Tobacco Education Program Spending and Tobacco Use by Adolescents

Abstract

This article measures the effect of tobacco education program spending on adolescent tobacco use by gender. We model how corruption influences the policymaker to increase subsidies for firms to the detriment of education spending leading to more addictive goods consumption but there may be a differential effect by gender. We estimate the effect of tobacco education program spending, instrumented by our corruption proxy, on adolescent tobacco use. Instrumenting for tobacco education spending mitigates estimation bias. More tobacco education program spending significantly increases the probability of never smoking for all adolescents but reduces the frequency of smoking for only adolescent females. One plausible explanation based on our theory is that females have a more inelastic marginal utility of health than males. If Texas reduced its corruption level to the same level as Idaho, the probability that an adolescent will never smoke increases by 26% and the number of smoking days for female adolescents drops by 4 days per month.

Key words: Tobacco education program spending; tobacco use; corruption; gender

JEL Codes: D73, H51, H75, I18

I. Introduction

Reducing tobacco use in the United States is critically dependent on preventing tobacco use during adolescence because 90% of cigarette smokers first tried smoking by the age of 18 (USDHHS, 2012). Even though cigarette consumption by U.S. youths have decreased, the use of tobacco products such as electronic cigarettes and hookahs by middle school and high school students have increased from 2011 to 2014 (CDCP, 2015). If the smoking trend continues, 7% of Americans younger than 18 years old will die early from a smoking related illness (USDHHS, 2014).

Various social, environmental, genetic and mental health factors are direct determinants of tobacco use among adolescents. For instance, peer pressure, stress, and depression, as well as a mother’s smoking during pregnancy are important contributors to the decision of an individual to smoke (USDHHS, 2012). One important factor that can correct for this behavior is tobacco education and prevention programs. Such programs counter advertise messages from tobacco advertisements and encourage tobacco-free environments (USDHHS, 2012). Also, such education, helps individuals understand how consumption of different types of goods affect their health outcome (Grossman, 1975).

Higher state tobacco program expenditures are more likely to have less self-reported cases of smoking among adolescents (Pentz et al. 1989; Taurus et al. 2005; Wakefield and Chaloupka, 2009), college students (Ciecierski et al. 2011) and adults (Rhoads 2012; Marti 2014). Cumulative state tobacco program expenditures also seem to reduce smoking in young adults (Farrelly et al. 2008; Farrelly et al. 2014). These studies show a strong correlation in preventing smoking as well as the frequency of tobacco use. However, there are two potential gaps in the literature. First, they do not show causality because they do not control for the endogeneity of spending. There may be a bi-causal relationship between spending and the prevalence of tobacco use. Not correcting for the effect leads to a bias in estimation. Second, an analysis of the differential impact of tobacco education spending between male and female adolescents while controlling for potential endogeneity has not been conducted. Only Ciecierski et al. (2011) estimated the differences on the impact of tobacco spending on tobacco use by gender but it was on college students and endogeneity was not controlled.

This article estimates the effect of tobacco education program on adolescent tobacco consumption by gender using an instrument from our theoretical model. First, we adapt a common agency model to show how corruption skews spending towards subsidies that benefit firms to the detriment of social services such as education if business groups lobby to influence the government's spending decision. The reduction in education expenditure leads to a decline in the probability of never smoking and induces more consumption of an addictive good by current users especially individuals with an elastic marginal utility of health perception. Second, we test the theoretical linkages in our model by first estimating the effect of a corruption proxy variable on tobacco education program spending and then determine how tobacco use is affected by this spending variable instrumented by the corruption variable. This is the first study to identify an instrument for tobacco education program spending in affecting tobacco use. This is also the first to theoretically link and empirically measure how corruption affects adolescents' tobacco use through this mechanism.

The availability of such educational and health programs that reinforce the negative link between tobacco use and health is dependent on the allocation of funds. The policymaker who allocates funds to various services such as public infrastructure, education, health and business development may be influenced by lobby groups (Allcott et al., 2006). Lobby groups composed of business firms who have more financial capital and common interests are likely to be more influential than those that are composed of regular citizens who are more dispersed and can have varying motives (Olson 1965). Lobby groups for businesses may be driven to obtain subsidies to increase their own production. A policymaker more susceptible to lobbying influence is more likely to provide business lobby groups with such subsidies to the detriment of funding availability for other social services such as education.

This article contributes to two branches of economic literature. First, we contribute to the literature on the effect of education programs on tobacco use. Education allows individuals to better understand the relationship between the type of health inputs they consume and their relationship to a health outcome (Grossman 1975). Strong correlations exist between education and health outcomes such as tobacco use (Van der Pol, 2011). When controlling for education level using an instrument such as parental education, education level also has a causal effect on reducing smoking participation (Kenkel et al., 2006; Nayga, 1998; Sander, 1995, 1998). State tobacco programs (Ong et al. 2003; Pierce et al. 1998) and spending on such programs (Farrelly et al. 2008; Farrelly et al. 2014; Pentz et al. 1989; Taurus et al. 2005; Wakefield and Chaloupka, 2009) are also effective in preventing tobacco use among youths though causality has not been rigorously proven.

This study contributes to the literature by offering an instrument, a corruption proxy, which affects tobacco use through the spending of tobacco education programs. This instrument satisfies the exclusion restriction and is identified from our theoretical model that hypothesizes how corruption affects spending composition in the state; which, in turn, affects adolescent tobacco use. The measure of corruption is a valid instrument for tobacco education spending since corruption only affects tobacco use through tobacco education spending and does not directly affect adolescent tobacco use.

Also, this study contributes to the literature by measuring and explaining the differential impact if tobacco education program spending on adolescent tobacco use by gender. US born, non-Hispanic white men report more smoking than other racial/gender groups. In fact, some groups of female adolescents self-report extremely low levels of smoking (Wade et al. 2013). Thus, there is likely to be differential tobacco policy effects by gender. Indoor smoking bans are more likely to reduce adolescent female tobacco use (Carton et al. 2016). On the other hand, men are more responsive to cigarette taxes than women (Goel and Nelson, 2005). Finally, tobacco spending has an insignificant effect on quitting attempts on college females but larger significant effects on college males (Ciecierski et al. 2011). We contribute to the literature by examining how tobacco program spending affects tobacco use of adolescents by gender. We also develop a theoretical model to identify an instrument and explain our empirical results relating the differential effect of tobacco program spending on adolescent tobacco use by gender.

We extend the literature on the effects of corruption on policy instruments. The literature classifies two types of corruption. Petty corruption involves payments to avoid the effects of legislated policies, while grand corruption occurs when special interest groups attempt to influence policy by offering political support (Wilson and Damania 2005; World Bank 2000). Throughout the paper, our definition of corruption refers to the latter. The seminal work by Grossman and Helpman (1994) highlighted the role of lobbying in distorting trade policies that benefited a particular lobby group. Import barriers are higher in countries where organized lobbying is more prevalent (Gawande and Bandyopadhyay, 2000; Goldberg and Maggi, 1999). Damania et al. (2003) and Damania and Fredriksson (2003) find that lobbying also affects the effectiveness of environmental policy. Countries that are open to trade and foreign direct investment may choose more lax environmental regulations due to the effect of lobbying contributions. Campaign contributions also influence tax policy. Chirinko and Wilson (2010) show that for every $1 in campaign contributions, businesses derive a $4 gain from lower corporate taxes.

Lobby groups can also affect public spending of the government. Keefer and Khemani (2005) write that for the poor to obtain public services, their ability to organize and lobby the government is important. Liu and Mikesell (2014) empirically estimate the effect of corruption on different types of state expenditures to show that it has adverse effects on education and health services but can increase capital construction and public infrastructure. They employ a dynamic panel model that does not account for annual dummies, does not cluster standard errors, and assumes that such expenditures are stock variables and not flows. We empirically estimate a model that accounts for state and year effects, clusters standard errors and treats annual expenditures as flows rather than stocks.

We are aware of one study to date that links the effects of corruption on smoking behavior. Bogdanovica et al. (2011) show that more corrupt countries tend to have higher smoking prevalence using a reduced form model with cross-country data. They hypothesize that corruption reduces available tobacco education and prevention programs leading to more use of tobacco products. We significantly add to their analysis by measuring the entire mechanism and not just employing a reduced form estimation.

We adapt a common agency model where businesses organize lobby groups to obtain a larger share of state expenditures to the detriment of providing social services. The policymaker weighs lobbying contribution and aggregate social welfare when choosing the composition of public spending between businesses and social services. The policymaker’s weight on political contribution is a measure of corruption. We show that a more corrupt policymaker will increase spending on subsidies to all firms which crowd out social services such as education programs when the policymaker tries to achieve a balanced budget. Lower spending on tobacco prevention and education programs unambiguously decrease the probability of never trying an addictive good. For current consumers of the addictive good, such a change in spending may also increase the consumption level when the elasticity of marginal utility of health is elastic where the consumer has a higher marginal utility from an additional unit of addictive good compared to an additional unit of health.

To test our theoretical results, we use individual level data on adolescent health choices and characteristics across states in the U.S. from the Youth Risk Behavior Surveillance System (YRBSS) and match them with state level tobacco education program spending data along with a proxy for state level corruption. Our corruption proxy measures the number of convicted public officials per state legislator.

We find that corruption has a negative and significant effect on tobacco education program spending. Our Stock-Yogo test indicates it is not a weak instrument. Tobacco education spending per capita decreases by $4 to $6 per capita for every 1 public official conviction per legislator. The instrumental variable estimates indicate that tobacco education program expenditure per capita has a negative and significant effect on adolescents' tobacco use. An additional $1 of tobacco education program spending per capita increases the probability that a respondent will never smoke by 8%. The effect is the same for males and females. We also find that more tobacco program spending significantly decreases the frequency of tobacco use for current female adolescent smokers but has an insignificant effect on their male counterparts. Based on our theoretical model, this may be due to females having a more inelastic marginal utility for health. If Texas, the most corrupt state in our sample, reduced its corruption level to the same level as Idaho, the least corrupt state in our sample, the probability that an adolescent will never smoke increases by 26% and the number of smoking days for female adolescents drops by 4 days per month.

II. Theoretical Framework

We present a theoretical model that illustrates a mechanism linking corruption to the consumption of an addictive good in order to derive testable theoretical hypotheses and identify an instrument for our empirical estimation.

2.1 Set up and Assumptions

There are two sectors in the economy. The first sector produces an addictive good that decreases the health level of an individual and its consumption creates a negative externality.

For example, consumption of tobacco products creates second-hand smoke and alcohol consumption could lead to drunk driving accidents. The second sector produces a composite good. Consumers decide how much to consume of each good given a budget constraint. The government chooses how much of its budget to allocate between subsidizing production in the two sectors and educating the populace on the link between using the addictive good and health. The government may be influenced in their spending allocation choice by a lobby group from the firms in the two sectors in the economy.

The representative individual has quasilinear utility over their consumption of the addictive good and composite good, $V = v(a, \theta(e)h(a); \boldsymbol{Z}) + c$ where a is the quantity of addictive good consumed, c is the quantity of composite good consumed, $h(a)$ is the true health level of the individual, e is the level of education chosen by the government, $\boldsymbol{Z}$ is a vector of individual characteristics and $0 < \theta(e) < 1$ is the weight that the individual places on how their own health yields utility. We define $H \equiv \theta(e)h(a)$ as the perceived health level of the individual. An increase in consumption of the addictive good decreases the true health level of the individual at a decreasing rate, i.e. $h_a < 0$ and $h_{aa} < 0$ (Chaloupka, 1991). Also, more educated individuals have a larger weight on how health influences utility, i.e. $\theta_e > 0$ (Cutler and Lleras-Muney, 2008, 2010; Grossman, 1972).[1] Note that in our specification, if $a = 0$ then $v(0, \theta(e)h(0); \boldsymbol{Z}) > 0$. We allow consumption of the addictive good to increase utility at a decreasing rate along with perceived health level, i.e. $v_a > 0$, $v_{aa} < 0$, $v_H > 0$, $v_{HH} < 0$ and $v_{aH} < 0$.

Output in each sector is sold in a competitive market. The price in the composite goods sector is normalized to 1. The production function for a representative firm in each sector is $f^j(k + g)\ \forall j \in a, c$ where k is privately purchased capital and g is government-

[1] With regard to tobacco control policies, cessation rates of current smokers are greater among higher educated groups compared to lower educated groups in select European countries (Schaap, et al. 2008).

provided capital. In both sectors, output is increasing at a decreasing rate in privately purchased capital, i.e. $f_k^j > 0$ and$f_{kk}^j < 0$ and k and g are substitutes, $f_{kg}^j < 0$.

We solve a three-stage complete information game for the subgame perfect Nash equilibrium using backward induction. In the first stage, a lobby group comprised of firms in both sectors presents a contribution-expenditure schedule to the government where it promises to provide contributions to the policymaker if a particular level of government-provided capital, g, is chosen. In the second stage, the government sets the composition of spending between the publicly provided input and education given a fixed budget while accounting for the contribution-expenditure schedule from the lobby group. Finally, firms in each sector simultaneously and independently purchase capital and individuals buy goods.

2.2 Solution Through Backward Induction

We start by solving the third stage and continue recursively.

2.2.1 Third Stage – Firm Input and Household Consumption Decision

The representative firms in each sector maximize profit,

(1) $\pi^j(p, r, g) = \max_k \{pf^j(k+g) - rk - t^j\}$

where r is the price of capital, t^j is a flat tax used to raise revenues to produce the government-provided input or education and p is the relative price of the addictive good such that the price of the composite good is normalized to 1. The first order condition is,

(2) $pf_k^j(k+g) - r = 0$,

which states that the value of marginal product of capital is equal to its input price. Because of our assumption of substitutability between privately purchased capital and government-provided capital, more government-provided resources will decrease the amount of privately purchased capital such that $\frac{dk}{dg} < 0$.

The representative household maximizes utility subject to the following budget constraint, $(1-t^l)I = pa + c$, where I is income and t^l is an income tax rate. Given the quasilinear utility function, the optimal condition that determines the level of consumption of the addictive good is,

(3) $v_a + v_H\theta(e)h_a - p \leq 0$.

Here, if the marginal disutility from the health effect of consuming the addictive good along with the purchasing price outweighs the marginal utility of its consumption, then $a = 0$. In this case, the utility from not consuming the addictive good is greater than the utility from consuming any positive level of the addictive good,

(4) $\Omega \equiv v^*(0, \theta(e)h(0); \boldsymbol{Z}) - (\hat{v}(\hat{a}, \theta(e)h(\hat{a}); \boldsymbol{Z}) - p\hat{a}) > 0 \quad \forall \ \hat{a} > 0$.

An interior solution exists if (3) holds with equality yielding a positive optimal level of the addictive good,

(5) $a^* = a(p, e; \boldsymbol{Z})$.

Addictive good consumption is dependent on price, education and individual characteristics.

The resulting indirect utility function is, $V^*(p, e, t^l, I; \boldsymbol{Z}) = S + (1-t^l)I$ where $S \equiv v^*(a^*, \theta(e)h(a^*); \boldsymbol{Z}) - pa^*$ is a measure of consumer surplus from the joint consumption of health and the addictive good. Even if no addictive good is consumed, consumer surplus is still positive since $S = v^*(0, \theta(e)h(0); \boldsymbol{Z}) > 0$. An increase in educational provision by the government, unambiguously increases consumer surplus since $\frac{dS}{de} = v_H^*\theta_e h > 0$.

We find that an increase in education has two effects on the consumer. First, if the individual's optimal level of addictive consumption is zero, the difference in utility from not consuming the addictive good versus consuming the addictive good will unambiguously increase when education rises, i.e. $\frac{d\Omega}{de} > 0$ (see Appendix 1). Therefore, education increases the possibility that an individual will never consume the addictive good. Second, if the consumer is already consuming the addictive good, an increase in education decreases the level of consumption of the addictive good, i.e. $\frac{da}{de} < 0$, only if (see Appendix 1),

(6) $\varepsilon > -\frac{v_{aa}h^2}{v_H h_a} - \frac{H}{\theta}$,

where $\varepsilon \equiv v_{HH}\frac{H}{v_H}$ is the elasticity of marginal utility of perceived health. This condition calls for the representative consumer to have an elasticity of marginal utility of health that is relatively inelastic. This implies that an additional unit of improved health quality will not decrease the marginal utility of health as much compared to an additional unit of consuming the addictive good.

Gender differences may contribute to different elasticities of marginal utility of health. Females are more likely to be health conscious than males because they tend to have a better knowledge and awareness of the importance of nutrition (Kiefer et al. 2005, Ek 2013). The higher level of health awareness among females may also explain why they are more likely to purchase health insurance than males (Cowan and Schwab 2016, Cylus et al. 2011). Thus, females are more likely to have a more inelastic marginal utility of perceived health which implies they are more likely to reduce addictive good consumption than males.

In summary, we find that education will increase the probability that non-users will never try the good but it may only help to reduce the level of addictive good consumption for current users only if the individual sufficiently cares about their own health.

2.2.2 Second Stage – Government's Budget Allocation Decision

The aggregate welfare in the economy is a summation of the aggregate profits in both sectors; welfare of the representative consumer net of disutility from the externality; and tax revenues net of the cost of providing education and government-provided input,

(7) $W = m^a \pi^{a*}(p, g, r, t^a) + m^c \pi^{c*}(p, g, r, t^c) + V^*(p, e, t^l, I; \boldsymbol{Z}) - X(p, e; \boldsymbol{Z}) +$
$m^a t^a + m^c t^c + t^l I - w^g g - w^e e,$

where $X(p, e; \boldsymbol{Z})$ is aggregate disutility that is external to the individual consumer; m^j are the total number of firms in sector $j \in a, c$; w^g is the price of the government-provided input; and w^e is the price of education.

A government planner who only maximizes the welfare function optimally selects the level of education and government-provided inputs to maximize welfare subject to the budget constraint that aggregate tax revenues equal aggregate expenditures, i.e. $m^a t^a + m^c t^c + t^l I = w^g g + w^e e$. Substituting the constraint into the welfare function and solving for e yields the following condition,

$$(8)\ \frac{\partial W}{\partial e} = \left(m^a p f_g^a + m^c f_g^c\right)\frac{dg}{de} + v_H^* \theta_e h - X_a \frac{da}{de} = 0,$$

where $\left.\frac{dg}{de}\right|_{d(m^a t^a + m^c t^c + n t^l I)=0} = -\frac{w^e}{w^g}$. Here, the marginal benefits from education in the form of increased marginal utility from health and reduction in the marginal disutility from the externality equal the summation of the value of marginal product from the government-provided input from all firms.

Following Grossman and Helpman (1994), a government planner who cares about lobby contributions as well as aggregate economic welfare maximizes the following function subject to the same budget constraint,

$$(9)\ \max_e G = W + \alpha L \qquad s.t.\, m^a t^a + m^c t^c + t^l I = w^g g + w^e e,$$

where L is the aggregate lobby contributions by all firms and α is the weight that the government planner places on the lobby contribution. The aggregate lobbying contribution in the government's welfare function can be viewed as monetary earnings that can be used to run for re-election or used privately by the government planner. When α is large, the government places more weight on its own self-interest than the welfare of their constituents. A number of studies interpret this weight, α, as a measure of corruption because a larger value implies more selfish behavior (see Damania et al. 2003, Damania and Fredriksson 2003, Fredriksson and Svensson 2003, Fredriksson et al. 2003).

The first order condition from the government's problem is,

$$(10) \qquad \frac{\partial G}{\partial e} = \left(m^a p f_g^a + m^c f_g^c\right)\frac{dg}{de} + v_H^* \theta_e h - X_a \frac{da}{de} + \alpha \frac{dL}{dg}\frac{dg}{de} = 0.$$

The government equates the marginal benefits from education (the second and third term) to the marginal benefits from government-provided inputs (first term) and the marginal cost of losing lobby contributions (last term). Note that the last term is derived from the lobby group's decision in the first stage.

2.2.3. First Stage – Lobby Group's Decision

The lobby group is composed of all the firms in both sectors of the economy. The lobby group chooses the amount to contribute to maximize aggregate profit for the entire production sector,

$$(11) \qquad \max_L m^a \pi^{a*}(p, g, r, t^a) + m^c \pi^{c*}(p, g, r, t^c) - L.$$

Taking the first order condition with respect to L, we find,

$$(12) \qquad \left(m^a p f_g^a + m^c f_g^c\right)\frac{dg}{dL} - 1 = 0.$$

The lobby group offers contributions to the government up to the point where the marginal cost of lobbying equals the value of marginal product of the government-provided input from lobbying. Using the inverse function rule, we re-write the above first order condition as, $\left(m^a p f_g^a + m^c f_g^c\right) = \frac{dL}{dg}$. The association offers a contribution – expenditure schedule to the government planner where an interior solution occurs when $\frac{dL}{dg} > 0$. This implies that the lobby group offers more contributions to the government only if more government-provided capital is produced. Bernheim and Whinston (1986) and Grossman and Helpman (1994) refer to this as the local truthfulness condition.

Substituting the local truthfulness condition into the first order condition of the government's problem in (10) yields,

$$(13) \qquad (1+\alpha)\left(m^a p f_g^a + m^c f_g^c\right)\frac{w^e}{w^g} = v_H^* \theta_e h - X_a \frac{da}{de}.$$

Note that compared to equation (8) where $\alpha = 0$, more weight is placed on the value of marginal product of the government-provided input for all firms when the policymaker cares about contributions from the lobby group. The optimal level of education provided by the government depends on the price of the addictive good, prices of government-provided inputs, measure of corruption and the size of the sector,

$$(14) \qquad e(\alpha, w^e, w^g, p, m^a, m^c; \boldsymbol{Z}).$$

The weight the government places on own welfare acts to increase the marginal value it places on the government-provided input. More formally, we find that the impact of α on e is the following, $\frac{de}{d\alpha} < 0$ (see Appendix 1). Our model shows that when all firms from both sectors lobby the government for the government-provided input, it crowds out tobacco prevention and education programs when a balanced budget is required.[2] Thus, more weight on lobbying contribution decreases education provision.

The total effect of the lobbying weight on the consumption of addictive goods is derived by combining the results in Stages 1 and 3. For an individual that does not consume an addictive good, the total effect of an increase in corruption leads to a decrease in the possibility of never consuming the good. For a current consumer of the addictive good, the total effect of an increase in corruption yields an increase in consumption of the addictive good, such that $\frac{da}{d\alpha} > 0$, as long as the elasticity of marginal utility of health is relatively inelastic (see Appendix 1). In this case, an increase in corruption leads to more of the government-provided input which crowds out education when a balanced budget is required, consequently resulting in more use of the addictive good.

[2] López and Galinato (2007) find that lobbying induces a biased allocation of public expenditures toward subsidies for private firms and causes public goods to be under-supplied that could have been used in education, research and development, health, and other social programs.

III. Empirical Model

To test the theoretical results, we estimate a two-equation model. Based on equations (14) and (5), we specify an instrumental variable – two-way fixed effects model to account for endogeneity of spending in the latter equation by using a proxy for corruption as an instrument in the former equation. From equation (5), the estimating equation is written as,

$$(15) \quad a_{isy} = \gamma_0 + \gamma_1 e_{sy} + \gamma_2 p_{sy} + \sum_{j=3}^{n} \gamma_j Z_{isy}^{j} + \vartheta_s + \rho_y + \epsilon_{isy}$$

where a_{isy} is a measure of addictive good consumption by an individual i in state s at year y, e_{sy} is a measure of education spending per capita in state s during year y, p_{sy} is a measure of the price of the addictive good in state s during year y, Z_{isy}^{j} is the jth demographic characteristic of an individual i in state s at year y, ϑ_s is a state fixed effect, ρ_y is a year fixed effect and ϵ_{isy} is a random disturbance term. For education spending to adversely affect the consumption of the addictive good, we expect $\gamma_1 < 0$ if a_{isy} is the frequency of using the addictive good and $\gamma_1 > 0$ if a_{isy} is the probability of never using the addictive good.

One important issue regarding the estimation of equation (15) is the endogeneity of the education spending variable. There is likely to be bi-directional causality. One possibility is that when states have more individuals consuming addictive goods, it will increase spending on education programs to reduce such a phenomenon. If this is the case, a fixed effects regression that does not account for this endogeneity will have a larger γ_1 compared to the case where endogeneity is controlled. Alternatively, a downward bias may occur if states with less smoking will tend to spend more on tobacco-control if the median voters are more likely to be anti-smoking. We estimate equation (15) using an instrumental variable model to correct for estimation bias where our instrument is from the equation below.

From our model, we write the following equation showing the determinants of education spending,

(16) $e_{sy} = \beta_0 + \beta_1 \alpha_{sy} + \sum_{j=2}^{n} \beta_j Z_{isy}^{j} + \sigma_s + \varepsilon_y + \mu_{isy}$

where α_{sy} is a measure of corruption in state s during year y, σ_s is a state fixed effect, ε_y is a year fixed effect and μ_{isy} is a random disturbance term. For the measure of corruption to adversely affect education spending, we expect, $\beta_1 < 0$. Our corruption measure acts as an instrument for education spending in equation (15) since it is not likely to directly affect the consumption of addictive goods except through the budget spending decision of the policymaker. The total effect of corruption on the level of addictive good consumption is $\beta_1 \gamma_1 > 0$ or when analyzing the probability of never using the addictive good it is $\beta_1 \gamma_1 < 0$.

There are several issues regarding the estimation of both equations. First, based on equation (14), we also identify prices of government-provided inputs and the number of firms in each sector as determinants of education spending. In our empirical framework, they can be interpreted as additional instruments suggested by our theoretical model. However, unlike our measure of corruption, which serves as our main instrument, prices of government-provided inputs and the number of firms may affect the purchase of addictive goods through other mechanisms aside from education spending. For instance, an increase in the number of firms providing the addictive good increases supply which can reduce equilibrium price of the addictive good leading to more of its purchase. Also, if government-provided inputs substitute or complement the privately purchased inputs by a firm, any change in the input price of the government-provided good will affect input use by the firm and consequently, supply of the addictive good. We use as our baseline estimation a just-identified system where only the corruption proxy is our instrument. However, we also estimate an over-identified system that includes proxies for prices of government-provided inputs and the number of firms as additional instruments to provide an additional robustness check that follows from our theoretical model.

The second issue is that there may be other state characteristics that create an environment where an individual becomes more or less likely to consume an addictive good. We include proxies for wealth and experience of the population, economic conditions and racial composition to control for these environmental factors at the state level. Finally, we cluster observations to account for autocorrelation among individuals within states.

IV. Data.

The most important variables in our estimation are a measure of addictive good consumption, education spending, and a corruption measure. We use individual level data on adolescent health choices and characteristics across U.S. states and match them with state level tobacco program spending along with a proxy for state level corruption. The length and width of our panel are limited by a combination of our individual level data and tobacco use data which only overlap the years 2009 and 2011 for 32 states. Table 1 presents the summary statistics and Appendix 2 details the definition and sources of the data.

Our main measure of addictive good consumption is tobacco use by adolescents reported every two years from the YRBSS. We use two measures of tobacco use in adolescents. The first is an indicator variable stating if they have ever smoked or not, which reflects the case comparing if $a = 0$ yields a higher level of utility than if a is some positive level. The second is a measure indicating the frequency an adolescent has smoked in the past 30 days which reflects the case where $a > 0$. The average number of adolescents who have never smoked is 65% in our sample. The highest rate in our sample is in Massachusetts where 77 % of the adolescent have never smoked while in Kentucky it is only 51%. The average frequency of smoking days in the past month is 2.5 days. The highest frequency is in Kentucky at 5.6 days per month while the lowest is in Oregon at 0.8 days per month.

Our measure of education expenditure is tobacco control program spending on tobacco prevention and control that can directly influence tobacco use by adolescents collected by the University of Illinois at Chicago Health Policy Center. The federal government launched the National Tobacco Control Program in 1999 to provide a foundation for state action. Different states have varying tobacco control programs that may even have started before the federal tobacco program. The statewide tobacco programs aim to prevent initiation among youth and young adults, promote quitting among youth and adults, eliminate exposure to secondhand smoke, and eliminate tobacco-related disparities among population groups. For example, the tobacco control programs run statewide media campaigns, execute regulatory initiatives, and funds organizations tasked to develop community partnerships for tobacco control, youth action programs, and school policy programs. In our sample, the average spending is $2.47 per capita, but there is a significant variation across the states. Delaware spends $11.24 per capita on the tobacco control programs while Tennessee spends only $0.27 per capita.

Our corruption measure is based on the number of public officials who have been convicted for violations of federal corruption laws reported in the Public Integrity Section of the U.S. Department of Justice.[3] We compile the total number of convicted public officials by state and divide them by the total number of state legislators in the State Senate and the State House of Representatives. Our corruption index is the number of the convicted public officials per legislator where a larger value indicates a more corrupt state. Other empirical studies on corruption have used similar corruption proxies (Adserà et al., 2003; Alt and Lassen, 2008, 2014; Glaeser and Saks, 2006; Liu and Mikesell, 2014; Meier and Holbrook, 1992; Zuo and Schieffer, 2013).[4] This variable serves as our main instrument in identifying

[3] The federal official bribery and gratuity statute, 18 U.S.C. § 201 (enacted 1962) defines the term "public official" as "a Member of Congress, Delegate, or Resident Commissioner, either before or after such official has qualified, or an officer or employee or person acting for or on behalf of the United States, or any department, agency or branch of Government thereof, including the District of Columbia, in any official function, under or by authority of any such department, agency, or branch of Government, or a juror."

[4] The underlying assumption that allows such use of the variable as a proxy in the empirical model is that legislators convicted of corruption are more likely to be influenced by lobbying. There are a number of examples of such occurrences at the federal level (DOJ, 2011) and the state level (DOJ 2012, Orso 2016, FBI 2011).

the effect of tobacco education program spending on tobacco use.

There are two potential criticisms of our corruption measure. First, the number of convicted public officials may not embody the true level of state corruption. Meier and Holbrook (1992) and Glaeser and Saks (2006) show how strongly correlated the state's public official conviction rankings match the general perception of state corruption. Using the full sample of our corruption index, the five most corrupt states are California, Florida, Texas, Ohio, and Illinois while the five least corrupt states are Maine, Rhode Island, Utah, Kansas and Idaho which matches general perception of state corruption rankings.

The second potential criticism is that our measure of corruption captures the effect of law enforcement ability and not corruption. However, Liu and Mikesell (2014) show that the conviction rate of public officials is not correlated with working hours of U.S. attorneys, a number of Federal state judges or district court caseloads which are measures of the degree of law enforcement or availability of court resources.[5]

We use other control variables from the YRBSS database in order to capture adolescents' characteristics, preferences and risk attitudes. We also include state demographic variables, racial composition and unemployment levels using data from the U.S. Census Bureau. Finally, we use cigarette tax data from Orzechowski and Walker (2014) to proxy for the price of tobacco products.

V. Results

We present Two-Way Fixed Effects regressions to estimate equation (16) and IV Two-Way Fixed Effects regressions to estimate equation (15). To increase the reliability of inference in our estimation, we cluster observations at the state level to obtain robust standard

[5] The alternative interpretation of our instrument as a measure of law enforcement ability instead of corruption has no effect on our empirical model. In this regard, the mechanism linking the two variables is that more expenditures are needed for more stringent law enforcement which crowds out some of the spending on other social services such as tobacco spending leading to a higher prevalence of smoking.

errors. We present two sets of regressions. The first set is our baseline model using corruption as our only instrument for tobacco education program spending which is our just identified model. The second set of regressions follows closer to our theoretical model by including more instruments that proxy equation (14) as an additional robustness check which is our over identified model. This includes the number of firms by state and the housing price index to proxy for the price of government-provided inputs.

5.1 *Baseline Results*

Table 2 presents the results measuring the effect of corruption on state level tobacco education program spending. The effect of corruption on tobacco education program spending is negative and significant in all specifications and we obtain reasonable magnitudes which indicate that our instrument is not weak.[6] Based on our estimates, for every 1 public official conviction per legislator, tobacco education program spending decreases by $4 to $6 per capita. For an average state in our sample, the corruption measure is 0.16. A one standard deviation increase in corruption corresponds to a drop in tobacco education program spending per capita by $0.52 to $0.86 which is approximately a 30% reduction in tobacco program spending from the mean level.

Table 3 summarizes the effect of tobacco education program spending on the choice of adolescents to smoke. After instrumenting with our corruption measure, we find a significant and consistent result that an increase in tobacco education program spending per capita by $1 leads to an increase in the probability that an adolescent will never smoke by 8%. The average spending on tobacco education program per capita is $2.47. A one standard deviation increase leads to an increase in the probability that an adolescent will never smoke by 18%. These values imply a point elasticity for never smoking equal to 0.32. Not

[6] We provide a more formal statistical test using the Stock-Yogo test for weak instruments in the following tables.

surprisingly, adolescents who are more risk averse, female and younger are more likely to never smoke than their peers.

Table 4 shows the results by gender subsamples. We find that there is no significant difference on the probability of never smoking by adolescent males and females from tobacco spending programs. The results are identical where a $1 per capita increase in tobacco program spending leads to a 8% increase in the probability of never smoking. This result is supported by our theory since tobacco education programs have an unambiguously positive effect on the likelihood of never smoking regardless of gender.

To formally determine the strength of our instrument, we employ the Stock-Yogo test for weak instruments. This tests weak instruments based on the bias of the estimator and the size of the distribution of the assumed Wald Statistic (Stock and Yogo, 2005). Using a maximal size test, we find that if we are willing to accept a rejection rate of at most 15% for the Wald test, our instrument is not weak as shown by our Kleibergen-Paap Wald F statistic. Note that this only holds for the just identified case.

The tobacco education program spending coefficient on our tobacco use variables using instrumental variables is smaller than the case where we only employ Fixed Effects estimation without instruments as shown in the last two columns of Table 3. Without accounting for the endogeneity of spending, an upward bias may occur in the Fixed Effects coefficient if more tobacco education program spending lowers tobacco use; which in turn, reduces tobacco education spending. The net effect is a lower level of tobacco education spending needed to create a reduction in tobacco use resulting in larger parameter estimates.

Using data from 1985 to 2003, Farrelly et al. (2008) find that if tobacco program expenditures per capita doubled, it would lead to a reduction in adult smoking by 1% to 1.7%. In a recent study, Farrelly et al. (2014) show that doubling cumulative funding for state tobacco control programs decrease the number of current adolescent smokers by 3.2% to

3.6%. Similarly, Ciecierski et al. (2011) find that a doubling in expenditures related to tobacco prevention per capita reduced college smoking by 3.8%. The average spending on tobacco programs per capita is $0.92 based on the sample data from 1997 (Ciecierski et al. 2011). The implicit elasticity of never smoking is 0.16. All three studies do not instrument for tobacco education program spending which implies a possible bias in estimates. Our results use a more recent sample of tobacco education expenditure with higher average spending per capita than previous years resulting in a larger elasticity. This implies that tobacco education program spending has not yielded a diminishing marginal return on the probability of never smoking which means that additional spending on tobacco education is not yet at the optimal level and may benefit from more state allocation in the program.

Table 5 shows the effect of tobacco education program spending per capita on the frequency of smoking days per month by adolescents. The effect of tobacco education program spending reduces the number of smoking days but the effect is not significant for all adolescents when introducing an instrument for the variable. However, tobacco spending has a differential effect on adolescent smoking days by gender as shown in Table 6. The effect is insignificant for males but for every dollar spent per capita, female adolescent smokers reduce smoking days by 1 per month. Our theoretical model provides a plausible explanation. Females are more likely to have an inelastic marginal utility for health than males which implies that female tobacco users are more likely to reduce their consumption.

The absolute value of the Fixed Effects estimates not controlling with instruments are larger in magnitude and significant. This indicates that not controlling with an instrument could overestimate the significance of tobacco education program spending in reducing the number of additional smoking days for current adolescent smokers. Rhoads (2012) find that for adults, comprehensive cumulative tobacco control expenditure with a 10% discount rate significantly affects an average number of cigarettes per smoking day. The potential endogeneity of tobacco expenditure was not controlled for in her estimation which could have led to the significance and upward bias in her estimates.

Interestingly, when focusing on the contemporaneous effect of tobacco expenditure on smoking days and allowing for higher discount rates with cumulative expenditure, Rhoads finds that the effect is not significant. Since her results regarding cigarette consumption on smoking days are not as robust compared to the prevalence of smoking, she concludes that tobacco programs are more effective in preventing and stopping adult smoking behavior altogether and will not necessarily aid in reducing the frequency of smoking. Our estimates point to similar results for adolescent smoking but with an important caveat. We find that the true value of tobacco education programs is the prevention of smoking for all adolescents and the reduction in the frequency of smoking for current adolescent smokers may significantly affect only individuals who have inelastic marginal utilities of health such as females.

5.2 Total Effect of Corruption on Tobacco Use

The total effect of corruption on tobacco use is summarized in Table 7. The empirical results support our theoretical predictions. As our corruption measure increases, the probability of not smoking significantly decreases. We find that a standard deviation increase in the public official conviction per legislator decreases the probability of not smoking by 7%. Based on our sample, Texas is the most corrupt state with an index of 0.52 and Idaho is the least corrupt with an index of 0.02. If Texas reduced its corruption to the level of Idaho, the probability that an adolescent will not smoke increases by 26%. The effect across gender is identical.

Corruption increases the frequency of smoking per month but the magnitude is only significant for females. Our results indicate that corruption can have a significant impact on the choice of an adolescent to engage in a risky activity or not through tobacco education programs. However, once the adolescent chooses to engage in smoking, the effect of corruption through education on reducing the frequency of the activity is not significant for individuals with elastic marginal utility of health such as males. However, it is significant for female adolescents because their marginal utility of health is likely to be more inelastic.

VI. Conclusion

This article investigates the link between tobacco education programs and adolescent tobacco use and how corruption affects this link. We theoretically model how corruption influences the policymaker to increase government spending that subsidizes production by firms to the detriment of providing public goods such as education and health services when meeting a balanced budget. The reduction in such spending services leads to an increase in consumption of addictive goods. Our theoretical model predicts that an increase in corruption unambiguously decreases the probability of never consuming an addictive good and may increase the level of consumption of an addictive good by current users under a certain condition. Our model shows that it is more difficult for users of addictive goods to reduce consumption when education increases if they have an elastic marginal utility of health. If this is the case, current consumers of the addictive good may trade off consuming more units of the addictive good rather than obtaining an additional unit of better health quality.

We test the results of our theoretical model by estimating a two-equation system. The first equation estimates the effect of convicted public officials per number of legislators, our proxy measure for corruption, on tobacco education program spending per capita. The second equation measures the effect of tobacco education program spending on two variables relating to tobacco use: the choice never to smoke and the frequency of smoking in the past month. The second equation uses an instrumental variable Fixed Effects approach where the instrument is our measure of corruption in the first equation.

Instrumenting with corruption reduces the bias in the coefficient for tobacco education program spending on tobacco use. We find that tobacco education program spending significantly increases the probability of never smoking for all adolescents but has a negative and significant effect of the frequency of smoking for female adolescents but not males. A $1 increase in tobacco education program spending per capita increases the probability of not smoking by 8% for all adolescents and a reduction of 1 smoking day per month for females.

Corruption significantly and consistently reduces tobacco education spending. Hence, the total effect of higher corruption on our indicators of tobacco use is significant and positive. More corruption decreases the probability of never smoking and the results are robust across various specification. Also, corruption does increase the frequency of smoking but the results are robust only for female adolescents. If Texas, the most corrupt state in our sample, reduced its corruption level to the same level as Idaho, the least corrupt state in our sample, the probability that an adolescent will never smoke increases by 26% in that state and the number of smoking days for female adolescents drops by 4 days per month.

The effect of corruption on our tobacco use indicators indicates that it is inelastic. The magnitude of the marginal effect is reasonable and relatively small. Relative to other direct factors such as prices, social pressure or family environment, we would not expect an underlying factor such as corruption to have a large magnitude. However, its significance is interesting from a policy standpoint since this is the first paper that we are aware of the empirically links corruption to adverse health effects through education spending. Thus, any potential reduction in corruption not only provides for better regulations and higher economic welfare (Djankov et al., 2002; Lambsdorff, 2001; Olken, 2006) but we also show that it has a positive effect on an individual's health quality.

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Table 1: Summary statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
State level					
Tobacco program	64	2.470	2.121	0.22	12.62
Corruption	64	0.165	0.142	0.010	0.575
Firms	64	155283.2	143854.3	19472	697082
Housing price index	64	0.959	0.0577	0.750	1
Cigarette tax	64	115.693	81.060	16.214	414.884
Median age	64	37.395	1.720	33.5	41.5
Median income	64	5.048	0.750	3.810	7.035
Unemployment	64	8.941	1.576	6.4	13.5
Hispanic portion	64	15.353	22.483	1.193	167.856
Male portion	64	49.219	0.536	48.358	50.548
Individual level					
Never smoke	27840	0.645	0.479	0	1
Smoking days	27289	2.532	7.252	0	30
Male	28256	0.495	0.500	0	1
Hispanic	28256	0.302	0.459	0	1
Combined race	28256	5.041	1.498	1	8
Age	28256	16.125	1.233	12	18
Never felt unsafe in school	28154	0.944	0.230	0	1

Table 2: First stage using two-way fixed effects, 2009-2011 for tobacco education program expenditure

	(1)	(2)	(3)	(4)
State characteristics				
Corruption	-6.079***	-4.931**	-3.692**	-3.907**
	(1.788)	(2.028)	(1.699)	(1.652)
Firms	0.00004*		0.00005*	
	(0.00002)		(0.00003)	
Housing price index	-3.536		-0.016	
	(2.402)		(2.389)	
Cigarette tax	-0.010***	-0.008*	-0.010**	-0.009**
	(0.003)	(0.005)	(0.004)	(0.004)
Median age	-1.989***	-1.585***		
	(0.378)	(0.469)		
Median income	0.713*	0.836**	0.479	0.852**
	(0.390)	(0.367)	(0.460)	(0.395)
Unemployment	-0.216**	-0.125		
	(0.088)	(0.097)		
Hispanic portion	0.064***	0.088***	0.083***	0.087***
	(0.013)	(0.009)	(0.023)	(0.015)
Male portion	-11.298***	-14.176***	-11.528***	-11.667***
	(1.937)	(1.501)	(3.464)	(2.148)
Individual characteristics				
Male	0.001	-0.001	0.0005	-0.0002
	(0.001)	(0.002)	(0.002)	(0.003)
Hispanic	0.019*	0.025*	0.018	0.043**
	(0.011)	(0.013)	(0.014)	(0.020)
Combined race	-0.003**	-0.004*	-0.001	-0.002
	(0.001)	(0.002)	(0.002)	(0.003)
Age	-0.0004	-0.002**	-0.001*	-0.002*
	(0.0005)	(0.0007)	(0.0008)	(0.0009)
Never felt unsafe in school	0.007**	0.012***	0.013***	0.012**
	(0.003)	(0.003)	(0.005)	(0.005)
Year and state dummies	Yes	Yes	Yes	Yes
N	28154	28154	28154	28154
Adj. R-sq	0.994	0.992	0.991	0.989

Clustered standard errors in parentheses.
* p<0.1 ** p<0.05 *** p<0.01

Table 3: The determinants of adolescents choosing not to smoke, 2009, 2011.

	IV- Two Way Fixed Effects		Fixed Effects	
	Just-identified	Over-identified	Just-identified	Over-identified
State characteristics				
Tobacco program	0.086***	0.084**	0.102***	0.100***
	(0.03)	(0.038)	(0.018)	(0.025)
Firms	0.000002		0.0000008	
	(0.000003)		(0.000003)	
Housing price index	0.763***		0.767***	
	(0.207)		(0.202)	
Cigarette tax	0.002***	0.002***	0.003***	0.002***
	(0.0004)	(0.0003)	(0.0003)	(0.0004)
Median age	0.081	-0.093	0.094	-0.073
	(0.073)	(0.129)	(0.076)	(0.100)
Median income	0.002	0.023	0.004	0.02
	(0.068)	(0.056)	(0.067)	(0.058)
Unemployment	0.017	0.013	0.018	0.014
	(0.013)	(0.013)	(0.013)	(0.013)
Hispanic portion	-0.007**	-0.011***	-0.009***	-0.012***
	(0.003)	(0.003)	(0.003)	(0.003)
Male portion	0.894*	1.199**	1.106**	1.424***
	(0.486)	(0.575)	(0.413)	(0.395)
Individual characteristics				
Male	-0.051***	-0.051***	-0.051***	-0.051***
	(0.008)	(0.008)	(0.008)	(0.008)
Hispanic	-0.016	-0.014	-0.017	-0.015
	(0.013)	(0.013)	(0.013)	(0.013)
Combined race	-0.025***	-0.025***	-0.025***	-0.025***
	(0.006)	(0.006)	(0.006)	(0.006)
Age	-0.058***	-0.058***	-0.058***	-0.058***
	(0.003)	(0.003)	(0.004)	(0.004)
Never felt unsafe in school	0.203***	0.203***	0.203***	0.203***
	(0.02)	(0.02)	(0.02)	(0.02)
Year and state dummies	Yes	Yes	Yes	Yes
N	27744	27744	27744	27744
Adj. R-sq	0.053	0.053	0.053	0.053
Kleibergen-Paap rk Wald F statistic	11.647^{+}	3.889		

Clustered standard errors in parentheses

* p<0.1 ** p<0.05 *** p<0.01; $^{+}$ - statistically significant when allowing for 15% rejection rate. The critical values for the Kleibergen-Paap rk Wald F statistic at the 10%, 15%, 20% and 25% maximal IV size for the just-identified case are 16.38, 8.96, 6.66 and 5.53, respectively. The corresponding critical values for the over identified case are 22.3, 12.83,9.54 and 7.80, respectively.

Table 4: The determinants of adolescents choosing not to smoke by gender in the just-identified model, 2009, 2011.

	IV-Two Way Fixed Effects		Fixed Effects	
	Male	Female	Male	Female
State characteristics				
Tobacco program	0.086**	0.087***	0.108***	0.098***
	(0.036)	(0.029)	(0.019)	(0.019)
Firms	0.000002	0.0000009	0.000001	0.0000004
	(0.000003)	(0.000004)	(0.000003)	(0.000004)
Housing price index	0.766***	0.788***	0.771***	0.792***
	(0.252)	(0.181)	(0.243)	(0.178)
Cigarette tax	0.002***	0.003***	0.003***	0.003***
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Median age	0.009	0.164**	0.026	0.174**
	(0.080)	(0.070)	(0.086)	(0.069)
Median income	0.056	-0.057	0.060	-0.055
	(0.062)	(0.076)	(0.061)	(0.076)
Unemployment	0.026**	0.006	0.028**	0.007
	(0.012)	(0.015)	(0.013)	(0.015)
Hispanic portion	-0.006*	-0.009***	-0.008***	-0.010***
	(0.003)	(0.003)	(0.003)	(0.003)
Male portion	0.520	1.242**	0.817*	1.389***
	(0.504)	(0.534)	(0.420)	(0.455)
Individual characteristics				
Hispanic	-0.053***	0.019	-0.053***	0.019
	(0.016)	(0.015)	(0.016)	(0.015)
Combined race	-0.018***	-0.031***	-0.018**	-0.031***
	(0.007)	(0.006)	(0.007)	(0.006)
Age	-0.069***	-0.049***	-0.069***	-0.049***
	(0.005)	(0.004)	(0.005)	(0.004)
Never felt unsafe in school	0.248***	0.162***	0.247***	0.161***
	(0.024)	(0.017)	(0.025)	(0.017)
Year and state dummies	Yes	Yes	Yes	Yes
N	13693	14051	13693	14051
Adj. R-sq	0.051	0.029	0.063	0.042
Kleibergen-Paap rk Wald F statistic	11.287^{+}	11.421^{+}		

Clustered Standard errors in parentheses;
* p<0.1 ** p<0.05 *** p<0.01; $^{+}$ - statistically significant when allowing for 15% rejection rate. The critical values for the Kleibergen-Paap rk Wald F statistic at the 10%, 15%, 20% and 25% maximal IV size are 16.38, 8.96, 6.66 and 5.53, respectively.

Table 5: The determinants of the frequency of adolescent smoking days, 2009, 2011.

	IV- Two Way Fixed Effects		Fixed Effects	
	Just-identified	Over-identified	Just-identified	Over-identified
State characteristics				
Tobacco program	-0.405	-0.877	-0.790**	-1.003**
	(0.471)	(0.570)	(0.329)	(0.435)
Firms	-0.0002***		-0.0001**	
	(0.00005)		(0.00005)	
Housing price index	-7.916**		-8.010**	
	(3.921)		(3.658)	
Cigarette tax	-0.020***	-0.027***	-0.024***	-0.028***
	(0.006)	(0.005)	(0.005)	(0.006)
Median age	-1.425	1.211	-1.733	1.054
	(1.122)	(1.764)	(1.176)	(1.548)
Median income	0.839	-0.402	0.776	-0.373
	(1.186)	(1.002)	(1.127)	(1.014)
Unemployment	-0.057	-0.186	-0.087	-0.189
	(0.234)	(0.231)	(0.232)	(0.231)
Hispanic portion	0.085*	0.151***	0.118**	0.162***
	(0.048)	(0.048)	(0.044)	(0.048)
Male portion	-10.059	-16.415**	-15.111**	-18.253**
	(7.237)	(7.784)	(6.441)	(6.668)
Individual characteristics				
Male	0.885***	0.886***	0.884***	0.886***
	(0.130)	(0.130)	(0.132)	(0.132)
Hispanic	-1.490***	-1.529***	-1.481***	-1.525***
	(0.234)	(0.238)	(0.234)	(0.241)
Combine race	0.495***	0.492***	0.494***	0.492***
	(0.063)	(0.062)	(0.063)	(0.063)
Age	0.677***	0.673***	0.676***	0.673***
	(0.071)	(0.071)	(0.072)	(0.072)
Never felt unsafe in school	-3.491***	-3.478***	-3.483***	-3.475***
	(0.458)	(0.460)	(0.466)	(0.466)
Year and state dummies	Yes	Yes	Yes	Yes
N	27195	27195	27195	27195
Adj. R-sq	0.049	0.049	0.049	0.049
Kleibergen-Paap rk Wald F statistic	11.815^{+}	3.944		

Clustered Standard errors in parentheses;
* p<0.1 ** p<0.05 *** p<0.01; $^{+}$ - statistically significant when allowing for 15% rejection rate. The critical values for the Kleibergen-Paap rk Wald F statistic at the 10%, 15%, 20% and 25% maximal IV size for the just-identified case are 16.38, 8.96, 6.66 and 5.53, respectively. The corresponding critical values for the over identified case are 22.3, 12.83,9.54 and 7.80, respectively.

Table 6: The determinants of the frequency of adolescent smoking days by gender in the just-identified model, 2009, 2011.

	IV-Two Way Fixed Effects		Fixed Effects	
	Male	Female	Male	Female
State characteristics				
Tobacco program	0.220	-1.306**	-0.721*	-1.010***
	(0.676)	(0.565)	(0.410)	(0.325)
Firms	-0.0001**	-0.0001***	-0.0001	-0.0002***
	(0.00007)	(0.00005)	(0.00007)	(0.00005)
Housing price index	-11.141*	-4.733*	-11.339**	-4.641
	(6.107)	(2.710)	(5.278)	(2.847)
Cigarette tax	-0.016*	-0.027***	-0.025***	-0.024***
	(0.008)	(0.009)	(0.006)	(0.005)
Median age	0.083	-3.374**	-0.613	-3.110**
	(1.531)	(1.475)	(1.360)	(1.320)
Median income	0.613	1.081	0.435	1.123
	(1.442)	(1.020)	(1.250)	(1.084)
Unemployment	-0.065	-0.046	-0.132	-0.020
	(0.281)	(0.235)	(0.264)	(0.236)
Hispanic portion	0.021	0.176***	0.100*	0.152***
	(0.066)	(0.056)	(0.054)	(0.049)
Male portion	2.200	-26.469***	-10.116	-22.583***
	(10.299)	(8.262)	(8.058)	(7.171)
Individual characteristics				
Hispanic	-1.467***	-1.501***	-1.446***	-1.509***
	(0.204)	(0.300)	(0.202)	(0.304)
Combined race	0.457***	0.525***	0.456***	0.526***
	(0.061)	(0.085)	(0.062)	(0.086)
Age	0.895***	0.463***	0.894***	0.464***
	(0.096)	(0.061)	(0.097)	(0.062)
Never felt unsafe in school	-5.337***	-1.933***	-5.320***	-1.939***
	(0.484)	(0.461)	(0.491)	(0.471)
Year and state dummies	Yes	Yes	Yes	Yes
N	13325	13870	13325	13870
Adj. R-sq	0.044	0.022	0.055	0.043
Kleibergen-Paap rk Wald F statistic	11.644^{+}	11.362^{+}		

Clustered Standard errors in parentheses;
* p<0.1 ** p<0.05 *** p<0.01; $^{+}$ - statistically significant when allowing for 15% rejection rate. The critical values for the Kleibergen-Paap rk Wald F statistic at the 10%, 15%, 20% and 25% maximal IV size are 16.38, 8.96, 6.66 and 5.53, respectively.

Table 7. The effect of corruption on adolescent tobacco use

Marginal Effect of Corruption	Probability of not smoking	Frequency of smoking days in the past month
Just-identified		
Tobacco program All	-0.520***	2.463
	(0.240)	(2.951)
Tobacco program Male	-0.526**	-1.351
	(0.271)	(4.171)
Tobacco program Female	-0.517***	7.782**
	(0.233)	(4.095)
Over-identified		
Tobacco program All	-0.512**	5.328
	(0.274)	(3.804)
Tobacco program Male	-0.536**	1.312
	(0.288)	(4.248)
Tobacco program Female	-0.482**	10.633***
	(0.277)	(5.238)

Note: Standard errors are calculated using the delta method. ***p<0.05, **p<0.1, *p<0.15.

Appendix

Appendix 1. Proofs for the Theoretical Model

To derive the effect of education on Ω, we take the derivative of (4) with respect to e,

(A1) $\frac{d\Omega}{de} = v_H^*\theta_e h(0) - \hat{v}_H\theta_e h(\hat{a})$.

Since $h(0) > h(\hat{a})$ and $v_H^* > \hat{v}_H$, $\frac{d\Omega}{de} > 0$.

To derive the effect of education on addictive goods consumed, i.e. $\frac{da}{de}$, recall that the first order condition from the consumer's problem when an interior solution exists is, $v_a + v_H\theta(e)h_a - p = 0$. Totally differentiating the first order condition yields,

(A2) $\frac{da}{de} = -\frac{v_{aa}\theta_e h + v_H\theta_e h_a + v_{HH}\theta\theta_e h_a}{\frac{\partial^2 V}{\partial a^2}}$.

The denominator is negative if V is concave so the sign hinges on the numerator. Since $v_{aa} < 0$, $v_{HH} < 0$, $\theta_e > 0$, and $h_a < 0$, the numerator is ambiguous. The numerator will be negative if the elasticity of marginal utility of health, $\varepsilon \equiv v_{HH}\frac{H}{v_H}$, is relatively inelastic. To see this, assume the numerator is negative and then divide the numerator by $\frac{H\theta_e h_a}{v_H\theta}$, which is negative, to find,

(A3) $\frac{Hv_{aa}h}{v_H\theta h_a} + \frac{H}{\theta} + v_{HH}\frac{H}{v_H} > 0$.

Put the last two terms in the right hand side, define $\varepsilon \equiv v_{HH}\frac{H}{v_H}$ and recall that $H = \theta h$,

(A4) $\varepsilon > -\frac{v_{aa}h^2}{v_H h_a} - \frac{H}{\theta}$.

The elasticity of marginal utility of health, ε, is negative and the two terms on the right hand side are negative. Thus, for the numerator to be negative, the inequality in (A4) must hold which implies that ε must be inelastic.

The optimal allocation of education spending is derived by substituting the local truthfulness condition, $\left(m^a p f_g^a + m^c f_g^c\right) = \frac{dL}{dg}$, and $\left.\frac{dg}{de}\right|_{d(m^a t^a + m^c t^c + n t^l I) = 0} = -\frac{w^e}{w^g}$, into equation (9) resulting in,

(A5) $\frac{\partial G}{\partial e} = -(1+\alpha)\left(m^a p f_g^a + m^c f_g^c\right)\frac{w^e}{w^g} + v_H^* \theta_e h - X_a \frac{da}{de} = 0.$

Finally, re-arranging (A5) yields equation (12).

Totally differentiating (A5), we find

(A6) $\frac{de}{d\alpha} = -\frac{-\left(m^a p f_g^a + m^c f_g^c\right)\frac{w^e}{w^g}}{\frac{\partial^2 G}{\partial e^2}}$. If G is concave, then $\frac{\partial^2 G}{\partial e^2} < 0$. Since the numerator is negative then $\frac{de}{d\alpha} < 0$.

The total effect of corruption on addictive good use is derived from totally differentiating equation (5). Here,

(A7) $\frac{da}{d\alpha} = \frac{da}{de}\frac{de}{d\alpha}$.

From (A2), $\frac{da}{de} < 0$ and from (A6), $\frac{de}{d\alpha} < 0$. Therefore, $\frac{da}{d\alpha} > 0$.

Appendix 2. Data Definition and Sources

Variable	Definition	Source
Tobacco program	Expenditures per capita on tobacco control programs by state	Center for Diseases Control and Prevention
Corruption	A number of convictions per legislator	US Department of Justice Book of States
Firms	A number of firms by state	US Census Bureau County Business Patterns
Housing price index	Housing price index, not seasonally adjusted (base year: 2009)	Federal Housing Finance Agency
Cigarette Tax	Cigarette tax (cent) per pack, deflated by 2009 CPI	Orzechowski and Walker, The Tax Burden on Tobacco, 2014
Median age	Median age in population	US Census Bureau
Median income	Median household Income in $10k, deflated by CPI 2009	US Census Bureau
Unemployment	Unemployment rate (%)	Bureau of Labor Statistics
Hispanic portion	The portion of people who are identified with Hispanic origin in population (%)	US Census Bureau
Male portion	The portion of male in population (%)	US Census Bureau
Never smoke	Indicating an adolescent who never smoked a cigarette, 1=never	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data

Smoking days	Smoking days in the past 30 days for adolescents	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data
Male	Indicating a male adolescent 1=male, 0=female	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data
Hispanic	Indicating a Hispanic or Latino adolescent 1=Hispanic or Latino	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data
Combined race	Indicating an adolescent in combined race and ethnicity 1=Combined race and ethnicity	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data
Age	Adolescent age in years	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data
Never unsafe	Indicating an adolescent who never felt unsafe in the past 30 days 1=never	Center for Diseases Control and Prevention Youth Risk Behavior Survey (YRBS) data