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Abstract: The analysis of regulations affecting addictive or habitual goods has drawn considerable controversy. Some studies have suggested that such regulations have only small welfare benefits, as consumers value these goods despite health benefits from quitting, while other studies suggest that information or behavioral problems make existing consumption decisions a poor guide to welfare evaluation. We examine potential utility offsets to health benefits of regulations affecting addictive or habitual goods theoretically and empirically. Our analysis focuses on individuals who consume these goods only, ignoring other social costs and benefits. Theoretically, we show the importance of several factors including: money saved in addition to health improvements; differentiating steady-state utility losses from short-term withdrawal costs; lack of utility loss for people dissuaded from starting to consume the good; and accounting for utility consequences of explicit or implicit cost increases. Our empirical analysis considers regulations that affect smoking. To measure the welfare cost of smoking cessation, we divide the population into those with more and less rational smoking behavior and use the valuation of smoking from more rational smokers to impute values of losses for less rational smokers. Our results show that the utility cost of smoking cessation is small relative to the health gains in people for whom withdrawal costs are the main utility loss of quitting, and even among people who have some ongoing loss, the utility offsets represent 20%–25% of the health gains. While marginal smokers induced to quit

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by regulations can be expected to have low or no steady-state loss, even this higher estimate is far below prevailing estimates of the utility cost of smoking used by the Food and Drug Administration and other analysts.

Keywords: behavioral; education and human capital; law and regulation; theory; addictive goods; rational behavior; hyperbolic discounting; utility offset.

Consumption of many addictive and habitual goods has significant health costs. In the United States, smoking accounts for 480,000 premature deaths annually, obesity leads to 110,000 deaths, and excess alcohol consumption results in approximately 88,000 premature deaths. In this context, would regulations aimed at curbing smoking, drinking, or excess caloric intake be welfare enhancing?

Economic theory is ambiguous on this question. Regulations that reduce consumption of goods with health harms improve health, but they also reduce utility if they discourage consumption of goods that consumers like. If people are well informed about the costs of health-harming goods and fully factor these health costs into their consumption decisions, then decisions are optimal without regulation, and the utility offset resulting from regulation will necessarily exceed the health and monetary savings of reduced consumption. However, if people are not fully informed, information is not sufficiently salient, or people have difficulty making behavioral changes that they would like to make, the utility offset to regulation may be smaller, and regulations may be welfare enhancing.

In this paper, we develop a framework for analyzing the utility consequences of regulations addressing addictive and habitual goods when people are imperfectly informed or not fully rational, and apply this analysis to the empirical example of smoking regulations. Our suggested approach values the benefits of regulations based on data on individuals who are likely to be well-informed and rational consumers. We apply these rational, well-informed valuations to the population as a whole.

The issue of utility offsets has been noted for some time. Still, it provokes considerable confusion. In its benefit-cost analyses of use of ephedrine alkaloids (FDA, 2004) and nutrition labels (FDA, 2014), the Food and Drug Administration (FDA) noted the potential utility offsets of each set of regulations, but did not estimate a magnitude. The issue of magnitudes first arose in the work of Gruber and Köszegi (2001), who parameterized a model of hyperbolic utility to estimate the welfare loss of excess smoking. The FDA's (2011) analysis of benefits from requiring graphic warning labels on cigarettes used an estimate from Gruber and Köszegi to approximate the utility offset from smoking cessation. The FDA estimated that requiring graphic warning labels would have significant utility offsets, with a range of 10%–90% of the health benefits and a "best guess" of 50% of the health benefits. Ashley, Nardinelli and Lavaty (2015) extended this analysis to examine the utility offset of antismoking policies, arguing that at least two-thirds of health benefits are offset by utility losses. The large magnitude of this offset has led to significant critiques of this analysis (e.g., Chaloupka et al., 2015), and thus far the debate remains unsettled.

Relative to previous studies, our work has four conceptual innovations. First, we explicitly highlight the distinction between more and less rational consumers, and show how the behavior of one group can be applied to valuations for the other. Our analysis follows that of the Australian Productivity Commission (2010, which analyzed gambling restrictions) and Jin, Kenkel, Liu and Wang (2015, which looked at smoking), though we depart from these studies in significant ways.

Second, we explicitly delineate the money savings from reduced consumption of health-harming goods and place those alongside the health benefits. Third, we show that the utility offsets from health-harming goods are generally smaller than previous research indicates. This is partly because the offset is conceptually based on the consumption of rational consumers, who consume less than not fully rational consumers, and partly because a good share of the utility offset is due to withdrawal costs, which decline in importance over time. In addition, people dissuaded from starting to consume the good have no or low utility loss, as they never develop the taste for it brought on by addiction or habit. Fourth, we show that regulations affecting the implicit or explicit price of the good lead to an additional welfare loss to consumers that needs to be counted.

Theoretically, the net effect of these considerations could lead to larger or smaller benefit-cost evaluations than conventional estimates. In the case of smoking, our empirical estimates indicate that the net benefit to consumers of regulations reducing consumption is more favorable than conventional estimates suggest. The most important factor in this conclusion is that withdrawal costs are a large share of the utility offset, and these offsets are time delimited, where the monetary and health benefits of reducing cigarette consumption are not.

Before we present our analysis, we delineate some boundaries. We consider only the consequences of consumption for the individual affected, ignoring the external consequences of consumption for nonconsumers. In addition, we ignore the impact of regulation on compliance costs to industry or monitoring costs to government except insofar as we consider the impact on prices that consumers face. We make these assumptions for simplicity; a full welfare analysis would need to relax each. Finally, we restrict our empirical analysis to smoking, though our methodology would readily apply to other addictive or habitual goods such as excessive food or alcohol intake and gambling.

The paper is structured as follows. Section 1 lays out the economic framework for welfare evaluation. Section 2 presents our empirical analysis of consequences for smoking. Section 3 remarks on population estimates. The last section concludes.

1 Economic framework

We analyze regulations affecting addictive or habitual goods. Addiction is defined as a "chronic, relapsing brain disease that is characterized by compulsive drug seeking and use, despite harmful consequences" (U.S. National Institute on Drug Abuse, 2015). The concept of "habit" is less clear-cut. We use it to refer to a behavior engaged in automatically, without conscious thought. While habits generally involve compulsive behavior and may be rewarding or reinforcing, they do not typically involve tolerance, psychoactive effects, or withdrawal. Addiction is clearly important for smoking, our empirical subject, as at least half of current smokers are estimated to be nicotine dependent (SAMHSA 2013).

Regulations that affect consumption of addictive or habitual goods will have a number of effects, both positive and negative. On the negative side, people who reduce consumption of such goods face costs of changing their habits: both withdrawal costs in the short term and the possibility of reduced satisfaction over the longer term. At the same time, consumers are healthier and spend less on the addictive good when they reduce their consumption. They may also gain utility, for example, by losing feelings of self-loathing or embarrassment from continuing to use a health-harming good (Piper, Kenford, Fiore & Baker, 2012).

The magnitude of these costs and benefits depends on how rationally consumers behave. As Becker and Murphy (1988) noted, addiction by itself does not imply that people's actions are irrational. The key issue is whether people make rational decisions in light of their addiction. We analyze addiction in concert with two other factors that limit rational decision-making. The first is a bias toward short-term benefits and costs and away from longer term benefits and costs. People who are excessively present-oriented will not make rational decisions to refrain from initiating or terminating consumption of harmful goods, even if they would agree that such changes would be beneficial. The second is information problems, where some people may not fully internalize the health costs of addictive goods consumption or how hard cessation really is. While present bias and information problems may affect many situations, they are particularly costly in the context of addictive goods, because failure to make sound decisions at one point in time will carry over into all future periods.

Throughout our analysis, we delineate two decisions: initiation and cessation. In the case of smoking, initiation decisions are typically made when young: 90% of smokers start before age 18. There is good reason to believe that such decisions are not fully rational. Most youths who start smoking do not initially enjoy the taste of cigarettes (Eissenberg & Balster, 2000, O'Connor et al., 2005); enjoyment of smoking comes over time, coevolving with nicotine addiction. Rather, most people initially begin smoking for attention, to look older, out of curiosity, to flaunt authority, or to fit in CDC (2012, Chapter 4). Beyond the teenage years, these considerations decline in importance and smoking initiation drops.

Cessation decisions are made throughout life, suggesting that youthful decision-making errors are less important. However, evidence suggests that decision-making regarding smoking cessation is not fully rational either. In particular, people seem to overestimate the probability that they will be able to quit smoking when they want and underestimate the severity of the health problems that smoking will lead to at the end of life (Sloan, Smith & Taylor, 2003). About 55% of high school seniors who are smoking daily say they will not be smoking 5 years later, but only 24% of them had in fact quit 5 years hence (CDC 2012: 249). Even among adults, the 2010–11 Tobacco Use Supplement to the Current Population Survey asked current adult smokers, "If you did try to quit smoking altogether in the next 6 months, how LIKELY do you think you would be to succeed – not at all, a little likely, somewhat likely or very likely?" Thirty-nine percent of people answered somewhat likely, and 24% answered very likely. In contrast, only 5%–10% of cessation attempts are successful. Thus, unrealistic expectations are a very real phenomenon. Further, when quit attempts are made, they are often not successful. Two-thirds of adult smokers say they are interested in quitting smoking completely, and 52% had a past-year quit attempt,[1] yet only 6% had recently succeeded in quitting.[2]

There are a number of economic theories that can explain why consumers may have unrealistic expectations or otherwise not act in accordance with their preferences: (1) consumers face challenges in fully understanding the consequences of their consumption decisions for later health; (2) preferences may not be consistent over time – for example, consumers may be overly sensitive to short-term costs relative to long-term gains; (3) behavior may be driven by habit and impulse more than rational consideration; and (4) aggressive marketing may influence behavior. Like much of the economics literature, we focus on the first two of these.[3] The evidence for oversensitivity to current costs is voluminous and is seen in many settings (DellaVigna, 2009). People have difficulty increasing their savings rate despite stating that they should save more, adhering to lower calorie diets despite a desire to lose weight, and exercising at the gym despite paying costly membership fees. We use such a model to examine the implications of regulation.

1 This rate is based on former smokers who had stopped smoking in the past year and current smokers who had refrained from smoking for one or more days in the past year because they wanted to quit.

2 U.S. Centers for Disease Control and Prevention (2011). Quitting is defined here as not having smoked at all in the 6 months preceding the interview.

3 Bernheim and Rangel (2004) model the third of these theories with a framework of "hot" and "cold" states, the distinction being the difference between rational behavior (the cold state) and behavior based on habit or impulse (the hot state). In their model, cues shift people from the cold to the hot state. This model is not sufficiently tractable for policy analysis, however.

1.1 Utility and equilibrium

We consider the hyperbolic discounting framework of Laibson (1997). Consider people having a utility function of the form:

$$W = U_t(a_t, S_t; c_t) + \beta \sum_{i=1}^{T-t} p_{t+i}(\boldsymbol{a})\delta^i U_{t+i}(a_t, S_t; c_t), \qquad (1)$$

where W is the discounted value of lifetime utility and U_t is the per-period utility function. We imagine there are two goods: an addictive good, with current consumption a_t, and all other goods c_t, where $c_t = Y - P_a a_t$ for constant income Y.[4] P_a is the constant real price of the addictive good. S_t is the stock of addiction entering period t – typically a weighted average of past consumption. We normalize the weights so that at constant a over time (denoted by $\bar{a}$), $\bar{S} = \bar{a}$; that is, the value of the existing stock is equal to the flow of annual consumption. $p_{t+i}(\boldsymbol{a})$ is the probability of survival to period $t + i$. It is conditional on the entire past history of consumption of the addictive good, denoted by $\boldsymbol{a}$. If only the cumulative stock of smoking matters, $\boldsymbol{a} = S_t$. More generally, smoking may affect health in a different way than it affects addiction.

For ease, we assume that utility is additively separable in the addictive good and all other goods, and that the marginal utility of all other goods is constant. This implies that $U_t = v(a_t, S_t) + (Y - P_a a_t)$. We further assume $v = v(\alpha_1 a_t - \alpha_2 S_t)$, where $v(.)$ is assumed to be concave.[5] α_1 measures the extent to which consumption of the addictive or habitual good increases current period utility. α_2 reflects withdrawal. It is the extent to which today's utility is lower if one consumed more of the good in the past, holding current consumption constant.

$v(.)$ may vary with age. Teens may benefit from the rebellious image that smoking conveys, while adults may not. It is possible that $\alpha_1 > 0$ for teens and $\alpha_1 \approx 0$ for adults; this would correspond to a situation where never-smoking adults would derive no pleasure from smoking.

One important case is where $\alpha_1 = \alpha_2$. If this is true, there is no steady-state benefit to consuming the addictive good. That is, $v(., .)$ is the same at any constant $\bar{a}$, even $\bar{a} = 0$. But there are withdrawal costs associated with moving from a higher

4 For convenience, there is no saving or borrowing.
5 Addiction is modeled empirically as adjacent complementarity – the value of consumption today is higher if consumption was greater in the past. We capture adjacent complementarity in a slightly nonstandard way. If a_t increases, then S_{t+1} increases as well. Because higher S_{t+1} leads to greater withdrawal costs, utility is lower in $t + 1$. Given the concavity of the utility function, this increases the return to a_{t+1}. An alternative way of capturing adjacent complementary would be to make $v(., .)$ quadratic in its two elements, as in Gruber and Köszegi (2001). Adopting such a utility function would not affect our analysis qualitatively.

a to a lower a, because reducing a below $\bar{S}$ would be utility-reducing. To avoid this withdrawal effect, people may not make the change.

People discount the future in two ways. The first is the standard exponential discount rate, δ. To avoid excess notation, we assume that $\delta = 1$. In addition, some people have a preference for current utility over all future utility, captured in the parameter β. Consumers with $\beta = 1$ apply the same discount between the present and the near future as they would between two adjacent periods in the future. Consumers with $\beta < 1$ apply an extra discount to all future periods relative to the present, so they will continually delay making investments with up-front costs, even if they would agree when thinking about what would best benefit them in the long term that the investment is a good idea. They are commonly referred to as hyperbolic.

Time-inconsistent discounting will lead to suboptimal outcomes. Incomplete information about future consequences of current actions will as well. People may not understand the health costs of the addictive good ($p_{t+i}(\boldsymbol{a})$) or how addictive the good is (α_2). For simplicity, we assume people understand the addictiveness of cigarettes (i.e., perceptions of α_2 are accurate) and examine the impact of inadequate understanding of the health cost of smoking – for example, the evidence that people do not appreciate how sick they will be at the end of life. We denote the perception of this variable as $\tilde{p}_{t+i}(\boldsymbol{a})$.

The individual's optimal consumption of the addictive good can be found by maximizing utility. This yields the first order condition:

$$\underbrace{\alpha_1 v_t'}_{\text{current consumption benefit}} - \underbrace{\alpha_2 \beta \sum \tilde{p}_{t+i} v_{t+i}' \frac{dS_{t+i}}{da_t}}_{\text{future withdrawal cost}} + \underbrace{\beta \sum U_{t+i} \frac{d\tilde{p}_{t+i}}{da_t}}_{\text{longevity cost}} = \underbrace{P_a}_{\text{forgone consumption}}. \quad (2)$$

The first term on the left-hand side of equation (2) is the current marginal benefit of consumption. That may involve direct consumption benefits or indirect benefits such as relaxation and weight loss. It also includes health-related quality of life. The second term is the discounted value of the future withdrawal cost that will be caused by consuming more of the addictive good in the current period. These costs arise as people reduce consumption and decay as the future stock of addictive capital declines (i.e., $\frac{dS_{t+i}}{da_t}$ declines with increasing i). The third term is the mortality impact – the reduction in lifetime utility from premature mortality due to smoking in period t. Note that $\frac{d\tilde{p}_{t+i}}{da_t} < 0$, so this term is negative. At the optimum, the consumer will trade off the sum of these impacts against the marginal utility of other consumption forgone, which is given by P_a.

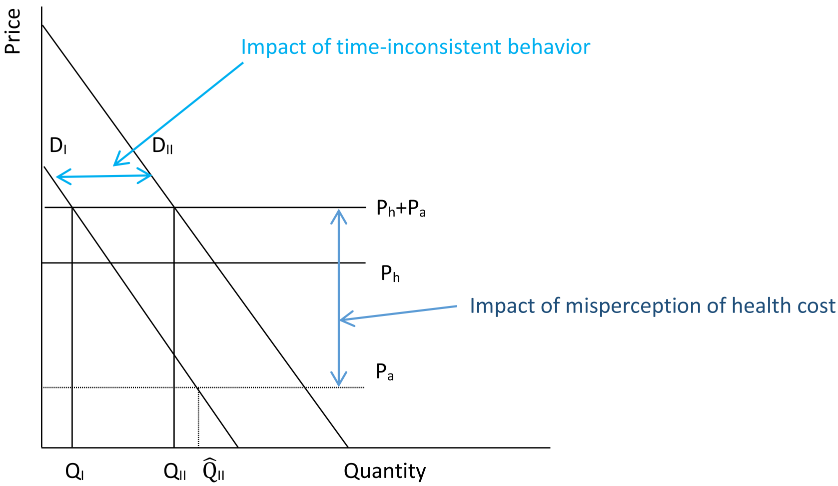

Figure 1 Equilibrium with two types of consumers. Type I consumers are rational and fully informed. Type II consumers are either imperfectly informed, in which case they overconsume because perceived costs are low ($\hat{Q}_{\mathrm{II}}$), or have difficulty constraining consumption (Q_{II}).

Figure 1 shows a graphical version of this equilibrium. As is the norm, we include the monetary price and health costs (the third and fourth terms) as costs, and the consumption benefits net of withdrawal (the first two terms) as the value to the individual, though no practical difference in results depends on whether a health harm is termed a cost or a negative benefit.

Because withdrawal costs vary with past consumption, so too will the value of current consumption. We start by drawing the short-run demand curve corresponding to the initial addictive stock. We return to the dynamics below.

This model can be applied for both existing users of the good and for potential initiators, although the empirical implementation differs between the two cases. Considering existing users first, we delineate two types of individuals: type I consumers who are fully rational and fully informed ($\beta = 1$ and $\tilde{p}_{t+i} = p_{t+i}$); and type II consumers who have time-inconsistent preferences ($\beta < 1$). The demand curves of the two types of consumers are shown by D_{I} and D_{II}; at any price, $D_{\mathrm{II}} > D_{\mathrm{I}}$ because of the additional weight that type II consumers place on short-term costs and benefits, and thus their overconsumption relative to rationally discounted targets.

There are two prices to consumption: the health cost, which we denote as P_h, and the market price of the good, P_a. Given these prices, consumers from the two groups will choose to consume Q_{I} and Q_{II}, respectively. There is a welfare loss for type II consumers because they overconsume the addictive good.

Q_{I} and Q_{II} would also differ if type II individuals misperceive the full health cost to using the addictive or habitual good ($\tilde{p}_{t+i} \neq p_{t+i}$). For example, if type II consumers do not perceive any health cost to using the good, the equilibrium will be along the common demand curve (D_{I}), but where their valuation of the good is equal to the monetary price of the good, P_a. The result is shown as $\hat{Q}_{\text{II}}$, which again is above Q_{I}.

1.2 Types of regulations

Several types of regulations could be enacted in such a market. Some regulations change the information available to consumers (as with ingredient labels) or the salience of the information (as with graphic warning labels for cigarettes). Other regulations require producers to change how they manufacture, distribute, or market their good, usually aiming to better satisfy public health or safety concerns. If such a change increases producers' costs, the higher costs may be passed through to consumers in the form of higher prices. Still other regulations change how products are marketed, distributed, or sold, for example, limiting vending machine sales of cigarettes. Finally, some regulations may require companies to alter or eliminate product attributes that people value, such as flavors or packaging, perhaps in the interest of reducing smoking initiation by youth.

Economically, these regulatory activities fit into two groups: those that affect information or its salience, and those that affect prices of the good. Explicit price increases might result from required manufacturing changes; implicit price increases are those resulting from higher search costs or reduced pleasure per unit of the good. We discuss the impact of information- and price-based regulations below, and in each case differentiate between the impact of regulations on existing users and on potential new users.

1.3 The welfare consequences of regulations

We start with regulations that increase the amount or salience of information about health effects. Information about some of the major harms of smoking, such as risks of lung cancer and heart disease, has been widely available for some time, making it tempting to ignore this issue for smoking. However, it is not clear that current regulations can be interpreted as occurring in a context of full information, given

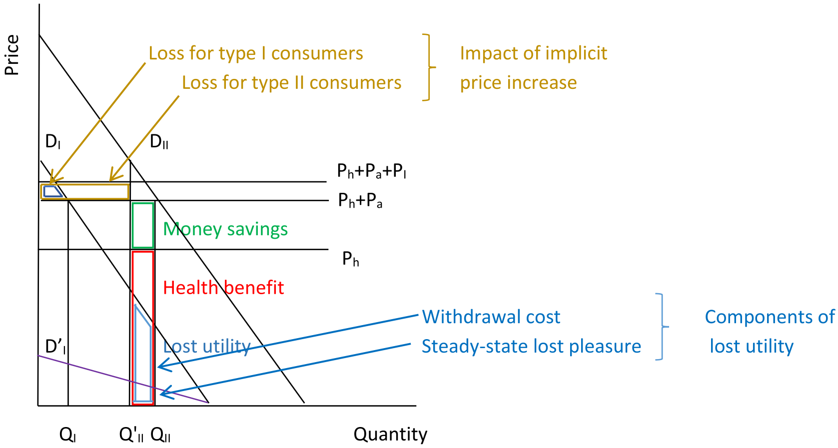

Figure 2 Welfare with regulatory interventions. The four impacts of regulations: (1) health benefits; (2) monetary savings; (3) lost utility, resulting from both withdrawal costs and steady-state lost pleasure; and (4) welfare losses from higher explicit or implicit prices for the good paid by continuing users.

limits on people's ability to keep up with an evolving subject. Further, the salience of the information varies over time.[6]

Figure 2 shows the welfare impacts of an information-based regulation. We consider a situation where type II consumers are fully informed about the harms of the good, but have difficulty cutting back to rational levels.[7] The regulation helps them do that, in part. As type I consumers are already rational, their demand is unaffected. The full impact of the regulation is therefore a reduction in type II consumption from Q_{II} to Q'_{II}.

With the reduction in demand, D_{II} would shift inward to pass through the new equilibrium. For simplicity, we do not show this in the figure. In the limit where type II consumers are fully constrained or otherwise induced to reduce consumption to Q_I, D_{II} would be equal to D_I.

As a consequence of the regulation, the welfare of type II consumers would be affected in three ways. First, there is the health benefit of reduced consumption. This is the red box in Figure 2: the expected health cost per unit consumed times the reduction in units consumed. This is the standard effect noted in the literature.

6 See Kenkel (2000, pp. 1697–1699) and Chaloupka and Warner (2000, p. 1595).
7 The welfare analysis of the regulation when type II consumers are misinformed about the true health risk is analogous to Figure 2, as the inability to act fully on information is analytically equivalent to a lack of full information.

Second, consumers would save money on the packs of cigarettes they no longer buy. This is the right-hand side of equation (2) and is shown as the green rectangle in Figure 2 – the retail price per pack times the reduction in consumption. The entirety of the green rectangle is a benefit to consumers, but not all of it is a social benefit. There may be lost tax revenue or producer surplus, which would be netted out for the social benefit. As noted above, we focus here only on the consumer component.

Third, there is a utility change associated with reduced consumption. This includes the first two terms on the left-hand side of equation (2). Graphically, this change in utility corresponds to the blue area under the type I demand curve for the addictive good between Q_{II} and the new level of consumption. The key point is that the demand curve for the *rational* consumer (type I), not the consumer with behavioral difficulties (type II), should be used. The reason is that the rational consumer's demand reflects the true value of smoking to all consumers – both type I and type II.

The analysis to this point has focussed on a single time period. When a regulation is just enacted, the utility lost from reduced consumption includes both withdrawal costs for those cutting back and any steady-state lost pleasure. Over time, however, the withdrawal costs will decline, as people adapt to less use of the addictive good. The steady-state costs will remain, but these are smaller than the short-run costs – perhaps significantly so.

Analytically, this distinction is seen in the first two terms in equation (2). Imagine a consumer who has been consuming a_{high} for a number of years – long enough for the stock of past consumption (S_t) to equal a_{high}. The annual benefit of consumption is then $v((\alpha_1 - \alpha_2) * a_{\mathrm{high}})$. Now suppose regulation induces the individual to switch to a_{low}. The steady-state benefit of consumption is $v((\alpha_1 - \alpha_2) * a_{\mathrm{low}})$. The loss in steady-state utility from the reduction in smoking is approximately $(\alpha_1 - \alpha_2) * v' * (a_{\mathrm{low}} - a_{\mathrm{high}})$. If $\alpha_1 \approx \alpha_2$ – that is, the major benefit of continuing to smoke is avoiding the withdrawal cost – there is very little steady-state loss to reduced consumption. But moving to that point involves withdrawal costs, which are given by $\sum_i v(\alpha_1 a_{\mathrm{low}} - \alpha_2 S_{t+i})$ for a one-time jump in consumption. These withdrawal costs may be large.

Graphically, this situation can be expressed as a rotation of the demand curve over time. If a person stops or cuts back on smoking, their stock of addictive capital declines in the future. This will lead to a downward rotation in the demand curve – the same quantity brings less value because it does not reduce withdrawal symptoms. This process continues until the addictive stock reaches its new, lower level.

In Figure 2, demand curve D'_{I} is the value of addictive or habitual good consumption to type I individuals in steady state, when the stock of addictive capital has declined to its long-run level. The downward slope to the demand curve is consistent with $\alpha_1 > \alpha_2$; type I individuals value the addictive or habitual good, even beyond avoiding withdrawal. Even still, the value of consumption is lower than in the short-run demand curve (D_{I}) because in the long run there are no withdrawal costs. The steady-state lost utility may be significantly lower than the short-run utility loss, as the figure delineates.

Distinguishing between withdrawal costs and steady-state welfare losses cannot be done without knowing α_1, α_2, and the evolution of S_t. We return to our empirical implementation of this below.

Regulations that affect price or product attributes have similar effects to the analysis above, with one addition – the impact of the price change on those who continue to use the addictive or habitual good. Suppose that a regulation increases the implicit price of the product from $P_{\mathrm{h}} + P_a$ to $P_{\mathrm{h}} + P_a + P_{\mathrm{I}}$, for example, by increasing manufacturing costs, raising the time associated with seeking out the good, or reducing valued attributes. The type II consumers who stop using the good are affected the same way: they receive health benefits and cost savings, and suffer lost utility.

There is an additional cost, however, corresponding to the higher implicit prices paid by the type I and type II consumers who continue to use the good. Figure 2 shows the implicit price increase and welfare changes that result from that. The additional loss for type II consumers is the higher cost times the consumption of remaining type II smokers. Type I consumers suffer that same loss and in addition there is a deadweight loss from those type I consumers who are discouraged from using the good but rationally would do so.

In each of these cases, the cost is the private cost to the individual. The social cost may be the same as this or smaller, for example, if some of the higher price is a transfer to the government or to private firms. Consistent with our earlier delineation, we consider only the impact on individual consumers in this paper.

In practice, it is sometimes difficult to determine if a regulation affects the price of using a good or not. For example, graphic warning labels on cigarettes increase the salience of health information for consumers but (possibly) reduce the smoking experience for those consumers who continue to smoke. Whether information affects implicit prices – and for whom – is an empirical matter as much as a theoretical one.

2 An empirical approach to welfare evaluation

The central empirical issue is how to apply this theory in practice. A variety of approaches to regulatory analysis of addictive or habitual goods have been suggested in the literature. These include contingent valuation estimating how much people are willing to pay for devices that reduce consumption without withdrawal costs (Weimer, Vining & Thomas, 2009), measuring the happiness or subjective well-being of people before and after cessation (Gruber & Mullainathan, 2005), and parameterizing a model of not fully rational consumers (Gruber & Köszegi, 2001; Ashley et al., 2015).

While the various approaches have advantages, they also have shortcomings that make them difficult to use with confidence in benefit-cost analysis. For example, studies finding smokers to have low willingness to pay for cessation products suggest they may view benefits of policies to promote cessation as worth only a bit more than the utility loss. However, it is also likely that smokers overestimate their ability to quit on their own (Sloan et al., 2003), which reduces the demand for cessation aids. Measuring changes in subjective well-being directly would seem to entail the fewest assumptions about sources of utility changes and their signs. Yet changes in measures of subjective well-being are not readily mapped into monetary values, making it difficult to use them in benefit-cost analysis. Finally, parameterized models of addictive consumption have the appeal of rigorous theoretical underpinnings, but their highly stylized character and sensitivity of results to changes in assumptions about parameter values raise doubts about whether they are currently well-enough developed for policy analysis. For this reason, we develop an alternative approach based on our theoretical analysis: we estimate demand curves for type I and type II individuals and use those to infer welfare gains and losses.

2.1 Baseline information

Our analysis is based on the demand curves analyzed above, so we start with empirical formulations of those curves. The data on smoking that we employ are from the 2010–11 Tobacco Use Supplement to the Current Population Survey (CPS-TUS). These data contain information on adults' current and former smoking status, and various measures of addiction and desire to quit smoking. We utilize the CPS data weighted to U.S. population totals.

The average smoker in the CPS-TUS consumed 230 packs of cigarettes annually, and the average retail price of cigarettes in 2010–2011 was \$5.43 (Orzechowski & Walker, 2012). Thus, the demand curve for the average smoker must pass through this point. Consistent with existing research on the elasticity of demand for cigarettes (Chaloupka & Warner, 2000, Gallet & List, 2003), we assume a price elasticity of -0.3. As in our theoretical description, we linearize the demand curve around the equilibrium values, implying a slope of $dP/dQ = -0.079$. We assume this slope applies for both type I and type II smokers.

There is no perfect division of the population into type I and type II smokers, as we do not know whose smoking behavior is rational or not across the population. In the absence of ideal information we make two cuts at the delineation between type I and type II consumers, each of which we continue through our analyses. Our first distinction separates those who are addicted to cigarettes from those who are not. A widely used measure of nicotine addiction is whether the person has their first cigarette within one-half hour of waking (CDC, 2014). We define type I smokers as those who do not have their first cigarette within one-half hour of waking, and type II smokers as those who do.

As Table 1 shows, 56% of current smokers fit the definition of not addicted (type I) and 44% are type II.[8] Type I and II smokers differ in systematic ways. Compared to type II smokers, type I smokers are younger (average age of 41 vs. 45), better educated (15% with a college degree vs. 9%), and have a higher income (18% with a family income above $60,000 vs. 14%). Type I smokers also consume fewer cigarettes than type II smokers: 152 packs per year compared to 327 packs per year.[9]

Our second proxy for type I and type II smokers uses demographic information that is associated with better information and more rational behavior. We consider type I smokers to be people aged 30–45 having a college degree or more, and type II smokers as those over age 45 or age 30–45 without a college degree. Individuals in the 30–45 age range began smoking well after the health risks of smoking became well-publicized and thus had better information with which to make decisions. Further, having a college education correlates with the time and ability to process scientific information about risks and with greater resources enabling people to carry through on forward-looking decisions. As education decisions are not yet final for much of the population below age 30 and full economic rationality for part of that group is suspect (as noted above), we omit them from this analysis.

Not surprisingly, smoking decisions vary greatly across these groups. Type I smokers smoke 162 packs per year, compared to 250 packs for type II smokers. Type I smokers are only 6% of the smoking population age 30 and above. Clearly this delineation does not fully reflect the type I population but rather captures a segment whose behavior may best approximate the rational benchmark. To the extent that many other people are rational smokers but are grouped as not fully rational, or that some of those who are 30–45 and well educated are not fully rational, this

8 When more detailed measures of nicotine dependence are used, the share of smokers categorized as nicotine dependent is higher (e.g., U.S. Substance Abuse and Mental Health Services Administration, 2013).

9 Some of this difference is due to differences in demographics between the two groups, but not the bulk of it. Using a Tobit model to control for differences in demographics across groups, the unadjusted difference of 175 packs per year corresponds to 154 packs per year (results not shown).

Table 1 Alternative delineations of Type I and Type II smokers.

	Degree of addiction		**Age and education**	
	Type I	Type II	Type I	Type II
	Not nicotine dependent	**Nicotine dependent**	**Age 30–45 and 4-year college degree or more**	**Age > 45 or age 30–45 and less than 4-year college**
Current smoking status				
% in current smoking population	55.9%	44.1%	5.6%	94.4%
# packs per current smoker	152	327	162	250
Long-run cessation				
% of ever smokers who currently smoke	—	—	34.4%	42.0%
# packs per ever smoker	—	—	56	105
Initiation*				
% ever smoker			19.9%	39.8%
% with sustained initiation	—	—	6.9%	16.7%
# packs per potential initiator	—	—	11	42

Note: Data are from the CPS-TUS and are weighted to national totals. People who are nicotine dependent have their first cigarette within one-half hour of waking. *For the initiation analysis, the Type II group includes people in the 30–45 age range only.

will bias us away from finding any large difference between the groups, thus overstating the potential losses from smoking cessation. For these reasons, we do not consider either measure superior to the other. Rather, we view the similarity of findings across two different measures a strength of our analysis.

2.2 Impact of a salience-based intervention that increases cessation

We start with an information intervention that reduces the share of overall smokers in the population by 10%. Because the intervention is based on information only, all of the reduction is assumed to be among type II consumers.

The welfare effects of such a policy can be measured in three steps, corresponding to Figure 2 above. The first impact is the health benefit to people who curb their consumption, including both improvements in morbidity and mortality. A number of studies show the adverse impact of smoking on length and quality of life (CDC, 2014). Mortality is the traditional consequence; a more recent literature has focussed on morbidity effects as well. We show results using only mortality and including morbidity as well. Valuing health benefits in dollar terms requires two additional parameters: the discount rate and the value of a quality-adjusted life year (QALY). Following standard OMB guidelines, we use two discount rates: 3% and 7%. In line with a recent review of high-quality research on values per statistical life (VSL) (Robinson & Hammitt, 2015), we anchor our estimates of the value per QALY in VSLs of \$4.3 million and \$9.3 million; accounting for age-related changes in the health-related quality of life, these estimates imply values per QALY of \$220,000 and \$480,000 at a 3% rate, and \$370,000 and \$790,000 at a 7% rate.[10] The results, shown in the first row of Table 2, are that continuing to smoke has a health cost of about \$200,000 to nearly \$1.5 million for a 35-year-old smoker.

Second, there is the money saved. Smokers who quit save \$5.43 for every pack they do not buy. The savings is \$1776 per year for the addiction-based delineation and \$1358 per year for the age/education delineation. We take the central value to be about \$1500 per year.

Finally, there is the utility offset from reduced smoking. We start on the utility offset using the implied value of cigarettes for type I consumers at the level of type II consumption. The estimates for the health harms of smoking described above imply that the health cost per pack of cigarettes ranges from \$25 to \$175 (the second row of Table 2). Given the slope of the demand curve, we can determine how much lower prices would need to be for type I consumers to smoke at the level of type II consumers.[11] We estimate the price reduction to be \$7–14 per pack. Multiplying the implied value of a pack of cigarettes by the number of packs given up yields utility losses ranging from \$5500 to \$54,000 for smokers who quit (the middle block of Table 2); focussing on results with both morbidity and mortality costs of smoking, we take the central value to be \$25,000.

10 One might alternatively attempt a full Monte Carlo analysis of the range of estimates, but we have not done so.

11 The necessary price change is given by $dP/dQ * (Q_{\mathrm{II}} - Q_{\mathrm{I}})$.

Table 2 Estimated utility losses from quitting using the demand approach for a 35-year-old smoker.

	VSL of $4.3 million				**VSL of $9.3 million**			
	3% discount rate		**7% discount rate**		**3% discount rate**		**7% discount rate**	
Health benefits included in estimate								
Mortality	yes	yes	yes	yes	yes	yes	yes	yes
Morbidity	no	yes	no	yes	no	yes	no	yes
Estimated health benefits of quitting now								
Expected lifetime health benefits	$462,400	$669,400	$209,000	$403,900	$1008,800	$1460,500	$446,300	$862,300
Implied health cost per pack	$55	$80	$25	$48	$120	$174	$53	$103
Utility loss of existing smokers who quit								
Addicted v. not	$15,300	$23,400	$5400	$13,000	$36,500	$54,200	$14,600	$30,900
Age/education	$13,400	$19,600	$5900	$11,600	$29,600	$43,100	$12,900	$25,400

Continued on next page.

Table 2 (Continued).

Utility loss as % of lifetime health benefit								
One-year loss:								
Addicted v. not	3%	4%	3%	3%	4%	4%	3%	4%
Age/education	3%	3%	3%	3%	3%	3%	3%	3%
Ongoing loss of 25% of first-year value								
Addicted v. not	23%	24%	18%	22%	26%	25%	23%	24%
Age/education	20%	20%	20%	19%	21%	20%	20%	20%

Notes: Values per statistical life are from Robinson and Hammitt (2015). Values per quality-adjusted life year (QALY) are adjusted to reflect age-related changes in health-related quality of life (Hanmer, Lawrence, Anderson, Kaplan & Fryback, 2006). In analyses including morbidity, smoking is assumed to reduce the QALY by .05 (from Jia & Lubetkin, 2010); after a person quits, the discount is assumed to fade out over the next 5 years. Expected lifetime health benefits of quitting are computed by taking the difference between the expected present discounted value of future QALYs if the person quits, to that if the person continues to smoke until death. Data on mortality risks are taken from Arias (2010, Table 1); data on relative risks for current and former smokers are from Vugrin et al. (2015, Appendix). To compute implied health cost per pack, we divide the expected lifetime health benefits of quitting (i.e., the cost the person would incur by continuing to smoke) by the expected number of packs the person would smoke: this is the expected additional number of years the person would smoke, times 232 packs per year (average packs per year, computed from the CPS-TUS). In estimates allowing for the possibility of ongoing utility losses from quitting, the loss is assumed to be 100% of the dollar value in the year when the smoker quits, 50% the next year, and 25% thereafter.

Withdrawal costs and steady-state utility loss

The component of the utility offset due to withdrawal will decline over time, as the stock of addictive capital declines. Estimating the component of this cost which is due to withdrawal is difficult. We make several passes at this.

A first pass is to see whether there are significant numbers of type II individuals for whom the marginal value of smoking seems to be entirely to avoid withdrawal. Evidence suggests this is the case. As noted above, two-thirds of current smokers say they want to quit, and 52% have made a quit attempt in the past year. Likely because of high withdrawal costs, most of these attempts have been unsuccessful. One interpretation of this evidence is therefore that about half the current smokers smoke only because the cost of withdrawal is high.

A second way to estimate the withdrawal cost is to estimate the QALY losses from symptoms frequently encountered during nicotine withdrawal and value those QALY losses in dollars. People who quit smoking may have a combination of anxiety, depression, headache, insomnia, and other symptoms. Research suggests that symptoms are most acute in the first month, and then decline progressively for most of a year (Hughes, 2006). By 1 year post-quitting, there are few physiological symptoms of withdrawal. As anxiety is among the most common side effects, we parameterize the utility loss as equivalent to a clinical case of anxiety. Sullivan, Lawrence and Ghushchyan (2005) estimate a decrement of 0.0421 in health-related quality of life resulting from anxiety. We assume the full decrement occurs in the first month of smoking cessation, then it gradually phases out over the next year.[12] Adding up over a year, this implies that the annual QALY loss from a single successful quit attempt is 0.0087.

Quitting smoking often takes multiple attempts. The majority of smokers (75%–80%) attempting to quit relapse within 6 months, and relapses may continue to occur even after years of abstinence (Zhou et al., 2009). Hughes, Keely and Naud (2004) estimate 10 to 14 attempts to quit based on a 5% or 3% success rate, with 50% of smokers quitting at some point. Data from the 2010–11 CPS-TUS show that 60% of everyday smokers who had made a quit attempt in the past year made two or more attempts. We thus assume two attempts per year and a total of 10 attempts before a successful quit, so that the average successful quit occurs over 6 years.

Failed quit attempts are likely to be shorter and less distressing than an eventual successful quit. Using data on the length of unsuccessful quit attempts (Hughes,

12 We apply QALY losses scaled down from the value of the loss during the acute phase: specifically, by one-half for month 2, one-fourth for month 3, one-eighth for months 4 through 6, and one-sixteenth for months 7 through 12.

2006), the average failed quit is assumed to involve approximately one-fourth of the QALY loss smokers experience from a successful quit. We assume this value applies to all failed quit attempts. The combined QALY loss from the sequence of failed attempts before a successful quit is thus 0.02175 (undiscounted).

Using the value of a QALY discussed above, the net result is that the cost of withdrawal symptoms from smoking cessation ranges from $6200 with a $220,000 value per QALY and 3% discount rate, to $19,800 for $790,000 value per QALY and a 7% discount rate. Given the shortness of the time period, the discount rate matters less than the VSL used. We take the central value of the withdrawal cost to be $12,500. By comparison, if we had assumed that withdrawal was equivalent to depression rather than anxiety, the utility cost of withdrawal would be about $18,600.[13] A reasonable estimate is likely in this range.

This estimate of QALY losses due to withdrawal symptoms is close to our estimates of lost utility from the demand-curve approach. At our central estimates, the withdrawal symptoms ($12,500–$18,600) are about one-half to three-quarters of the utility loss of smoking cessation ($25,000). Some part of the remaining one-quarter to one-half may represent other transitory utility costs of quitting smoking (for example, missing the sensory experience of smoking at accustomed times and places (Piasecki, Piper & Baker, 2010), and another part may constitute a steady-state loss for people who continue to miss smoking after they quit.

Economic theory suggests that the people most likely to quit in response to regulation are those for whom the steady-state loss is smallest. All else equal, people with the lowest cumulative costs are most likely to withdraw when given an incentive to do so. Thus, our expectation is that the remaining one-quarter to one-half of the utility loss will typically be over when withdrawal has run its course. As a sensitivity test, though, we consider the impact if one-quarter of the utility loss reflects steady-state loss.

A third way to examine the importance of withdrawal costs is to examine the long-run smoking behavior of type I and type II individuals. To the extent that the steady-state value of smoking is low, the divergence between type I and type II consumers should grow over time, as type I individuals should reduce smoking at a greater rate than type II individuals. In fact, this is true. Using our age/education delineation of the type I and type II populations, only 34% of ever smoking type I individuals currently smoke, compared to 42% of type II ever smokers (Table 1). When combined with the smaller number of cigarettes smoked, average current consumption is half as large for type I ever smokers compared to type II ever smokers.

13 Depression is estimated to have a quality of life decrement of 0.0625.

A final way to gage the value of steady-state utility loss is to measure the smoking rate among those for whom the health costs are low. If smoking has high implicit value, such individuals should be particularly likely to smoke. An example of this approach comes from the work of Oster, Dorsey and Shoulson (2013), who study the behavior of people at high risk for Huntington's disease. People who have a parent with Huntington's have a 50% chance of inheriting the disease. Those with the disease are extremely unlikely to survive to old age; thus, the health consequences of smoking for this group are lower. Oster et al. examine the subsequent smoking behavior of people with *ex ante* identical risk, some of whom learn they have Huntington's and others who learn they do not. They show that among ever smokers, the smoking rate of those who learn they have the disease is 69% higher than the rate among those who learn they do not have the disease. This finding suggests some ongoing utility loss for former smokers, though it is clouded by the fact that smoking reduces anxiety, which is likely to be higher among those who test positive.

Given this range of data, we present several estimates of the share of the utility loss due to withdrawal relative to health benefits of quitting. Our first estimate is the most straightforward: a large number of people report wanting to quit smoking but are unable to overcome the withdrawal cost; we assume that the marginal quitter who quits as a result of a new regulation is one for whom the utility loss ends after withdrawal is complete. In this case, the full utility loss occurs in the year when the smoker quits and is zero thereafter. This is not true for all individuals. Thus, we also consider a situation where one-quarter of the initial loss persists in the steady state as a bound on what the extent of the loss could be if some people who quit continue to miss smoking after withdrawal has passed.

The last part of Table 2 shows the ratio of the utility costs of quitting relative to estimates of the morbidity and mortality benefits from quitting to a 35-year-old smoker. Although utility losses from quitting are relatively large in the short run, they wind up being small relative to estimated benefits from improved health and longer life expectancy. When utility costs are assumed to be entirely due to withdrawal, the utility losses represent about 3%–4% of lifetime health benefits. Under the assumption that one-quarter of the value of the initial loss is ongoing, the offsets would represent 20%–25% of the value of the lifetime health benefits. Whether a given regulation would result in an expected offset ratio toward the lower or higher end of this range depends on characteristics of the regulation; only if the regulation cuts fairly deeply into the smoking population would we expect to see an offset ratio toward the higher end of the range. Even in the case where a regulation induces nonmarginal quitting, the ratio of utility loss to health benefits falls at the low end of the 10%–90% range given in previous work.

Impact of implicit price increases

A regulation that also affects price would have an additional utility offset for existing smokers who continue to smoke, because they will pay higher prices for those cigarettes. Using the demand curves above, reducing demand by 10% would require an effective price increase of $1.78 per pack in the addiction-based delineation or $1.93 in the age/education delineation. We calculate the welfare loss from this by assuming that all continuing smokers pay the higher price – though the extent to which this is true for all smokers, as opposed to some smokers, is an empirical question. For type II consumers, the welfare loss is the price increase times the equilibrium number of packs smoked (225 or 304 per year per continuing smoker after the price increase, depending on the delineation method used), so total losses sum to $435 or $543 per continuing smoker per year. For type I consumers, the loss is analogously defined but also includes a loss associated with the decline in packs consumed (23–24 packs), together amounting to approximately $251 or $289 per smoker per year. Taking weighted averages across the two groups, this increased spending amounts to $375 or $427 per continuing smoker per year, or approximately $400.

2.3 Valuing effects on initiation

The analysis of initiation is conceptually similar to that of cessation: we estimate the cost savings and utility offsets to those who are deterred from initiating, along with any additional costs to those who initiate even after the regulation. Using the same methodology as before, the health benefits of noninitiation for an 18-year-old are substantial, ranging from $312,000 to $1.2 million when morbidity and mortality costs are included, depending on assumptions for the VSL and discount rate.[14] The money savings from reduced spending on cigarettes is again $5.43 per pack, or about $1350 per deterred initiator per year.

The difficult question is again the utility offset – what is the lost utility of the type II individuals who are deterred from smoking by regulations? Empirically, we will measure this as the implied value of smoking for type I individuals were they to smoke at the level of type II individuals.

To focus on initiation, we confine the analysis to individuals aged 30–45, who came of age at a time when the harms of smoking were generally well known. Thus, we can approximate the informed population's smoking decisions. We can only estimate initiation rates by demographics, since we do not know initiation rates by

14 The estimated lifetime health benefits are lower for 18- versus 35-year-olds because longevity gains occur in the more distant future and so are more heavily discounted.

potential to become addicted. As shown in Table 1, type I and type II individuals have very different smoking initiation and cessation patterns. About 80% of type I individuals never smoked, compared to only 60% of type II individuals. Further, most of the type I individuals who started smoking subsequently quit; fewer type II individuals quit. Together these differences yield current smoking rates of 7% for type I individuals and 17% for type II. While the type I rate suggests an annual initiation rate consistent with well-informed standard preferences of around 7%, even this estimate is likely too high as some well-educated young smokers probably initiated "accidentally" in their teens and now would prefer to quit.[15] Thus, the "rational" smoking rate not conditional on having started may be much below 7%.

What then can we infer about the value of forgone utility of cigarette consumption for type II individuals deterred from initiating? As noninitiators face no withdrawal cost, the only potential utility loss they could experience would be a steady-state loss from not consuming cigarettes. Whether there is such a loss depends on how type I individuals would value the consumption done by type II individuals, which in this case entails gaging how individuals at the 17th percentile of the type I distribution of cigarette consumption would value smoking. To match the 17% smoking rate of type II individuals, demand among type I individuals would need to rise by 140%. Assuming the same demand elasticity as in the cessation analysis,[16] the monetary cost of smoking would need to turn significantly *negative* to induce type I consumers to smoke at the same rate as type II consumers. With our expectation that 7% overstates the rational smoking prevalence, the required price would have to be even more negative to induce this increase in demand.

Given these estimates, it seems implausible that people far from the margin of smoking value cigarettes highly. Put another way, because people deterred from starting to smoke never develop a special taste for tobacco products, they are able to get equal or better satisfaction from consuming other products, so a regulation that deters them from starting to smoke entails no utility loss. Therefore, the weight of the evidence suggests that analyses should assume no lost utility for prevented initiation among type II individuals. The health benefit and money saved would then be the full benefit.

The analysis of how a price- or attribute-based regulation would affect initiation also requires accounting for the higher price that people who choose to smoke even

15 For example, 50% of type I smokers in the 30–45 age range say they are seriously considering quitting within the next 6 months, and 33% report a high overall interest in quitting (8–10 on a scale of 1–10).

16 Existing research shows a wide range of estimates of the price elasticity of youth initiation, ranging from essentially 0 to as high as −0.8 (DeCicca, Kenkel & Mathios, 2002; Carpenter & Cook, 2008; Nonnemaker & Farrelly, 2011). Assuming a lower elasticity for youth initiation than the elasticity for existing users would imply the monetary cost of smoking would need to turn even more negative to induce type I consumers to smoke at the type II rate.

in the face of those higher prices will pay. A price increase of about $1.40 would be needed to reduce the quantity of cigarettes consumed by potential initiators by 10%.[17] The welfare loss from this would be about $275 for each continuing initiator each year ($1.40 × ∼200 packs), assuming all continuing initiators paid the higher cost. This offsets some, but not all, of the health benefits and cost savings.

2.4 Summary

Table 3 presents a summary of our findings. The upper panel of the table is the analysis of cessation for both types of regulations. The second row of each panel shows the money savings for people deterred from smoking, which are added to the health benefits in the first row.

The most difficult issue is the utility loss from reduced smoking. The potential for utility losses is greatest among smokers who quit, although most losses can be expected to be transitory because of the importance of withdrawal. Among others potentially affected by regulations, young people deterred from initiating do not experience utility losses, while people who continue to smoke experience losses only if prices increase or product attributes change in ways that reduce their value. Altogether this analysis suggests that utility offsets will vary across regulations, depending on the changes in behavior the regulation is expected to cause at the intensive and extensive margins.

3 Population estimates

The total benefits of a regulation are given by the amounts in Table 3, multiplied by the number of people affected in each category, summed across people for each year of the time horizon of the analysis, then discounted to the present using appropriate discount rates (3% or 7%).

In the tables in the Appendix, we present illustrative examples from such an exercise, using as an example a regulation that increases price. Without going into great detail, several points are relevant. First, the total value of the offsets is substantial in the first few years. For a policy that reduces smoking by 10% (about 100,000 people in a cohort of 35-year-old smokers), the estimated utility loss climbs to about

17 From Table 1, average packs per year are 11 and 42 for type I and type II potential initiators respectively; with the two group's shares of potential initiators being about one-third and two-thirds, average packs for all potential initiators is about 33. Again taking the demand elasticity to be −0.3, the fact that the demand curve passes through the point $\{p = \$5.43,\ q = 42\}$ implies $dq/dp = -2.33$. Then the price increase that would decrease average packs per potential initiator by 10% (3.33 packs) is $3.33/2.33 = \$1.40$.

Table 3 Summary of utility offsets for existing smokers and potential initiators*.

	Regulation Type			
	Information or salience intervention only		Regulation that increases effective cigarette price	
Existing smokers	Induced quitters	Smokers who continue to smoke	Induced quitters	Smokers who continue to smoke
Health benefits	yes	no	yes	some
Money saving	~$1500 per year	—	~$1500 per year	—
Utility loss (gain)				
One-time	$12,500–$25,000	—	$12,500–$25,000	—
Ongoing	Possible loss of $6250	—	Possible loss of $6250	−$400 per year
Potential initiators	Dissuaded initiators	People who still initiate	Dissuaded initiators	People who still initiate
Health benefits	yes	no	yes	some
Money saving	~$1350 per year	—	~$1350 per year	—
Utility loss (gain)				
One-time	—	—	—	
Ongoing	—	—	—	−$275 per year

*Regulation assumed to reduce consumption of existing smokers by 10% and reduces initiation by 10%.

$1 billion in the initial years. Withdrawal is costly, and that is reflected in the estimates. The offsets in the following years are much smaller. For reduced initiation, the calculations are even more favorable for regulations, as there is no withdrawal cost from noninitiation.

For both initiation and cessation, there are substantial health benefits associated with quitting to which these items are offsets. Over the longer term then, the utility offsets from reduced consumption will typically be modest relative to the lifetime health and monetary gains from reduced smoking. In the example we present, over the 50 years after the regulation takes effect, the utility losses of continuing smokers and smokers induced to quit would together represent about 8% of the value of health and monetary gains if the smokers induced to quit by the regulation experience no ongoing loss. The share would be higher if some quitters experience ongoing loss but even in the outside case that all of them do, the loss would not exceed 20% of health and monetary gains.

4 Conclusions

There have been a variety of estimates of the welfare consequences of regulations affecting addictive and habitual goods, particularly tobacco use. On the one hand, FDA (2011) and Ashley et al. (2015) argue that 10%–90% of the health benefits of smoking could be offset by the lost pleasure from smokers consuming less. On the other hand, Chaloupka et al. (2015) argue that because most smoking is initiated while people are teens, when decisions are unlikely to be rational, there should be no utility offset for smoking reduction.

Our analysis shows that neither of these analyses is complete. Relative to the approaches in the literature, we make several innovations. First, we delineate the reduced spending on smoking and present monetary estimates of that. Second, we show that the utility offsets of reducing consumption have both short-term withdrawal costs and longer term steady-state utility costs. Each cost is important in the short run, but withdrawal costs decline over time. Third, there may be additional costs for people who continue to consume the addictive or habitual good even after the regulatory intervention, if regulations change the explicit or implicit price of the good.

Empirically, we measure the utility offset of regulations using information on consumption of rational individuals and applying that to less rational individuals. Our estimates of utility losses or withdrawal costs from quitting smoking are meaningful in the short run. That said, they are small relative to the lifetime health benefits of quitting: below 5% for regulations that induce quitting only among smokers who experience no steady-state loss, and no higher than 20%–25% in the outside case that all of them do. As we expect most regulations to induce quitting among smokers who will not miss smoking in the long term, a population-level estimate of the offset ratio will be closer to 5%. These estimates are well below those reported in previous work.

We also find that considering initiation separately from cessation is important in considering consumer surplus changes from policy interventions. For those who are addicted, withdrawal costs are substantial, while noninitiation avoids these costs. Over the longer term, reduced initiation will generate much larger benefits than will cessation among existing users.

In interpreting these results, it is important to keep in mind that the theoretical and empirical analyses focus only on individuals who are directly affected by regulation, ignoring issues of second-hand smoke, changes in producer surplus, changes in government finances, or deadweight loss from necessary changes in other tax revenue.

Further, the empirical work in the current paper focuses on the case of cigarette smoking. That said, the approach developed here can be extended to analysis of regulations in other areas where there are concerns about whether observed consumption levels of some segment of consumers may exceed their desired levels. This situation may characterize a variety of food and tobacco products that have adverse health consequences when consumed habitually, for example menu labeling, removal of trans-fats from foods, and related policies, where issues of addiction, incomplete or nonsalient information, time inconsistency, inaccurate expectations, and related problems may drive a wedge between consumers' decision utility and the experienced utility that will result from their actions.

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Table A1 Example of total offsets from a regulation that increases the effective price of cigarettes: Cohort of 35-year-old existing smokers.

Year	Numbers of people affected by the regulation ('000)			Millions of dollars (undiscounted)					
				Continuing smokers		Smokers who quit		Total utility losses (continuing smokers and quitters) if loss of quitters is:	
	Smokers	Newly induced quitters	Cumulative #of quitters	Lost utility from higher price per pack (a) ×$400	Money saving (c) ×$1500	Lost utility from quitting assuming the loss is:			
						All withdrawal (d) ×$25,000	25% steady state*	All withdrawal	25% steady state*
0	1012								
1	1002	10	10	−$401	$15	−$253	−$253	−$654	−$654
2	986	15	25	−$395	$38	−$379	−$506	−$774	−$900
3	961	25	51	−$384	$76	−$632	−$885	−$1017	−$1270
4	946	15	66	−$378	$99	−$379	−$854	−$758	−$1232

Continued on next page.

Table A1 (Continued).

5	936	10	76	−$374	$114	−$253	−$759	−$627	−$1133
6	926	10	86	−$370	$129	−$253	−$790	−$623	−$1161
7	921	5	91	−$368	$137	−$126	−$727	−$495	−$1095
8	916	5	96	−$366	$144	−$126	−$727	−$493	−$1093
9	911	5	101	−$364	$152	−$126	−$759	−$491	−$1123
10	911	0	101	−$364	$152	$0	−$664	−$364	−$1,028

*$25,000 in the first year, $12,500 in the second, and $6250 thereafter. Number of 35-year-old smokers is from the IPUMs version of the National Health Interview Survey, 2013 (Minnesota Population Center and State Health Access Data Assistance Center, 2015). Health benefits do not count gains to continuing smokers from consuming a lower number of packs per year.

Table A2 Cumulative benefits and costs of a regulation that increases the effective price of cigarettes: Cohort of 35-year-old existing smokers.

	Present value in millions (3% discount rate)				Utility offset to health & monetary benefits if losses of quitters are:	
	Utility losses of continuing smokers + quitters if losses of quitters are		Health & monetary benefits	Total net benefits		
Years since the regulation took effect:	Withdrawal only	25% steady state			Withdrawal only	25% steady state
10	−$5589	−$9262	$9984	−$4866	56%	93%
20	−$7826	−$15,487	$32,188	$8875	24%	48%
30	−$9267	−$19,708	$58,182	$29,206	16%	34%
40	−$10,027	−$22,269	$91,522	$59,226	11%	24%
50	−$10,293	−$23,504	$125,982	$92,186	8%	19%

Values are adjusted for mortality risks specific to smokers and nonsmokers. See notes to Table 2 for explanation of data sources and derivation of health benefits.

Table A3 Example of total offsets from a regulation that increases the effective price of cigarettes: Cohort of 18-year-old potential initiators.

Year	Numbers of people affected by the regulation ('000): Continuing initiators	Numbers of people affected by the regulation ('000): Deterred initiators	Millions of dollars (undiscounted): Continuing initiators: Lost utility from higher price per pack (a) ×$275	Millions of dollars (undiscounted): Deterred initiators: Money savings (b) ×$1350	Millions of dollars (undiscounted): Deterred initiators: Lost utility
1	808	90	−$222	$121	0
2	808	90	−$222	$121	0
3	808	90	−$222	$121	0
4	808	90	−$222	$121	0
5	808	90	−$222	$121	0
6	808	90	−$222	$121	0
7	808	90	−$222	$121	0
8	808	90	−$222	$121	0
9	808	90	−$222	$121	0
10	808	90	−$222	$121	0

Number of 18-year-olds is taken from the IPUMs version of the National Health Interview Survey, 2013. Health benefits do not count gains to continuing smokers from consuming a lower number of packs per year.

Table A4 Cumulative benefits and costs of a regulation that increases the effective price of cigarettes: Cohort of 18-year-old potential initiators.

Years since the regulation took effect:	Present value in millions (3% discount rate): Utility losses: Continuing initiators	Present value in millions (3% discount rate): Utility losses: Deterred initiators	Present value in millions (3% discount rate): Health & monetary benefits	Present value in millions (3% discount rate): Total net benefits	Utility offset to health & monetary benefits
10	$1951	0	$15,895	$13,944	12.3%
20	$3382	0	$31,092	$27,710	10.9%
30	$4421	0	$43,768	$39,347	10.1%
40	$5141	0	$57,128	$51,986	9.0%
50	$5585	0	$74,323	$68,739	7.5%
60	$5797	0	$94,796	$88,999	6.1%
70	$5852	0	$111,876	$106,024	5.2%
80	$5855	0	$117,846	$111,991	5.0%

Values are adjusted for mortality risks specific to smokers and nonsmokers. See notes to Table 2 for explanation of data sources and derivation of health benefits.

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