AN EMPIRICAL STUDY OF RATIONAL ADDICTION: THE EFFECTS OF QUITTING AIDS ON SMOKING CESSATION

by

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DEDICATION

I dedicate this paper to my loving family, Lori, Tom, and Kacey. Their unwavering support and love have made me the person I am today, and none of my accomplishments would be possible without them. They've encouraged me to pursue my dreams and have inspired me to be the best man I can be. One day I hope to support you all with the same support you have given me for many years.

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ABSTRACT

This paper explores the relationship between the use of quitting aids and smoking cessation using United States (US) survey data from the 2018-2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS). Becker and Murphy's (1988) theory of rational addiction implies that strong rational addictions must terminate abruptly. In other words, strong addictions only cease by the user quitting "cold turkey". I empirically test this hypothesis using a "double-hurdle" approach, outlined by Jones (1994). A smoker's decision to quit and their conditional quitting success is modeled in two stages. In the first stage, a probit model is estimated for their decision to quit. In the second stage, conditional on their quit attempt, an additional probit model is estimated on whether the quit attempt was successful. The results indicate that the use of certain quitting aids have a significant effect on a smoker's chances of successfully quitting.

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LIST OF ABBREVIATIONS

ACS American Cancer Society

BLS Bureau of Labor Statistics

COPD chronic obstructive pulmonary disease

CPS Current Population Survey

e-Cigarette electronic cigarette

FDA Food and Drug Administration

NCI National Cancer Institute

NHIS National Health Interview Survey

NRT Nicotine Replacement Therapy

TUS-CPS Tobacco Use Supplement to the Current Population Survey

U.S. United States

CHAPTER 1:

INTRODUCTION

[Every smoker] behaves like two people, one who wants clean lungs and long life and another who adores tobacco. [...] The two are in a continual contest for control; the 'straight' one often in command most of the time, but the wayward one needing only to get occasional control to spoil the other's best laid plan.

Egonomics, or the Art of Self-Management (Schelling, 1978)

Cigarette use kills more than 480,000 Americans each year and remains the leading cause of preventable death in the United States (U.S.). In 2019, an estimated 34.1 million adults were active cigarette smokers in the United States. Each year, the U.S. spends between $132.5 and $175.9 billion on smoking-related illnesses (Maciosek *et al.*, 2015).

Cessation, or the discontinuance of use, is said to be one of the most important actions a smoker can take to improve their health. Quitting reduces the risk of many adverse health effects, including cancer and chronic obstructive pulmonary disease (COPD). In 2015, an estimated 68% of adult smokers wanted to quit, equal to about 22.7 million people (CDC, 2022).

The large monetary and welfare costs associated with smoking have led economists and health scientists alike to study the consumption of addictive products such as

tobacco and nicotine. While addicts were once viewed as irrational agents, Becker & Murphy (1988) theory of rational addiction provides a framework in which consumers can be both economically rational and addicted to harmful goods. In regards to smoking cessation, smokers are said to weigh the expected benefits of quitting against the expected costs. If the expected benefits outweigh the expected costs, they will quit. If the costs outweigh the benefits, they will remain a smoker. The theory of rational addiction has many important implications, one of which is that strong addictions can only be terminated abruptly. In other words, strong rational addictions only cease when the consumer quits "cold turkey". However, the American Cancer Society (ACS) states that Nicotine Replacement Therapy (NRT) can increase an addict's chances of successfully quitting. NRT may be categorized as a "quitting aid", defined as any good which lowers the disutility of not smoking (Gruber & Köszegi, 2001). Examples of quitting aids include nicotine patches, electronic-cigarettes (e-cigs), smokeless tobacco, and cigars. The use of quitting aids in a smoker's quit attempt or the use of tobacco breaks the cold turkey protocol if the product contains nicotine. The use of nicotine based quitting aids, or NRT, also violates a cold-turkey protocol, as nicotine is the addictive compound present in cigarettes.

In this paper, I empirically test Becker and Murphy's (1988) results that strong addictions end only with cold turkey protocol. Following Jones (1994) and Feng (2005)'s empirical tests on smoking cessation, I implement a "double-hurdle" approach to test this hypothesis of the theory of rational addiction. The model is estimated using data from the 2018-2019 Tobacco Use Supplement to the Current Population Survey (TUS-CPS). The results have useful implications in public policy discussions surrounding tobacco use and smoking cessation.

The current analysis contributes to previous research on rational addiction and smoking cessation in a number of ways. First, the study uses recently released, comprehensive tobacco use data with detailed information on the use of alternative products to aid a smoker's quit attempt. The 2018-2019 survey wave was the first to contain questions on the use of heated tobacco products to aid smokers' quit attempts. Second, this paper is among the first to explicitly test the cold turkey hypothesis of Becker & Murphy (1988) using a double-hurdle approach. This model is appropriate when examining the factors that impact both a smoker's motivation to quit along with their quitting success. Lastly, as electronic cigarette (e-Cigarette) and smokeless tobacco use prevalence increases, so does the need to reexamine the relationship between rational addiction theory and quitting aids. In 2018, an estimated 8.1 million U.S. adults were current e-Cigarette users (Creamer *et al.*, 2019). The rising popularity of using these products to aid cessation provides a useful framework to empirically test Becker and Murphy's (1988) theory implications.

The rest of the paper is structured as follows: Chapter 2 presents a theoretical framework of the economic modeling of addiction. Chapter 3 reviews relevant literature surrounding rational addiction, smoking cessation, quitting aids, and methods to model a smoker's quitting behavior. Chapter 4 presents the data and econometric specifications used. Chapter 5 details the empirical results. Chapter 6 provides a discussion of these results, and chapter 7 presents robustness checks. Chapter 8 concludes the paper.

CHAPTER 2:

THEORETICAL BACKGROUND

2.1 Addiction

The purpose of this section is to provide the theoretical concepts that this study relies on. These concepts are also utilized in Becker and Murphy's (1988) theory of rational addiction.

Addictive consumption differs from the consumption of other goods by the presence of three critical factors: tolerance, reinforcement, and withdrawal (Chaloupka, 1991). Other definitions have emphasized compulsive consumption, intoxication, and impairment of control (Chaloupka *et al.*, 2000).

Tolerance is defined as the body's adaptation to taking a drug or substance. Generally, tolerance implies that a given level of consumption yields the consumer less utility as cumulative past consumption is higher. This means that more of the drug must be consumed to achieve the same level of utility. However, tolerance is displayed differently in the case of cigarettes and other nicotine based products. In these cases, tolerance reflects the overcoming of the initially negative physical reactions to early consumption experiences (Chaloupka *et al.*, 2000). Additionally, in the case of tobacco use, tolerance does not result in a continuing escalation of use, but rather in the maintenance of a plateau. In other words, cigarette smokers

typically plateau at a given level of daily consumption as their tolerance rises, as opposed to other substance users whose consumption may continually rise as their tolerance increases.

Reinforcement is viewed as the learned responses to consumption and the rewards associated with it. In the case of cigarette smoking and tobacco use, reinforcement can have benefits or costs (Ashton & Stepney, 1982). Positive reinforcement comes from the pleasure (i.e., positive utility) that results from smoking cigarettes, such as the pharmacological effects from nicotine consumption. Negative reinforcement may take the form of smoking to avoid a negative stimulus, such as smoking to avoid stress or nicotine withdrawals.

Withdrawal is the negative physical reactions to the cessation or reduction of consumption. For cigarette smokers, these reactions may include increased irritability, inability to concentrate, increased anxiety, elevated blood pressure and heart rate. Withdrawal symptoms may lead the user to continuing use in order to avoid feeling worse, as opposed to taking the drug in order to feel better (Ashton & Stepney, 1982).

The proceedings from the National Institute on Drug Abuse's 1998 conference *Addicted to Nicotine* provides a complete review of this literature as well as a general review of the state of the science on nicotine addiction (Swan & Balfour, 1999).

2.2 Utility Maximization and Rationality

It is possible to model the demand for addictive substances as a standard constrained utility maximization problem, where the economic agent seeks to maximize lifetime utility subject to a budget constraint, as shown in equation 2.1:

$$U(t) = f[C(t), X(t)] \tag{2.1}$$

where *C(t)* is the consumption of an addictive substance at time t, and *X(t)* is the consumption of a composite good at time t.

This optimization problem produces a demand function of the form

$$C(t) = g[P(t), Y(t), \mathbf{Z}(t)] \tag{2.2}$$

where *P(t)* is the current price of the addictive substance, *Y(t)* is the agent's income, and $\boldsymbol{Z}(t)$ is a vector of variables reflecting consumer tastes.

This conventional neoclassical approach provides a framework to model the demand for addictive substances, but has received criticism since it's conception from many economists. One major criticism is that in this methodology, current consumption of an addictive good only depends on current factors, and not past consumption or future expectations. Increases in current prices will decrease current consumption, an implication generally agreed upon in the empirical literature. However, increases in past prices and/or anticipated increases in future prices will have no impact on current consumption levels. Therefore, the model does not allow for the possibility that addicts may 'stockpile' their inventory if they anticipate a future price increase. Lastly, this methodology does not reflect the role of tolerance on consumption, or the dependence of current consumption on past consumption decisions.

Following the criticisms of the conventional approach, myopic models were developed (Houthakker & Taylor, 1966; Gorman, 1967; Pollack, 1975) which allow the current consumption of an addictive substance to depend on both current and past factors. The optimization problem remains a standard constrained optimization problem, where the economic agent seeks to maximize lifetime utility subject to a budget constraint, but is modified to take the following form:

$$U(t) = f[C(t), C(t-1), X(t)] \tag{2.3}$$

where *C(t)* and *X(t)* are previously defined, and *C(t-1)* is the consumption of the addictive substance in the previous time period. The inclusion of *C(t-1)* allows the current consumption of the good to depend on prior consumption. The optimization problem yields a demand function of the form

$$C(t) = g[P(t), C(t-1), Y(t), \mathbf{Z}(t)] \tag{2.4}$$

The consumption good is defined as addictive if an increase in past consumption increases current consumption. As seen in the conventional optimization problem, an increase in current prices will decrease current consumption. Additionally, past price increases will also decrease current consumption for addictive goods (by decreasing past consumption). However, any anticipated future price increases will have no affect on current consumption levels, leading to the 'stockpiling' problem of the conventional model, i.e., while the myopic model reflects the relationship between current consumption and past decisions, it does not account for the future costs (or benefits) of consumption when making current consumption decisions.

This criticism is the basis for the rational addiction model, outlined by Becker and Murphy (1988), building upon previous work from Lluch (1974), Spinnewyn (1981), and Boyer (1983). Rationality in this context simply implies that consumer's take into account the relationship between past, present, and future consumption decisions in their utility-maximization problem. This differs from the previous models of addiction, as consumer's now take into account any future consequences of their

consumption of addictive goods.

Becker & Murphy (1988) assume that individuals maximize utility over their life while taking into account the future consequences of their choices. The utility of a consumer at any point in time depends on the consumption of two goods, C and Y. The utility maximization problem, subject to the consumer's budget constrained is given by:

$$U(t) = U[C(t), Y(t), S(t)], \tag{2.5}$$

where at any point in time t, an individual's utility, *U(t)*, depends on current addictive consumption, *C(t)*, current consumption of a composite of non-addictive consumption, *Y(t)*, and the stock of past consumption, *S(t)*. The two goods are distinguished by assuming that current utility also depends on a measure of past consumption of C but not of Y. Past consumption of C affects current utility through a process of "learning by doing," as summarized by the stock of "consumption capital" (S) (Becker & Murphy, 1988).

U(t) is assumed to be a strictly concave function of C, Y, and S, and that the lifetime utility function is separable over time in C, Y, and S, but not in C and Y alone. Tolerance is reflected in the optimization problem by assuming that the marginal utility of the addictive stock is negative. Reinforcement is incorporated by assuming that an increase in the addictive stock raises the marginal utility of current addictive consumption. Lastly, withdrawal is reflected in equation 2.5 since total utility decreases with the cessation of consumption of the addictive good C.

The stock accumulation process is defined as:

$$\partial S(t)/\partial t = C(t) - \delta S(t) - h[D(t)], \tag{2.6}$$

where $\partial S(t)/\partial t$ t is the rate of change over time in S, C is gross investment in "learning," the instantaneous depreciation rate δ measures the exogenous rate of disappearance of the physical and mental effects of past consumption of C, and *D(t)* represents expenditures on endogenous depreciation or appreciation (Becker & Murphy, 1988).

Maximizing the objective utility function described by equation 2.5 subject to a budget constraint and the stock accumulation process shown by equation 2.6 yields the following first order condition for the addictive good:

$$U_C(t) = \mu\pi_C(t), \tag{2.7}$$

where μ is defined as the marginal utility of wealth and $\pi_C(t)$ is the total price of the addictive good, which depends on both the monetary cost of the good and the future utility costs (or shadow price) of the addictive stock (Becker & Murphy, 1988; Chaloupka *et al.*, 2000). In the case of cigarette smoking, the total price of consumption is often greater than its monetary cost, due to the health consequences of consumption.

Given a quadratic utility function, and the individual's rate of time preference, σ, being equal to the market interest rate, the optimization problem yields a structural demand function for the consumption of the addictive good equalling:

$$C(t) = g[P(t), C(t-1), C(t+1), Y(t), \mathbf{Z}(t)] \tag{2.8}$$

where *P(t)*, *C(t-1)*, *Y(t)*, and ***Z****(t)* are previously defined, and *C(t+1)* is the future consumption of the addictive good.

The rational addiction model addresses previous critiques of the conventional and myopic models of addiction by allowing the current consumption of an addictive good to depend on past, current, and future factors. Rational addicts are said to consider future consequences of their consumption decisions when making current choices. Additionally, increases in past, current, or future prices will cause a decrease in current consumption.

The rational addiction model also has implications for cessation; the process of ending consumption of an addictive product.

2.3 Smoking Cessation

The Becker and Murphy rational addiction model implies that strong rational addictions (addictions where the costs of quitting quitting rise rapidly relative to small reductions in consumption) can only terminate abruptly, or by the addict stopping consumption 'cold turkey'. A rational addict is said to end their addiction only if factors sufficiently lower either their demand for the addictive good, or their stock of consumption capital. An addict's consumption is said to decline more rapidly over time when a change in current consumption has a larger effect on future consumption. The effect on future consumption is larger when the degree of addiction is stronger. Thus, rational addicts end stronger addictions more rapidly than weaker ones (Becker & Murphy, 1988), and strong addictions can *only* end cold-turkey.

This cold-turkey quitting approach is needed to terminate strong rational addictions despite the large 'disutility' addicts may experience from cessation. For example, smokers commonly report headaches, irritability, and increased anxiety when stop-

ping their use of cigarettes. Despite these significant costs, Becker and Murphy's model implies that smokers must terminate use abruptly to *successfully* quit. The decision to quit cold-turkey is rational because smokers trade a large short-term loss in utility for an even larger long-term gain. Becker & Murphy (1988) state "weak wills and limited self-control are not needed to under stand why addictions to smoking, heroin, and liquor can end *only* when the consumption stops abruptly".

Although strong rational addictions only cease abruptly, rationality does not stop addicts from searching for ways to lower this associated short-run loss in utility. For example, smokers commonly attend 'stop smoking' clinics, or use internet quitting aids or NRT in an attempt to reduce the pains associated with cessation. The observation that smoker's employ these techniques in the real-world does not violate Becker and Murphy's model. However, the explicit consumption of the addictive product to lower the disutility associated with cessation is not permitted to cease strong addictions. For example, a smoker who successfully uses e-cigarettes to aid their attempt to quit violates the cold-turkey quitting protocol, therefore not conforming to the rational addict framework.

However, in contrast to Becker and Murphy, Suranovic *et al.* (1999) predict gradual reductions in consumption will likely lead to quitting for 'weak' addictions (Chaloupka *et al.*, 2000). Their model also that suggests aging is enough to encourage cessation among certain smokers. As smokers age, the health consequences associated with smoking become more apparent, thus raising the perceived benefits of cessation, increasing the likelihood that smokers will quit. Along with testing the cold-turkey implication of the rational addict framework, this analysis will also test the hypothesis that older smokers are more likely to quit than younger smokers.

CHAPTER 3:

LITERATURE REVIEW

3.1 Economic Modeling of Addiction

Economists have long been interested in the modeling of addiction. In the early 1900's, many economists viewed addictive consumption as imperfectly rational behavior, and thus outside the realm of standard neoclassical economic analysis. For example, many assumed that higher prices for addictive goods would not, in fact, reduce consumption (Chaloupka *et al.*, 2000). However, some economists argued that standard tools of economic modeling could be well applied to addictive behaviors. Stigler & Becker (1977) asserted that the traditional economic approach offers guidance in tackling problems of addiction, and that "no other approach of remotely comparable generality and power is available" (Stigler & Becker, 1977, p. 77). Recent economic analysis has examined addictive behaviors, including smoking, in both theoretical and empirical models.

Due to the psychological and medical consequences of addiction, other disciplines have also developed a rich stream of literature on compulsive consumption. Solomon & Corbit's (1978) seminal paper was regarded by many psychologists as the most successful attempt at the time of providing a general theory capable of explaining psychological addiction. Addiction is not viewed as an abnormality, but the in-

evitable consequence of a normally functioning system which opposes affective or hedonic states. For example, love is deemed an addictive phenomenon characterized by habituation to the presence of the loved one and intensified aversion in the absence of the loved one. This framework helped establish addiction as a much more general phenomenon than something only confined to a few chemical substances. Because of this, the modeling of addiction began to draw more attention from behavioral economists.

Generally, economic models of addiction vary widely in the assumptions made about the level of rationality among consumers. These models can be broken into three groups (Chaloupka *et al.*, 2000). The first of these models views consumers as imperfectly rational agents. In these models, consumer preferences are not consistent throughout their life. For example, consumers may have two competing sets of preferences: one for good health and long life; and the other for the pleasure of smoking, as highlighted by the Schelling (1978) quote at the start of this study. This can explain why smokers may choose to smoke at one age with the intention of quitting later, but then change their mind as they get older (Gruber & Köszegi, 2001; O'Donoghue & Rabin, 1999; Thaler & Loewenstein, 1992).

The second modeling approach views consumers as myopic, or shortsighted, in their consumption decisions, mentioned in the previous section. Current consumption of addictive products is assumed to be based on past consumption (i.e. assuming that products can be addictive), but addicts do not take into account the future costs of their addiction when making current consumption choices. Several studies have empirically tested this model of myopic consumers, and concluded that cigarettes are addictive in an economic sense. In other words, current cigarette consumption is

increased by past consumption. These empirical studies also show that higher prices reduces demand for cigarettes (Farrell, 1952; Young, 1983; Mullahy, 1985; Baltagi & Levin, 1986; Pekurinen, 1989).

The third modeling approach, and the one that this paper is primarily concerned with assumes addicts are rational in the sense that they are aware of the dependence of current choices on past behavior (as in the myopic addiction models), and consider the future consequences of their addictions when making current consumption choices (Chaloupka *et al.*, 2000). Multiple empirical tests of the rational addiction model confirm that smoking is an economically rational behavior and that increases in cigarette prices lead to reductions in cigarette smoking. However, the theory of rational addiction has mixed empirical evidence.

3.2 Empirical Tests of Rational Addiction

Following Becker and Murphy's (1988) theory of rational addiction, researchers began to empirically test the implications of their theory. These papers sought to provide empirical evidence that addicts are in fact rational in their consumption choices.

Jones (1994) modeled the decision to quit smoking using a double-hurdle probit methodology using data from the Health and Lifestyle Survey. Smoker health, medical advice, social interaction, and consumption levels were all included in the estimated model. Consumption, social interaction, and current health status were shown to be significant in effecting quitting rates, while the effectiveness of medical advice was ambiguous (Jones, 1994). This study uses the double-hurdle methodology outlined by Jones (1994), but differs in that the use of quitting aids, such as NRT, are included in my estimated model.

Using state excise tax and monthly consumption data, Gruber & Köszegi (2001)

provide evidence that smokers are forward-looking in their smoking decisions. Preferences with respect to smoking are also assumed to be time-inconsistent. A new model of addictive behavior is developed, taking as its starting point the standard "rational addiction" model, but incorporating time-inconsistent preferences and forward-looking behavior (Gruber & Köszegi, 2001). The model implies that optimal government policy should depend on both the externalities that smokers impose on others and on the "internalities" imposed by smokers on themselves. The optimal tax per pack of cigarettes is shown to optimally be at least one dollar higher under their formulation than in the rational addiction case (Gruber & Köszegi, 2001).

Feng (2005) addresses the claim proposed by Keeler *et al.* (1999) that self-control theory competes with rational addiction to explain a smoker's quitting behavior. Feng (2005) argues that a smoker's rationality plays a critical role in his decision to quit, but whether the quitting will be successful or not is affected by his self-control and other socioeconomic characteristics. This is empirically tested using data from the TUS-CPS, and a double-hurdle probit model, as outlined by Jones (1994), confirms hypotheses derived by both theories (Feng, 2005). This study also uses more recent data from the TUS-CPS questionnaire.

Piccoli & Tiezzi (2021) addresses one of the main empirical problems associated with rational addiction theory, described by Gruber & Köszegi (2001). Namely, that its derived demand equation is not empirically distinguishable from those of models with forward-looking behavior but with time-inconsistent preferences. A general specification of the rational addiction model is derived, yielding a microfounded test of time-consistency. This test allows the authors to distinguish between time-consistent versus time-inconsistent naïve agents. Using data from a panel of Russian individuals,

the empirical results conform to the theoretical predictions of the rational addiction model. The proposed test for time-consistency does not reject the hypothesis that Russian cigarette consumers are time-consistent (Piccoli & Tiezzi, 2021).

Baltagi & Geishecker (2006) examine whether Russian alcohol consumers are rational in their consumption decisions. Eight rounds of a nationally representative Russian survey spanning the period 1994-2003 is used to estimate a rational addiction model for alcohol consumption. Women consumers are not found to conform to the rational addiction framework, while men are (Baltagi & Geishecker, 2006). This finding provides support for my robustness checks in chapter 7.

Baltagi & Griffin (2002) utilized a panel of 42 U.S. states from 1959-1994 to estimate a rational addiction model for liquor consumption in the U.S.. Their results were consistent with the rational addiction hypothesis outlined by Becker & Murphy (1988), but these results were sensitive to the assumption of homogeneity across states or over time.

3.3 Smoking Cessation & Quitting Aids

Schwartz (1992) provides a theoretical framework of smoking cessation treatment. The three phases of cessation treatment are said to be preparation, intervention, and maintenance. Preparation aims to increase the smoker's motivation to quit and to build confidence that they can be successful in their quit attempt. Intervention can take any number of forms (or a combination of them) to help smokers to achieve abstinence. Maintenance, including support, coping strategies, and substitute behaviors such as NRT, is deemed *necessary* for permanent abstinence. Quitting aid products are said to be particularly useful for smokers who show evidence of strong physiologic addiction to nicotine (Schwartz, 1992). This finding directly contradicts

the cold turkey implication of rational addiction theory and provides the basis for this paper.

Johnson *et al.* (2019) examined past-12-month quit attempts and smoking cessation in the U.S. from 2006 to 2016. The authors aimed to understand whether the current use of electronic cigarettes was associated with a change in past-12-month quit attempts and successful smoking cessation at the population level. The data used was a sample of 25- to 44-year-olds from the National Health Interview Survey (NHIS) and the 2006-2007, 2010-2011, and 2014-2015 survey waves from the TUS-CPS. Using multivariable logistic regression, Johnson *et al.* (2019) found that current e-cigarette use was significantly associated with increased past-12-month quit attempts and smoking cessation. Additionally, they found that past-12-month quit attempts and smoking cessation increased among adults aged 25-44 since 2006. While the paper did not aim to empirically test rational addiction theory, their results are inconsistent with the hypothesis that e-cigarette use is delaying quit attempts and leading to decreased smoking cessation. Therefore, their empirical results contradict the claim that strong addictions can only cease cold-turkey. Their findings actually suggest that e-cigarette use contributes to a reduction in traditional cigarette use among established smokers (Johnson *et al.*, 2019).

Zavala-Arciniega *et al.* (2022) assessed the roles of e-cigarette flavoring, device type, and use frequency on cigarette smoking cessation behaviors among U.S. adult dual users of both cigarettes and e-cigarettes. Using the recently released 2018-2019 waves of the TUS-CPS, the authors analyzed a sample of 1,038 adult dual users of cigarettes and e-cigarettes using multinomial regression models. Three smoking cessation behavior stages in current smokers are defined: pre-contemplation, contempla-

tion, and the preparation to quit smoking. The authors regressed smoking cessation behavior stages on e-cigarette flavoring, device type, and use frequency, adjusting for sociodemographic and cigarette characteristic covariates. The results indicated that the type of e-cigarette and the frequency of e-cigarette use affects smoking cessation behaviors among adult dual users of cigarettes and e-cigarettes. This provides no evidence that e-cigarette use affects smoking cessation, but does reinforce the findings in Johnson *et al.* (2019) that e-cigarette use significantly affects the decision to quit.

Shi *et al.* (2016) test whether the use of e-cigarettes among early adopters was associated with increased cigarette smoking cessation and reduced cigarette consumption using a sample from the 2010-2011 TUS-CPS longitudinal cohort and multivariate logistic regression models. Their results showed that smokers who had used e-cigarettes for cessation were less likely to successfully quit for 30+ days at the follow-up survey. They conclude that the use of first generation e-cigarettes to aid cigarette smoking cessation was not associated with improved cessation or with reduced consumption, even among heavier smokers (Shi *et al.*, 2016). These results directly contradict the findings of Johnson *et al.* (2019), and are consistent with the cold-turkey implication of rational addiction theory.

Kalkhoran & Glantz (2016) conduct a meta-analysis to assess the association between e-cigarette use and cigarette smoking cessation among adult cigarette smokers, irrespective of their motivation for using e-cigarettes. Findings based on 38 studies, including clinical trials, cohort studies, and cross-sectional studies, conclude that e-cigarettes are associated with significantly less quitting among smokers. Although there are currently contradicting results in the literature, this meta-analysis provides conclusive evidence that the use of e-cigarettes do not aid smoking cessation, a finding

consistent with rational addiction theory.

A study from Jackson *et al.* (2019) aimed to estimate the effectiveness of smoking cessation aids and test whether their effectiveness differs according to cigarette addiction, socio-economic status, age or gender. Using a correlational design with cross-sectional survey data in England, the authors found the use of e-cigarettes and varenicline are associated with higher abstinence rates following a quit attempt. Additionally, the use of prescription NRT is associated with higher cessation rates, but only in older smokers, and the use of internet aids corresponds with increased cessation, but only in smokers from lower socio-economic status.

These studies did not aim to explicitly test rational addiction theory, but the contradictory results suggest that smokers may benefit from using quitting aids to aid cessation, as opposed to quitting cold-turkey. One explanation for the contradictory results between publications is the methodology used. None of these studies used a double-hurdle methodology, and instead typically used multivariate logistic regression. Therefore, the authors are modeling the unconditional quit success of smokers, not their quit success conditional on the decision to quit. This difference is one way in which my analysis adds to the current literature on rational addiction and smoking cessation.

CHAPTER 4:

DATA & METHODOLOGY

4.1 Data

The data used in this study are obtained from the Tobacco Use Supplements to the Current Population Survey (TUS-CPS) conducted in July 2018, January 2019, and May 2019. This study aggregates the three survey waves to form a large, representative cross-sectional data set.

The Current Population Survey (CPS) is a monthly survey of about 60,000 U.S. households sponsored jointly by the U.S. Census Bureau and the U.S. Bureau of Labor Statistics (BLS). The CPS is one of the primary sources of labor force statistics for the U.S. population and is widely used in empirical research across disciplines. The Tobacco Use Supplement is a survey of tobacco use sponsored by the National Cancer Institute (NCI), and has accompanied the CPS every 3-4 years since 1992-93. The TUS-CPS is the largest nationally representative survey of adult tobacco use in the U.S., with 150,000 self-respondents per wave. Topics in the TUS-CPS survey include cigarette smoking status, smoking history, dependence, quit attempts, aids, intentions around quitting, and sociodemographic data from core Census variables. The CPS has certain advantages over other commonly used data sets and is regularly used in the smoking cessation literature.

Every CPS monthly survey consists of eight different rotation groups, and households within each rotation differ in the month they are first surveyed. Sample households are surveyed for four consecutive months, leave the sample for 8 months, and then return to be surveyed for another four consecutive months before being dropped from the CPS permanently. By aggregating CPS data sets from July 2018, January 2019 and May 2019, there is no overlap between any of the samples. For example, no one surveyed in July would be surveyed in either January or May again. Therefore there is no need to account for the possibility that the same households are included more than once in the aggregated sample. For additional information on the rotational arrangements of the CPS, see Feng (2001).

In the model that I propose, the binary dependent variable ATTEMPT is equal to one if the respondent has attempted to quit within the last 12 months of the time of the survey, regardless of how long that quit attempt lasted. This is the dependent variable used in the first stage of the double-hurdle probit model. The binary variable QUIT is a dummy variable equal to 1 if the respondent quit smoking for less than 12 months but more than 1 month (30 days) prior to the date of the survey. Quit attempts therefore are deemed successful if the attempt lasted for 30 days or longer. This assumption has been used in the existing smoking cessation literature, for example in Feng (2005).

Age variables are created, indicating how old the respondent was at the time of the survey. Education variables are created to test the hypothesis that more schooling is associated with higher quit attempt and cessation rates. Variables capturing additional demographic information, such as race, gender, marital status, and military status are also included in the analysis. The dummy variable EMPLOYED is equal

to 1 if the respondent was employed a week before the survey. Respondents who are unemployed, retired, or not seeking employment are marked as 0. Smoking habits, such as menthol preferences, average daily consumption, and initiation age are also defined. Additionally, respondent's attitudes towards smoking, including attitudes towards smoking in public spaces and vehicles, are represented.

This analysis is most interested in the interactions between quitting aids and quit success. Respondent's were asked whether they used specific products, such as NRT, e-cigarettes, or prescription medication to aid quitting. Each of these quitting aids serve different purposes in a smoker's quit attempt. NRT, for example, lowers the disutility associated with cessation by providing the smoker with nicotine without the harmful externalities associated with smoking cigarettes. The use of prescription medication, such as Wellbutrin, also aim to lower the disutility associated with cessation, however these medications contain no nicotine and act very differently than NRT or e-cigarettes. Binary variables are created to examine the role of each of these quitting aids on a smoker's likelihood of attempting to quit and successfully quitting. Table 4.1 defines the entire set of variables used in this study.

Table 4.1: Variable Definitions

Name	Description
AGE1824	A dummy equal to one if the respondent's age is between 18 and 24 years old, zero otherwise
AGE2534	A dummy equal to one if the respondent's age is between 25 and 34 years old, zero otherwise
AGE3544	A dummy equal to one if the respondent's age is between 35 and 44 years old, zero otherwise

Continue on next page

Table 4.1 – *Continued from previous page*

Name	Description
AGE4554	A dummy equal to one if the respondent's age is between 45 and 54 years old, zero otherwise
AGE5564	A dummy equal to one if the person's age is between 55 and 64 years old, zero otherwise
AGE65UP	A dummy equal to one if the person's age is above 64 years old, zero otherwise
NOHSDIPLOMA	A dummy equal to 1 if the respondent's highest education obtained was less than a high school diploma, 0 otherwise
HSDIPLOMA	A dummy equal to 1 if the respondent's highest education obtained was a high school diploma, 0 otherwise
SOMECOLLEGE	A dummy equal to 1 if the respondent's highest education obtained was some college courses but no degree, 0 otherwise
ASSOCIATES	A dummy equal to 1 if the respondent's highest education obtained was an associates degree, 0 otherwise
BACHELORS	A dummy equal to 1 if the respondent's highest education obtained was a bachelors degree, 0 otherwise
MASTERS	A dummy equal to 1 if the respondent's highest education obtained was a masters degree, 0 otherwise
DOCTORATE	A dummy equal to 1 if the respondent's highest education obtained was a doctorate or professional school degree (e.g. PhD, JD, MD), 0 otherwise
MALE	A dummy equal to 1 if the respondent identified as a male, 0 otherwise
WHITE	A dummy equal to 1 if the respondent identified as white, 0 otherwise
HISPANIC	A dummy equal to 1 if the respondent identified as Hispanic, Latino, or Spanish, 0 otherwise
MARRIED	A dummy equal to 1 if the respondent was married at the date of survey, 0 otherwise
EMPLOYED	A dummy equal to 1 if the respondent was employed a week before the survey, 0 otherwise
JUL18	A dummy equal to 1 if the respondent was surveyed in July 2018, 0 otherwise
JAN19	A dummy equal to 1 if the respondent was surveyed in January 2019, 0 otherwise
MAY19	A dummy equal to 1 if the respondent was surveyed in May 2019, 0 otherwise

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Table 4.1 – *Continued from previous page*

Name	Description
ARMEDFORCES	A dummy equal to 1 if the respondent has ever served on active duty in the U. S. Armed Forces, 0 otherwise
INITIATION_AGE	Respondent's age when they they first began to smoke fairly regularly
DAILY_CONSUMPTION	The average number of cigarettes consumed per day
MENTHOL_SMOKER	A dummy equal to 1 if the smoker typically smokes menthol cigarettes, 0 otherwise
ATTEMPT	A dummy equal to 1 if the respondent had reportedly tried to quit smoking at least once in the 12 months prior to the survey, 0 otherwise
QUIT	A dummy equal to 1 if the respondent quit smoking for less than 12 months but more than 1 month (30 days) prior to the date of the survey
DOCTOR_VISIT	A dummy equal to 1 if the respondent had seen a medical doctor in the 12 months prior to the survey, 0 otherwise
DOCTOR_ADVICE	A dummy equal to 1 if the respondent received medical advice to quit smoking during the 12 months prior to the survey, 0 otherwise
WORKPLACE_RESTRICTIONS	A dummy equal to 1 if smoking was restricted in any way at the respondent's place of work, 0 otherwise
HOME_SMOKING_ATTITUDES	A dummy variable equal to 1 if smoking was allowed in ANY capacity inside the respondent's home, 0 otherwise
VEHICLE_SMOKING_ATTITUDES	A dummy variable equal to 1 if the respondent believed smoking SHOULD be allowed, in any capacity, inside vehicles with other people present, 0 otherwise
FEDERAL_WARNING	A dummy equal to 1 if the respondent had seen messages in newspapers or on television in the 6 months prior to the survey that said a Federal Court has ordered tobacco companies to make statements about the dangers of smoking cigarettes, 0 otherwise
NICOTINE_AID	A dummy equal to 1 if the respondent had used a nicotine aid in their quit attempt, e.g. nicotine patches, gum, or lozenges, 0 otherwise
PRESCRIPTION_AID	A dummy equal to 1 if the respondent had used a prescription pill in their quit attempt, e.g. Chantix, Varenicline, or Wellbutrin, 0 otherwise
TELEPHONE_AID	A dummy equal to 1 if the respondent had used a telephone help line or quit line in their quit attempt, 0 otherwise
COUNSELING_AID	A dummy equal to 1 if the respondent had received one-on-one in-person counseling in their quit attempt, 0 otherwise

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Table 4.1 – *Continued from previous page*

Name	Description
SUPPORT_GROUP_AID	A dummy equal to 1 if the respondent had used a stop smoking clinic, class, or support group in their quit attempt, 0 otherwise
INTERNET_AID	A dummy equal to 1 if the respondent had used a internet or web-based program or tool including smartphone apps in their quit attempt, 0 otherwise
SMOKELESS_TOBACCO_AID	A dummy equal to 1 if the respondent had tried to quit by SWITCHING to smokeless tobacco such as chewing tobacco, snuff, or snus, 0 otherwise
CIGAR_AID	A dummy equal to 1 if the respondent had tried to quit by SWITCHING to regular cigars, cigarillos, little filtered cigars or ANY pipes filled with tobacco, 0 otherwise
E._CIGARETTE_AID	A dummy equal to 1 if the respondent had tried to quit by SWITCHING to electronic or E-cigarettes, 0 otherwise
FAMINC	Total family income in the 12 months prior to the survey, expressed in income intervals stipulated in the CPS basic monthly data set

4.2 Sample Descriptive Statistics

This analysis is concerned with the quitting efforts of smokers who smoke everyday and have smoked at least 100 cigarettes in their lifetime. Respondents who reported that they smoke some days but not everyday are not included in the sample. This approach is widely used in the smoking cessation literature, and is employed in this study to confine the sample to those who more likely exhibit a "strong addiction", as outlined by Becker & Murphy (1988). Following Feng (2005), the three groups of subjects examined in this study are successful quitters, unsuccessful quitters, and non-quitters. A successful quitter is defined as a previous everyday smoker who, at the time of the survey, had quit for one month or longer, but less than 12 months before the start of the survey. An unsuccessful quitter is a smoker who attempted to

quit at least once in the 12 months prior to the survey, but did not cease smoking for longer than 30 days. A non-quitter is a everyday smoker who did not attempt to quit in the 12 months prior to the survey.

Table 4.2: Summary Statistics - Everyday Smokers

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	11106	9.566	4.089	1	16
AGE1824	11106	0.038	0.191	0	1
AGE2534	11106	0.157	0.364	0	1
AGE3544	11106	0.186	0.389	0	1
AGE4554	11106	0.198	0.399	0	1
AGE5564	11106	0.252	0.434	0	1
AGE65UP	11106	0.168	0.374	0	1
NOHSDIPLOMA	11106	0.152	0.359	0	1
HSDIPLOMA	11106	0.411	0.492	0	1
SOMECOLLEGE	11106	0.213	0.409	0	1
ASSOCIATES	11106	0.11	0.313	0	1
BACHELORS	11106	0.089	0.284	0	1
MASTERS	11106	0.021	0.142	0	1
DOCTORATE	11106	0.005	0.073	0	1
MALE	11106	0.493	0.5	0	1
WHITE	11106	0.851	0.357	0	1
HISPANIC	11106	0.059	0.236	0	1
MARRIED	11106	0.384	0.486	0	1
EMPLOYED	11106	0.538	0.499	0	1
JUL18	11106	0.357	0.479	0	1
MAY19	11106	0.31	0.463	0	1
JAN19	11106	0.332	0.471	0	1
ARMEDFORCES	11106	0.104	0.306	0	1
INITIATION_AGE	11106	17.626	5.34	1	70
DAILY_CONSUMPTION	11106	14.456	7.969	1	40
MENTHOL_SMOKER	11106	0.292	0.455	0	1
ATTEMPT	11106	0.416	0.493	0	1
QUIT	11106	0.101	0.301	0	1
DOCTOR_VISIT	11106	0.712	0.453	0	1
DOCTOR_ADVICE	11106	0.543	0.498	0	1
WORKPLACE_RESTRICTIONS	11106	0.35	0.477	0	1
HOME_SMOKING_ATTITUDES	11106	0.469	0.499	0	1
HOME_VAPING_ATTITUDES	11106	0.419	0.493	0	1
WORKPLACE_SMOKING_ATTITUDES	11106	0.388	0.487	0	1
SOCIAL_SMOKING_ATTITUDES	11106	0.735	0.441	0	1
VEHICLE_SMOKING_ATTITUDES	11106	0.59	0.492	0	1
FEDERAL_WARNING	11106	0.595	0.491	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

This analysis examines two samples. Sample 1 is the entire sample of everyday

smokers, and sample 2 contains only successful and unsuccessful quitters (smokers who have attempted to quit).

Sample 1 contains 11,106 respondents. Forty one percent of everyday smokers had attempted to quit at least once in the 12 months prior to the survey, and 10.1% had successfully quit. The sample is almost evenly split between male and female smokers, with 49.3% of respondents reporting as male. Eighty five percent of the full sample reports as being white, nearly 6% of respondents reported as Hispanic. About 85% of the sample obtained at least a high school diploma or equivalent, with 8.9% of respondents obtaining a bachelors degree. Thirty eight percent of everyday smokers were married at the time of the survey, and 53.8% were currently employed. The most common age of respondent's was between 55 and 64, with 25.2% of respondents falling within this age bracket.

The average smoking initiation age, defined as age when the respondent first began to smoke fairly regularly, was about 17.5 years old. The average number of cigarettes consumed daily on average was about 14.5 cigarettes. Nearly 30% of the full sample reportedly smoked menthol cigarettes. The survey wave with the most respondents was July 2018, representing 35.7% of all respondents.

Seventy one percent of everyday smokers had visited a medical doctor in the 12 months prior to the survey, with 54.3% of smokers receiving medical advice to quit smoking. Additionally, nearly 60% of the sample had seen messages in newspapers or on television in the 6 months prior to the survey that said a Federal Court has ordered tobacco companies to make statements about the dangers of smoking cigarette. The summary statistics for the full sample are given in Table 4.2.

Sample 2, comprised of smokers who had tried to quit, contains 4,617 respondents.

Table 4.3: Summary Statistics - Successful and Unsuccessful Quitters

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	4617	9.465	4.145	1	16
AGE1824	4617	0.048	0.214	0	1
AGE2534	4617	0.177	0.382	0	1
AGE3544	4617	0.184	0.388	0	1
AGE4554	4617	0.19	0.392	0	1
AGE5564	4617	0.246	0.431	0	1
AGE65UP	4617	0.155	0.362	0	1
NOHSDIPLOMA	4617	0.145	0.352	0	1
HSDIPLOMA	4617	0.395	0.489	0	1
SOMECOLLEGE	4617	0.23	0.421	0	1
ASSOCIATES	4617	0.113	0.317	0	1
BACHELORS	4617	0.091	0.287	0	1
MASTERS	4617	0.023	0.148	0	1
DOCTORATE	4617	0.004	0.062	0	1
MALE	4617	0.461	0.499	0	1
WHITE	4617	0.832	0.374	0	1
HISPANIC	4617	0.059	0.236	0	1
MARRIED	4617	0.366	0.482	0	1
EMPLOYED	4617	0.524	0.499	0	1
JUL18	4617	0.363	0.481	0	1
MAY19	4617	0.311	0.463	0	1
JAN19	4617	0.326	0.469	0	1
ARMEDFORCES	4617	0.102	0.303	0	1
INITIATION_AGE	4617	17.912	5.567	1	61
DAILY_CONSUMPTION	4617	13.267	7.535	1	40
MENTHOL_SMOKER	4617	0.31	0.463	0	1
ATTEMPT	4617	1	0	1	1
QUIT	4617	0.242	0.428	0	1
DOCTOR_VISIT	4617	0.764	0.425	0	1
DOCTOR_ADVICE	4617	0.6	0.49	0	1
WORKPLACE_RESTRICTIONS	4617	0.35	0.477	0	1
HOME_SMOKING_ATTITUDES	4617	0.427	0.495	0	1
HOME_VAPING_ATTITUDES	4617	0.403	0.491	0	1
WORKPLACE_SMOKING_ATTITUDES	4617	0.326	0.469	0	1
SOCIAL_SMOKING_ATTITUDES	4617	0.693	0.461	0	1
VEHICLE_SMOKING_ATTITUDES	4617	0.546	0.498	0	1
FEDERAL_WARNING	4617	0.62	0.485	0	1
NICOTINE_AID	4617	0.312	0.463	0	1
PRESCRIPTION_AID	4617	0.158	0.365	0	1
TELEPHONE_AID	4617	0.056	0.23	0	1
COUNSELING_AID	4617	0.062	0.241	0	1
SUPPORT_GROUP_AID	4617	0.024	0.154	0	1
INTERNET_AID	4617	0.025	0.156	0	1
SMOKELESS_TOBACCO_AID	4617	0.045	0.208	0	1
CIGAR_AID	4617	0.029	0.169	0	1
E.CIGARETTE_AID	4617	0.253	0.435	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

Table 4.4: Summary Statistics - Successful Quitters

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	1118	9.58	4.161	1	16
AGE1824	1118	0.064	0.246	0	1
AGE2534	1118	0.199	0.4	0	1
AGE3544	1118	0.2	0.4	0	1
AGE4554	1118	0.179	0.383	0	1
AGE5564	1118	0.211	0.408	0	1
AGE65UP	1118	0.146	0.353	0	1
NOHSDIPLOMA	1118	0.128	0.334	0	1
HSDIPLOMA	1118	0.401	0.49	0	1
SOMECOLLEGE	1118	0.219	0.414	0	1
ASSOCIATES	1118	0.121	0.326	0	1
BACHELORS	1118	0.103	0.304	0	1
MASTERS	1118	0.022	0.148	0	1
DOCTORATE	1118	0.006	0.079	0	1
MALE	1118	0.494	0.5	0	1
WHITE	1118	0.828	0.377	0	1
HISPANIC	1118	0.072	0.259	0	1
MARRIED	1118	0.364	0.481	0	1
EMPLOYED	1118	0.528	0.499	0	1
JUL18	1118	0.374	0.484	0	1
MAY19	1118	0.313	0.464	0	1
JAN19	1118	0.313	0.464	0	1
ARMEDFORCES	1118	0.1	0.3	0	1
INITIATION_AGE	1118	17.896	4.98	1	48
DAILY_CONSUMPTION	1118	12.618	7.493	1	40
MENTHOL_SMOKER	1118	0.334	0.472	0	1
ATTEMPT	1118	1	0	1	1
QUIT	1118	1	0	1	1
DOCTOR_VISIT	1118	0.73	0.444	0	1
DOCTOR_ADVICE	1118	0.561	0.497	0	1
WORKPLACE_RESTRICTIONS	1118	0.341	0.474	0	1
HOME_SMOKING_ATTITUDES	1118	0.362	0.481	0	1
HOME_VAPING_ATTITUDES	1118	0.376	0.485	0	1
WORKPLACE_SMOKING_ATTITUDES	1118	0.323	0.468	0	1
SOCIAL_SMOKING_ATTITUDES	1118	0.67	0.47	0	1
VEHICLE_SMOKING_ATTITUDES	1118	0.503	0.5	0	1
FEDERAL_WARNING	1118	0.606	0.489	0	1
NICOTINE_AID	1118	0.275	0.447	0	1
PRESCRIPTION_AID	1118	0.171	0.377	0	1
TELEPHONE_AID	1118	0.047	0.211	0	1
COUNSELING_AID	1118	0.061	0.239	0	1
SUPPORT_GROUP_AID	1118	0.023	0.151	0	1
INTERNET_AID	1118	0.018	0.133	0	1
SMOKELESS_TOBACCO_AID	1118	0.051	0.22	0	1
CIGAR_AID	1118	0.027	0.162	0	1
E.CIGARETTE_AID	1118	0.246	0.431	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

The average family income remains relatively unchanged from sample 1. 46.1% of respondents reported as male, slightly less than the full sample. Average education, race, and marital status also is reflective of the full sample.

Sixty percent of successful and unsuccessful quitters received medical advice to stop smoking, about 6% more than the full sample. On average, successful and unsuccessful quitters smoked 13.2 cigarettes per day, over 1 cigarette less than sample 1. 35% of smokers faced some form of a workplace smoking restriction, identical to the full sample.

Quitting aid variables are also defined for this sample. Thirty one percent of smokers who attempted to quit used a nicotine aid in their quit attempt. Nearly 16% used a prescription pill, and about 6% received one-on-one counseling. Twenty five percent of smokers used e-cigarettes to aid their quit attempt. The summary statistics for sample 2 are given in Table 4.3.

Table 4.4 provides summary statistics for smokers who successfully quit. Overall, 1,118 respondent's successfully quit smoking for 30 days or longer. Nearly 20% of successful quitters were between 25 and 34 years old. Successful quitters on average smoked 12.6 cigarettes per day, slightly less than sample 2. The remaining descriptive statistics can be found in Table 4.4

Figure 4.1 depicts the location densities of current male smokers in both the 2014-2015 and 2018-2019 TUS-CPS waves. The states with the highest proportion of current male smokers in 2018-2019 are Kentucky, West Virginia, and Alaska.

Figure 4.2 depicts the proportion of current female smokers by state for the two most recent TUS-CPS survey waves. For both survey waves, the region with the highest proportion of current female smokers was the midwest, followed by the south,

northeast, and western united states.

Figure 4.1: Male Current Smokers by State

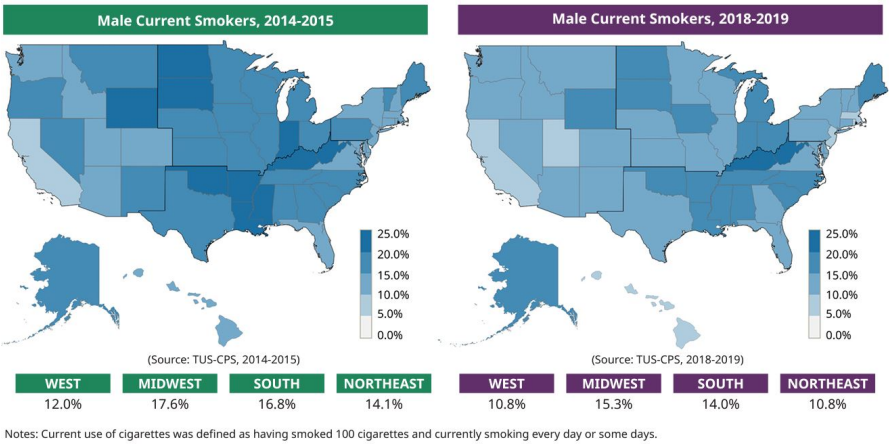


Figure 4.2: Female Current Smokers by State

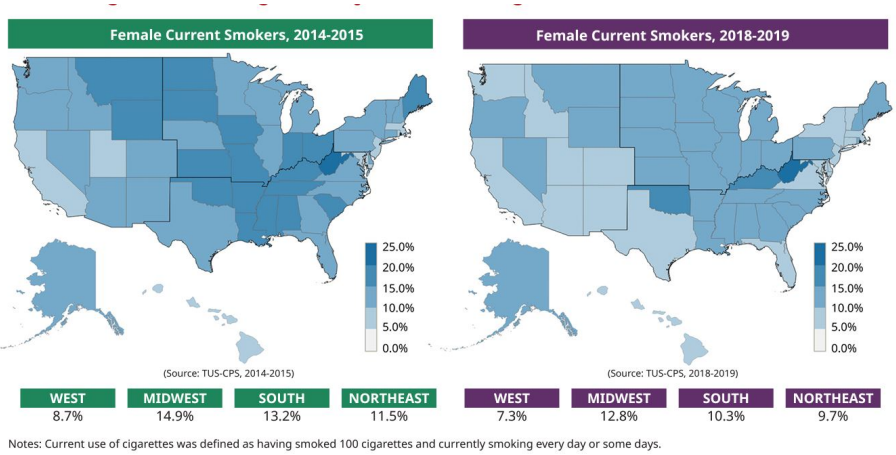
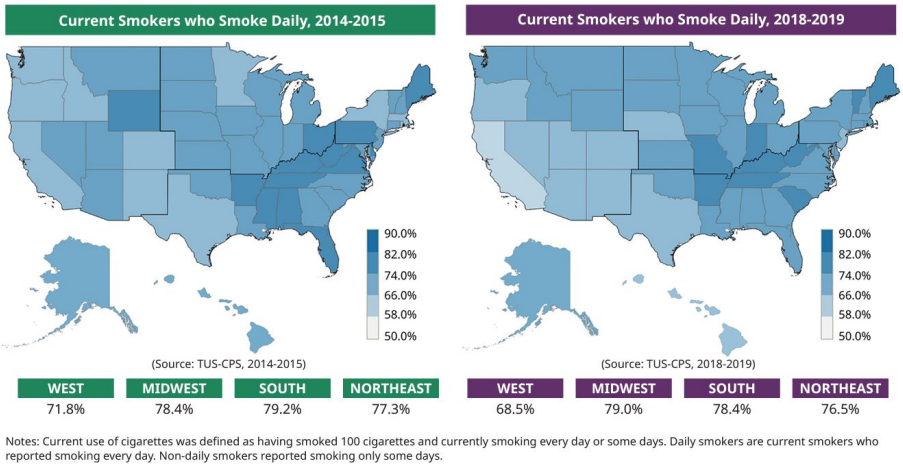


Figure 4.3 depicts the proportion of current, everyday smokers by state for the 2014-2015 and 2018-2019 TUS-CPS survey waves. In the 2018-2019 survey wave, the midwest region had the highest percentage of smokers who smoke everyday, followed by the south, northeast, and western regions.

Figure 4.3: Current Everyday Smokers by State



4.3 Econometric Model, Identification, and Estimation

Following Jones (1994) and Feng (2005), this study uses a double-hurdle probit model to analyze smoking cessation. A probit regression is first estimated on the smoker's decision to quit, or the "attempt" equation, and then, conditional on this decision to quit, a second probit regression is estimated, or the "conditional success" equation. Additionally, an "unconditional success" probit model is estimated on whether a smoker's quit attempt was successful, unconditional on their decision to quit.

The use of probit models are appropriate when the outcome variable of interest is binary, as in this study. To illustrate the probit model, let v be a binary variable taking two possible values, 0 and 1. The probit model assumes:

$$Pr(v = 1|x) = \Phi(\alpha + \theta'\mathbf{x}) \tag{4.1}$$

where Φ denotes the standardized normal distribution function, and $\mathbf{x}$ denotes a q-dimensional random vector (Finney, 1971; Muthén, 1979). The multinomial probit model also assumes the errors are distributed multivariate normal with mean 0 (Dow & Endersby, 2004).

The econometric model in this study is characterized by the following equations:

$$Attempt : ATTEMPT = X_1\beta + \epsilon_1 \tag{4.2}$$

and

$$ConditionalSuccess : QUIT = X_2\gamma + \epsilon_2 \tag{4.3}$$

In Eqs. (4.2) and (4.3), ATTEMPT denotes the attempt to quit and QUIT denotes the smoker's conditional quitting success. X_1 and X_2 are vectors of explanatory variables, including the constant terms, and ϵ_1 and ϵ_2 are error terms with a bivariate normal distribution. This model is estimated using maximum likelihood estimation.

One benefit of the double-hurdle methodology is that X_1 and X_2 can contain different explanatory variables. In the proposed model, X_2 contains the same variables as X_1, with the addition of the quitting aid variables outlined in table 4.1. These variables should have no effect on a smoker's likelihood of attempting to quit, but effect the smoker's costs of quitting and thus may significantly impact their quit success.

CHAPTER 5:

RESULTS

5.1 Unconditional Quitting Success

The first regression estimated in my analysis as a baseline is a multivariate probit regression with a smoker's unconditional quitting success as the dependent variable. Columns 1 and 2 in table 5.1 gives the estimated coefficients and standard errors.

Table 5.1: Probit models: unconditional quitting success, attempt and conditional success

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
FAMINC	0.001	0.005	-0.006*	0.004	0.002	0.006
MIDWEST	-0.019	0.051	0.026	0.037	-0.085	0.061
SOUTH	-0.033	0.046	-0.023	0.033	-0.062	0.055
NORTHEAST	-0.005	0.058	0.134***	0.042	-0.085	0.069
JAN19	-0.080*	0.041	-0.053*	0.030	-0.064	0.050
MAY19	-0.033	0.042	-0.026	0.030	-0.022	0.050
INITIATION_AGE	0.005	0.003	0.008***	0.002	-0.002	0.004
AGE2534	-0.192**	0.085	-0.152**	0.070	-0.171*	0.101
AGE3544	-0.259***	0.085	-0.292***	0.069	-0.169*	0.102
AGE4554	-0.363***	0.087	-0.325***	0.069	-0.263**	0.104
AGE5564	-0.416***	0.086	-0.348***	0.069	-0.342***	0.103

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Table 5.1 – *Continued from previous page*

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
AGE65UP	-0.405***	0.093	-0.489***	0.073	-0.294***	0.112
HSDIPLOMA	0.098*	0.054	0.005	0.038	0.123*	0.066
SOMECOLLEGE	0.090	0.061	0.108**	0.043	0.078	0.073
ASSOCIATES	0.178**	0.071	0.046	0.050	0.190**	0.085
BACHELORS	0.178**	0.075	0.006	0.054	0.219**	0.091
MASTERS	0.074	0.129	0.070	0.091	0.160	0.151
DOCTORATE	0.279	0.224	-0.261	0.176	0.598*	0.310
MALE	0.083**	0.038	-0.030	0.027	0.107**	0.046
WHITE	-0.029	0.050	-0.091**	0.037	0.021	0.059
HISPANIC	0.045	0.069	-0.067	0.053	0.103	0.085
MARRIED	-0.046	0.038	-0.072***	0.027	-0.027	0.045
EMPLOYED	-0.072	0.049	-0.106***	0.035	-0.063	0.059
ARMEDFORCES	-0.021	0.061	0.076*	0.043	-0.040	0.074
DAILY_CONSUMPTION	-0.013***	0.002	-0.015***	0.002	-0.006*	0.003
MENTHOL_SMOKER	0.091**	0.039	0.014	0.028	0.083*	0.047
DOCTOR_VISIT	-0.021	0.053	0.139***	0.038	-0.071	0.066
DOCTOR_ADVICE	-0.002	0.048	0.186***	0.034	-0.038	0.058
WORK_RESTRICTIONS	-0.070	0.047	-0.021	0.034	-0.066	0.057
HOME_SMOKING	-0.136***	0.046	-0.118***	0.033	-0.186***	0.055
HOME_VAPING	0.017	0.046	0.114***	0.032	0.088	0.055
WORKPLACE_SMOKING	-0.009	0.040	-0.177***	0.029	0.075	0.049
SOCIAL_SMOKING	-0.082**	0.041	-0.098***	0.030	-0.042	0.049
VEHICLE_SMOKING	-0.146***	0.038	-0.098***	0.027	-0.133***	0.045
FEDERAL_WARNING	-0.002	0.035	0.094***	0.025	-0.025	0.042
NICOTINE_AID	0.356***	0.048			-0.108**	0.047
PRESCRIPTION_AID	0.545***	0.059			0.188***	0.058
TELEPHONE_AID	-0.032	0.103			-0.042	0.099
COUNSELING_AID	0.187*	0.096			0.067	0.092
SUPPORT_GROUP_AID	0.059	0.148			0.013	0.142
INTERNET_AID	-0.134	0.150			-0.241*	0.144
SMOKELESS_AID	0.325***	0.101			0.086	0.099

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Table 5.1 – *Continued from previous page*

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
CIGAR_AID	0.171	0.129			-0.078	0.125
E.CIGARETTE_AID	0.435***	0.050			-0.046	0.051
Constant	-0.936***	0.124	0.317***	0.095	-0.292**	0.149

Family income is shown to have no significant effect on a smoker's unconditional quitting success. Smoker's home states are also shown to have no effect on their success rates, as shown by the MIDWEST, SOUTH, and NORTHEAST region variables [1]. Respondent's who were given the survey in January 2019 are shown to be less likely to successfully quit than those surveyed in July 2019. Initiation age is also shown to have no significant effect on their unconditional quitting success. However, smokers who, on average, smoke fewer cigarettes per day are more likely to successfully quit. Married smokers do not exhibit a higher likelihood of success, as marital status is not statistically significant in the estimated model.

Completing high school is shown to increase a smoker's unconditional quitting success. Receiving an associates or bachelors degree is also associated with higher cessation rates, but this effect diminishes with graduate education.

All age groups are found to significantly affect the likelihood of successfully quitting, with the relationship being monotonic from ages 25 to 64, consistent with findings in Feng (2005). However, these coefficients are negative, implying that older

[1]State dummies were used in this study but are not reported in Table 5.1. Results do not vary qualitatively when compared to the model using region dummies. Full results are available upon request.

smokers are less likely to successfully quit, relative to smokers aged 18-24. Overall, smokers aged 55-64 are found to have the least probability of successfully quitting.

Male smokers are more likely to successfully quit, while marital status and employment status have no significant effect. Participation in the U.S. armed forces also has no significant effect on cessation rates. Menthol smokers are more likely to quit successfully, contrary to common findings in the medical literature. smokers who received medical advice to quit smoking are not more likely to successfully quit, as are smokers who face smoking restrictions at work.

Respondent's who allow smoking in their homes in some capacity are less successful in their quit attempts, but vaping restrictions at home have no significant effect. Whether respondent's feel smoking *should* be allowed at work has no effect on their quit success, but smokers who believe smoking *should* be allowed at social venues are less likely to successfully quit. The same is true for smokers that believe smoking *should* be allowed in vehicles while other people are present.

Respondent's who reportedly saw a Federal warning on the dangers of cigarettes were not shown to exhibit a higher cessation rates. smokers who used both nicotine and prescription aids in their quit attempt are more likely to successfully quit unconditional on their quit attempt. However, telephone, counseling, support groups, and internet aids are not statistically significant in column 1.

The use of smokeless tobacco, e.g. chewing tobacco, increases the likelihood of successfully quitting, while the use of cigars to aid a quit attempt has no significant effect. smokers who use e-cigarettes are significantly more likely to successfully quit. Of all the quitting aids, prescription pills are shown to be the most effective, followed by e-cigarettes, nicotine replacement therapy (NRT), smokeless tobacco, and

counseling.

5.2 The Motivation to Quit

Column 2 in table 5.1 depicts the coefficients and standard errors for the "attempt" probit equation. This model estimates which factors significantly affect a smoker's decision to attempt to quit.

Family income is found to effect a smoker's decision to quit, although this result is not significant at the 5% level. smokers from the northeast U.S. are found to be more likely to attempt quit than respondents from other regions. Respondents who were given the survey in January 2019 are less likely to attempt to quit than those surveyed in July 2019, as shown by the significance of the JAN19 variable. Male's are not found to be more likely to attempt to quit than females, but white smokers are less likely to attempt to quit.

All age groups are statistically significant. smokers aged 25-34 are the most likely to begin a quit attempt, while smokers aged 65 and up are the least likely. The age at which a smoker started smoking fairly regularly is also statistically significant. All else equal, the longer a smoker has smoked, the more likely they are to begin a quit attempt.

Educational attainment is not shown to affect a smoker's decision to quit, with the exception of those who've taken some college courses, who are more likely to try to quit relative to those who did not receive a high school diploma. Married smokers are less likely to begin a quit attempt than single smokers. Employed smokers also have a lower probability to attempt to quit. Participation in the U.S. armed forces does have significant effect on a smoker's decision to quit, although this result is not significant at the 5% level.

A smoker's level of daily consumption is found to be statistically significant at all levels, with heavier use being associated with a decreased probability of attempting to quit. However, menthol preferences have no significant effect on a smoker's decision to quit. Smokers who visited a medical doctor are more likely to try to quit, as are smokers who received medical advice to quit smoking. Respondent's who received medical advice to quit smoking are more likely to try to quit than those who only visited a medical doctor.

Whether a smoker faces any workplace restrictions on smoking has no significant effect on their decision to quit. Smokers who allow smoking in any capacity in their homes are less likely to begin to quit than those who do not. However, smokers who allow e-cigarette use in their homes are found to have a higher likelihood of trying to quit. Smokers who believe smoking *should* be allowed at work, social venues, and in vehicles are all found to have a lower probability of attempting to quit. Smokers who viewed a Federal warning on the dangers of cigarette smoking were more likely to try to quit than those who did not. Based on the estimated coefficients reported in Table 5.1, an employed, white, married, 25 year-old smoker with some college education who smokes 15 cigarettes per day, saw a Federal warning on the dangers of smoking, and received medical advice to quit smoking would experience a 39.8% chance of attempting to quit.

5.3 Conditional Quitting Success

Column 3 of table 5.1 gives the coefficients and standard errors of the "conditional quitting success" probit regression. This equation models a smoker's likelihood of successfully quitting, conditional on their attempt to quit.

Family income remains statistically insignificant. Smokers with higher incomes are

not more likely to successfully quit than lower-income smokers. Conditional on their decision to quit, smokers from different U.S. regions experience no differences in their likelihood of success. All age group variables are statistically significant with negative coefficients, with smokers aged 55-64 experiencing the lowest likelihood of quitting. A smoker's initiation age has no significant effect on their chances of successfully quitting.

The significance of education attainment remains unchanged from the unconditional success equation, but the magnitude of differences between the ASSOCIATES and BACHELORS coefficients has increased. All else equal, smokers with bachelors degrees are more likely to successfully quit than smokers with associates degrees. Graduate education has no effect on quitting success.

Male smokers remain more likely to successfully quit than female smokers, however the size of this coefficient increases from 0.08 in the unconditional success equation to 0.11 in the conditional success model. White and Hispanic smokers are not more or less likely to quit than non-white and non-Hispanic smokers. Although married smokers are less likely to begin a quit attempt, marital status has no significant effect on whether a smoker successfully quits conditional on their decision to quit. Employment status also has no significant effect on quit success once a smoker decides to quit.

Average daily consumption is statistically significant in the preferred conditional success equation, implying that heavy smokers are less likely to succeed once they decide to quit, contradicting findings presented by Feng (2005). Menthol preferences are also found to be significant in the preferred conditional success estimation, but with a positive coefficient. All else equal, menthol smokers *are not* less likely to

succeed once they decide to quit. Smokers who saw a medical doctor and received medical advice to quit smoking are not shown to be more likely to succeed in their quit attempt. Although doctor visits and medical advice promote the decision to quit, they have no effect on a smoker's likelihood of successfully quitting.

Workplace smoking restrictions have no effect on probability of successfully quitting. Allowing smoking inside the home is shown to significantly decrease a smoker's chances of quitting, and the magnitude of this effect is larger conditional on their decision to quit. Smokers who allow vaping inside the home are not more or less likely to successfully quit. Conditional on the decision to quit, smokers who believe smoking *should* be allowed at social venues and in the workplace are not less likely to succeed, but smokers who believe smoking *should* be allowed in vehicles are. Whether a smoker viewed a Federal cigarette warning message is not statistically significant on their conditional quit success.

The use of nicotine to aid a quit attempt remains statistically significant, however, the sign of this coefficient is negative in the conditional quit success equation. This implies that smokers who use nicotine aids are *less* likely to succeed once they decide to quit. This result opposes the results of the unconditional success equation, where nicotine aids are found to increase the chances of succeeding. The use of prescription aids, such as Chantix or Wellbutrin, increase a smokers chances of successfully quitting, however the magnitude of this effect is significantly lower in the preferred conditional success equation. Telephone, counseling, and support group aids have no effect on the likelihood of success. Smokers who used internet-based quitting aids are less likely to successfully quit, but these results are not statistically significant at the 5% level. The use of smokeless tobacco, e.g. chewing tobacco, is now insignificant

in the preferred conditional success equation. Conditional on the decision to quit, the use of smokeless tobacco to aid quitting does not increase a smoker's chances of succeeding. The use of cigars also has no significant effect. Additionally, the use of e-cigarettes is not statistically significant in the preferred estimation. While this coefficient was statistically significant in column 1, it is now not significantly different from 0. Thus, the use of e-cigarettes does not increase *or* decrease the chances of succeeding, conditional on the decision to quit.

CHAPTER 6:

DISCUSSION

6.1 Implications for Rational Addiction Theory

The aim of this study is to examine the relationship between quitting aids and smoking cessation. Specifically, by empirically testing the hypothesis that strong addictions can only be stopped by the user quitting cold turkey (Becker & Murphy, 1988).

Unconditional on a smoker's quit attempt, nicotine aids, or NRT, is shown to increase the chances of quit success. This finding is not consistent with the hypothesis proposed by rational addiction theory, as nicotine is the addictive compound found in cigarettes and most tobacco products (Stolerman & Jarvis, 1995). Therefore, the use of NRT directly violates the cold turkey quitting protocol. However, in the preferred conditional success probit model, the use of nicotine products to aid quitting is shown to *decrease* a smoker's likelihood of successfully quitting. This finding is thus consistent with the cold turkey hypothesis derived from rational addiction theory.

The use of prescription pills, such as Chantix, is shown to increase a smoker's chances of success in both probit estimations, although this effect is significantly smaller in the conditional success equation. However, these prescription pills do not contain any nicotine, and thus should be treated no differently than the use of other quitting aids such as smoking clinics or help groups. Therefore, the finding that these

prescription medications do increase a smoker's chances of successfully quitting is also consistent with the cold turkey hypothesis of Becker & Murphy (1988). These medications are aimed to reduce the disutility associated with cessation, and lower the utility associated with consumption. The use of such products remains within the framework of rationality, so long as they do not contain the addictive consumption good, as is the case with these prescription medications. The theory implies that smokers will search for ways to lower the short-term costs associated with cessation, and these products are one way in which rational addicts seek to minimize these costs.

Although the use of telephone, counseling, support groups, and internet cessation aids are consistent with rational addiction theory, this study finds no evidence that such methods offer any support in smoking cessation efforts. It may be the case that these quitting aids do not significantly reduce the disutility associated with smoking cessation, and therefore do not increase a quitter's chances of succeeding. The short-term costs associated with quitting likely remain relatively unchanged despite the use of such quitting aids.

The use of smokeless tobacco, such as chewing tobacco, is shown to positively impact the probability of successfully quitting in the unconditional success equation. However, this positive effect disappears in the preferred conditional success estimation. As is the case with NRT, the use of smokeless tobacco to aid a quit attempt violates the cold turkey protocol, given that the products contain nicotine. However, the use of such products is shown to have no significant effect on a smoker's quitting efforts. This finding is also consistent with that of Becker & Murphy (1988). The use of cigars to aid quitting is also shown to have no effect, coinciding with rational addiction theory.

According to Creamer *et al.* (2019), the prevalence of e-cigarette use increased during 2017–2018. Although e-cigarettes are not an FDA approved smoking cessation product, these products are increasingly being used to aid smoking cessation efforts. In the unconditional success equation, the use of e-cigarettes to aid cessation are shown to increase cessation rates. However, conditional on a smoker's decision to quit, these products also are found to have no statistically significant effect on quitting success. This finding is different from that of Johnson *et al.* (2019), but consistent with the meta-analysis found in Kalkhoran & Glantz (2016). Because e-cigarettes commonly contain nicotine as well, their use to aid cessation violates the theory of rational addiction. The results in the conditional success equation are consistent with the theory.

Therefore, based on the preferred conditional success probit estimation, this paper finds no evidence that smoker's violate the cold-turkey implication of rational addiction theory. Conversely, the use of NRT is shown to decrease cessation rates among everyday smokers, a finding consistent with Becker & Murphy (1988). This result opposes the majority of the medical literature surrounding NRT and smoking cessation, likely due to the modeling differences between this study and those regularly found in medical journals. Multinomial logit regressions are commonly used in cessation studies outside of economics, which do not model a smoker's conditional quitting success. As shown in this studies results, the differences between the two model specifications can have large effects on the empirical results.

Additionally, smoker's daily consumption levels do significantly effect a smoker's chances of succeeding once they decide to quit. This finding is contrary to Feng (2005) and is consistent with the idea that heavy smokers are "trapped" into their smoking

behavior based on their consumption levels. Smokers with higher education levels, specifically those who obtain associates or bachelor degrees, are generally more likely to succeed in their conditional quit attempts. This finding is consistent with Feng (2005), but contradicts the theory of self control proposed by Keeler *et al.* (1999).

Smokers aged 45-54, 55-64 and 64 and up are all less likely to successfully quit than younger smokers. Additionally, aging is associated with a lower likelihood of attempting to quit, with the relationship being monotonic. This finding contradicts the model of Suranovic *et al.* (1999) which suggests aging is enough to encourage cessation among certain smokers. Older smokers are not only less likely to try to quit, they are less likely to succeed once they do decide to quit. Lifetime gains in utility from quitting decreases as one ages, and older persons are less concerned about the future consequences of current consumption (Becker & Murphy, 1988). Therefore, this finding is also consistent with rational addiction theory.

Although the findings of this paper are largely consistent with rational addiction theory, the double-hurdle modeling specification used in this study may create a selection problem. This selection bias concern can be addressed by estimating the probit models jointly, as outlined by Feng (2005). Future research examining the role of quitting aids on smoking cessation should consider this joint estimation to address the selection problem. Additionally, this analysis did not use the CPS provided weights, which are rough measure of the number of actual persons that the sample person represents. The absence of these weights also creates possible selection bias concerns, and future analysis should consider the use of these weights to further the discussion.

6.2 Policy Implications

Policy makers are likely interested in both increasing smoker's desires to quit and their likelihood of successfully quitting. Thus, the results in this study are useful in smoking cessation policy discussions.

In April of 2022, the Food and Drug Administration (FDA) proposed a ban on menthol flavoring in cigarettes. This ban is said to increase the likelihood of cessation and help adult smokers quit. However, the results of this study find no evidence that menthol preferences have any effect on smoker's motivations to quit, along with cessation rates. In the conditional quit success equation, menthol smokers have no significant differences in quitting success than non-menthol smokers, and the unconditional quit success model finds menthol smokers are *more* likely to quit successfully. Policy makers should thus closely examine the claims that menthol smokers are less likely to successfully quit. The FDA also claims the ban on menthol cigarettes will reduce youth smoking initiation, which is outside the scope of this study.

Smokers who viewed a Federal warning outlining the dangers of cigarettes were found to be more likely to attempt to quit. Although these messages had no effect on quitting success, increases in health information messages are effective policy tools since they increase motivations to quit. Messages outlining the consequences of allowing smoking in the home may also be effective to promote quitting and cessation rates, as smokers who allowed smoking in the home were significantly less likely to try to quit and succeed in quitting. Smoker's who believe smoking should be allowed in vehicles with others present are also less likely to succeed in quitting. A useful policy tool therefore could be additional advertisements describing the dangers of second-hand smoke. Since undergraduate education is shown to increase a

smoker's chances to quit, any incentives to promote additional schooling is also likely to increase cessation rates.

The negative relationship between nicotine aids and cessation rates also has useful policy implications. Taxation of such products will decrease demand, and thus increase cessation rates among smokers. Conversely, prescription aids appear to be very useful tools to aid cessation. Increasing demand for these products, through advertising or price decreases, may increase the chances of quitting among smokers. These results and those from the meta-analysis of Kalkhoran & Glantz (2016) suggest that e-cigarette use is associated with significantly lower cessation rates. Higher taxation of such products may be a useful tool to decrease e-cigarette demand. Given that the prevalence of e-cigarette use among adults aged 18–24 years is higher than that among other adult age groups (Creamer *et al.*, 2019), advertisements highlighting the consequences of e-cigarette use may decrease youth initiation rates as well, a desirable outcome for many policy makers.

Any other measures that increase the likelihood of attempting to quit and the conditional probability of successfully quitting should also be considered.

CHAPTER 7:

ROBUSTNESS CHECKS

Motivated by the findings of Baltagi & Geishecker (2006), this study splits the data into samples of male and female smokers as a robustness check. The three previously discussed probit models are re-estimated for the all female sample, along with a sample of smokers aged 18-34.

Table 7.1: Female sample probit models: unconditional quitting success, attempt and conditional success

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
FAMINC	-0.004	0.007	-0.006	0.005	-0.007	0.008
MIDWEST	-0.053	0.073	-0.0003	0.052	-0.122	0.086
SOUTH	-0.084	0.065	-0.024	0.047	-0.140*	0.078
NORTHEAST	0.012	0.080	0.070	0.059	-0.052	0.095
JAN19	-0.142**	0.059	-0.099**	0.041	-0.106	0.069
MAY19	-0.021	0.058	-0.008	0.042	-0.010	0.069
INITIATION_AGE	0.001	0.004	0.006*	0.003	-0.006	0.005
AGE2534	-0.279**	0.122	-0.162	0.101	-0.266*	0.145
AGE3544	-0.372***	0.123	-0.245**	0.100	-0.306**	0.145
AGE4554	-0.382***	0.123	-0.174*	0.100	-0.334**	0.145
AGE5564	-0.411***	0.121	-0.297***	0.098	-0.288**	0.144
AGE65UP	-0.437***	0.129	-0.441***	0.103	-0.281*	0.155

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Table 7.1 – *Continued from previous page*

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
HSDIPLOMA	0.037	0.076	-0.020	0.054	0.037	0.090
SOMECOLLEGE	-0.012	0.084	0.100*	0.060	-0.049	0.098
ASSOCIATES	0.089	0.096	-0.013	0.069	0.086	0.114
BACHELORS	0.113	0.105	-0.078	0.076	0.170	0.126
MASTERS	-0.045	0.179	0.146	0.123	-0.042	0.202
DOCTORATE	0.276	0.354	-0.238	0.279	0.592	0.468
WHITE	-0.034	0.071	-0.067	0.053	-0.012	0.084
HISPANIC	0.137	0.102	0.040	0.081	0.158	0.121
MARRIED	0.012	0.055	-0.059	0.039	0.039	0.064
EMPLOYED	-0.105	0.073	-0.090*	0.052	-0.111	0.086
ARMEDFORCES	-0.070	0.174	0.011	0.121	-0.044	0.201
DAILY_CONSUMPTION	-0.017***	0.004	-0.018***	0.003	-0.009*	0.005
MENTHOL_SMOKER	0.126**	0.052	0.049	0.038	0.110*	0.063
DOCTOR_VISIT	-0.064	0.077	0.181***	0.055	-0.146	0.095
DOCTOR_ADVICE	0.018	0.065	0.163***	0.046	-0.021	0.078
WORK_RESTRICTIONS	-0.063	0.073	-0.094*	0.052	-0.009	0.086
HOME_SMOKING	-0.159**	0.065	-0.068	0.046	-0.250***	0.076
HOME_VAPING	0.096	0.063	0.105**	0.044	0.182**	0.074
WORKPLACE_SMOKING	-0.013	0.058	-0.222***	0.041	0.093	0.069
SOCIAL_SMOKING	-0.025	0.057	-0.067	0.042	-0.007	0.067
VEHICLE_SMOKING	-0.162***	0.053	-0.107***	0.038	-0.137**	0.062
FEDERAL_WARNING	0.004	0.050	0.038	0.035	0.021	0.059
NICOTINE_AID	0.331***	0.066			-0.109*	0.065
PRESCRIPTION_AID	0.590***	0.077			0.234***	0.076
TELEPHONE_AID	-0.033	0.130			-0.080	0.125
COUNSELING_AID	0.131	0.124			0.046	0.120
SUPPORT_GROUP_AID	0.099	0.188			0.122	0.182
INTERNET_AID	-0.021	0.180			-0.165	0.175
SMOKELESS_AID	0.251	0.191			0.135	0.186
CIGAR_AID	0.135	0.235			-0.095	0.230
E.CIGARETTE_AID	0.353***	0.069			-0.090	0.069

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Table 7.1 – *Continued from previous page*

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
Constant	-0.694***	0.171	0.329**	0.133	0.001	0.204

Table 7.2: Young adult sample probit models: unconditional quitting success, attempt and conditional success

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
FAMINC	0.001	0.010	-0.004	0.008	-0.0004	0.012
MIDWEST	-0.013	0.106	0.133	0.083	-0.168	0.127
SOUTH	0.006	0.095	0.039	0.075	-0.065	0.116
NORTHEAST	-0.042	0.129	0.145	0.100	-0.179	0.154
JAN19	0.026	0.086	-0.036	0.067	0.065	0.104
MAY19	0.009	0.088	-0.047	0.067	0.088	0.105
INITIATION_AGE	-0.024**	0.012	0.008	0.009	-0.042***	0.014
HSDIPLOMA	0.130	0.114	0.100	0.084	0.140	0.138
SOMECOLLEGE	0.111	0.126	0.153	0.095	0.058	0.150
ASSOCIATES	0.171	0.155	0.001	0.119	0.267	0.189
BACHELORS	0.107	0.171	-0.034	0.130	0.185	0.208
MASTERS	-0.081	0.454	-0.049	0.351	0.068	0.535
DOCTORATE	0.977*	0.559	-0.002	0.526	1.600*	0.866
WHITE	-0.059	0.100	-0.029	0.079	-0.040	0.121
MALE	0.126	0.079	0.076	0.061	0.166*	0.095
HISPANIC	0.051	0.124	-0.128	0.101	0.177	0.155
MARRIED	0.046	0.079	0.106*	0.062	-0.025	0.095
EMPLOYED	-0.079	0.096	-0.072	0.076	-0.076	0.116
ARMEDFORCES	0.094	0.172	-0.020	0.140	0.211	0.213
DAILY_CONSUMPTION	-0.031***	0.006	-0.021***	0.004	-0.020***	0.007

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Table 7.2 – *Continued from previous page*

	Unconditional Success		Attempt Equation		Conditional Success	
	Coefficient	Standard Error	Coefficient	Standard Error	Coefficient	Standard Error
MENTHOL_SMOKER	0.087	0.075	0.057	0.059	0.038	0.091
DOCTOR_VISIT	0.021	0.098	0.091	0.076	0.025	0.119
DOCTOR_ADVICE	0.008	0.097	0.099	0.076	-0.016	0.116
WORK_RESTRICTIONS	-0.093	0.086	0.021	0.067	-0.120	0.104
HOME_SMOKING	-0.275***	0.100	-0.326***	0.074	-0.298**	0.118
HOME_VAPING	0.028	0.093	0.171**	0.070	0.125	0.109
WORKPLACE_SMOKING	0.003	0.085	-0.251***	0.065	0.146	0.105
SOCIAL_SMOKING	-0.035	0.085	-0.102	0.067	-0.001	0.100
VEHICLE_SMOKING	-0.083	0.079	0.074	0.062	-0.155*	0.094
FEDERAL_WARNING	-0.020	0.072	0.064	0.056	-0.036	0.086
NICOTINE_AID	0.286***	0.108			-0.156	0.108
PRESCRIPTION_AID	0.239	0.174			-0.025	0.172
TELEPHONE_AID	0.194	0.312			0.109	0.307
COUNSELING_AID	0.134	0.283			0.011	0.281
SUPPORT_GROUP_AID	-0.860	0.607			-0.999	0.641
INTERNET_AID	-0.639**	0.317			-0.519*	0.299
SMOKELESS_AID	0.460***	0.168			0.145	0.169
CIGAR_AID	0.025	0.286			-0.240	0.280
E.CIGARETTE_AID	0.550***	0.093			-0.052	0.098
Constant	-0.479*	0.263	0.039	0.204	0.438	0.322

The female sample contains 5,631 total smokers, of which 2,488 had attempted to quit at least once in the prior year. About 22.7% of female quitters successfully quit for 30 days or longer. 32.2% reported that they used a nicotine aid in their quit attempt, and 26.8% reported that they used e-cigarettes to aid their attempt. The average smoking initiation age was about 18 years old, and female smokers on average smoked about 13 cigarettes per day. The full description of this sample's summary

statistics can be found in the Appendix tables A.1 and A.2.

The young adult smokers sample, comprised of smokers aged 18-34, contains 2,167 total subjects. Of these 2,167 respondents, 1,040 had attempted to quit in the 12 months prior to the survey. About 20% of the total sample is aged 18-24, and 80% aged 25-34. 85% of young adult smokers had obtained at least a high school education. The average smoking initiation age was about 16.8 years old, the lowest of any sample in this study. Smokers aged 18-34 smoked 12.5 cigarettes per day on average. Of the young adults who attempted to quit, about 23.4% used a nicotine aid, and 33.4% used e-cigarettes to aid their attempt, significantly more than the full sample and female sample. Remaining summary statistics for the young adult sample can be found in Appendix tables A.3 and A.4.

Tables 7.1 and 7.2 display coefficients and standard errors for the estimated probit equations for the female and young adult subsamples, respectively. Family income remains insignificant for the attempt, unconditional, and conditional quit success equations in both subsamples. Initiation age positively effects the likelihood that female smokers will attempt to quit, but has no effect on young adult's decision to quit. However, smoking initiation age is significant with a negative coefficient in column 3 of table 7.2. This implies that recently initiated smokers have a lower chance of succeeding conditional on their quit attempt.

Educational attainment has no effect on the decision to quit or quitting success for both samples, with the exception of young adult smoker's who obtained doctorates. This result likely stems from the very small sample of young adults who've obtained this degree. Married young adults are more likely to decide to quit than single young adults. This is likely from the idea that smoking brings negative externalities to the

smokers' family members (Feng, 2005). However, marital status has no effect on the chances of success for either subsample. Race also has no significant effect in any estimated regression equation.

Daily cigarette consumption has negative effects on quit attempts and cessation rates for both subsamples, as expected. Female menthol smokers are also shown to be more likely to successfully quit, contrary to the FDA findings described in Chapter 6. Smoking restrictions inside the home remain significant, and negatively effect quitting and cessation rates, consistent with the results from the full sample.

The use of nicotine aids positively effects unconditional quitting success, but this effect is not statistically different from 0 in the conditional success equation, confirming the results derived from the full sample of everyday smokers. The use of prescription aids among female smokers is again shown to increase conditional and unconditional quitting success, with the effect being less pronounced in the conditional success equation. However, the use of prescription aids is not statistically significant in the young adults sample. This is likely due to the low amount of young respondents who reportedly used prescription aids (7.8%). In the full sample, nearly 16% of respondents reportedly used prescription aids. The use of all other quitting aids, including the nicotine based smokeless tobacco and e-cigarette products, remain insignificant in both samples conditional on a smoker's decision to quit. These findings are consistent with the full sample model and provide evidence that the results in this paper are robust.

CHAPTER 8:

CONCLUSION

This study aims to empirically test an implication of rational addiction theory that strong rational addictions can only cease by the addict quitting cold turkey (Becker & Murphy, 1988). The relationship between the use of quitting aids and the likelihood of quitting success is examined using a double-hurdle probit model, previously used by Jones (1994) and Feng (2005). First, a probit equation is estimated on a smoker's decision to quit, referred to as the "attempt" equation. Then, conditional on their decision to quit, a second probit equation is estimated on the likelihood of successfully quitting, referred to as the "conditional success" equation.

Using nationally representative cross-sectional data from the 2018-2019 survey waves of the Tobacco Use Supplement to the Current Population Survey (TUS-CPS), the results indicate that the use of nicotine based quitting aids do not increase the likelihood of successfully quitting. Nicotine replacement therapy (NRT), such as nicotine gum and patches, are shown to *decrease* a smoker's chances of successfully quitting conditional on their decision to quit. Because nicotine is the addictive compound found in cigarettes and other tobacco products (US Department of Health and Human Services), the use of such products to aid quitting directly violates the cold turkey protocol. Therefore this finding is consistent with rational addiction theory. The use of other nicotine based products, such as e-cigarettes, smokeless tobacco, and

cigars are found to have no effect on a smoker's conditional quitting success. Smokers also commonly attend stop smoking clinics, counseling sessions, and use internet quitting aids to lower the disutility associated with cessation. This study finds no evidence that the use of such products increases the likelihood of successfully quitting, conditional on the smoker's decision to quit.

Daily cigarette consumption, smoking initiation age, medical advice to quit smoking, and Federal warnings about the dangers of cigarettes all are shown to effect a smoker's motivation to quit. Smokers aged 65 and older are also found to be the least likely to decide to quit, as lifetime gains in utility from quitting decreases as one ages, and older persons are less concerned about the future consequences of current consumption (Becker & Murphy, 1988).

The overall results of this study are consistent with the cold turkey implications of the theory of rational addiction. The robustness of these results are checked by creating two subsamples, consisting of female smokers and young adult smokers, aged 18-34. The empirical results from obtained from these subsamples are consistent with the findings from the full sample of everyday smokers.

Given policymakers' often seek to increase smoker motivations to quit and promote smoking cessation, the results from this study are useful in policy discussions. Increases in messaging depicting the costs of cigarette and tobacco use are shown to increase quitting rates, as the perceived costs of smoking increase. United States (US) policymakers should also reassess the proposed menthol ban, as the results in this paper indicate that menthol preferences do not effect a smoker's conditional quit success. Any additional measures that increase motivations to quit and the conditional probability of successfully quitting should also be considered. As the prevalence

of e-cigarette use and other nicotine based quitting aids rises, future research should continue to examine the relationship between these products and cigarette cessation rates. Better understanding this relationship equips policy makers with data to better inform tobacco related policies and regulations. Future research on the effect of quitting aids on smoking cessation should utilize panel data for more robust causal inferences. Currently this approach is limited by the unavailability of recent panels (the latest available TUS-CPS panel is from 2011) that is needed to examine the increase in recent quitting aid prevalence.

REFERENCES

Ashton, Heather, & Stepney, Rob. 1982. *Smoking: Psychology and pharmacology*. Vol. 244. Taylor & Francis.

Baltagi, Badi H, & Geishecker, Ingo. 2006. Rational alcohol addiction: evidence from the Russian longitudinal monitoring survey. *Health economics*, **15**(9), 893–914.

Baltagi, Badi H, & Griffin, James M. 2002. Rational addiction to alcohol: panel data analysis of liquor consumption. *Health Economics*, **11**(6), 485–491.

Baltagi, Badi H, & Levin, Dan. 1986. Estimating dynamic demand for cigarettes using panel data: the effects of bootlegging, taxation and advertising reconsidered. *The Review of Economics and Statistics*, 148–155.

Becker, Gary S, & Murphy, Kevin M. 1988. A theory of rational addiction. *Journal of political Economy*, **96**(4), 675–700.

Boyer, Marcel. 1983. Rational demand and expenditures patterns under habit formation. *Journal of Economic Theory*, **31**(1), 27–53.

CDC. 2022 (Mar). *Smoking cessation: Fast facts*.

Chaloupka, Frank. 1991. Rational addictive behavior and cigarette smoking. *Journal of political Economy*, **99**(4), 722–742.

Chaloupka, Frank J, Tauras, John A, & Grossman, Michael. 2000. The economics of addiction. *Tobacco control in developing countries*, 107–129.

Creamer, MeLisa R, Wang, Teresa W, Babb, Stephen, Cullen, Karen A, Day, Hannah, Willis, Gordon, Jamal, Ahmed, & Neff, Linda. 2019. Tobacco product use and cessation indicators among adults—United States, 2018. *Morbidity and mortality weekly report*, **68**(45), 1013.

Dow, Jay K, & Endersby, James W. 2004. Multinomial probit and multinomial logit: a comparison of choice models for voting research. *Electoral studies*, **23**(1), 107–122.

Farrell, Michael J. 1952. Irreversible demand functions. *Econometrica: Journal of the Econometric Society*, 171–186.

Feng, Shuaizhang. 2001. The longitudinal matching of Current Population Surveys: A proposed algorithm. *Journal of Economic and Social Measurement*, **27**(1-2), 71–91.

Feng, Shuaizhang. 2005. Rationality and self-control: The implications for smoking cessation. *The Journal of Socio-Economics*, **34**(2), 211–222.

Finney, David J. 1971. Probit analysis, Cambridge University Press. *Cambridge, UK*.

Gorman, William M. 1967. Tastes, habits and choices. *International economic review*, **8**(2), 218–222.

Gruber, Jonathan, & Köszegi, Botond. 2001. Is addiction "rational"? Theory and evidence. *The Quarterly Journal of Economics*, **116**(4), 1261–1303.

Houthakker, Hendrik S, & Taylor, Lester D. 1966. Consumer demand in the United States, 1929-1970; analyses and projections.

Jackson, Sarah E, Kotz, Daniel, West, Robert, & Brown, Jamie. 2019. Moderators of real-world effectiveness of smoking cessation aids: a population study. *Addiction*, **114**(9), 1627–1638.

Johnson, Linda, Ma, Yinjiao, Fisher, Sherri L, Ramsey, Alex T, Chen, Li-Shiun, Hartz, Sarah M, Culverhouse, Robert C, Grucza, Richard A, Saccone, Nancy L, Baker, Timothy B, *et al.* 2019. E-cigarette usage is associated with increased past-12-month quit attempts and successful smoking cessation in two US population–based surveys. *Nicotine and Tobacco Research*, **21**(10), 1331–1338.

Jones, Andrew M. 1994. Health, addiction, social interaction and the decision to quit smoking. *Journal of health economics*, **13**(1), 93–110.

Kalkhoran, Sara, & Glantz, Stanton A. 2016. E-cigarettes and smoking cessation in real-world and clinical settings: a systematic review and meta-analysis. *The Lancet Respiratory Medicine*, **4**(2), 116–128.

Keeler, Theodore E, Marciniak, Martin, & Hu, Teh-wei. 1999. Rational addiction and smoking cessation: An empirical study. *The Journal of Socio-Economics*, **28**(5), 633–643.

Lluch, Constantino. 1974. Expenditure, savings and habit formation. *International Economic Review*, 786–797.

Maciosek, Michael V, Xu, Xin, Butani, Amy L, & Pechacek, Terry F. 2015. Smoking-

attributable medical expenditures by age, sex, and smoking status estimated using a relative risk approach. *Preventive medicine*, **77**, 162–167.

Mullahy, John. 1985. *Cigarette smoking: habits, health concerns, and heterogeneous unobservables in a microeconometric analysis of consumer demand*. University of Virginia.

Muthén, Bengt. 1979. A structural probit model with latent variables. *Journal of the American Statistical Association*, **74**(368), 807–811.

O'Donoghue, Ted, & Rabin, Matthew. 1999. Doing it now or later. *American economic review*, **89**(1), 103–124.

Pekurinen, Markku. 1989. The demand for tobacco products in Finland. *British journal of addiction*, **84**(10), 1183–1192.

Piccoli, Luca, & Tiezzi, Silvia. 2021. Rational addiction and time-consistency: An empirical test. *Journal of Health Economics*, **80**, 102546.

Pollack, Robert A. 1975. The intertemporal cost of living index. *Pages 179–198 of: Annals of Economic and Social Measurement, Volume 4, number 1*. NBER.

Schelling, Thomas C. 1978. Egonomics, or the art of self-management. *The American Economic Review*, **68**(2), 290–294.

Schwartz, Jerome L. 1992. Methods of smoking cessation. *Medical Clinics of North America*, **76**(2), 451–476.

Shi, Yuyan, Pierce, John P, White, Martha, Vijayaraghavan, Maya, Compton, Wilson, Conway, Kevin, Hartman, Anne M, & Messer, Karen. 2016. E-cigarette use

and smoking reduction or cessation in the 2010/2011 TUS-CPS longitudinal cohort. *BMC public health*, **16**(1), 1–9.

Solomon, Richard L, & Corbit, John D. 1978. An opponent-process theory of motivation. *The American Economic Review*, 12–24.

Spinnewyn, Frans. 1981. Rational habit formation. *European Economic Review*, **15**(1), 91–109.

Stigler, George J, & Becker, Gary S. 1977. De gustibus non est disputandum. *The american economic review*, **67**(2), 76–90.

Stolerman, Ian P, & Jarvis, MJ. 1995. The scientific case that nicotine is addictive. *Psychopharmacology*, **117**(1), 2–10.

Suranovic, Steven M, Goldfarb, Robert S, & Leonard, Thomas C. 1999. An economic theory of cigarette addiction. *Journal of health economics*, **18**(1), 1–29.

Swan, G.E., & Balfour, D.J.K. 1999. *Nicotine and tobacco research: Proceedings from "Addicted to Nicotine: A National Research Forum"*.

Thaler, Richard, & Loewenstein, George. 1992. Intertemporal choice. *Journal of Economic Perspectives*, **3**, 181–193.

Young, Trevor. 1983. The demand for cigarettes: alternative specifications of Fujii's model. *Applied Economics*, **15**(2), 203–211.

Zavala-Arciniega, Luis, Hirschtick, Jana L, Meza, Rafael, & Fleischer, Nancy L. 2022. E-cigarette characteristics and cigarette smoking cessation behaviors among US

Adult dual users of cigarettes and e-cigarettes. *Preventive medicine reports*, **26**, 101748.

APPENDIX A:

TABLES

Table A.1: Summary Statistics - Female Everyday Smokers

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	5631	9.297	4.126	1	16
AGE1824	5631	0.036	0.185	0	1
AGE2534	5631	0.155	0.362	0	1
AGE3544	5631	0.182	0.386	0	1
AGE4554	5631	0.202	0.402	0	1
AGE5564	5631	0.257	0.437	0	1
AGE65UP	5631	0.169	0.374	0	1
NOHSDIPLOMA	5631	0.14	0.348	0	1
HSDIPLOMA	5631	0.392	0.488	0	1
SOMECOLLEGE	5631	0.221	0.415	0	1
ASSOCIATES	5631	0.126	0.332	0	1
BACHELORS	5631	0.093	0.291	0	1
MASTERS	5631	0.023	0.15	0	1
DOCTORATE	5631	0.004	0.064	0	1
MALE	5631	0	0	0	0
WHITE	5631	0.857	0.35	0	1
HISPANIC	5631	0.048	0.214	0	1
MARRIED	5631	0.375	0.484	0	1
EMPLOYED	5631	0.489	0.5	0	1
JUL18	5631	0.358	0.48	0	1
MAY19	5631	0.306	0.461	0	1
JAN19	5631	0.335	0.472	0	1
ARMEDFORCES	5631	0.021	0.142	0	1
INITIATION_AGE	5631	18.051	5.615	1	70
DAILY_CONSUMPTION	5631	13.273	7.373	1	40
MENTHOL_SMOKER	5631	0.337	0.473	0	1
ATTEMPT	5631	0.442	0.497	0	1
QUIT	5631	0.101	0.301	0	1
DOCTOR_VISIT	5631	0.78	0.414	0	1
DOCTOR_ADVICE	5631	0.595	0.491	0	1
WORKPLACE_RESTRICTIONS	5631	0.375	0.484	0	1
HOME_SMOKING_ATTITUDES	5631	0.48	0.5	0	1
HOME_VAPING_ATTITUDES	5631	0.423	0.494	0	1
WORKPLACE_SMOKING_ATTITUDES	5631	0.338	0.473	0	1
SOCIAL_SMOKING_ATTITUDES	5631	0.718	0.45	0	1
VEHICLE_SMOKING_ATTITUDES	5631	0.574	0.495	0	1
FEDERAL_WARNING	5631	0.618	0.486	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

Table A.2: Summary Statistics - Female Successful and Unsuccessful Quitters

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	2488	9.186	4.219	1	16
AGE1824	2488	0.044	0.206	0	1
AGE2534	2488	0.168	0.374	0	1
AGE3544	2488	0.181	0.385	0	1
AGE4554	2488	0.209	0.407	0	1
AGE5564	2488	0.246	0.431	0	1
AGE65UP	2488	0.152	0.359	0	1
NOHSDIPLOMA	2488	0.14	0.347	0	1
HSDIPLOMA	2488	0.377	0.485	0	1
SOMECOLLEGE	2488	0.24	0.427	0	1
ASSOCIATES	2488	0.125	0.33	0	1
BACHELORS	2488	0.088	0.284	0	1
MASTERS	2488	0.027	0.161	0	1
DOCTORATE	2488	0.003	0.057	0	1
MALE	2488	0	0	0	0
WHITE	2488	0.841	0.366	0	1
HISPANIC	2488	0.054	0.227	0	1
MARRIED	2488	0.359	0.48	0	1
EMPLOYED	2488	0.475	0.499	0	1
JUL18	2488	0.367	0.482	0	1
MAY19	2488	0.314	0.464	0	1
JAN19	2488	0.319	0.466	0	1
ARMEDFORCES	2488	0.021	0.143	0	1
INITIATION_AGE	2488	18.243	5.882	1	60
DAILY_CONSUMPTION	2488	12.225	6.941	1	40
MENTHOL_SMOKER	2488	0.357	0.479	0	1
ATTEMPT	2488	1	0	1	1
QUIT	2488	0.227	0.419	0	1
DOCTOR_VISIT	2488	0.823	0.382	0	1
DOCTOR_ADVICE	2488	0.643	0.479	0	1
WORKPLACE_RESTRICTIONS	2488	0.361	0.48	0	1
HOME_SMOKING_ATTITUDES	2488	0.446	0.497	0	1
HOME_VAPING_ATTITUDES	2488	0.408	0.491	0	1
WORKPLACE_SMOKING_ATTITUDES	2488	0.282	0.45	0	1
SOCIAL_SMOKING_ATTITUDES	2488	0.682	0.466	0	1
VEHICLE_SMOKING_ATTITUDES	2488	0.529	0.499	0	1
FEDERAL_WARNING	2488	0.63	0.483	0	1
NICOTINE_AID	2488	0.322	0.467	0	1
PRESCRIPTION_AID	2488	0.175	0.38	0	1
TELEPHONE_AID	2488	0.067	0.25	0	1
COUNSELING_AID	2488	0.07	0.255	0	1
SUPPORT_GROUP_AID	2488	0.027	0.163	0	1
INTERNET_AID	2488	0.032	0.175	0	1
SMOKELESS_TOBACCO_AID	2488	0.024	0.152	0	1
CIGAR_AID	2488	0.017	0.129	0	1
E.CIGARETTE_AID	2488	0.268	0.443	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

Table A.3: Summary Statistics - Everyday Smokers Aged 18-34

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	2167	9.403	4.015	1	16
AGE1824	2167	0.194	0.395	0	1
AGE2534	2167	0.806	0.395	0	1
AGE3544	2167	0	0	0	0
AGE4554	2167	0	0	0	0
AGE5564	2167	0	0	0	0
AGE65UP	2167	0	0	0	0
NOHSDIPLOMA	2167	0.15	0.357	0	1
HSDIPLOMA	2167	0.441	0.497	0	1
SOMECOLLEGE	2167	0.236	0.425	0	1
ASSOCIATES	2167	0.092	0.29	0	1
BACHELORS	2167	0.072	0.259	0	1
MASTERS	2167	0.006	0.08	0	1
DOCTORATE	2167	0.003	0.053	0	1
MALE	2167	0.506	0.5	0	1
WHITE	2167	0.835	0.371	0	1
HISPANIC	2167	0.084	0.277	0	1
MARRIED	2167	0.291	0.454	0	1
EMPLOYED	2167	0.699	0.459	0	1
JUL18	2167	0.395	0.489	0	1
MAY19	2167	0.294	0.456	0	1
JAN19	2167	0.311	0.463	0	1
ARMEDFORCES	2167	0.042	0.201	0	1
INITIATION_AGE	2167	16.863	3.253	6	32
DAILY_CONSUMPTION	2167	12.563	6.938	1	40
MENTHOL_SMOKER	2167	0.389	0.488	0	1
ATTEMPT	2167	0.48	0.5	0	1
QUIT	2167	0.136	0.343	0	1
DOCTOR_VISIT	2167	0.595	0.491	0	1
DOCTOR_ADVICE	2167	0.395	0.489	0	1
WORKPLACE_RESTRICTIONS	2167	0.443	0.497	0	1
HOME_SMOKING_ATTITUDES	2167	0.325	0.469	0	1
HOME_VAPING_ATTITUDES	2167	0.388	0.487	0	1
WORKPLACE_SMOKING_ATTITUDES	2167	0.329	0.47	0	1
SOCIAL_SMOKING_ATTITUDES	2167	0.725	0.447	0	1
VEHICLE_SMOKING_ATTITUDES	2167	0.641	0.48	0	1
FEDERAL_WARNING	2167	0.548	0.498	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019

Table A.4: Summary Statistics - Successful and Unsuccessful Quitters Aged 18-34

Variable	N	Mean	Std. Dev	Min	Max
FAMINC	1040	9.448	4.05	1	16
AGE1824	1040	0.213	0.41	0	1
AGE2534	1040	0.787	0.41	0	1
AGE3544	1040	0	0	0	0
AGE4554	1040	0	0	0	0
AGE5564	1040	0	0	0	0
AGE65UP	1040	0	0	0	0
NOHSDIPLOMA	1040	0.133	0.339	0	1
HSDIPLOMA	1040	0.437	0.496	0	1
SOMECOLLEGE	1040	0.261	0.439	0	1
ASSOCIATES	1040	0.09	0.287	0	1
BACHELORS	1040	0.07	0.256	0	1
MASTERS	1040	0.007	0.082	0	1
DOCTORATE	1040	0.003	0.054	0	1
MALE	1040	0.493	0.5	0	1
WHITE	1040	0.829	0.377	0	1
HISPANIC	1040	0.079	0.27	0	1
MARRIED	1040	0.311	0.463	0	1
EMPLOYED	1040	0.695	0.461	0	1
JUL18	1040	0.397	0.49	0	1
MAY19	1040	0.293	0.455	0	1
JAN19	1040	0.31	0.463	0	1
ARMEDFORCES	1040	0.041	0.199	0	1
INITIATION_AGE	1040	17.033	3.235	6	32
DAILY_CONSUMPTION	1040	11.568	6.653	1	40
MENTHOL_SMOKER	1040	0.407	0.491	0	1
ATTEMPT	1040	1	0	1	1
QUIT	1040	0.284	0.451	0	1
DOCTOR_VISIT	1040	0.634	0.482	0	1
DOCTOR_ADVICE	1040	0.428	0.495	0	1
WORKPLACE_RESTRICTIONS	1040	0.453	0.498	0	1
HOME_SMOKING_ATTITUDES	1040	0.264	0.441	0	1
HOME_VAPING_ATTITUDES	1040	0.369	0.483	0	1
WORKPLACE_SMOKING_ATTITUDES	1040	0.261	0.439	0	1
SOCIAL_SMOKING_ATTITUDES	1040	0.687	0.464	0	1
VEHICLE_SMOKING_ATTITUDES	1040	0.627	0.484	0	1
FEDERAL_WARNING	1040	0.564	0.496	0	1
NICOTINE_AID	1040	0.234	0.423	0	1
PRESCRIPTION_AID	1040	0.078	0.268	0	1
TELEPHONE_AID	1040	0.026	0.159	0	1
COUNSELING_AID	1040	0.034	0.18	0	1
SUPPORT_GROUP_AID	1040	0.011	0.102	0	1
INTERNET_AID	1040	0.035	0.183	0	1
SMOKELESS_TOBACCO_AID	1040	0.071	0.257	0	1
CIGAR_AID	1040	0.029	0.167	0	1
E.CIGARETTE_AID	1040	0.334	0.472	0	1

Sources: Current Population Survey Tobacco Use Supplements 2018-2019