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Tobacco Education Program Spending and Tobacco Use among Adolescents

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This article measures the effect of tobacco education program spending on adolescent tobacco use. We model how corruption influences the policy maker's decision on subsidies that benefit firms to the detriment of education spending and its differential effect by gender. We estimate the effect of tobacco education program spending, instrumented by our corruption proxy, on adolescent tobacco use. More tobacco education program spending significantly increases the probability of never smoking among all adolescents but reduces the frequency of smoking only among adolescent females. One plausible explanation is that females have a more inelastic marginal utility of health than males.

Key words: corruption, gender, lobbying

Introduction

Reducing tobacco use in the United States is critically dependent for preventing tobacco use during adolescence; 90% of cigarette smokers first tried smoking before age 18 (U.S. Department of Health and Human Services, 2012). Even though cigarette consumption by U.S. youths has decreased, the use of tobacco products such as electronic cigarettes and hookahs among middle and high school students increased from 2011 to 2014 (Centers for Disease Control and Prevention, 2015). If the trend continues, 7% of Americans younger than 18 years old will die early from a smoking-related illness (U.S. Department of Health and Human Services, 2014).

Various social, environmental, genetic, and mental health factors are direct determinants of tobacco use among adolescents. For instance, peer pressure, stress, and depression are important contributors to an individual's decision to smoke (U.S. Department of Health and Human Services, 2012). Tobacco education and prevention programs can correct for this behavior. Such programs counter messages from tobacco advertisements and encourage tobacco-free environments (U.S. Department of Health and Human Services, 2012). Also, such education helps individuals understand how consuming different types of goods affects their health outcomes (Grossman, 1975).

Higher expenditures on state tobacco programs are more likely to have less self-reported cases of smoking among adolescents (Pentz et al., 1989; Tauras et al., 2005; Wakefield and Chaloupka, 2000), college students (Ciecierski et al., 2011), and adults (Rhoads, 2012; Marti, 2014). Cumulative expenditures on state tobacco programs are associated with reduced smoking in young adults (Farrelly et al., 2008, 2014). These studies show a strong correlation with preventing smoking as well as the frequency of tobacco use. However, there are two potential gaps in the literature. First, the literature does not show causality because it does not control for the endogeneity of spending.

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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 spending on tobacco use by gender, but it was on college students and endogeneity was not controlled.

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 policy maker who allocates funds to various services such as public infrastructure, education, health, and business development may be influenced by lobby groups (Allcott, Lederman, and Lopez, 2006). Lobby groups of business firms who have more financial capital and common interests are likely to be more influential than lobby groups of regular citizens, who are dispersed and may have varying motives (Olson, 1965). Lobby groups for businesses may be driven to obtain subsidies to increase their own production. A policy maker 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. When policies are skewed in favor of lobby groups, this is a form of corruption called grand corruption (Anderson et al., 2000).[1] Throughout the paper, our definition of corruption refers to this form.

This article estimates the effect of tobacco education programs 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 toward subsidies that benefit firms to the detriment of social services such as education if business groups lobby to influence the government's spending decision. Reducing education expenditures decreases the probability of never smoking and induces more consumption of an addictive good, especially among individuals with elastic marginal utility of health perception. Second, we test the theoretical linkages in our model by estimating the effect of a corruption variable on tobacco education program spending and then measuring how tobacco use is affected by this spending variable instrumented by our corruption proxy.

This article contributes to two branches of the 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, Lillard, and Mathios, 2006; Nayga, 1999; Sander, 1995, 1998). State tobacco programs (Ong, Alamar, and Glantz, 2003; Pierce et al., 1998) and spending on such programs (Farrelly et al., 2008, 2014; Pentz et al., 1989; Tauras et al., 2005; Wakefield and Chaloupka, 2000) 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, that affects tobacco use through spending on tobacco education programs. We identify this instrument from our theoretical model.

This study also contributes to the literature by measuring and explaining the differential impact of tobacco education program spending on adolescent tobacco use by gender. U.S.–born, non-Hispanic white men report more smoking than other racial/gender groups. Some groups of female adolescents self-report extremely low levels of smoking (Wade, Lariscy, and Hummer, 2013). Thus, there are 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), but men are more responsive to cigarette taxes than women (Goel and Nelson, 2005). Finally, tobacco spending has an insignificant

[1] 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; Anderson et al., 2000).

effect on quitting attempts among college females but significant effects on college males (Ciecierski et al., 2011).

We extend the literature on the effects of corruption on policy instruments. 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, Fredriksson, and List (2003) and Damania, Fredriksson, and List (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 businesses derive a $4 gain from lower corporate taxes for every $1 in campaign contributions.

Lobby groups also affect public spending by the government. Keefer (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 corruption 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. Using a reduced form model with cross-country data, Bogdanovica et al. (2011) showed that more corrupt countries tend to have a higher prevalence of smoking. They hypothesized that corruption reduces available tobacco education and prevention programs, leading to more use of tobacco products. We add to their analysis by measuring the entire mechanism rather than simply employing a reduced-form estimation.

We adapt a common agency model in which businesses organize lobby groups to obtain a larger share of state expenditures, to the detriment of providing social services. The policy maker weighs lobbying contribution and aggregate social welfare when choosing the composition of public spending between businesses and social services. The policy maker's weight on political contribution is a measure of corruption. We show that a more corrupt policy maker will increase spending on subsidies to all firms, which crowds out social services such as education programs, when the policy maker tries to achieve a balanced budget. Lower spending on tobacco prevention and education programs unambiguously decreases the probability of never trying an addictive good. Among current consumers of the addictive good, such a change in spending may also increase the consumption level when the elasticity of the marginal utility of health is elastic and when there is 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 United States from the CDC Youth Risk Behavior Surveillance System (YRBSS) and match them with state-level spending on tobacco education programs 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 significant negative effect on tobacco education program spending. Our Stock–Yogo test indicates that our corruption proxy is not a weak instrument. Per capita tobacco education spending decreases by $4–$6 for each public official conviction per legislator. The instrumental variable (IV) estimates indicate that tobacco education program expenditure per capita has a significant negative effect on adolescents' tobacco use. An additional $1 of per capita tobacco education program spending 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 among current female adolescent smokers but has an insignificant effect on males. Based on our theoretical model, this may be due to females having a more inelastic marginal utility for health.

Theoretical Framework

We present a theoretical model that illustrates a mechanism linking corruption to the consumption of an addictive good.

Setup and Assumptions

There are two sectors in the economy. The first produces an addictive good that decreases an individual's health level, and consumption of that good creates a negative externality. For example, tobacco consumption creates secondhand 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 lobby groups from the firms in the two sectors.

The representative individual has quasilinear utility over his or her 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 individual's true health level, e. is the individual's education level, $\boldsymbol{Z}$ is a vector of individual characteristics, and $0 < \theta(e) < 1$ is the weight that the individual places on his or her own health value. We define $H \equiv \theta(e)h(a)$ as the individual's perceived health level. An increase in consumption of the addictive good decreases the individual's true health level at a decreasing rate (i.e., $h_a < 0$ and $h_{aa} < 0$) (Chaloupka, 1991). Also, more educated individuals place more weight on how health influences utility (i.e., $\theta_e > 0$) (Cutler and Lleras-Muney, 2008, 2010; Grossman, 1972).[2] In our specification, if $a = 0$, then $v(0,\theta(e)h(0);\boldsymbol{Z}) > 0$. Increasing addictive good consumption and perceived health level raises utility at a decreasing rate (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-provided capital. In both sectors, output is increasing at a decreasing rate in privately purchased capital, (i.e., $f^j_k > 0$ and $f^j_{kk} < 0$) and k and g are substitutes (i.e., $f^j_{kg} < 0$).

We solve a three-stage complete information game for the subgame perfect Nash equilibrium using backward induction. In the first stage, a lobby group of firms in both sectors presents a contribution-expenditure schedule to the government, promising to contribute to the policy maker if a particular level of government-provided capital, g, is chosen. In the second stage, the government sets the composition of spending between the government-provided capital 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.

Solution through Backward Induction

We start by solving the third stage and continue recursively.

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

Third Stage: Firm Input and Household Consumption Decision

The representative firms in each sector maximize profit by choosing the amount of capital k,

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

where r is the price of capital, t^j is a flat tax used to raise revenues to produce the government-provided capital 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

$$pf_k^j(k+g) - r \quad = \quad 0, \tag{2}$$

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: $(1 - t^i)I = pa + c$, where I is income and t^i is an income tax rate. The optimal condition that determines the level of consumption of the addictive good is

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

If the marginal disutility from the health effect of consuming the addictive good plus 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:

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

An interior solution exists if equation (3) holds with equality, yielding a positive addictive good level:

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

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

The resulting indirect utility function is $V^*(p,e,t^l,I;\boldsymbol{Z}) = S + (1 - t^i)I$, 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 0, 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 A). 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., $\frac{da}{de} < 0$, see appendix A) only if

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

where $\varepsilon \equiv v_{HH}\frac{H}{v_H}$ is the elasticity of marginal utility of perceived health. This condition calls for the consumer to have a relatively inelastic elasticity of marginal utility of health, implying 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, Rathmanner, and Kunze, 2005; Ek, 2015). 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 that they are more likely to reduce addictive good consumption than males.

In summary, we find that education will increase the probability that nonusers will never try the good, but it may only help to reduce the level of addictive good consumption among current users if the individual sufficiently cares about his or her own health.

Second Stage: Government's Budget Allocation Decision

Aggregate welfare in the economy is a summation of 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 capital:

$$(7) \quad \begin{aligned} W &= m^a \pi^{a*}(p,g,r,t^a) + m^c \pi^{c*}(p,g,r,t^c) + V^*(p,e,t^i,I;\mathbf{Z}) \\ &\quad -X(p,e;\mathbf{Z}) + m^a t^a + m^c t^c + t^i I - w^g g - w^e e, \end{aligned}$$

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

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

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

where $\frac{dg}{de}|_{d(m^a t^a + m^c t^c + t^i I)=0} = -\frac{w^e}{w^g}$. The marginal benefits from education in the form of increased marginal utility from health and reduced marginal disutility from the externality are equal to the summation of the value of marginal product from the government-provided capital 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:

$$(9) \quad \max_{e,g} G = W + \alpha L \ s.t. \ m^a t^a + m^c t^c + t^i I = w^g g + w^e e,$$

where L is 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 its constituents. A number of studies interpret this weight, α, as a measure of corruption because a larger value implies more selfish behavior (see Damania, Fredriksson, and List, 2003; Damania and Fredriksson, 2003; Fredriksson and Svensson, 2003; Fredriksson, List, and Millimet, 2003).

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

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

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

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:

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

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

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

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 capital from lobbying. Using the inverse function rule, we rewrite the above first-order condition as $(m^a p f_g^a + m^c f_g^c) = \frac{dL}{dg}$. 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 equation (10) yields

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

Compared to equation (8), in which $\alpha = 0$, equation (13) places more weight on the value of the marginal product of government-provided capital for all firms when the policy maker cares about lobby group contributions. The optimal level of education provided by the government depends on the price of the addictive good, the price of government-provided capital, the measure of corruption, and the size of the sector:

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

The weight the government places on its own welfare acts to increase the marginal value it places on government-provided capital. More formally, we find that the impact of α on e is $\frac{de}{d\alpha} < 0$ (see Appendix A). Our model shows that when all firms from both sectors lobby the government for the government-provided capital, tobacco prevention and education programs are crowded out when a balanced budget is required.[3] 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 who does not consume an addictive good,

[3] López and Galinato (2007) find that lobbying induces a biased allocation of public expenditures toward subsidies for private firms and causes public goods, such as education, research and development, health, and other social programs, to be undersupplied.

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 A). In this case, an increase in corruption leads to more government-provided capital, which crowds out education when a balanced budget is required, resulting in more use of the addictive good.

Empirical Model

To test the theoretical results, we estimate a two-equation model. Based on equations (14) and (5), we specify an IV–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

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

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 per capita education spending 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, they will increase spending on education programs to reduce the 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 in which endogeneity is controlled for. Alternatively, a downward bias may occur if states with less smoking tend to spend more on tobacco control when the median voters are more likely to be anti-smoking. We estimate equation (15) using an IV model to correct for estimation bias, where our instrument is from equation (16), which shows the determinants of education spending:

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

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 policy maker. The total effect of corruption on the level of addictive good consumption is $\beta_1\gamma_1 > 0$, 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 the prices of government-provided capital 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, the price of government-provided capital 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 capital 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 a just-identified system as our baseline estimation, in which only the corruption proxy is our instrument. However, we also estimate an overidentified system that includes proxies for the price of government-provided capital 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 other state characteristics may create an environment in which 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 other environmental factors at the state level. We also include a proxy for state tobacco regulation stringency. The American Stop Smoking Intervention Study developed a measure of the state tobacco control environment called the Strength of Tobacco Control (SoTC) index (Jayawardhana et al., 2014). Using the SoTC index controls for tobacco regulation stringency but could introduce an endogeneity problem because of a bi-causal relationship in which stringent tobacco regulations are imposed because of the rise in adolescent tobacco use. We mitigate this possibility by employing a 5-year lag on this index in our robustness check. Finally, we cluster standard errors to account for autocorrelation among individuals within states.

Data

The most important variables in our estimation are education spending, a measure of addictive good consumption, and a corruption measure. We match individual-level data on adolescent health choices and characteristics across U.S. states with state-level tobacco program spending and 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 for 2009 and 2011 for 32 states. Table 1 presents the summary statistics and Appendix B details the variable definitions and data sources.

Our main measure of addictive good consumption is tobacco use among adolescents, reported every 2 years from the YRBSS. We use two measures of tobacco use in adolescents. The first is an indicator variable that states whether they have ever smoked, which reflects the case in which $a = 0$ yields a higher level of utility than $a > 0$. The second measure indicates the frequency with which an adolescent has smoked in the past 30 days, which reflects the case where $a > 0$. An average of 65% of adolescents in our sample have never smoked. Massachusetts has the highest rate of never smoking (77% of adolescents), while Kentucky has the lowest rate (51%). On average, adolescents had smoked an average of 2.5 days in the past month. 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 spending on tobacco prevention and control programs, which can directly influence tobacco use among adolescents, collected by the University of Illinois at Chicago Health Policy Center. In 1999, the federal government launched the National Tobacco Control Program to provide a foundation for state action. States have varying tobacco control programs, some of which started before the federal tobacco program.[4] The statewide tobacco programs aim to prevent initiation among youth and young adults, promote quitting among youth and adults, and eliminate exposure to secondhand smoke. The tobacco control programs may run statewide media campaigns, execute regulatory initiatives, or fund organizations tasked with developing community partnerships for tobacco control, youth action programs, and school policy

[4] Revenue sources for tobacco program spending come from federal and state funds as well as tobacco companies. In 1998, cigarette manufacturers reached the largest civil litigation settlement in U.S. history, with 46 states and 6 other U.S. jurisdictions, called the Master Settlement Agreement (MSA) (Jayawardhana et al., 2014). States received annual payments in perpetuity to compensate them for health care costs from tobacco-related illnesses (Public Health Law Center, 2015).

Table 1. Summary Statistics

Variable	No. of Obs.	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	155,283.2	143,854.3	19,472	697,082
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
Lagged SoTC index	64	0.026	0.693	−2.3	1.641
Individual level					
Never smoke	27,840	0.645	0.479	0	1
Smoking days	27,289	2.532	7.252	0	30
Male	28,256	0.495	0.500	0	1
Hispanic	28,256	0.302	0.459	0	1
Combined race	28,256	5.041	1.498	1	8
Age	28,256	16.125	1.233	12	18
Never felt unsafe in school	28,154	0.944	0.230	0	1

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 tobacco control programs, while Tennessee spends only $0.27 per capita.

Our corruption measure is based on the number of public officials convicted of violating the federal corruption laws reported in the Public Integrity Section of the U.S. Department of Justice.[5] We compile the total number of convicted public officials by state and divide by the total number of state legislators in the state's Senate and House of Representatives. Our corruption index is the number of 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, Boix, and Payne, 2003; Alt and Lassen, 2008, 2014; Glaeser and Saks, 2006; Liu and Mikesell, 2014; Meier and Holbrook, 1992; Zuo and Schieffer, 2013).[6] This variable serves as our main instrument to identify 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 are to general perceptions 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

[5] The federal official bribery and gratuity statute, 18 U.S.C. §201 (enacted 1962), defines a "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.

[6] 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 (U.S. Department of Justice, 2011) and the state level (U.S. Department of Justice, 2012; Orso, 2016; Federal Bureau of Investigation, 2011).

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	28,154	28,154	28,154	28,154
Adj. R^2	0.994	0.992	0.991	0.989

Notes: Clustered standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level.

states are Maine, Rhode Island, Utah, Kansas, and Idaho, which matches general perceptions of state corruption rankings.

The second potential criticism is that our measure of corruption captures the effect of law enforcement ability rather than corruption. However, Liu and Mikesell (2014) show that the conviction rate of public officials is not correlated with working hours of U.S. attorneys, number of federal state judges, or district court caseloads, which are measures of the degree of law enforcement or availability of court resources.[7]

[7] 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.

We use other control variables from the YRBSS database 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. We use cigarette tax data from Orzechowski and Walker (2014) to proxy for the price of tobacco products. Finally, we use data on 5-year lagged SoTC index by state from Bridging the Gap (2018) to control for tobacco regulatory changes. This index captures the resources allocated to tobacco control activities and the capacity for tobacco control, such as state leadership and program efforts engaged in media and program services. The SoTC index proxies for other tobacco control activities aside from tobacco education programs.

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, we cluster standard errors at the state level.

Baseline Results

Table 2 presents results measuring the effect of corruption on state-level tobacco education program spending, which is negative and significant in all specifications. We obtain reasonable magnitudes, indicating that our instrument is not weak.[8] Based on our estimates, for every 1 public official conviction per legislator, tobacco education program spending decreases by \$4–\$6 per capita. The average state in our sample has corruption measure of 0.16. A 1-standard-deviation increase in corruption corresponds to a drop in per capita tobacco education program spending of \$0.52–\$0.86, approximately a 30% reduction from the mean level.

Table 3 summarizes the effect of tobacco education program spending on adolescents' choice to smoke. After instrumenting with our corruption measure, we find a significant and consistent result that a \$1 increase in per capita tobacco education program spending increases the probability that an adolescent will never smoke by 8%. Average per capita spending on tobacco education programs is \$2.47. A 1-standard-deviation increase in spending leads to an 18% increase in the probability that an adolescent will never smoke. These values imply a point elasticity for never smoking equal to 0.32. Adolescents who are more risk averse, female, and younger are more likely to never smoke.

We find that the effect of tobacco program spending on the probability of never smoking among adolescent males and females is similar, where a \$1 increase in per capita tobacco program spending leads to an 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.

To formally determine the strength of our instrument, we employ the Stock–Yogo (2005) test for weak instruments, which tests weak instruments based on the bias of the estimator and the size of the distribution of the assumed Wald statistic. Using a maximal-size test, we find that our instrument is not weak if we are willing to accept a rejection rate of at most 15% for the Wald test, as shown by our Kleibergen–Paap rk Wald F-statistic.[9]

The tobacco education program spending coefficient on our tobacco use variables using IV is smaller than when we only employ fixed effects estimation without instruments. Without accounting

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

[9] The critical values for the maximal IV relative bias test cannot be calculated for our baseline just-identified model. This is because the maximal IV relative bias uses the finite sample distribution of the IV estimator and can only be calculated where the appropriate moments exists, that is, when the equation is suitably overidentified. The mth moment of an IV estimator exists if and only if $m < (L - K + 1)$, where L denotes excluded instruments and K denotes endogenous regressors (Baum, Schaffer, and Stillman, 2007).)

Table 3. The Determinants of Adolescents Choosing Not to Smoke in a Just-Identified Model, 2009, 2011

	IV–Two-Way Fixed Effects			Two-Way Fixed Effects		
	All	Male	Female	All	Male	Female
State characteristics						
Tobacco program	0.086***	0.086**	0.087***	0.102***	0.108***	0.098***
	(0.03)	(0.036)	(0.029)	(0.018)	(0.019)	(0.019)
Firms	0.000002	0.000002	0.0000009	0.0000008	0.000001	0.0000004
	(0.000003)	(0.000003)	(0.000004)	(0.000003)	(0.000003)	(0.000004)
Housing price index	0.763***	0.766***	0.788***	0.767***	0.771***	0.792***
	(0.207)	(0.252)	(0.181)	(0.202)	(0.243)	(0.178)
Cigarette tax	0.002***	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)
Median age	0.081	0.009	0.164**	0.094	0.026	0.174**
	(0.073)	(0.080)	(0.070)	(0.076)	(0.086)	(0.069)
Median income	0.002	0.056	−0.057	0.004	0.060	−0.055
	(0.068)	(0.062)	(0.076)	(0.067)	(0.061)	(0.076)
Unemployment	0.017	0.026**	0.006	0.018	0.028**	0.007
	(0.013)	(0.012)	(0.015)	(0.013)	(0.013)	(0.015)
Hispanic portion	−0.007**	−0.006*	−0.009***	−0.009***	−0.008***	−0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Male portion	0.894*	0.520	1.242**	1.106**	0.817*	1.389***
	(0.486)	(0.504)	(0.534)	(0.413)	(0.420)	(0.455)
Individual characteristics						
Male	−0.051***			−0.051***		
	(0.008)			(0.008)		
Hispanic	−0.016	−0.053***	0.019	−0.017	−0.053***	0.019
	(0.013)	(0.016)	(0.015)	(0.013)	(0.016)	(0.015)
Combined race	−0.025***	−0.018***	−0.031***	−0.025***	−0.018 * *	−0.031***
	(0.006)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)
Age	−0.058***	−0.069***	−0.049***	−0.058***	−0.069***	−0.049***
	(0.003)	(0.005)	(0.004)	(0.004)	(0.005)	(0.004)
Never felt unsafe in school	0.203***	0.248***	0.162***	0.203***	0.247***	0.161***
	(0.02)	(0.024)	(0.017)	(0.02)	(0.025)	(0.017)
Year and state dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	27,744	13,693	14,051	27,744	13,693	14,051
Adj. R^2	0.053	0.051	0.029	0.053	0.063	0.042
Kleibergen–Paap rk Wald F-statistic	11.647	11.287	11.421			

Notes: Clustered standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. The 95% confidence interval for the tobacco program spending coefficient for the IV–two-way fixed effects for all genders, males, and females are [0.026, 0.145], [0.015, 0.156] and [0.029, 0.144], respectively. All Kleibergen–Paap rk Wald F-statistic are 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. No critical values for the maximal IV relative bias for the just-identified case are calculated because it does not satisfy the moment conditions needed for the test to be implemented.

Table 4. The Determinants of the Frequency of Adolescent Smoking Days in a Just-Identified Model, 2009, 2011

	IV–Two-Way Fixed Effects			Two-Way Fixed Effects		
	All	**Male**	**Female**	**All**	**Male**	**Female**
State characteristics						
Tobacco program	−0.405	0.220	−1.306**	−0.790**	−0.721*	−1.010***
	(0.471)	(0.676)	(0.565)	(0.329)	(0.410)	(0.325)
Firms	−0.0002***	−0.0001**	−0.0001***	−0.0001**	−0.0001	−0.0002***
	(0.00005)	(0.00007)	(0.00005)	(0.00005)	(0.00007)	(0.00005)
Housing price index	−7.916**	−11.141*	−4.733*	−8.010**	−11.339**	−4.641
	(3.921)	(6.107)	(2.710)	(3.658)	(5.278)	(2.847)
Cigarette tax	−0.020***	−0.016*	−0.027***	−0.024***	−0.025***	−0.024***
	(0.006)	(0.008)	(0.009)	(0.005)	(0.006)	(0.005)
Median age	−1.425	0.083	−3.374**	−1.733	−0.613	−3.110**
	(1.122)	(1.531)	(1.475)	(1.176)	(1.360)	(1.320)
Median income	0.839	0.613	1.081	0.776	0.435	1.123
	(1.186)	(1.442)	(1.020)	(1.127)	(1.250)	(1.084)
Unemployment	−0.057	−0.065	−0.046	−0.087	−0.132	−0.020
	(0.234)	(0.281)	(0.235)	(0.232)	(0.264)	(0.236)
Hispanic portion	0.085*	0.021	0.176***	0.118**	0.100*	0.152***
	(0.048)	(0.066)	(0.056)	(0.044)	(0.054)	(0.049)
Male portion	−10.059	2.200	−26.469***	−15.111**	−10.116	−22.583***
	(7.237)	(10.299)	(8.262)	(6.441)	(8.058)	(7.171)
Individual characteristics						
Male	0.885***			0.884***		
	(0.130)			(0.132)		
Hispanic	−1.490***	−1.467***	−1.501***	−1.481***	−1.446***	−1.509***
	(0.234)	(0.204)	(0.300)	(0.234)	(0.202)	(0.304)
Combined race	0.495***	0.457***	0.525***	0.494***	0.456***	0.526***
	(0.063)	(0.061)	(0.085)	(0.063)	(0.062)	(0.086)
Age	0.677***	0.895***	0.463***	0.676***	0.894***	0.464***
	(0.071)	(0.096)	(0.061)	(0.072)	(0.097)	(0.062)
Never felt unsafe in school	−3.491***	−5.337***	−1.933***	−3.483***	−5.320***	−1.939***
	(0.458)	(0.484)	(0.461)	(0.466)	(0.491)	(0.471)
Year and state dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	27,195	13,325	13,870	27,195	13,325	13,870
Adj. R^2	0.049	0.044	0.022	0.049	0.055	0.043
Kleibergen–Paap rk Wald F-statistic	11.815	11.644	11.362			

Notes: Clustered standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. The 95% confidence interval for the tobacco program spending coefficient for the IV–two-way fixed effects for all genders, males, and females are [-1.328, 0.517], [-1.104, 1.544] and [-2.413, -0.198], respectively. All Kleibergen–Paap rk Wald F-statistic are 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. No critical values for the maximal IV relative bias for the just-identified case are calculated because it does not satisfy the moment conditions needed for the test to be implemented.

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 reduce tobacco use, resulting in larger parameter estimates.

Using data from 1985–2003, Farrelly et al. (2008) found that doubling per capita tobacco program expenditures doubled would lead to a 1%–1.7% reduction in adult smoking. In a recent study, Farrelly et al. (2014) showed that doubling cumulative funding for state tobacco control programs decreased the number of current adolescent smokers by 3.2%–3.6%. Similarly, Ciecierski et al. (2011) found that doubling per capita expenditures related to tobacco prevention reduced college smoking by 3.8%. Based on the sample data from 1997, the average per capita spending on tobacco programs is $0.92 (Ciecierski et al., 2011). The implicit elasticity of never smoking is 0.16. None of the three studies instrument for tobacco education program spending, which implies a possible bias in estimates.

Table 4 shows the effect of per capita tobacco education program spending on the frequency of smoking days per month among adolescents. Tobacco education program spending reduces the number of smoking days, but the effect is not significant among all adolescents when introducing an instrument for the variable. However, tobacco spending has a differential effect on adolescent smoking days by gender. The effect is insignificant among males, but female adolescent smokers reduce smoking days by 1 per month for every $1 spent per capita. 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 significant and larger in magnitude. 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 among current adolescent smokers. Rhoads (2012) found that, among adults, comprehensive cumulative tobacco control expenditure with a 10% discount rate significantly affects the average number of cigarettes per smoking day. She did not control for the potential endogeneity of tobacco expenditure in her estimation, which could have led to the significance and upward bias in her estimates.

Interestingly, when focusing on the contemporaneous effects of tobacco expenditure on smoking days and allowing for higher discount rates with cumulative expenditure, Rhoads found that the effect is not significant. Since her results regarding cigarette consumption on smoking days were not as robust compared to the prevalence of smoking, she concluded 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, with an important caveat. We find that the true value of tobacco education programs is preventing smoking among all adolescents, and reducing the frequency of smoking among current adolescent smokers may significantly affect only individuals with inelastic marginal utilities of health, such as females.

Table 5 compare the effect of tobacco program spending with tobacco taxes on adolescent smoking decisions. The elasticity of tobacco taxes on the probability of not smoking is 69% larger than the elasticity of tobacco programs. Furthermore, tobacco taxes are much more effective at reducing the frequency of smoking days among females relative to tobacco programs. Also, the frequency of smoking days among males significantly declines when faced with a higher tobacco tax but is not responsive to tobacco program spending.

Robustness Checks

We conduct two robustness checks. First, we present a set of regressions that follows closer to our theoretical model by including more instruments that proxy equation (14), which is our overidentified model, including the number of firms by state and the housing price index (to proxy for

Table 5. Elasticity of Tobacco Program Spending versus Tobacco Tax on Adolescent Tobacco Decisions

Elasticity	Probability of Not Smoking	Frequency of Smoking Days in the Past Month
Tobacco program spending elasticity		
All	0.270***	−0.326
	(0.096)	(0.378)
Male	0.285**	0.149
	(0.120)	(0.459)
Female	0.261***	−1.276**
	(0.088)	(0.552)
Tobacco tax elasticity		
All	0.456***	−0.956
	(0.072)	(0.273)
Male	0.458**	−0.649*
	(0.081)	(0.339)
Female	0.468***	−1.639***
	(0.074)	(0.545)

Notes: Standard errors are calculated using the delta method. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level.

the price of government-provided capital). From Table 6, we show that in our overidentified model, the magnitude and significance of the coefficients are very similar to the baseline just-identified case. However, the Stock–Yogo test results indicate a weak instrument problem after adding the new variables identified in our model as instruments. Thus, adding such instruments from our theoretical model does not change our baseline results, but it is best to use the just-identified baseline model because of the reliability of the main instrument.

Next, we use a 5-year lag of the SoTC index to control for other tobacco regulatory changes (Table 7). This has a significant effect on both adolescents' decision to smoke and the frequency of adolescent smoking days. However, introducing the new variable does not change the sign or significance of the tobacco program spending coefficient.

Total Effect of Corruption on Tobacco Use

Table 8 summarizes the total effect of corruption on tobacco use. The empirical results support our theoretical predictions. As our corruption measure increases, the probability of not smoking significantly decreases. We find that a 1-standard-deviation increase in convictions of public official per legislator decreases the probability of not smoking by 7%. From 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 Idaho's level, the probability that an adolescent will not smoke would increase by 26%.

Corruption increases the frequency of smoking, but the magnitude is only significant for females. Our results indicate that corruption has a significant impact on an adolescent's choice to engage in smoking activities through tobacco education programs. However, once the adolescent chooses to engage in smoking, the effect of corruption on reducing the frequency of the activity is not significant for males. It may be significant for female adolescents because their marginal utility of health is likely to be more inelastic.

Table 6. Determinants of Tobacco Use with Added Instruments in an Overidentified Model

	IV–Two-Way Fixed Effects		Two-Way Fixed Effects	
	Choosing Not to Smoke	**Frequency of Smoking**	**Choosing Not to Smoke**	**Frequency of Smoking**
State characteristics				
Tobacco program	0.084**	−0.877	0.100***	−1.003**
	(0.038)	(0.570)	(0.025)	(0.435)
Cigarette tax	0.002***	−0.027***	0.002***	−0.028***
	(0.0003)	(0.005)	(0.0004)	(0.006)
Median age	−0.093	1.211	−0.073	1.054
	(0.129)	(1.764)	(0.100)	(1.548)
Median income	0.023	−0.402	0.02	−0.373
	(0.056)	(1.002)	(0.058)	(1.014)
Unemployment	0.013	−0.186	0.014	−0.189
	(0.013)	(0.231)	(0.013)	(0.231)
Hispanic portion	−0.011***	0.151***	−0.012***	0.162***
	(0.003)	(0.048)	(0.003)	(0.048)
Male portion	1.199**	−16.415**	1.424***	−18.253**
	(0.575)	(7.784)	(0.395)	(6.668)
Individual characteristics				
Male	−0.051***	0.886***	−0.051***	0.886***
	(0.008)	(0.130)	(0.008)	(0.132)
Hispanic	−0.014	−1.529***	−0.015	−1.525***
	(0.013)	(0.238)	(0.013)	(0.241)
Combine race	−0.025***	0.492***	−0.025***	0.492***
	(0.006)	(0.062)	(0.006)	(0.063)
Age	−0.058***	0.673***	−0.058***	0.673***
	(0.003)	(0.071)	(0.004)	(0.072)
Never felt unsafe in school	0.203***	−3.478***	0.203***	−3.475***
	(0.02)	(0.460)	(0.02)	(0.466)
Year and state dummies	Yes	Yes	Yes	Yes
N	27,744	27,195	27,744	27,195
Adj. R^2	0.053	0.049	0.053	0.049
Kleibergen–Paap rk Wald *F*-statistic	3.889	3.944		

Notes: Clustered standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. The 95% confidence interval for the tobacco program spending coefficients for the IV–two-way fixed effects are [0.010, 0.158] for the dependent variable, adolescents choosing not to smoke, and [-1.994, 0.241] for the frequency of adolescent smoking days, respectively. The critical values for the maximal IV size are 22.3, 12.83, 9.54, and 7.80 at the 5%, 10%, 20%, and 30%, respectively. The critical values for the Kleibergen–Paap rk Wald *F*-statistic at the 5%, 10%, 20%, and 30% maximal IV relative bias are 13.91, 9.08, 6.46, and 5.39, respectively.

Conclusion

We investigate the link between tobacco education program spending and adolescent tobacco use. We theoretically model how corruption influences the policy maker 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. Reducing such spending leads to an increase in the 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

Table 7. The Determinants of Adolescents' Tobacco Choices with the Inclusion of the SoTC Index in a Just-Identified Model, IV–Two-Way Fixed Effects, 2009, 2011

	Choosing Not to Smoke			Frequency of Smoking Days		
	All	Male	Female	All	Male	Female
State characteristics						
Tobacco program	0.096***	0.098***	0.096***	−0.589	0.033	−1.475***
	(0.026)	(0.032)	(0.028)	(0.425)	(0.703)	(0.426)
Firms	−0.000001	−0.000001	−0.000001	−0.0001***	−0.0001**	−0.0001**
	(0.000003)	(0.000003)	(0.000004)	(0.00003)	(0.00004)	(0.00004)
Housing price index	0.980***	1.007***	0.978***	−11.50***	−14.70**	−8.337***
	(0.199)	(0.236)	(0.180)	(3.797)	(6.006)	(2.845)
Cigarette tax	0.003***	0.003***	0.003***	−0.026***	−0.023**	−0.034***
	(0.0005)	(0.0005)	(0.0005)	(0.007)	(0.011)	(0.007)
Median age	0.095	0.023	0.176***	−1.646*	−0.120	−3.597***
	(0.066)	(0.072)	(0.067)	(0.927)	(1.442)	(1.246)
Median income	0.042	0.104**	−0.026	0.192	−0.097	0.497
	(0.049)	(0.045)	(0.061)	(0.725)	(0.986)	(0.706)
Unemployment	0.028**	0.039***	0.015	−0.242*	−0.261	−0.219
	(0.011)	(0.011)	(0.014)	(0.146)	(0.191)	(0.195)
Hispanic portion	−0.004*	−0.002	−0.006**	0.037	−0.027	0.127***
	(0.003)	(0.003)	(0.003)	(0.031)	(0.055)	(0.041)
Male portion	0.522	0.104	0.915*	−3.950	8.302	−20.23***
	(0.426)	(0.454)	(0.468)	(5.222)	(9.136)	(6.013)
Individual characteristics						
Male	−0.051***			0.883***		
	(0.008)			(0.131)		
Hispanic	−0.0178	−0.054***	0.0178	−1.464***	−1.447***	−1.471***
	(0.013)	(0.015)	(0.014)	(0.235)	(0.211)	(0.297)
Combined race	−0.025***	−0.018***	−0.031***	0.489***	0.452***	0.519***
	(0.006)	(0.007)	(0.006)	(0.062)	(0.062)	(0.084)
Age	−0.058***	−0.068***	−0.049***	0.675***	0.892***	0.463***
	(0.003)	(0.005)	(0.004)	(0.071)	(0.095)	(0.061)
Never felt unsafe in school	0.203***	0.247***	0.161***	−3.483***	−5.325***	−1.930***
	(0.020)	(0.024)	(0.017)	(0.457)	(0.482)	(0.460)
Lagged SoTC index	0.053***	0.059***	0.046***	−0.877***	−0.874***	−0.874***
	(0.012)	(0.015)	(0.014)	(0.217)	(0.318)	(0.201)
Year and state dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	27,744	13,693	14,051	27,195	13,325	13,870
Adj. R^2	0.044	0.051	0.030	0.037	0.045	0.023
Kleibergen–Paap rk Wald F-statistic	13.499	13.077	13.386	13.638	13.407	13.291

Notes: Clustered standard errors in parentheses. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level. All Kleibergen–Paap rk Wald F-statistic are 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. No critical values for the maximal IV relative bias for the just-identified case are calculated because it does not satisfy the moment conditions needed for the test to be implemented.

Table 8. The Effect of Corruption on Adolescent Tobacco Use

Marginal Effect of Corruption	Probability of Not Smoking	Frequency of Smoking Days in the Past Month
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)

Notes: Standard errors are calculated using the delta method. Single, double, and triple asterisks (*, **, ***) indicate significance at the 10%, 5%, and 1% level.

level of consumption of an addictive good among 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 users 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. 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 and has a significant negative effect on the frequency of smoking among female adolescents (but not among males). A $1 increase in per capita tobacco education program spending increases the probability of not smoking by 8% among all adolescents and reduces smoking days by 1 day per month among females. Interestingly, tobacco taxes seem to have a larger and more significant effect on adolescent tobacco decisions than tobacco program spending.

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 that of Idaho, the least corrupt state in our sample, the probability that an adolescent will never smoke would increase by 26% and the number of smoking days among female adolescents would drop by 4 days per month.

The effect of corruption on our tobacco use indicators 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 that 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 individuals' health quality.

Future studies may be interested in using our conceptual framework to analyze the effect of health spending on other health-related outcomes such as obesity, alcoholism, or drug use. Caution must be taken in extrapolating similar results for other health outcomes without careful empirical analysis since the mechanisms relating individual health outcomes to public spending composition may differ. It would be worthwhile to use a similar framework and test whether the corruption index is a viable instrument for such an analysis.

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Appendix A: Proofs for the Theoretical Model

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

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

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

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

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

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

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

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

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

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

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

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

Totally differentiating equation (A5), we find

$$\text{(A6)} \qquad \frac{de}{d\alpha} = -\frac{-(m^a p f_g^a + m^c f_g^c)\frac{w^e}{w^g}}{\frac{\partial^2 G}{\partial e^2}}.$$

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,

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

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

Appendix B: Data Definition and Sources

Variable	Definition	Source
Tobacco program	Per capita expenditures on tobacco control programs by state	Centers for Disease Control and Prevention (CDC)
Corruption	Number of convictions per legislator	U.S. Department of Justice Book of States
Firms	Number of firms by state	U.S. 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 (in cents) per pack, deflated by 2009 consumer price index (CPI)	Orzechowski and Walker (2014)
Median age	Median age in population	U.S. Census Bureau
Median income	Median household income (in $ten thousands), deflated by 2009 CPI	U.S. Census Bureau
Unemployment	Unemployment rate (%)	U.S. Bureau of Labor Statistics
Hispanic portion	Portion of population identified with Hispanic origin (%)	U.S. Census Bureau
Male portion	Portion of males in population (%)	U.S. Census Bureau
Never smoke	Indicator variable equal to 1 if an adolescent has never smoked a cigarette, and 0 otherwise	CDC Youth Risk Behavior Surveillance Survey (YRBSS) data
Smoking days	Smoking days in the past 30 days for adolescents	CDC YRBSS data
Lagged SoTC Index	5-year lagged Strength of Tobacco Control (SoTC) index	BridgingtheGap (2018)
Male	Indicator variable equal to 1 if adolescent is male, 0 if female, and 0 otherwise	CDC YRBSS data
Hispanic	Indicator variable equal to 1 if adolescent is Hispanic or Latino, and 0 otherwise	CDC YRBSS data
Combined race	Indicator variable equal to 1 if adolescent identifies as multiracial or multiethnic, and 0 otherwise	CDC YRBSS data
Age	Age (in years)	CDC YRBSS data
Never unsafe	Indicator variable equal to 1 if adolescent has never felt unsafe in the past 30 days, and 0 otherwise	CDC YRBSS data