet because \( b + \varepsilon > p \) the behavioral agent receives care. This area can be broken down further, according to whether \( b + \varepsilon > c \). When this inequality holds, decision benefits are above cost even though true benefits are below cost. In this case, overutilization will not be solved by setting price at true cost. Examples such as people demanding ineffective (or possibly harmful) antibiotics for sinus or ear infections, the overtreatment of prostate cancer, and the extremely high demand for MRIs for back pain may illustrate such overutilization. Finally, the area of overutilization when \( b + \varepsilon \leq c \) illustrates traditional overutilization due to moral hazard.

Misutilization is not solely a consequence of health insurance when there is behavioral hazard. Underuse, not just overuse, is a concern, and overuse may not be solved by setting prices at true cost. We next turn to the effects of these findings on the interpretation of observed elasticities and implications for assessing welfare effects and optimal insurance design.

3 Moral Hazard Cannot be Inferred From the Demand Curve Alone

Behavioral hazard dramatically alters standard intuitions for how we think about the welfare impact of copay changes. Reducing a copay that is less than cost has two effects. Absent a demand response, it raises utility for people who are sick enough that they demand treatment, generating insurance value. Of course, people may choose to consume more care. The welfare impact of this increase depends on the magnitude and direction of behavioral hazard.

For a simple illustration, assume people are risk-neutral and consider the effect of reducing the copay from cost (\( c \)) to zero in Panel (a) of Figure 3, which compares the welfare impact of the change in utilization when there is only moral hazard to when there is also underuse from negative behavioral hazard. The dark grey area represents the standard deadweight loss triangle — the moral hazard cost of insurance. This area is positive because people who get treated only when the price is below marginal cost must have a willingness to pay below this cost. It is also greater the flatter the demand curve: more elastic demand means a greater moral hazard cost of insurance.

An often implicit assumption underlying the standard approach is that we can equate demand or willingness to pay with the true marginal benefit of treatment. Behavioral hazard drives a wedge between these objects. For example, Panel (a) illustrates the case where all people have a propensity to underuse because of negative behavioral hazard and share the same \( \varepsilon < 0 \). In this case, the marginal benefit curve lies above the demand curve and the vertical difference equals \( |\varepsilon| \). When the magnitude of negative behavioral hazard (\( |\varepsilon| \)) is sufficiently large, the marginal benefit of treatment
Notes: Panel (a) considers the welfare impact of reducing the copay to zero when there is only moral hazard to when there is also negative behavioral hazard. Panel (b) considers the welfare impact of increasing the copay above cost when there is only moral hazard to when there is also positive behavioral hazard.

outweighs the marginal cost even when the copay equals zero. In this case, reducing the copay to zero no longer has an associated welfare cost of increased utilization, but rather a welfare benefit equal to the light grey area in the figure. Also, this area is greater the flatter is demand: more elastic demand now means a greater benefit of insurance.

Panel (b) illustrates the case where all people share the same $\varepsilon > 0$ and shows how overuse due to behavioral hazard has different implications than overuse due to moral hazard. In particular, consider raising the copay above cost. While absent behavioral hazard this would lead to the standard deadweight loss triangle equal to the dark grey area, with positive behavioral hazard it leads to a welfare gain equal to the light grey area. When people overuse due to behavioral hazard, failing to cover or even penalizing the use of treatments can be beneficial. We next formalize the intuitions from the graphical analysis.

### 3.1 Analysis

**With behavioral hazard, the marginal person does not necessarily value treatment at the copay**

Differentiate $W$ with respect to $p$ subject to the break-even constraint, and convert into a money metric by normalizing the increase in welfare by the welfare gain from increasing income by 1. The following proposition details the resulting formula:
Proposition 1. The welfare impact of a marginal copay change is given by

\[
\tilde{W}'(p) \equiv \frac{\partial W}{\partial p} \cdot \frac{\partial W}{\partial y} = \frac{w'(p) \cdot (c - p + \varepsilon_{\text{avg}}(p))}{w'(p) - M(p)} - I(p) \cdot M(p),
\]

where

\[
I(p) = \frac{\mathbb{E}[U'(C)|m = 1] - \mathbb{E}[U'(C)]}{\mathbb{E}[U'(C)]}
\]
equals the insurance value to consumers \((C = y - P - s + m \cdot (b - p))\), defined to equal 0 when \(M(p) = 0\), and

\[
\varepsilon_{\text{avg}}(p) = \mathbb{E}[\varepsilon|b + \varepsilon = p]
\]
equals the average size of marginal behavioral hazard at copay \(p\).

Proof. All proofs are in the Online Appendix.

To interpret Proposition 1, first consider the standard model with just moral hazard, where \(\varepsilon_{\text{avg}}(p) = 0\) for all \(p\). In this case, the first term of (5), \(-M'(p)(c - p)\), represents the welfare gain from reducing moral hazard: it can be thought of as the number of people who are at the margin multiplied by the difference between the social cost and social value of their treatment—the marginal inefficiency—\((c - p) > 0\). Note that the sensitivity of demand, \(M'(p)\), is a sufficient statistic for measuring this gain, since the marginal social value is a known function of the copay when people are rational. The second term represents the reduction in insurance value for all treated individuals, where our assumptions guarantee that \(I(p) > 0\) for all \(p > 0\) when individuals are rational.

Behavioral hazard alters the first term because it changes who is at the margin: with behavioral hazard, the welfare impact of lower utilization equals \(-M'(p)(c - p + \varepsilon_{\text{avg}}(p))\), which can be thought of as the number of people who are at the margin multiplied by the difference between the social cost and social value of their treatment, \((c - (p - \varepsilon_{\text{avg}}(p)))\). As we saw in the graphical example above, the sign of this term becomes ambiguous. When behavioral hazard is on average positive at the margin, \(\varepsilon_{\text{avg}}(p) \geq 0\), this term is greater than with moral hazard alone: increasing the copay from an amount less than cost has an even greater benefit of decreasing overutilization. On the other hand, when behavioral hazard is on average negative at the margin, \(\varepsilon_{\text{avg}}(p) < 0\), this term may be negative: increasing the copay can have the cost of increasing underutilization.\(^{15}\)

\(^{15}\)While not the focus of our analysis, with behavioral hazard the sign on the insurance value term is also ambiguous. In the standard model, the sick who demand treatment are worse off than the sick who do not, even post treatment, so
Note that what matters for calculating the welfare impact of a marginal copay change is the average *marginal* size of behavioral hazard at copay \( p \), \( \varepsilon^{\text{avg}}(p) = \mathbb{E}[\varepsilon'|b + \varepsilon = p] \), rather than the average *unconditional* size, \( \mathbb{E}[\varepsilon'] \). To see why, consider a situation where some people simply forget to get treated (e.g. forget a prescription refill) with some probability \( \phi \), but otherwise make an accurate cost-benefit calculation. In our framework, this can be captured by assuming that \( \varepsilon(s; \theta) \) is very negative with probability \( \phi \) and otherwise equals zero. While the average degree of behavioral hazard in this example can be quite negative, behavioral hazard does not influence who is at the margin, since anyone who responds to a copay change is someone who makes an accurate cost-benefit calculation. Indeed, in this case the marginal degree of behavioral hazard is zero.

**With behavioral hazard, demand responses do not measure the extent of moral hazard**

Proposition 1 also formalizes the standard intuition that when there is merely moral hazard, the overall demand response is a powerful tool for measuring the welfare impact of the changes in utilization driven by copay changes. Indeed, \( -M'(p) \cdot (c - p) \) is necessarily increasing in \( |M'(p)| \) when \( p < c \). But it shows that when there is behavioral hazard this composite response is harder to interpret: looking at demand responses alone may provide a misleading impression, since \( -M'(p) \cdot (c - p + \varepsilon^{\text{avg}}(p)) \) is not necessarily increasing in \( |M'(p)| \). A high response might indicate a great deal of moral hazard (and hence a cost of providing insurance) or could indicate a great deal of negative behavioral hazard or price-responsive underutilization (and hence an additional benefit to insurance).

In practice, researchers effectively ignore behavioral hazard by focusing on aggregate demand responses in calculating the welfare impact of copay changes. For example, researchers calculated a welfare loss of $291 per person from moral hazard in 1984 dollars based on evidence from the RAND Health Insurance Experiment suggesting a demand elasticity of roughly -.2 (Manning et al. 1987; Feldman and Dowd 1991). While recent economic research has questioned whether such a single elasticity can accurately summarize how people will respond to changes in non-linear health insurance contracts (Aron-Dine, Einav, and Finkelstein 2013), there has been less emphasis on reexamining the basic assumption that the price sensitivity of demand meaningfully captures the degree of moral hazard. Indeed, in a recent review article of developments in the study of moral hazard in health insurance since Arrow’s (1963) original article, Finkelstein (2014) equates evidence of moral hazard with evidence of the price sensitivity of demand for medical care.

A closer look at available evidence challenges this assumption. Table 2 summarizes evidence indicating that demand for “effective care” is often as elastic as demand for “ineffective care”.

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Analysis of the RAND health insurance experiment found that cost-sharing induced the same 40% reduction in demand for beta blockers as it did for cold remedies - with reductions for drugs deemed “essential” on average quite similar to those for drugs deemed “less essential” (Lohr et al. 1986).\(^{16}\) Goldman et al. (2006) estimate that a $10 increase in copayments drives similar reductions in use of cholesterol-lowering medications among those with high risk (and thus presumably those with high health benefits) as those with much lower risk. A quasi-experimental study of the effects of small increases in copayments (rising from around $1 to around $8) among retirees in California by Chandra, Gruber, and McKnight (2010) suggests that HMO enrollees’ elasticity for “lifestyle drugs” such as cold remedies and acne medication is virtually the same as for acute care drugs such as anti-convulsants and critical disease management drugs such as beta-blockers and statins — all clustered around -0.15 (2007; unpublished details provided by authors). To take a particularly striking example, which we discuss in greater detail below, relatively small reductions in copayments even after an event as salient as a heart attack still produce improvements in adherence (Choudhry et al. 2011). The evidence in fact suggests that the degree of moral hazard cannot be inferred from aggregate demand responses.\(^{17}\)

So how can we systematically distinguish between behavioral hazard and moral hazard? One method is to measure health responses.

**With behavioral hazard, measuring health responses helps identify who is at the margin**

We can re-express the welfare impact of a marginal copay change in terms of health responses. Let \(H(p) = \mathbb{E}[m(p) \cdot b - s]\) equal the aggregate level of health given copay \(p\), which represents the expected value of disease severity post treatment decisions at copay level \(p\) in income-equivalent units. We have the following result:

**Proposition 2.** Consider a copay \(p\) at which demand is price-sensitive, so \(M'(p) < 0\), and let \(U\) be linear. The welfare impact of a marginal copay change is

\[
\tilde{W}'(p) = -M'(p) \cdot \left( c - \frac{H'(p)}{M'(p)} \right).
\]

\(^{16}\)While we have framed the analysis in terms of the insurer setting a copayment for a specific disease and treatment, we could re-interpret the model as being about an insurer who sets the same copayment across a set of treatments with common cost \(c\). For example, we could think of the insurer as setting the copay for drugs within some formulary tier. Under this interpretation, \(\gamma\) indexes observable conditions that the insurer does not distinguish between in setting copays. The analysis would proceed in a similar fashion, but under this interpretation an analyst can disaggregate the demand response into the response for each condition \(\gamma\), which can provide information on the degree to which the total response reflects some combination of behavioral hazard and moral hazard when there is a prior sense of the marginal value of different treatments.

\(^{17}\)It is important to note that there are also examples of behavior consistent with the traditional model of moral hazard, including from RAND and the decades since. Taubman et al. (2014), for example, show that gaining insurance coverage (and the associated drop in prices) increased emergency department visits particularly for less urgent or more discretionary conditions.
Table 2: Demand Responses Often not Related to Value of Care

<table>
<thead>
<tr>
<th>Study</th>
<th>Price Change</th>
<th>Change in Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lohr et al. (1986)</td>
<td>Cost-sharing vs. none in RAND</td>
<td>Higher Value: 21% ↓ in use of highly effective care; 40% ↓ in beta blockers, 44% ↓ in insulin</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower Value: 26% ↓ in less effective care; 6% ↓ in hayfever treatment, 40% ↓ in cold remedies, 31% ↓ in antacids</td>
</tr>
<tr>
<td>Goldman et al. (2006)</td>
<td>$10 ↑ in copay (from $10 to $20)</td>
<td>Compliance with cholesterol meds among high risk ↓ from 62% to 53%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Compliance with cholesterol meds among low risk ↓ from 52% to 46%; medium ↓ from 59% to 49%</td>
</tr>
<tr>
<td>Selby et al. (1996)</td>
<td>Introduction of $25-$35 ER copay</td>
<td>9.6% ↓ in visits for emergency conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21% ↓ in visits for non-emergency conditions</td>
</tr>
<tr>
<td>Johnson et al. (1997)</td>
<td>↑ from 50% coinsurance with $25 max to 70% coinsurance with $30 max</td>
<td>40% ↓ in use of antiasthmatics; 61% ↓ in thyroid hormones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40% ↓ in non-opiate analgesics; 22% ↓ in topical anti-inflammatories</td>
</tr>
<tr>
<td>Tamblyn et al. (2001)</td>
<td>Introduction of coinsurance, $25 max deductible, $100 deductible, $200 max for Rx</td>
<td>9.1% ↓ in essential drugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.1% ↓ in non-essential drugs</td>
</tr>
<tr>
<td>Chandra et al. (2010)</td>
<td>↑ in copayments from $1 to $8</td>
<td>Elasticity of around .15 for acute care and chronic care Rx</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elasticity of around .15 for “lifestyle” Rx</td>
</tr>
</tbody>
</table>

Sources: Authors’ summary of literature (see bibliography)
Further, $H'(p)/M'(p) = p$ if and only if $\varepsilon^{avg}(p) = 0$ and, more generally, $\varepsilon^{avg}(p) = p - H'(p)/M'(p)$.

The first part of this proposition indicates that, all else equal, the welfare impact of a copay increase inversely depends on the marginal health value of care.\(^{18}\) This is true not only when there is behavioral hazard, but also in the rational model. Intuitively, a copay increase is less desirable when it discourages high-value care rather than low-value care. The second part clarifies why standard formulas for the welfare impact of copay changes are not expressed in terms of health responses: absent behavioral hazard, we can equate the health response with the copay since being marginal reveals indifference. But it goes on to show that we cannot do this when there is the possibility of marginal behavioral hazard: with behavioral hazard, we can no longer infer the health response from knowledge that someone is marginal. Rather, we can infer the degree of marginal behavioral hazard from the deviation between the copay and the marginal health value of treatment.

In some of the cases described above, there are indications that the copay changes are associated with large health implications, providing further suggestive evidence for behavioral hazard in such cases. As summarized in Table 3, the copay increase studied by Chandra et al. (2010) was associated with an increase in subsequent hospitalizations and Hsu et al. (2006) similarly find that the imposition of a cap on Medicare drug benefits lead to an greater nonelective hospital use. Choudhry et al. (2011) find that providing post-heart attack medications for free is associated with a reduced rate of subsequent major vascular events to an extent that, as we will discuss below, is inconsistent with plausible parameters under the standard model.

A challenge to using data on health responses to calibrate the degree of behavioral hazard is that the health response may be difficult to observe or map to hedonic benefits. It may be possible to estimate how much a pill reduces mortality risk and translate this into (money-metric) utility; it may be more difficult to estimate the unpleasantness of side-effects or the inconvenience of treatment. In some instances, however, we may have enough information to confidently bound the unobservable component, in which case we can still say something about the sign and possibly the magnitude of behavioral hazard.\(^{19}\) This is more likely in the case of highly effective treatments.

---

\(^{18}\)The assumption of linear utility simplifies the presentation by allowing us to abstract from the insurance value term. It also simplifies the relationship between $\varepsilon^{avg}(p)$ and $H'(p)/M'(p)$. Otherwise, $\varepsilon^{avg}(p) \approx p - H'(p)/M'(p)$ when $U$ is approximately linear.

\(^{19}\)To illustrate, decompose the change in health per marginal change in demand into observable and unobservable components:

$$\frac{H'(p)}{M'(p)} = h_o(p) + h_u(p),$$

where $h_o(p)$ represents the observable component, and $h_u(p)$ the unobservable component. For example, the observable component could include a proxy for quality-adjusted life years gained per marginal filled prescription and the unobservable component could include non-pecuniary costs (e.g., side-effects) associated with filling the prescription.
### Table 3: Responses to Price Changes Can Have Large Health Implications

<table>
<thead>
<tr>
<th>Study</th>
<th>Price Change</th>
<th>Use Change</th>
<th>Health Value [illustrative fact]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandra et al. (2010)</td>
<td>$7 ↑ in drug copay (from ~$1 to ~$8)</td>
<td>Elasticities: .15 for essential drugs; .23 for asthma meds, .12 for cholesterol meds, .22 for depression meds</td>
<td>Offsetting 6% ↑ in hospitalization</td>
</tr>
<tr>
<td>Hsu et al. (2006)</td>
<td>Imposition of $1000 annual cap</td>
<td>↑ in non-adherence to antihypertensives, statins, diabetes drugs by ~30%</td>
<td>13% ↑ in nonelective hospital use; 3% ↑ in high blood pressure (among hypertensives); 9% ↑ in high cholesterol (among hyperlipidemics); 16% ↓ in glycemic control (among diabetics)</td>
</tr>
<tr>
<td>Lohr et al. (1986)</td>
<td>Cost-sharing vs. none in RAND</td>
<td>↓ in use of insulin by 44%, beta blockers by 40%, antidepressants by 36%</td>
<td>[Consistent filling of diabetic med prescriptions ↓ hospitalization risk from 20-30% down to 13% (Sokol et al. 2005)]</td>
</tr>
<tr>
<td>Selby et al. (1996)</td>
<td>Introduction of $25-$35 ER copay</td>
<td>9.6% ↓ in visits for emergency conditions</td>
<td>Emergency conditions included coronary arrest, heart attack, appendicitis, respiratory failure, etc.</td>
</tr>
<tr>
<td>Choudhry et al. (2011)</td>
<td>Elimination of Rx copays for post-heart attack patients</td>
<td>4-6 percentage point ↑ in medication adherence</td>
<td>Rates of total major vascular events ↓ by 1.8 ppt, heart attacks by 1.1 ppt</td>
</tr>
</tbody>
</table>

Sources: Authors’ summary of literature (see bibliography)
Notes: Health value comes from same study when available. [“Illustrative facts” come from other studies.]
with few side effects than in treatments with non-pecuniary costs that may be experienced quite differently across people (e.g., colonoscopies). Section 6 shows that good prior knowledge of the psychology underlying behavioral hazard can help estimate the marginal degree of behavioral hazard in the latter situations.

3.2 An Illustration

We illustrate the potential magnitude of the importance of taking behavioral hazard into account by further drawing on Choudhry et al. ’s (2011) work on the effects of eliminating copays for recent heart attack victims. They randomly assigned patients discharged after heart attacks to a control group with usual coverage (with copayments in the $12-$20 range) or a treatment group with no copayments for statins, beta blockers, and ACE inhibitors (drugs of known efficacy), and tracked adherence rates and clinical outcomes over the next year. Faced with lower prices, consumers used more drugs: the full coverage group was significantly more adherent to their medications, using on average $106 more worth of cardiovascular-specific prescription drugs.

Under the moral hazard model, this fact alone tells us the health consequences of eliminating copays. Rational patients forgo only care with marginal value less than their out-of-pocket price. The average patient share under usual coverage in the Choudry data is about 25%, implying that the extra care consumed when copays are eliminated has a monetized health value of at most $.25 on the dollar. Given the $106 increase in spending, the moral hazard model then predicts a health impact of at most $106 \cdot .25 = $26.50 per patient. This in turn implies a moral hazard welfare loss from eliminating copayments of at least $106(1 - .25) = $79.50 per person. In other words, the $106 increase in spending is comprised of $26.50 of health value plus $79.50 of excess utilization. This is the kind of exercise routinely performed with demand data.

But Choudhry et al. collected data on health impacts, which we can use to gauge the performance of the moral hazard model by comparing the implied health benefits with the observed ones. The increase in prescription drug use was associated with significantly improved clinical outcomes:

(All in dollars). If we can bound the unobservable component as belonging to \([h_U(p), \tilde{h}_U(p)]\), then we can also bound the extent of behavioral hazard:

\[\varepsilon_{avg}(p) \in [p - (h_O(p) + \tilde{h}_U(p)), p - (h_O(p) + \tilde{h}_U(p))].\]

20 We use this particular study because it measures not only demand responses, but also a rich variety of health responses. While the setting is admittedly quite specific, we believe the qualitative conclusions are illustrative for broader populations and treatments. Online Appendix C provides a stylized example using the case study of treatment for high blood pressure, though it is difficult to perform a rigorous analysis given data limitations.

21 Given the assumption that people have linear demand curves, we can derive a tighter lower bound on the welfare loss under the standard model. In this case, the moral hazard model implies a welfare loss of at least $106(1 - .25/2) = $92.75 (see, e.g., Feldman and Dowd 1991).
patients in the full coverage group had lower rates of vascular events (1.8 percentage points), myocardial infarction (1.1 percentage points), and death from cardiovascular causes (.3 percentage points). We apply the commonly used estimate of a $1 million value of a statistical life to the reduction in the mortality to get a crude measure of the dollar value of health improvements.\footnote{This calculation is admittedly crude, but provides an illustrative example. Estimates of the value of a statistical life clearly vary based on the age at which death is averted and the life expectancy gained – averting the death of a young healthy worker might be valued at $5 million - and mortality is only one aspect of the potential changes in health. While the estimated reduction in mortality is not statistically significant at conventional levels, the other health impacts are. We focus on the mortality reduction because it is easiest to monetize in this illustration.} This implies that the elimination of copays leading to a .3 percentage point reduction in mortality generates a value of $3,000. This $3,000 improvement \emph{substantially exceeds} the standard model’s prediction of $26.50, suggesting large negative behavioral hazard. Applying the traditional moral hazard calculus in this situation implies that people place an unrealistically low valuation on their life and health.\footnote{It seems unlikely that the cost of unobserved side-effects of statins, beta blockers, and ACE-inhibitors is anywhere near $2894 for a given patient in a year, so taking these effects into account should not reverse the conclusion that eliminating copayments leads to a welfare gain.}

For welfare calculations, the theoretical analysis above highlights the need to use an estimate of the marginal private health benefit in the presence of behavioral hazard. As a rough back-of-the-envelope calculation, the $3,000 improvement in mortality minus the $106 increase in spending generates a surplus of $2,894 per person (a gross return of $28 per dollar spent). The presence of behavioral hazard thus reverses how we interpret the demand response to eliminating copayments: moral hazard implies a welfare loss, while behavioral hazard implies a gain that is over 30 times larger.\footnote{As in basic moral hazard calculations, this analysis ignores substitution between treatments. In this example, total spending (prescription drug plus nondrug) went \emph{down} by a small, non-statistically significant amount when copayments were eliminated on preventive medications after heart attack, as did insurer costs. Taking these non-significant offset effects at face value would imply that welfare goes up even before taking behavioral hazard into account (Glazer and McGuire 2012), though it raises a puzzle as to why private insurers did not reduce copays on their own. However, even in this case, incorporating behavioral hazard substantially changes the analysis by providing a much stronger rationale for reducing the copay. More generally, evidence suggests that reducing copays on high-value care does not generate cost savings over short (1-3 year) horizons (Lee et al. 2013).}

\section{Implications for Optimal Copays}

We have seen that behavioral hazard can influence whether changing copays from existing levels is good policy. This section describes some features of the optimal plan when behavioral hazard is taken into account.

Consider again Equation (5), which gives us the welfare impact of a marginal copay increase. Setting this equal to zero yields a candidate for the optimal copay. To limit the number of cases, we focus attention on the standard situation where some but not all sick people are treated at the
optimum: an optimal copay $p^B$ satisfies $M'(p^B) < 0$ and $M(p^B) > 0$. This is true under our assumptions, for example, when people are not too risk averse, i.e., when $-U''/U'$ is sufficiently small over the relevant range of $C$. For presentational simplicity, we also focus on the situation where the optimal copay is unique. Defining $p^{\text{min}} = \inf \{ p : M(p) < q \}$ to equal the lowest copay where not every sick person demands treatment and $p^{\text{max}} = \sup \{ p : M(p) > 0 \}$ to equal the highest copay where some sick person demands treatment, we assume the following.

**Assumption 1.** The optimal copay is unique and satisfies $p^B \in (p^{\text{min}}, p^{\text{max}})$.

**Proposition 3.** Assuming $p^B \neq 0$, the optimal copay satisfies

$$
\frac{c - p^B}{p^B} = \frac{I}{\eta} - \frac{\varepsilon^{\text{avg}}}{p^B},
$$

where $\eta = -M'(p)p/M(p)$ equals the elasticity of demand for treatment, $I$ the insurance value, and $\varepsilon^{\text{avg}}$ the average size of marginal behavioral hazard, all evaluated at $p^B$.

Proposition 3 expresses the optimal copay in terms of reduced-form elasticities as well as the degree of behavioral hazard and the curvature of the utility function. It says that, fixing insurance value and the cost of treatment, the optimal copay is increasing in the demand elasticity and the degree to which behavioral hazard is positive. This simple formula illustrates a number of ways in which behavioral hazard fundamentally changes how we think about optimal copays.

**Optimal copays can substantially deviate from cost even when coverage generates little or no insurance value**

A simple implication of Equation (6) is that health “insurance” can provide more than financial protection: it can lead to more efficient health delivery. Even when individuals are risk-neutral and there is no value to financial insurance ($I = 0$), Equation (6) indicates that the optimal copay can differ from cost to provide insurees with incentives for more efficient utilization decisions. In fact, when consumers are risk-neutral, the extent of behavioral hazard (at the margin) fully determines the optimal copay. In this case, the optimal copay formula reduces to $p^B = c + \varepsilon^{\text{avg}}(p^B)$: the optimal copay acts like a Pigouvian tax to induce the marginal insuree to fully internalize their “internality”. Unlike in the standard model, there is no clear incentive-insurance tradeoff.

**Optimal copays can be extreme: It can be optimal to fully cover treatments that are ineffective for some insurees or to deny coverage of treatments that benefit insurees**

A related implication is that optimal copays can be more extreme than in a model with only moral hazard. Absent behavioral hazard, the optimal copay strictly lies between the value that provides
full insurance (i.e., the value that makes $I(p) = 0$) and cost when insurees are risk averse and demand is elastic. Intuitively, without behavioral hazard, slightly raising the copay from the amount that provides full insurance has only a second order cost through reducing insurance value but a first order benefit through controlling moral hazard; slightly reducing the copay from cost has a second order cost through inducing moral hazard but a first order benefit through increasing insurance value. In the standard model, it cannot be optimal to deny coverage of treatments that benefit some risk averse individuals and it cannot be optimal to fully cover or subsidize treatments when people are price-sensitive at the full coverage copay.

Behavioral hazard alters these prescriptions. When behavioral hazard is sufficiently positive, the optimal copay can be above cost even when the individual is risk-averse: it can be good to let insurers discriminate against certain treatments, as suggested by Panel (b) of Figure 3. When behavioral hazard is sufficiently negative, the optimal copay can be below the level that provides full financial protection, even if demand is price-sensitive at this copay: paying people to get treated can be optimal, as illustrated in Panel (a) of Figure 3. In this spirit, some insurers have begun to experiment with paying patients to take their medications (Belluck 2010; Volpp et al. 2009).

**Optimal copays depend on health value, not just demand elasticities**

Optimal copays likely vary more across treatments than in a model with only moral hazard. The standard model says that, fixing insurance value, copays should be higher the larger the cost and elasticity of demand (Zeckhauser 1970), as can be seen from plugging $e^{avg} = 0$ into Equation (6). That model suggests, for example, that copays should be lower for emergency care (where demand is less elastic) than for regular doctor’s office visits (where it is presumably more price sensitive). However, it also leads to some counterintuitive prescriptions: It suggests that copays should be similar across broad categories of drugs with similar price elasticities, even if they have very different efficacies.

Behavioral hazard alters these prescriptions as well. To see this, make the approximation $e(s; \theta) \approx e'(s; \theta) \forall (s, \theta)$ and plug $e^{avg}(p) \approx p - H'(p)/M'(p)$ (Proposition 2 establishes that the second approximation follows from the first) into (6), yielding

$$
\frac{c - p^B}{p^B} \approx \frac{I}{\eta} + \left( \frac{H'(p^B)}{p^B M'(p^B)} - 1 \right).
$$

(7)

From Equation (7), all else equal copays should be decreasing in the net return to the last private dollar spent on treatment, $|H'(p)| / (p |M'(p)|) - 1$, so the value of treatment now enters into the determination of the optimal copay insofar as it influences $H'(p)$. For a given demand response to copays, copays should be lower when this demand response has greater adverse effects on health.
This connects to value-based insurance design proposals (Chernew, Rosen and Fendrick 2007) where, all else equal, cost sharing should be lower for higher value care. While the marginal rather than the average value of care appears in Equation (7), knowledge of the average health value of care can provide a useful signal about the marginal health value. Consider a case where the demand curve slopes down only because of behavioral hazard: $Var(\varepsilon) > 0$, but $Var(b) = 0$. Then the marginal individual at any copay where demand is price-sensitive must have a marginal health value equal to the average value $b$, which also can be expressed as $(H(p_{\text{min}}) - H(p_{\text{max}})) / (M(p_{\text{min}}) - M(p_{\text{max}}))$. (Recall that $p_{\text{min}}$ equals the lowest copay where some of the sick do not demand treatment and $p_{\text{max}}$ equals the largest copay where some people still demand treatment.) Generalizing this example to allow for heterogeneity in private benefits in addition to heterogeneity in behavioral hazard yields the following result.

**Proposition 4.** Assume $U$ is linear, $M'(c) \neq 0$, and the distribution $Q(s, \theta, \gamma)$ is such that $b(s; \gamma)$ and $\varepsilon(s; \theta)$ are independently distributed according to symmetric and quasiconcave densities with $Var(\varepsilon) > 0$.

1. $p_B > c$ if $\frac{H(p_{\text{min}}) - H(p_{\text{max}})}{M(p_{\text{min}}) - M(p_{\text{max}})} < c$ and $E[\varepsilon] \geq 0$.

2. $p_B = c$ if $\frac{H(p_{\text{min}}) - H(p_{\text{max}})}{M(p_{\text{min}}) - M(p_{\text{max}})} = c$ and $E[\varepsilon] = 0$.

3. $p_B < c$ if $\frac{H(p_{\text{min}}) - H(p_{\text{max}})}{M(p_{\text{min}}) - M(p_{\text{max}})} > c$ and $E[\varepsilon] \leq 0$.

This shows that with behavioral hazard, the average value of care provides a useful signal for the optimal copay. So long as there is some variability in behavioral hazard across people and behavioral hazard does not systematically push people to privately overuse high-value treatments or privately underuse low-value treatments, then the optimal copay is above cost whenever the treatment is not socially beneficial on average and is below cost whenever the treatment is socially beneficial on average. Take the case where $E[\varepsilon] = 0$. The average value of care signals the expected direction of behavioral hazard at the margin, since—as is familiar from standard signal-extraction arguments—the marginal patient’s expected valuation lies between the copay (his “revealed” valuation if there is no behavioral hazard) and the unconditional average valuation (his valuation if being marginal was independent of true valuation). The marginal degree of behavioral hazard is then negative at copays below the expected value of treatment and positive at copays above the expected value of treatment. To illustrate, returning to the example where $Var(b) = 0$ we have

\cite{Chambers2012} The assumptions that $b$ and $\varepsilon$ are independently distributed according to symmetric and non-degenerate quasiconcave distributions guarantee that $E[b|\varepsilon = p] \in (p, E[b])$ (see, e.g., Chambers and Healy 2012). In a different context, Spinnewijn (2014) similarly shows that even when people make mean-zero errors in deciding whether to purchase insurance (which are independent of true insurance value), a selection argument implies that the demand curve systematically overestimates the insurance value for the insured and systematically underestimates the insurance value for the uninsured.
that the marginal degree of behavioral hazard satisfies \( b + \varepsilon = p \Rightarrow \varepsilon = p - b \), which clearly is negative if and only if the copay is below the expected value of treatment.

These results suggest that optimal copays should depend on the value of treatment in addition to the demand response. For example, we might expect that we should have high copays for procedures that are not recommended but sought by the patient nonetheless and low copays in situations where people have asymptomatic chronic diseases for which there are effective drug regimens. While advocated by some health researchers—for example, Chernew et al. (2007)—such differential cost-sharing is a rarity in practice; we return to some possible reasons in Section 6 below.

5 The Pitfalls of Ignoring Behavioral Hazard

Behavioral hazard modifies the central insights of the standard model. The goal of this section is to give a sense of how important it is to take behavioral hazard into account – how wrong would the analyst be if he ignored behavioral hazard?

While the optimal copay, \( p^B \), satisfies \( \bar{W}'(p^B) = 0 \), where \( \bar{W} \) is defined in Equation (5), a candidate for the “neo-classical optimal copay”, \( p^N \), satisfies the following condition.

**Definition 1.** \( p^N \) is a candidate for the neo-classical optimal copay when

\[
\frac{\partial \bar{W}^N(p^N)}{\partial p} = -M'(p) \cdot (c - p) - I(p) \cdot M(p) = 0
\]

and (i) \( \frac{\partial \bar{W}^N}{\partial p} \geq 0 \) in a left neighborhood of \( p^N \), (ii) \( \frac{\partial \bar{W}^N}{\partial p} \leq 0 \) in a right neighborhood of \( p^N \), and (iii) at least one of the inequalities in (i) or (ii) is strict for some \( p \) in the relevant neighborhoods.

In other words, \( p^N \) is a copay that an analyst applying the standard model to estimates of the demand and insurance value schedules, \((M(\cdot), I(\cdot))\), thinks could be optimal. The neo-classical optimal and true optimal copays will clearly coincide when \( \varepsilon(s; \theta) = 0 \) \( \forall s, \theta \). The direction of the deviation between these copays is also intuitive. As established in Online Appendix A, there is a welfare benefit to raising the copay from the neo-classical optimum whenever behavioral hazard is on average positive for people at the margin, and there is a welfare benefit to reducing the copay from the neo-classical optimum whenever behavioral hazard is on average negative for people at the margin.\(^{26}\) Less obvious, the deviation between the neoclassical optimal and true optimal copays can be huge:

\(^{26}\)A somewhat more subtle point can be seen by focusing on the case where behavioral hazard is either systematically positive or negative, meaning that \( \varepsilon(s; \theta) \) (weakly) shares the same sign across \( (s, \theta) \). In this context, Proposition 6 in Online Appendix A implies that optimal copays exceed the neo-classical optimal copay so long as some marginal individuals exhibit positive behavioral hazard, as in this case \( \varepsilon^{avg}(p) > 0 \), and is below the neo-classical optimal copay.

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Proposition 5. Suppose $U$ is strictly concave, $\varepsilon(s; \theta) = \bar{\varepsilon} \in \mathbb{R}$, and $b(s; \gamma) = s \forall (s, \gamma, \theta)$.

1. If $\bar{\varepsilon}$ is sufficiently large then the neo-classical analyst believes $p^N = 0$ is a candidate for the optimal copay but the optimal copay in fact satisfies $p^B \geq c$.

2. If $\bar{\varepsilon}$ is sufficiently low then the neo-classical analyst believes $p^N = c$ is a candidate for the optimal copay but the optimal copay in fact satisfies $p^B \leq 0$.

When behavioral hazard is extreme, the neo-classical optimal copay is exactly wrong: the situations in which the neo-classical analyst believes that copays should be really low are precisely those situations where copays should be really high and vice versa.\footnote{Strict concavity matters for this result. With linear utility the neo-classical analyst believes $p^N = c$ is a candidate for the optimal copay, independent of $\bar{\varepsilon}$. The assumption that $b(s; \gamma) = s$ simplifies matters by guaranteeing that there is always a non-negative candidate for the neo-classical optimal copay because it implies that a zero copay (rather than a negative one) maximizes insurance value when all the sick are treated.} In the case of very positive behavioral hazard, almost everybody gets treated at $p \approx c$, so the neo-classical analyst thinks there is no benefit to controlling moral hazard but there is an insurance value to reducing copays, suggesting to him an optimal copay of at most zero. In reality, however, many people who demand treatment at $p = c$ are inefficiently doing so, yielding a large benefit to controlling behavioral hazard by raising the copay above cost. So long as people are not extremely risk averse, a copay above cost is better than any copay below cost. In the case of very negative behavioral hazard, almost nobody gets treated at $p \approx c$, so the neo-classical analyst sees a huge benefit to controlling moral hazard since nobody appears to value the treatment as much as it costs. So long as people are not extremely risk averse, the neo-classical analyst believes the copay should roughly equal cost. In reality, however, even at a copay of zero, people at the margin of getting treated have a benefit above cost. There is no benefit to controlling behavior by raising the copay above zero, but there is an insurance value cost, making the optimal copay at most zero.

An immediate corollary of Proposition 5 is the following:

**Corollary 1.** Suppose $U$ is strictly concave, $b(s; \gamma) = s$, $\varepsilon(s; \theta) = \bar{\varepsilon} \in \mathbb{R} \forall (s, \gamma, \theta)$, and

$$
\bar{\varepsilon} = \begin{cases} 
  e & \text{with ex ante probability } \rho \in (0, 1) \\
  -e & \text{with ex ante probability } 1 - \rho.
\end{cases}
$$

so long as some marginal individuals exhibit negative behavioral hazard. Consider the case of positive behavioral hazard. Increasing the copay by a small amount from $p = p^N$ has the welfare benefit of counteracting the behavioral hazard of some individuals, and the welfare cost of raising the copay above the optimum for people who behave according to the standard model. This result says that the welfare benefit of counteracting behavioral hazard wins out. The intuition, similar to that in O’Donoghue and Rabin’s (2006) analysis of optimal sin taxes, is that since $p^N$ is the optimal copay for standard agents, any small change from $p = p^N$ only has a second-order cost on their welfare. On the other hand, since people with positive behavioral hazard are inefficiently using too much care at $p = p^N$, a small reduction in the amount of care they receive has a first-order welfare benefit. While the presence of people who behave according to the standard model can impact the magnitude of the deviation between the optimal copay and the neo-classical optimum, it does not influence the direction of this deviation.
For sufficiently large $e$: $p^B \geq c$ or $p^B \leq 0$, where (i) $p^B \geq c$ if $p^N = 0$ (but not $p^N = c$) is a candidate for the neo-classical optimal copay and (ii) $p^B \leq 0$ if $p^N = c$ (but not $p^N = 0$) is a candidate for the neo-classical optimal copay.

This corollary essentially restates Proposition 5 to say that when behavioral hazard is extreme, knowing that the neo-classical analyst believes that the copay should be very low signals that it should be very high and knowing that he believes the copay should be very high signals that it should be very low. For example, when the neo-classical optimal copay is 0, i.e. full insurance, the optimal copay is above $c$, i.e., no insurance.\footnote{We can also see that when behavioral hazard is extreme, there is always a candidate for the neo-classical optimal copay satisfying $|p^B - p^N| \geq c$: the degree to which the optimal copay can vary in response to behavioral hazard is larger than the degree to which the neo-classical optimal copay can vary in response to more standard considerations, like the elasticity of demand or the degree of risk aversion. Indeed, without behavioral hazard, the optimal copay always lies in $[0, c]$ under the assumption that $b(s; \gamma) = s$.}

For a numerical illustration, take the case where utility is quadratic, $s$ is uniformly distributed, getting treated returns a person to full health, and the degree of behavioral hazard is constant across the population. Table 4 details a resulting calculation for parameter values described in the notes. This example highlights several points. First, $p^B > p^N$ whenever behavioral hazard is positive, and $p^B < p^N$ whenever behavioral hazard is negative. Second, the optimal copay $p^B$ is increasing in $\tilde{\varepsilon}$. Third, the neo-classical optimal copay $p^N$ is instead decreasing in $\tilde{\varepsilon}$. Fourth, and as a result of the fact that $p^B$ and $p^N$ move in opposite directions as $\tilde{\varepsilon}$ moves away from 0, the deviation between $p^B$ and $p^N$ can be huge.\footnote{The case where $\tilde{\varepsilon} = 99$ provides an illustrative example of the last point. This is a situation where there is a lot of overuse due to behavioral hazard, and patients are reasonably risk averse. The analyst who looks for behavioral hazard will understand that copays should be really high to counteract overuse due to behavioral hazard: $p^B = 197.92$, which is well above the cost of treatment, $c = 100$. The neo-classical analyst who believes that everybody accurately trades off costs and benefits in making treatment decisions will observe that everybody gets treated when the price is less than or equal to 99 and half the population gets treated when the price is $299 / 2$. Since the cost of treatment is $c = 100$, it looks to the analyst like there is very little benefit to controlling moral hazard: almost everybody seems to value the treatment at more than its cost, and the extremely small fraction who do not still seem to value the treatment at 99% of its cost. On the other hand, since people are risk averse, there is a benefit to reducing copays. In fact, the marginal insurance benefit appears to exceed the marginal moral hazard cost at a copay of 99. Further, since the marginal moral hazard cost is zero at all lower copays (everybody is already getting treated), the neo-classical analyst believes the copay should go all the way down to zero when in fact optimally it should be almost double the cost!}

These results illustrate that setting copays under the assumption that the demand response signals the degree of moral hazard leads to very wrong policy conclusions when behavioral hazard is extreme. The example of Choudhry et al. (2011) on eliminating copays for recent heart attack victims dramatically illustrates this for the case of negative behavioral hazard: given the sizable demand response to eliminating copayments for statins, beta blockers, and ACE inhibitors, a neo-classical analyst could mistakenly conclude that this is bad policy. There are also examples consistent with misreaction in the other direction, where the traditional model suggests low copays because insurees exhibit little price-sensitivity, while incorporating behavioral hazard might
Table 4: Numerical Illustration Comparing the Neo-classical Optimal Copay to the Optimal Copay

<table>
<thead>
<tr>
<th>Neo-classical Optimal Copay ($p^N$)</th>
<th>Optimal Copay ($p^B$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\xi = -99$</td>
<td>99.98</td>
</tr>
<tr>
<td></td>
<td>0.02</td>
</tr>
<tr>
<td>$\xi = 0$</td>
<td>97.95</td>
</tr>
<tr>
<td>$\xi = 99$</td>
<td>197.82</td>
</tr>
</tbody>
</table>

Notes: $U(C) = \alpha C - \beta C^2$ for $\alpha = 7000$, $\beta = 1/2$; $s \sim U[0, \bar{s}]$ for $\bar{s} = 200$; $b(s; \gamma) = s$ for all $(s, \gamma)$; and $\varepsilon(s; \theta) = \bar{\varepsilon}$ for all $(s; \theta)$. We use the following values for the calculations: $y = 2500$, $q = .1$, $c = 100$, and $\bar{\varepsilon} \in \{-99, 0, 99\}$. There is a unique candidate for the neo-classical optimal copay in all cases. Note that since $c = 100$, the copay coincides with the coinsurance rate in percentage units.

suggest higher copays because the evidence suggests persistent overuse. An example is the case of low price elasticities among the elderly for drugs deemed “inappropriate” for their conditions (Costa Font et al. 2011).

6 Further Issues and Extensions

6.1 Using Information on Psychological Underpinnings

We have drawn out the implications of behavioral hazard generally, without distinguishing among various psychologies that could underlie it. This section describes two ways in which making such distinctions can be helpful. First, it can allow us to predict the degree of behavioral hazard in situations where measuring health responses is infeasible. Second, it can suggest new policy instruments that would usefully target specific psychologies.

When it is difficult to use evidence on health responses to measure the degree of behavioral hazard, knowledge of the psychology underlying behavioral hazard can be useful (Beshears et al. 2008, Mullainathan, Schwartzstein and Congdon 2012). For example, if behavioral hazard arises from present-bias, then knowing the degree to which treatment benefits or costs are delayed can predict behavioral hazard and thereby suggest which treatments should have higher or lower copays. Gruber and Koszegi (2001) follow this sort of approach in estimating the marginal internality for the case of cigarette purchase decisions.

Identifying the specific psychologies can also motivate the use of non-financial instruments to change behavior—sometimes called nudges (Thaler and Sunstein 2008). There is substantial evidence that nudges such as reminders or framing to increase salience or reduce hassle can affect utilization (Schedlbauer et al. 2010; Schroeder et al. 2004; Strandbygaard et al. 2010; Long et al.
To incorporate such instruments into the framework, suppose there is a set $\mathcal{N}$ of nudges available to the insurer, where a nudge is modeled as affecting demand through influencing the behavioral error $\varepsilon$, so for $n \in \mathcal{N}$, we have $\varepsilon = \varepsilon_n(s; \theta)$. The direct cost to the insurer of nudge $n$ is $\psi(n) \geq 0$, where we suppose there is a “default nudge” $n = 0 \in \mathcal{N}$ with $\psi(0) = 0$. So far we have implicitly assumed that the insurer sets the default nudge and have notationally suppressed the relationship between the nudge and the behavioral error.

Can we use responses to nudges to measure the magnitude of behavioral hazard? It is tempting to say that responses to reminders, for example, gauge the extent of inattention. But as Bordolo, Gennaioli and Shleifer (2015) point out, this inference may not be valid because people may overreact to such nudges. Nudges can be a useful tool for calibrating the degree of behavioral hazard, but only when we have a precise sense for how nudges affect the error—that is, how $\varepsilon_n$ varies in $n$. For those cases, Proposition 7 in the Online Appendix describes conditions under which the degree of marginal behavioral hazard can be calibrated by comparing the demand response to nudges to the demand response to prices.\(^{31}\) Heuristically, if we find that a nudge believed to lead to better decisions increases demand for treatment more than a $d$ decrease in the copay, that suggests that agents are undervaluing treatment by at least $d$ at the margin.\(^{32}\)

It is difficult to perform this exercise rigorously with existing data because of the lack of studies estimating the impact of nudges and copays simultaneously. However, the limited available evidence on the effects of nudges on adherence suggests that behavioral hazard can be significant. For example, Long et al. (2012) compare peer mentoring and financial incentives to improve glucose control among African American veterans. While they do not measure impacts on drug adherence, they find that a peer mentoring program improved blood sugar control more than a $100-$200 incentive did, which is suggestive of substantial negative behavioral hazard. (Also see Appendix C for evidence on the impact of nudges on hypertension.)

Nudges are also potentially useful policy tools for counteracting behavioral hazard when we...
can be sure that they are reducing errors overall. A benefit of using nudges is that they can target behavioral hazard better than copays can. For example, if some fraction of the population exhibits negative behavioral hazard under the default nudge, \( \varepsilon_0(s; \theta) < 0 \ \forall s \) while some fraction acts unbiased, then there does not exist a copay that leads to first-best utilization: while \( p = c \) leads to first-best utilization in the unbiased population, it leads to underuse among the people who exhibit negative behavioral hazard. Further, while some \( p < c \) may potentially lead to efficient utilization in the population that exhibits negative behavioral hazard it leads to overuse among the people who are unbiased. On the other hand, if there is a “perfectly de-biasing nudge” \( n^* \) that eliminates behavioral hazard, \( \varepsilon_{n^*}(s; \theta) = 0 \ \forall (s, \theta) \), then using that nudge leads to first-best utilization when \( p = c \).\(^{33}\) Of course, it is implausible that a perfectly de-biasing nudge exists.

A cost of using certain nudges—at least for now—is that it is uncertain how effective they are at reducing behavioral hazard. Studying the optimal mix of nudges and copays in the design of health insurance, taking such uncertainty into account, is an interesting topic for future research.

6.2 Incorporating Testing Decisions

The existence of behavioral hazard can have ripple effects through other aspects of the delivery system, particularly if early utilization such as diagnostic testing has cascade effects for downstream care. In the traditional model, the additional information yielded by low-cost tests should only improve patient welfare, but with behavioral hazard, subsequent misbehavior can add large costs. We briefly extend the model to allow for a testing stage which reveals \( s \), and suppose the person gets treated only if he is tested. To illustrate through a specific example, further suppose that \( U'' = 0, s \sim U[0,1], c = 3/4, \) and \( \varepsilon = 3/4 \) for everybody. Without testing, nobody gets treated and welfare is \( E[-s] = -1/2 \cdot q \). With testing, everybody gets treated if \( p \leq c \), and welfare equals \(-3/4 \cdot q < -1/2 \cdot q\). So tests have a substantially negative return if behavioral hazard is uncontrolled (\( p = p^N = c \)) and it is better not to test: the return on testing equals \((-3/4 - (-1/2)) \cdot q = (-1/4) \cdot q\). But it is better to test if behavioral hazard is controlled. If behavioral hazard is perfectly counteracted (say, in this example, with copay \( p^B = c + \varepsilon \)), then tests would have a positive return: the return on testing is then \((-15/32 - (-1/2)) \cdot q = (1/32) \cdot q\).

So taking health responses into account in setting copays for treatment decisions can be doubly beneficial: not only does it lead to better decisions at the treatment stage, but it can feed back to result in better policy at the testing stage.

The medical community has designed testing guidelines that implicitly acknowledge the im-

\(^{33}\)It is tempting to suppose that nudging in a way that eliminates errors is always optimal when such nudging is possible and does not have direct costs. However, when people are risk averse then such debiasing can undermine broader social welfare in cases when it increases demand and, with it, the moral hazard cost of insurance (Mullainathan, Schwartzstein and Congdon 2012; Pauly and Blavin 2008).
perfections in the downstream decision-making of patients and physicians alike. The “Choosing Wisely” initiative launched by internal medicine physicians highlights common screenings and tests that they have blanket recommendations against, not because the tests themselves are cost-ineffective conditional on optimal downstream care, but explicitly because of the probability of downstream care that is likely to harm patient health but is delivered nonetheless (Morden et al. 2014). These tests yield useful information that should be acted upon for only a subset of identifiable patients, but many other patients end up receiving care (whether because of the disutility of “doing nothing” or mistaken beliefs about efficacy) that is at best useless and at worst harmful, making the expected value of performing the test on anyone negative.34 This downstream suboptimal care is of course the product of both patient and physician decision-making, and there may be ample parallel opportunity to redesign physician incentives to take into account the psychology of their decision-making (as well as train them to help take into account the behavioral decision-making of their patients).35 But if physician and patient behavioral hazard in subsequent care decisions could be addressed, it would be efficient to conduct many of these tests.

6.3 Analyzing What the Market Will Provide

Given the welfare benefits of counteracting behavioral hazard, one question is why existing plans do not seem to do so. As shown in Online Appendix Table 2, typical health insurance plans have a copay structure that varies little within broad categories of treatments (e.g., physician office visits, inpatient services, branded drugs, generic drugs), while counteracting behavioral hazard requires a more nuanced structure where copayments are a function of the health benefit associated with the care for a particular patient. In an earlier version of this paper (Baicker, Mullainathan and Schwartzstein 2013) we extend the model to consider what a competitive market will provide in equilibrium under the simplifying assumption of a representative insuree, which requires additional assumptions on the degree to which insurees are sophisticated about behavioral hazard. We show how even though optimal insurance could reduce behavioral hazard, market-provided insurance may not. If enrollees are sophisticated, perfectly predicting their behavioral hazard and insuring accordingly, then market-provided insurance would be optimally designed to counteract behavioral hazard. But with naive enrollees, insurers have less incentive to mitigate underuse since naive consumers will not fully value copays designed to counteract their biases.36 These problems are

34Ding et al. (2011) and others have calculated the economic costs associated with “incidental” findings — abnormalities detected in asymptomatic patients in the course of a separate evaluation.
35One study found, for example, that physicians’ propensity to prescribe contraindicated antibiotics for their patients rose over the duration of their shift - a pattern attributed to physicians’ diminishing capacity to resist patient requests for prescriptions (Linder et al. 2014).
36Insurers will face some incentive to counteract negative behavioral hazard since naive consumers over-estimate their demand in this case, which creates some benefit to reducing copays. But, in general, negative behavioral haz-
especially severe when insurers have nudges as well as copays available and when they have limited time horizons (and thus do not bear the full cost of enrollees’ future health care use). In particular, if insurees do not appreciate the impact of nudges, then we would expect the insurer to supply nudges that minimize costs rather than maximize surplus.

These results suggest that when insurees are naive about their biases, then competitive forces only create incentives for the insurer to counteract biases when this saves the insurer money. Since the gains from reducing copays for antidiabetics, beta blockers and other negative behavioral hazard care may not accrue to the insurer, these results may shed light on why more health insurance plans do not incorporate behavioral hazard into their copayment structures. For example, Beaulieu et al. (2003) estimate that investment in diabetes disease management produces very small monetary gains for insurers over a 10 year horizon, but would produce $30,000 per patient in improved quality of life and longevity. The potential for market failure suggests that government interventions may be welfare-improving over market outcomes even in the absence of selection or externalities. An important direction for future work is to develop a better understanding of the degree to which insurees are sophisticated about behavioral hazard in making insurance plan choices how the government could intervene to help counteract behavioral hazard.

7 Discussion

There is ample evidence that moral hazard alone cannot explain the patterns of misutilization observed throughout the health care system. We build a framework for analyzing the relationship

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37Nevertheless, insurers could increase profits by promoting adherence to medications and treatments that save money over a reasonably short horizon (relative to the typical tenure of their enrollees), and the model suggests that insurers will invest in encouraging care in such instances. For example, flu shots are often given for free and at enrollees’ convenience. Perhaps for a similar reason, insurers are also funding research into promoting adherence to certain treatments (Belluck 2010) and in-house programs aimed at improving adherence, such as Humana’s “RxMentor” or United’s “Refill and Save” programs. Aetna’s tracking suggests that its program targeting chronic disease patients has improved adherence (Sipkoff 2009). FICO, known for its widely-purchased credit score, is now even selling medication adherence scores to insurers, intended to predict how likely patients are to adhere (Parker-Pope 2011).

38Additionally, while it could be efficient to provide negative prices (subsidies) to use high-value care (Volpp. et. al. 2009), practical considerations may make this infeasible. Current regulatory restrictions may also limit the ability of insurers to counteract behavioral hazard. For example, there are limits to the ability of insurers to offer plans with different copayments for the same drug to different patients, or for plans operating within Medicare to offer negative prices (cash incentives) to enrollees.

39We abstract from ex ante heterogeneity among consumers and issues of selection. Of course, adverse selection provides a rationale for government intervention even in the standard model. Sandroni and Squintani (2007, 2010), Jeleva and Villeneuve (2004), and Spinnewijn (2013, 2014) explore how ex ante heterogeneity in risk perceptions or overconfidence alter equilibrium insurance contracts, the relationship between risk and insurance coverage, and the welfare impact of various government policies, e.g., insurance mandates.
between insurance coverage and health care consumption that also includes behavioral hazard. Incorporating behavioral hazard alongside moral hazard changes the fundamental tradeoff between insurance and incentives. With only moral hazard, lowering copays increases the insurance value of a plan but reduces its efficiency by generating overuse. With the addition of behavioral hazard, lowering copays may potentially both increase insurance value and increase efficiency by reducing underuse. This means that having an estimate of the demand response is no longer enough to set optimal copays; the health response needs to be considered as well. This provides a theoretical foundation for value-based insurance design, where copays should optimally be lower both when price changes have relatively small effects on demand and when they have relatively large effects on health. We show that ignoring behavioral hazard can lead to welfare estimates that are both wrong in sign and off by an order of magnitude.

The framework developed is amenable to a number of extensions. While our model is static, it could be extended to consider how behavioral hazard affects optimal copays for preventive care, where initial underuse could generate high future costs (and possibly overuse). The New England Healthcare Institute estimates that eliminating non-adherence could save $290 billion a year. Further exploration of the sophistication of behavioral consumers and intertemporal incentives for insurers may help explain the kinds of insurance plans we would expect to be provided in the marketplace and the potential role of public policy. Work could also draw out more nuanced implications for the use of nudges versus copayments. And while we highlight that the main results do not depend on the underlying psychological forces generating behavioral hazard, greater understanding of those forces could help estimate the degree of behavioral hazard in different settings and inform the optimal design of nudges.

The finding that optimal insurance features depend crucially on how prices affect both quantity demanded and health highlights the value of having empirical estimates of both demand responses and health responses to changes in copays (see also Lee et al. 2013). There is often limited data linking insurance and clinical outcomes—and performing an exhaustive list of experiments and calculations would certainly be daunting—but a small number of conditions account for a large share of health spending. Patients with circulatory system conditions like high blood pressure and high cholesterol are responsible for 17% of total health care spending; mental conditions like depression for another 9%; respiratory conditions like asthma another 6%; and endocrine conditions like diabetes another 4% (Roehrig et al. 2009). This means that a limited number of studies linking price changes, demand changes, and health changes could go a long way.\footnote{Even absent such multi-step evidence, however, we can glean some benchmarks about the potential benefits of optimal copayment design in a model with both moral hazard and behavioral hazard from the literature that looks at particular steps in this chain. This requires applying results from one particular step (e.g. the effect of a copay change on one measure of adherence, such as refilling prescriptions) generated from a particular marginal population to the next step (e.g. effect of a different measure of adherence, such as missed pills, on heart attacks) generated in

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The model captures important features of the health care landscape. Many of the domains of care that are responsible for a substantial share of total health care utilization are sensitive to copay changes, and many of the treatments affected seem to have health value that differs from that implied by moral hazard alone. Failing to incorporate behavioral hazard into models of optimal insurance design can not only generate very wrong answers— but very wrong answers with substantial import for millions of people. The framework developed here builds a foundation for more sophisticated insurance design that incorporates both demand and health responses in balancing insurance protection with efficient resource use.

References


a different setting with a different population, over a different time frame, etc. Appendix C provides a very stylized example using the case study of treatment for high blood pressure. High blood pressure afflicts 68 million adults in the U.S. (CDC Vital Signs 2011) and is an important driver of overall health care costs. Using existing estimates, we show that small reductions in copays increase compliance with anti-hypertensive therapy and that better compliance generates substantial health gains. This implies a large net return on the marginal social dollar spent on improving blood-pressure medication adherence and suggests that the failure of existing plans to address behavioral hazard could be generating large welfare costs. Rosen et al. (2005) perform a similar exercise to predict the cost-effectiveness of first-dollar coverage of ACE inhibitors for Medicare beneficiaries with diabetes.


Einav, Liran, Amy Finkelstein, and Heidi Williams, “Paying on the Margin for Medical Care: Evidence from Breast Cancer Treatments.”


Gann, Carrie, “Man Dies From Toothache, Couldn’t Afford Meds,” ABC News, 2011.


Appendix (for Online Publication)

A Further Results

A.1 Comparing the Neo-classical Optimal Copay to the Optimal Copay

Proposition 6. Suppose the neo-classical analyst believes $p^N$ is a candidate for the optimal copay where $M'(p^N) \neq 0$.

1. $\tilde{W}'(p^N) > 0$ if $\varepsilon^{avg}(p^N) > 0$. Moreover, $p^B > p^N$ under the additional assumption that $\tilde{W}(p)$ is strictly quasi-concave over $(p^{min}, p^{max})$.

2. $\tilde{W}'(p^N) < 0$ if $\varepsilon^{avg}(p^N) < 0$. Moreover, $p^B < p^N$ under the additional assumption that $\tilde{W}(p)$ is strictly quasi-concave over $(p^{min}, p^{max})$.

This result says that there is a welfare benefit to raising the copay from the neo-classical optimum whenever behavioral hazard is on average positive for people at the margin given this copay, and we further know that the optimal copay is above the neo-classical optimum whenever $\tilde{W}$ satisfies the classical regularity assumption of being strictly quasi-concave. Similarly, there is a welfare benefit to reducing the copay whenever behavioral hazard is on average negative for people at the margin, and the optimal copay is below the neo-classical optimum whenever $\tilde{W}$ is strictly quasi-concave. For example, the neo-classical analyst may underestimate the optimal copay in the case of antibiotics for children’s ear infections but overestimate the optimal copay in the case of statins for people who have recently had a heart attack.

A.2 Using Nudges to Identify Behavioral Hazard

The next result describes conditions under which nudges can be used to help estimate the degree of marginal behavioral hazard.

Proposition 7. Suppose that $\varepsilon_n(s; \theta)$ is constant in $\theta$ and $b(s; \gamma)$ is constant in $\gamma$ for all $(n, s)$. Let $\varepsilon_n(p) = \mathbb{E}[\varepsilon_n | b + \varepsilon_n = p]$ equal the degree of marginal behavioral hazard given nudge $n$ and copay $p$.

1. (Negative behavioral hazard). Suppose we know that $\varepsilon_0 \leq 0$ and $\varepsilon_n \leq 0$ for all $s$. Further, let $p_0, p_n$ be such that $p_0 < p_n$, but $0 < M_0(p_0) \leq M_n(p_n) < q$. Then,

$$-\varepsilon_0(p_0) \geq p_n - p_0.$$  (8)
2. (Positive behavioral hazard). Alternatively, suppose we know that $\varepsilon_0 \geq 0$ and $\varepsilon_n \geq 0$ for all $s$. Further, let $p_0, p_n$ be such that $p_n < p_0$, but $0 < M_n(p_n) \leq M_0(p_0) < q$. Then,

$$
\varepsilon_0(p_0) \geq p_0 - p_n.
$$

(9)

To illustrate how Proposition 7 can be used to estimate $\varepsilon_0$, suppose a researcher is convinced that a treatment is undervalued, and he has access to nudge $n$ which he believes reduces behavioral hazard. Bound (8) can be applied whenever demand is interior and $M_0(p_0) \leq M_n(p_n)$. The latter condition can be re-written as

$$
\frac{M_n(p_0) - M_0(p_0)}{\text{demand response to nudge}} - \frac{[M_n(p_0) - M_n(p_n)]}{\text{demand response to co-pay change}} \geq 0,
$$

(10)

so bound (8) can be applied whenever the demand response to an increase in copay from $p_0$ to $p_n$, fixing the nudge at $n$, is lower in magnitude than the demand response to the nudge, fixing the copay at $p_0$. Thus, the tightest lower bound a researcher can estimate for $-\varepsilon_0(p_0)$ for a given nudge $n$ is $\tilde{p}_n - p_0$, where $\tilde{p}_n$ is the value of $p_n$ that equates the demand response to an increase in copay to the demand response to the nudge; i.e., it is the value that makes (10) hold with equality.

Absent further assumptions, it is necessary to both have an estimate of the impact of a nudge on demand as well as an estimate of demand sensitivity to copays under the nudge to directly apply Equation (10). For example, if the aim is to estimate the marginal behavioral error by examining the impact of a peer mentoring program on prescription drug utilization, Equation (10) requires knowledge both of how the program affects utilization, fixing the copay, and how utilization responds to greater copays when the program is in place. Under stronger assumptions, for example that demand is linear and demand sensitivity to copays is independent of the nudge, it is possible to use less local estimates of this sensitivity.\footnote{To see this, suppose the conditions of the first part of Proposition 7 hold and, additionally, demand can be written as $M_j(p) = \alpha_j - \beta \cdot p$ for nudges $j = 0, n$. Then bound (8) implies that

$$
-\varepsilon_0(p_0) \geq (M_n(p_0) - M_0(p_0))/\beta,
$$

where the right hand side of the inequality gives the amount that copays need to decrease to get a demand response of $(M_n(p_0) - M_0(p_0))$.}

B Further Definitions and Proofs

Before we get to the proofs, we introduce some useful definitions.
Recall that \( m(p) \) equals a person’s demand for treatment at price \( p \)

\[
m(p) = \begin{cases} 
1 & \text{if } b(s; \gamma) + \varepsilon(s; \theta) \geq p \\
0 & \text{if } b(s; \gamma) + \varepsilon(s; \theta) < p
\end{cases}
\]

and

\[
M(p) = \mathbb{E}[m(p)] = q \mathbb{E}[m(p)|\text{sick}]
\]
equals (per capita) aggregate demand at price \( p \). We can break aggregate demand down into demand given various values of the parameters \((\gamma, \theta)\):

\[
M(p; \gamma, \theta) = \mathbb{E}[m(p)|\gamma, \theta] = q \mathbb{E}[m(p)|\gamma, \theta, \text{sick}] \Rightarrow M(p) = \mathbb{E}_G[M(p; \gamma, \theta)] = \int M(p; \gamma, \theta) dG(\gamma, \theta).
\]

Further letting \( s(p; \gamma, \theta) \) equal the marginal disease severity given \( \gamma, \theta \):

\[
s(p; \gamma, \theta) = \begin{cases} 
\underline{s} & \text{if } p < b(\underline{s}; \gamma) + \varepsilon(\underline{s}; \theta) \\
\text{the value } s' \text{ satisfying } b(s'; \gamma) + \varepsilon(s'; \theta) = p & \text{if } b(\underline{s}; \gamma) + \varepsilon(\underline{s}; \theta) \leq p \leq b(\bar{s}; \gamma) + \varepsilon(\bar{s}; \theta) \\
\bar{s} & \text{if } p > b(\bar{s}; \gamma) + \varepsilon(\bar{s}; \theta)
\end{cases}
\]
demand given \((\gamma, \theta)\) can be re-written as

\[
M(p; \gamma, \theta) = q \cdot [1 - F(s(p; \gamma, \theta))].
\]

Likewise, let

\[
H(p; \gamma, \theta) = q \cdot \mathbb{E}[m(p) \cdot b - s|\gamma, \theta, \text{sick}] \Rightarrow H(p) = \int H(p; \gamma, \theta) dG(\gamma, \theta).
\]

Finally, let

\[
b(p; \gamma, \theta) \equiv b(s(p; \gamma, \theta); \gamma)
\]
equal the benefit to getting treated of the marginal agent given price \( p \) and parameters \((\gamma, \theta)\) and

\[
\varepsilon(p; \gamma, \theta) \equiv \varepsilon(s(p; \gamma, \theta); \theta)
\]
equal the corresponding marginal degree of behavioral hazard.
Given these definitions, we can re-express the benevolent insurer’s problem as maximizing

\[ W(p) = (1 - q)U(y - P) + q \mathbb{E}[U(y - P - s + m(p)(b - p)) | \text{sick}] \]

\[ = (1 - q)U(y - P) + q \mathbb{E}_G \left[ \int_{\mathbb{R}}^{s(p; \gamma, \theta)} U(y - P - s) dF(s) + \int_{s(p; \gamma, \theta)}^{s} U(y - P - s + b(s; \gamma) - p) dF(s) \right] \]

subject to \( P = M(p) \cdot (c - p) \).

**Lemma 1.** For any function \( r(s, \gamma, \theta) \) that takes on real values and all \( p \) satisfying \( M'(p) \neq 0 \) we have:

\[ \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{\partial p} \cdot r(s(p; \gamma, \theta), \gamma, \theta) \right] = \mathbb{E}[r(s; \gamma, \theta) | b + \epsilon = p]. \]

**Proof.** By the law of iterated expectations:

\[ \mathbb{E}[r(s, \gamma, \theta) | b + \epsilon = p] = \mathbb{E}[\mathbb{E}[r(s, \gamma, \theta) | b + \epsilon = p, \gamma, \theta] | b + \epsilon = p] = \mathbb{E}[r(s(p; \gamma, \theta), \gamma, \theta) | b + \epsilon = p], \]

where the final expectation is taken with respect to the distribution over \((\gamma, \theta)\) given \( b + \epsilon = p \). The probability density function of this distribution equals \( \tilde{f}(p; \gamma, \theta) \cdot g(\gamma, \theta) / \tilde{f}(p) \) by Bayes’ rule, where \( \tilde{f}(-; \gamma, \theta) \) is the probability density function over \( b + \epsilon \) given \((\gamma, \theta)\). The latter probability density function is derived from the probability distribution function over \( s \), \( f(s) \), via a change of variables where \( p = b(s; \gamma) + \epsilon(s; \theta) \equiv \phi(s; \gamma, \theta) \). By standard arguments, \( \tilde{f}(p; \gamma, \theta) = f(\phi^{-1}(p)) \cdot |d\phi^{-1}/dp| \), where here \( \phi^{-1}(p) = s(p; \gamma, \theta) \) and \( d\phi^{-1}/dp = -\frac{1}{\partial_{\gamma} s + \partial_{\epsilon} s/\partial s} = \frac{\partial s(p; \gamma, \theta)}{\partial p} \), so \( \tilde{f}(p; \gamma, \theta) = f(s(p; \gamma, \theta)) \cdot \frac{\partial s(p; \gamma, \theta)}{\partial p} \). Using (12), we then have

\[ \mathbb{E}[r(s, \gamma, \theta) | b + \epsilon = p] = \frac{\int r(s(p; \gamma, \theta), \gamma, \theta) \cdot f(s(p; \gamma, \theta)) \cdot \frac{\partial s(p; \gamma, \theta)}{\partial p} dG(\gamma, \theta)}{\int f(s(p; \gamma, \theta)) \cdot \frac{\partial s(p; \gamma, \theta)}{\partial p} dG(\gamma, \theta)}. \]

Substituting

\[ \frac{f(s(p; \gamma, \theta)) \frac{\partial s(p; \gamma, \theta)}{\partial p}}{\int f(s(p; \gamma, \theta)) \frac{\partial s(p; \gamma, \theta)}{\partial p} dG(\gamma, \theta)} = \frac{\partial M(p; \gamma, \theta)}{\partial p} / M'(p) \]

into (13) yields the desired equality. 

**Proof of Proposition 1.** Differentiating (11) yields

\[ W'(p) = -\mathbb{E}[U'(C)] \cdot \frac{\partial P}{\partial p} - \mathbb{E}[\mathbb{E}[U'(C) | m = 1, \gamma, \theta] M(p; \gamma, \theta)] \]

\[ + q \mathbb{E}_G \left[ f(s(p; \gamma, \theta)) \frac{\partial s(p; \gamma, \theta)}{\partial p} (U(y - P - s(p; \gamma, \theta)) - U(y - P - s(p; \gamma, \theta) + b(p; \gamma, \theta) - p)) \right]. \]
Now substituting in

\[
\frac{\partial P}{\partial p} = M'(p) \cdot (c - p) - M(p)
\]

\[
\varepsilon(p; \gamma, \theta) = p - b(p; \gamma, \theta)
\]

\[
\varepsilon'(p; \gamma, \theta) = \frac{U(y - P - s(p; \gamma, \theta)) - U(y - P - s'(p; \gamma, \theta) - \varepsilon(p; \gamma, \theta))}{\mathbb{E}[U'(C)]}
\]

\[
\frac{\partial M(p; \gamma, \theta)}{\partial p} = -q f(s(p; \gamma, \theta)) \frac{\partial s(p; \gamma, \theta)}{\partial p}
\]

\[
I = \frac{\mathbb{E}[U'(C)|m = 1] - \mathbb{E}[U'(C)]}{\mathbb{E}[U'(C)]}
\]

\[
\mathbb{E}[\mathbb{E}[U'(C)|m = 1, \gamma, \theta] M(p; \gamma, \theta)] = \mathbb{E}[U'(C)|m = 1] \cdot M(p),
\]

re-arranging, and converting into a money-metric, we have

\[
\frac{\partial W}{\partial p} / \frac{\partial W}{\partial y} = -M'(p) \cdot (c - p) - \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{\partial p} \varepsilon'(p; \gamma, \theta) \right] - I \cdot M(p).
\]

Further letting

\[
\varepsilon^{\text{avg}}(p) \equiv \mathbb{E}[\varepsilon'|b + \varepsilon = p] = \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{\partial p} \varepsilon'(p; \gamma, \theta) \right]
\]

equal the average normalized marginal behavioral error at price \( p \) where the equality follows from Lemma 1 (we let \(-M'(p) \cdot \varepsilon^{\text{avg}}(p) = 0 \) whenever \( M'(p) = 0 \)), we can re-express the welfare impact of a copay change as

\[
\frac{\partial W}{\partial p} / \frac{\partial W}{\partial y} = -M'(p) \cdot (c - p + \varepsilon^{\text{avg}}(p)) - I \cdot M(p).
\]

\[\blacksquare\]

**Proof of Proposition 2.** Given linear \( U \), the welfare impact of a marginal copay change is \( \tilde{W}'(p) = -M'(p) \cdot (c - p + \varepsilon^{\text{avg}}(p)) \) by Proposition 1. It thus suffices to show that

\[
\varepsilon^{\text{avg}}(p) = p - \frac{H'(p)}{M'(p)}.
\]

To show (14), first expand

\[
H(p; \gamma, \theta) = q \cdot \left( \int_{s(p; \gamma, \theta)}^{s'(p; \gamma, \theta)} -sdF(s) + \int_{s(p; \gamma, \theta)}^{\bar{s}} b(s; \gamma) - sdF(s) \right).
\]
After some substitution and simplification, Leibniz’s rule then gives us that
\[
\frac{\partial H(p; \gamma, \theta)}{\partial p} = \frac{\partial M(p; \gamma, \theta)}{\partial p} \cdot s(p; \gamma, \theta) + \frac{\partial M(p; \gamma, \theta)}{\partial p} \cdot [b(p; \gamma, \theta) - s(p; \gamma, \theta)] = \frac{\partial M(p; \gamma, \theta)}{\partial p} \cdot b(p; \gamma, \theta).
\]
As a result, \( \frac{\partial H(p; \gamma, \theta)}{\partial p} / \frac{\partial M(p; \gamma, \theta)}{\partial p} = b(p; \gamma, \theta) \), which using the equality \( b(p; \gamma, \theta) + \varepsilon(p; \gamma, \theta) = p \) yields
\[
\varepsilon(p; \gamma, \theta) = p - \frac{\partial H(p; \gamma, \theta)}{\partial p} / \frac{\partial M(p; \gamma, \theta)}{\partial p}.
\] (15)

From the proof of Proposition 1, \( \varepsilon^{\text{avg}}(p) = \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{\partial p} \cdot \varepsilon'(p; \gamma, \theta) \right] \), which with the assumption of linear utility implies that
\[
\varepsilon^{\text{avg}}(p) = \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{p(M'(p))} \cdot \varepsilon(p; \gamma, \theta) \right].
\] (16)

Plugging (15) into (16) then gives us
\[
\varepsilon^{\text{avg}}(p) = \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{p(M'(p))} \cdot \left( p - \frac{\partial H(p; \gamma, \theta)}{\partial p} / \frac{\partial M(p; \gamma, \theta)}{\partial p} \right) \right] = p - \frac{H'(p)}{M'(p)},
\]
thus establishing (14).

\[\blacksquare\]

**Proof of Proposition 3.** Trivially comes from setting (5) equal to zero and re-arranging.

**Proof of Proposition 4.** First note that
\[
\mathbb{E}[b|\text{sick}] = \frac{H(p^{\text{min}}) - H(p^{\text{max}})}{M(p^{\text{min}}) - M(p^{\text{max}})}
\]
so we can substitute \( \mathbb{E}[b|\text{sick}] \) for \( (H(p^{\text{min}}) - H(p^{\text{max}}))/(M(p^{\text{min}}) - M(p^{\text{max}})) \) in the rest of the proof.

Since \( U \) is linear,
\[
\tilde{W}'(p) = -M'(p) \cdot (c - p + \varepsilon^{\text{avg}}(p)) = -M'(p) \cdot (c - b^{\text{avg}}(p)),
\]
where \( b^{\text{avg}}(p) \equiv \mathbb{E}_G \left[ \frac{\partial M(p; \gamma, \theta)}{p(M'(p))} \cdot b(p; \gamma, \theta) \right] = \mathbb{E}[b + \varepsilon = p] \) by Lemma 1. As a result,
\[
\tilde{W}'(p) = -M'(p) \cdot (c - \mathbb{E}[b + \varepsilon = p]).
\]
By Proposition 3 in Chambers and Healy (2012), when $\mathbb{E}[\varepsilon] = 0$ for almost every $p$ there exists an \( \alpha \in [0, 1] \) such that $\mathbb{E}[b + \varepsilon = p] = \alpha \cdot p + (1 - \alpha) \cdot \mathbb{E}[b|\text{sick}]$. Since the distribution of $\varepsilon - \mathbb{E}[\varepsilon]$ is symmetric and quasi-concave whenever the distribution of $\varepsilon$ is symmetric and quasi-concave, Chambers and Healy’s result further implies that when $\mathbb{E}[\varepsilon] < 0$ then for almost every $p$ there exists an $\alpha \in [0, 1]$ such that $\mathbb{E}[b + \varepsilon = p] > \alpha \cdot p + (1 - \alpha) \cdot \mathbb{E}[b|\text{sick}]$ and when $\mathbb{E}[\varepsilon] > 0$ then for almost every $p$ there exists an $\alpha \in [0, 1]$ such that $\mathbb{E}[b + \varepsilon = p] < \alpha \cdot p + (1 - \alpha) \cdot \mathbb{E}[b|\text{sick}]$. Armed with these facts, we can establish the three parts of the proposition:

1. If $\mathbb{E}[b|\text{sick}] < c$ and $\mathbb{E}[\varepsilon] \geq 0$, then $\mathbb{E}[b + \varepsilon = p] < c$ for all $p < c$. As a result, $\tilde{W}'(p) \geq 0$ for such $p$ with strict inequality when $M'(p) \neq 0$, in particular at $p = c$ given the assumption that $M'(c) \neq 0$, implying that $p^B > c$.

2. If $\mathbb{E}[b|\text{sick}] = c$ and $\mathbb{E}[\varepsilon] = 0$, then $\mathbb{E}[b + \varepsilon = c] = c$, while $\mathbb{E}[b + \varepsilon = p] < c$ for $p < c$ and $\mathbb{E}[b + \varepsilon = c] > c$ for $p > c$. This implies that $\tilde{W}'(p) \geq 0$ for $p \leq c$, $\tilde{W}'(p) = 0$ for $p = c$, and $\tilde{W}'(p) \leq 0$ for $p > c$, so $p^B = c$.

3. If $\mathbb{E}[b|\text{sick}] > c$ and $\mathbb{E}[\varepsilon] \leq 0$, then $\mathbb{E}[b + \varepsilon = p] > c$ for all $p \geq c$. As a result, $\tilde{W}'(p) \leq 0$ for such $p$ with strict inequality when $M'(p) \neq 0$, in particular at $p = c$ given the assumption that $M'(c) \neq 0$, implying that $p^B < c$.

\[
\text{Lemma 2. Suppose } U \text{ is strictly concave, } \varepsilon(s; \theta) = \bar{\varepsilon} \in \mathbb{R} \text{ and } b(s; \gamma) = s \text{ for all } (s, \gamma, \theta).
\]

1. If $\bar{\varepsilon} > 0$ then $I(p) \leq 0$ for all $p \leq 0$ with equality at $p = 0$ and $I(p) > 0$ for all $p > 0$ satisfying $M(p) > 0$.

2. If $\bar{\varepsilon} < 0$ then $I(p) < 0$ for all $p < 0$ satisfying $M(p) > 0$.

Proof. Recall

\[
I(p) = \frac{\mathbb{E}[U'(C)|m = 1] - \mathbb{E}[U'(C)]}{\mathbb{E}[U'(C)]},
\]

where $C = y - P - s + m \cdot (b - p)$, which under the assumption that $b = s$ reduces to

\[
C = \begin{cases} 
    y - P - p & \text{when } m = 1 \\
    y - P - s & \text{when } m = 0.
\end{cases}
\]

Since $s \geq 0$, whenever $p < 0$ we have $y - P - p > y - P - s$, which implies that $I(p) < 0$ for all $p < 0$ satisfying $M(p) > 0$, establishing part 2 of the lemma.

To establish part 1 now specialize to the case where $\bar{\varepsilon} > 0$. In this case, for all $p \leq 0$ we have $M(p) > 0$, so $I(p) < 0$ for all $p < 0$. Moreover, for $p = 0$, $C$ equals $y - P$ for everybody so
Proof of Proposition 5. First consider the case where $\bar{\varepsilon}$ is large. Specifically, suppose $\bar{\varepsilon} > c$, so everybody gets treated when $p = c$. In this case, $M'(p) = 0$ for $p < c$, so $d\bar{W}^N(p)/dp = -M'(p) \cdot (c - p) - I(p) \cdot M(p) = 0$ for all $p \geq 0$, with strict inequality for $p \in (0, c]$. This implies that $p^N \leq 0$. Since, additionally, $I(p) \leq 0$ for $p \leq 0$ with equality at $p = 0$ (by the assumption that $b(s; \gamma) = s$) and strict inequality when $p$ is smaller than but sufficiently close to 0, we have that $d\bar{W}^N(p)/dp \geq 0$ for $p < 0$ with strict inequality for $p$ sufficiently close to 0, so $p^N = 0$. On the other hand, since demand must be price sensitive at the optimal copay (by Assumption 1), we must have that $p^B > c$ when $\bar{\varepsilon} > c$. For example, if $-U''/U' \approx 0$, then $p^B \approx c + \bar{\varepsilon} > c$, since this copay implements first best utilization.

If $\bar{\varepsilon}$ is sufficiently low, for example $\bar{\varepsilon} < -\bar{s}$, then $M(p) = 0$ for all $p \geq 0$, so $d\bar{W}^N(p)/dp = 0$ for all $p \geq 0$. Since, in addition, $I(p) < 0$ for all $p < 0$ satisfying $M(p) > 0$, we have $d\bar{W}^N(p)/dp \geq 0 \forall p \leq 0$ with strict inequality whenever $M(p) = 0$ or $M'(p) \neq 0$. The neoclassical analyst thus believes that $p^N = c$ is a candidate for the optimal copay. On the other hand, since nobody gets treated at positive values of $p$, we must have $p^B < 0$ by the assumption that $M'(p^B) \neq 0$ (Assumption 1). To illustrate, if $-U''/U' \approx 0$, then $p^B \approx c + \bar{\varepsilon} < c - \bar{s} < 0$.

Proof of Corollary 1. Follows immediately from Proposition 5.

Proof of Proposition 6. By definition,

$$\frac{d\bar{W}^N}{dp}(p^N) = -M'(p^N) \cdot (c - p^N) - I(p^N) \cdot M(p^N) = 0.$$

As a result,

$$\frac{d\bar{W}}{dp}(p^N) = -M'(p^N) \cdot (c - p^N + \varepsilon^{\text{avg}}(p^N)) - I(p^N) \cdot M(p^N) = -M'(p^N) \cdot \varepsilon^{\text{avg}}(p^N),$$

which takes the sign of $\varepsilon^{\text{avg}}(p^N)$ given the assumption that $M'(p^N) \neq 0$.

Under the assumption that $\bar{W}(p)$ is strictly quasi-concave over $(p_{\text{min}}, p_{\text{max}})$ then $\bar{W}(p)$ must be nondecreasing for all $p < p^B$ and nonincreasing for all $p > p^B$. Given the result that $\bar{W}'(p^N)$ takes the sign of $\varepsilon^{\text{avg}}(p^N)$ this means that $p^B > p^N$ when $\varepsilon^{\text{avg}}(p^N) > 0$ and $p^B < p^N$ when $\varepsilon^{\text{avg}}(p^N) < 0$.

Proof of Proposition 7. (Part 1) Let $s_0$ denote the severity of the marginal agent given copay $p$ and
nudge \( n = 0 \), so

\[
b(s_0) + \varepsilon_0(s_0) = p_0.
\]  

(This is uniquely defined by the assumption that \( b \) and \( \varepsilon \) are constant in \((\gamma, \theta)\).) Since \( M_n(p_n) \geq M_0(p_0) \), we also have that

\[
b(s_0) + \varepsilon_n(s_0) \geq p_n.
\]

Inserting the first equality into the second expression yields

\[
p_n - p_0 \leq \varepsilon_n(s_0) - \varepsilon_0(s_0) \leq -\varepsilon_0(s_0),
\]

where the final inequality follows from the assumption that \( \varepsilon_n(s_0) \leq 0 \).

The proof of the second part is similar, and hence omitted.

\[\Box\]

## C Case Study on Hypertension

High blood pressure is a prevalent and potentially deadly condition: 68 million adults in the U.S. have high blood pressure (CDC Vital Signs 2011), which is associated with adverse events such as heart attacks and stroke that carry with them serious health consequences including risk of death. The cost of treating hypertension and its consequences is high: Hodgson and Cai (2001) estimate the expenditures associated with hypertension and its effects to be about 12.5% of health expenditures, or over $5,000 annually per hypertensive patient ($3,800 in 1998, inflated using CPI). We use this important disease as a stylized example to illustrate implications of a model that incorporates behavioral hazard, examining: (1) the existence of effective treatments to avoid adverse consequences; (2) adherence and responsiveness to nudges; (3) effects of adherence on blood pressure and health outcomes.

### The Efficacy of Drug Treatments and Consequences of Uncontrolled Hypertension:

There are several classes of drugs (such as beta blockers and ACE inhibitors) that aim to reduce patients’ blood pressure and thereby reduce the chance of serious downstream health events. The medical literature suggests that policies that increased compliance with anti-hypertensives would have substantial health effects through lowering blood pressure. Use of beta-blockers post-heart attack can reduce subsequent mortality by more than 40% (Soumerai, 1997). Hsu et al. (2006) found a 30% drop in anti-hypertensive compliance was associated with a 3% increase in hypertension and subsequent hospital and emergency department use. Anderson et al. (1991) present a model of
how risk factors such as hypertension are associated with adverse events including heart attack and stroke in a non-elderly population, and calculate an overall risk of mortality from cardiovascular disease. For a 50 year old non-smoking, non-diabetic man with somewhat elevated cholesterol, a decrease in systolic blood pressure from 160 mmHg to 140 mmHg would reduce the risk of 10-year cardiovascular disease mortality by 2.5 percentage points; a decrease in diastolic blood pressure from 100 to 90 would reduce it by 5 percentage points. Long, Cutler et al. (2006) find that the advent of anti-hypertensive drugs reduced blood pressure in the population over age 40 by 10 percent or more, and averted 86,000 deaths from cardiovascular disease in 2001 and 833,000 hospitalizations for stroke and heart attack. They also note that in addition to these health improvements observed under existing use, under “guideline” use these numbers might have been twice as high – suggesting that improved patient adherence (as well as physician prescribing practices) might generate substantial health gains.

**Adherence and Responsiveness to Nudges and Copays:** Patient adherence to anti-hypertensives is not only far from perfect, but is sensitive to both finances and nudges. Schroeder et al. (2008) review the evidence on adherence to anti-hypertensives and efforts to improve it based on non-financial strategies, including studies that use reminder systems and innovative packaging. Overall adherence to hypertensive therapies is around 50%-70%, but such interventions were able to increase it by around 10-20 percentage points. Several of the studies they review that focus on strategies such as reminders find not only improvements in adherence but reductions in blood pressure. McKenney (1992) for example finds that an intervention including electronic medicine caps and reminders increased adherence by 20 percentage points and reduced systolic and diastolic blood pressure by 10-20 mmHg. Several of the studies examining price-elasticity of pharmaceutical use mentioned above look at results for anti-hypertensives in particular. Many of these estimates cluster around -0.1 to -0.2 (including Chandra, Gruber and McKnight 2010; Landsman et al. 2005; and Chernew et al. 2008). The drop in use found by Hsu et al. (2006) was in response to the imposition of a cap on drug benefits (with the imposition of caps in general resulting in a decrease of 30% in pharmaceutical use but an offsetting increase in non-elective hospital use of 13% and emergency department use of 9%).

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42 Chandra et al. (2010) find an elasticity of -0.09 for anti-hypertensives among chronically ill HMO patients, based on an increase in copayments of around $5 (unpublished detail). Chernew et al. (2008) estimate elasticities of -0.12 for ACE inhibitors/ARBs and -0.11 for beta blockers, based on copay reductions from $5 to 0 for generics and $25 to $12.50 for branded drugs. Landsman et al. (2005) find elasticities of -0.16 for ARBs and CCBs and -0.14 for ACE inhibitors, based on the introduction of tiering that raised copays by $20 or less. Lohr et al. (1986) find a reduction in use of beta blockers of 40% among those exposed to copayments in the RAND HIE versus those who were not, but the finding was not statistically significant. Similarly, Hsu et al. (2006) find that the imposition of a cap on Medicare beneficiaries’ drug benefits results in an increase in anti-hypertensive non-adherence of 30%.
Effects on Health Outcomes: Unlike the Choudhry et al. (2011) study examined in the main text, most of these studies do not individually include the full set of outcomes needed to perform welfare calculations under models of moral hazard and behavioral hazard (and indeed, many do not even report the change in total (all-payer) drug expenditures), but they can be used in combination to illustrate the point. For example, the drop in total drug utilization in one of the policy experiments studied in Chandra et al. (2010) is around $23 a month when copays go up to about $7.50 per drug among members who use about 1.4 drugs per month, or to a coinsurance rate of about 22% of the $48 per month in drug spending. Following the logic from the Choudhry example in the main text, the standard moral hazard model would thus suggest that this copay increase generated less than about $5 per month in health cost (with the remaining $18 reduction in utilization attributable to reduced moral hazard) - which is clearly at odds with the observed changes in health outcomes. The imposition of benefit caps studied by Hsu et al. (2006) produced a similar magnitude decline in utilization, and was associated with an increase in death rates of 0.7 percentage points, along with increased blood pressure, cholesterol, and blood sugar - implying a cost from increased mortality alone of $7,000 using conventional valuations.

Another way of synthesizing this stylized evidence is to calculate the likely mortality reduction from changes in copayments or nudges that promote adherence and compare it to the cost of the intervention. Estimates suggest that interventions like a $5 reduction in copayments or a nudge with comparable demand response applied to the 40% of people who are not adherent could increase compliance with anti-hypertensive therapy by something like 10 percentage points, resulting in a decrease in blood pressure of 15 mm and subsequent 3 percentage point reduction in deaths from cardiovascular disease (and even greater gains for readily-identifiable subpopulations like those with previous heart attacks, who may see a 40 percent reduction in subsequent mortality). This reduction in mortality would be valued at $30,000. This might be compared to the cost of an adherence program. If such a program worked on ¼ of the people to whom it was applied and came at a cost of less than $7,500, then it would be welfare improving based on this outcome alone. Given the estimates of the total annual cost of treating hypertensive patients (around $5,000), and that these interventions largely operate on the low-marginal-cost margin of increased adherence to prescriptions that have already been obtained through an office visit, this seems likely to be the case.

43Chandra et al. (2010) do not measure health directly, but the increased hospitalization rate is indicative of substantially worse outcomes. These stylized examples ignore the fact that the price of drugs is not likely an adequate proxy for their actual marginal cost.

44How we value reductions in mortality and improvements in health is of course a subject of major debate. Some estimates of the monetary value of life-years are derived from revealed preference arguments that are inherently grounded in a rational agent model, but others are based on labor market earnings, social welfare arguments, etc. Commonly used estimates cluster around $100,000 per “quality-adjusted life year” and $1 million per death averted (although this clearly varies based on the age at which death is averted and the life expectancy gained – averting the death of a young healthy worker might be valued at $5 million).
- and is consistent with meta-analysis suggesting that interventions to manage use of hypertension medications were highly cost-effective (Wang 2011).

As the Cutler et al. (2007) estimates suggest, there could be around 90,000 total deaths averted through greater compliance with optimal antihypertensive therapy, suggesting the scope of such gains could be vast. Furthermore, this can be viewed as a lower bound, insofar as there are many other health benefits of reduced hypertension beyond just the deaths from cardiovascular disease – including improved quality of life and lower incidence of expensive hospitalizations, etc. This example clearly over-simplifies (to the point of inaccuracy) complex medical pathways, but is meant to be illustrative both about the steps involved in such a calculation and the rough order of magnitude of the potential effects.

D Appendix Tables
### Appendix Table 1: Examples of Underuse and Overuse

#### Panel A: Underuse of High-Value Care

<table>
<thead>
<tr>
<th>Estimates of return to care</th>
<th>Possible unobserved private costs (side-effects often rare)</th>
<th>Usage rates of clinically relevant population</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statins</strong></td>
<td>Muscle pain, digestive problems</td>
<td>Adherence &lt; 70% (2)</td>
</tr>
<tr>
<td>Reduce all cause mortality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Relative Risk=.88)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>cardiovascular disease</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mortality (RR .81)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>myocardial infarction or</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coronary death (RR .77)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Beta-blockers</strong></td>
<td>Fatigue, cold hands</td>
<td>Adherence &lt; 50% (4)</td>
</tr>
<tr>
<td>Reduce mortality by 25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>post heart attack (3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anti-asthmatics</strong></td>
<td>Stomach upset, headache, bruising</td>
<td>Adherence &lt; 50% (6)</td>
</tr>
<tr>
<td>Reduce hospital admissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Odds Ratio=.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improve airflow resistance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(OR .43)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anti-diabetics</strong></td>
<td>Headache, stomach upset</td>
<td>Adherence &lt; 65% (8)</td>
</tr>
<tr>
<td>Decrease cardiovascular</td>
<td></td>
<td></td>
</tr>
<tr>
<td>mortality (OR .74)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Immunosuppressants for</strong></td>
<td>Infections</td>
<td>Adherence &lt; 70% (9)(10)</td>
</tr>
<tr>
<td><strong>Kidney Transplant</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended Care</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Care of known efficacy</td>
<td>Time costs; discomfort of</td>
<td>&lt; 40% of diabetics receive semi-annual blood</td>
</tr>
<tr>
<td>including immunizations</td>
<td>screening; acknowledgment of</td>
<td>tests (11)</td>
</tr>
<tr>
<td>and disease management,</td>
<td>disease</td>
<td>Recommended immunization rates</td>
</tr>
<tr>
<td>follow-up care post surgery</td>
<td></td>
<td>60% for children, 24% for adolescents (12)</td>
</tr>
<tr>
<td><strong>Pre-natal care</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reduces infant mortality</td>
<td>Time costs</td>
<td>&lt; 50 % receive adequate or better care</td>
</tr>
<tr>
<td>(RR .47 to .57)</td>
<td></td>
<td>(13)(14)</td>
</tr>
</tbody>
</table>

#### Panel B: Overuse of Low-Value Care

<table>
<thead>
<tr>
<th>Estimates of return to care to patient</th>
<th>Possible unobserved private benefits</th>
<th>Usage rates in populations with low benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MRI for low back pain</strong></td>
<td>Anxiety reduction</td>
<td>16% of doctors report routine use of MRI (15)</td>
</tr>
<tr>
<td>Increase the number of surgeries with</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no resultant improvement in outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(15) (16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PSA testing</strong></td>
<td>Uncertainty reduction</td>
<td>49% of 50- to 79-year old men have had PSA test in past 2 years (18)</td>
</tr>
<tr>
<td>No significant mortality change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(17)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Prostate cancer surgery</strong></td>
<td>Anxiety reduction</td>
<td>57% of patients receive radical prostatectomy or radiation as initial treatment (20)</td>
</tr>
<tr>
<td>No difference in overall survival</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(19)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Antibiotics for children's ear aches</strong></td>
<td>Positive action</td>
<td>98% of visits result in antibiotic Rx (22)</td>
</tr>
<tr>
<td>At best modest improvement, but with common side-effects (rashes, diarrhea)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(21)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sources: Authors' summary of literature:
(1) Cholesterol Trmt Trialists Collab (2005)
(2) Pittmen et al. (2011)
(3) Yusuf et al. (2010)
(4) Kramer et al. (2006)
(5) Krishnan et al. (2009)
(6) Krishnan et al. (2004)
(7) Selvin et al. (2008)
(8) Bailey and Kodack (2011)
(9) Butler et al. (2004)
(10) Dobbels et al. (2010)
(11) Sloan et al. (2004)
(12) McInerny, Cull, and Yudkowsky (2005)
(13) McInerny, Cull, and Yudkowsky (2009)
(14) Collins and David (1992)
(15) Jarvick et al. (2003)
(16) Chou et al. (2009)
(17) Schroeder et al. (2012)
(18) Ross, Berkowitz, and Ekwueme (2008)
(19) Holmberg et al. (2002)
(20) Lu-Yao and Greenberg (1994)
(21) Glasziou et al. (2004)
(22) Froom (1990)
### Appendix Table 2: Typical Health Insurance Plan Features

<table>
<thead>
<tr>
<th>Public Plans</th>
<th>Notes</th>
<th>Copay Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal Employees Health Benefits Plan</td>
<td>Menu of private plans offered to federal employees. Details for most popular plan given</td>
<td>Physician office visit: $20 Inpatient services: 15% Rx: Mail: $10 generic, $65 branded; Retail: 20%</td>
</tr>
<tr>
<td>Medicare</td>
<td>A&amp;B (Hospital and physician) D (Drugs). Varied private plans. Basic plan given</td>
<td>Physician: 20% Inpatient: $1,156 deductible (60 days) + $289/day (thereafter) Rx: 25% up to initial coverage limit, 100% in &quot;doughnut hole&quot;; 5% above</td>
</tr>
<tr>
<td>Tricare Standard Plan</td>
<td>Civilian health benefits for military personnel/additional agencies, families</td>
<td>Physician: 20% Inpatient: max($25/admission, $15.65/day) Rx: Mail: $0 generic, $9 preferred branded, $25 non-preferred; Retail: 5/12/25</td>
</tr>
<tr>
<td>Medicaid</td>
<td>Varies state to state</td>
<td>Physician: 25 states have copays for physician visits</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Private Plans</th>
<th>Notes</th>
<th>Copay Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employer-sponsored</td>
<td>Varies. Averages given</td>
<td>Physician: $22 generalist; $32 specialist Rx: $10 generic; $29 preferred branded; $49 non-preferred branded</td>
</tr>
</tbody>
</table>

Sources:
Medicare: http://www.medicare.gov/cost/.
Private plan: Kaiser Family Foundation Health Research & Education Trust (2011)
Appendix References


CDC Vital Signs: High Blood Pressure and Cholesterol, National Center for Chronic Disease Prevention and Health Promotion, 2011.


Lohr, Kathleen N, Robert H Brook, Caren J Kamberg, George A Goldberg, Arleen Leibowitz, Joan Keesey, David Reboussin, and Joseph P Newhouse, “Use of Medical care in the RAND Health Insurance Experiment: Diagnosis and Service-Specific Analyses in a Randomized Controlled Trial.” Medical Care, 1986, pp. S1–S87.


