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The Trade and Health Effects of Tobacco Regulations

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We examine how cross-country differences in tobacco regulations affect tobacco imports and consumer health. We find that tobacco imports increase when a rich exporter's tobacco regulations are stringent relative to the regulations of its poor importing trade partner. The main policy driver may be differences in marketing and counter-advertising tobacco regulations between trading partners. If a rich exporting country adopts counter-advertising tobacco regulations, mortality and morbidity from tobacco-related diseases in the poor importing country increase by four and eighty smokers per million people annually, respectively. Our results highlight the importance of accounting for spillovers in an increasingly multilateral economy.

Key words: bilateral trade effect, gravity model, mortality, tobacco regulation

Introduction

The World Health Organization estimates that tobacco use kills 5 million people annually and projects that world tobacco consumption will increase. Policy-makers have attempted to reduce tobacco consumption using a variety of tobacco regulations—such as marketing bans that limit cigarette advertisements, age and smoking-location restrictions, and warning labels informing consumers of the health effects of smoking (Laugesen and Meads, 1991).

The effects of these regulations on tobacco consumption have been analyzed extensively (Chaloupka and Warner, 2000). Marketing bans have yielded mixed results. In OECD countries, the effect of comprehensive marketing bans on tobacco consumption has ranged from insignificant (Stewart, 1993; Nelson, 2003) to modest (Laugesen and Meads, 1991; Saffer and Chaloupka, 2000). However, in developing countries, comprehensive marketing bans significantly reduce tobacco consumption (Blecher, 2008). There is a general consensus that smoke-free zones or smoking-location regulations significantly reduce cigarette consumption (Chapman et al., 1999). Similarly, counter-advertising efforts have been effective in reducing tobacco consumption in the United States (Lewit, Coate, and Grossman, 1981; Schneider, Klein, and Murphy, 1981; Warner, 1981; Baltagi and Levin, 1986; Hu, Sung, and Keeler, 1995).

While tobacco consumption is projected to increase in developing economies, tobacco consumption is declining in developed economies due, in part, to a variety of related regulations. Production in developed economies has not decreased as fast as domestic consumption since developed countries are a significant contributor in the export of tobacco (Food and Agriculture Organization of the United Nations, 2003). The United States and European Union were two of the top three exporters of raw tobacco from 1998 to 2000 (Commission of the European Communities, 2003). There are assertions that tobacco industries in developed economies target developing countries with relatively more lax tobacco regulations (World Health Organization, 2008; Smith, 2015). Although extensive analysis on the impact of tobacco regulations on own-country tobacco consumption has been conducted, no study has investigated the spillover effects of tobacco

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regulations on tobacco trade flow. Given the projected rise in tobacco consumption in developing economies and the importance of trade in facilitating this rise, understanding the effects of tobacco-related regulations on tobacco trade flows is important to help develop policies that can further curb tobacco use.

This article fills this gap in the literature by examining the effects of the difference between importer and exporter tobacco regulations on the flow of tobacco trade and its consequent health effects. We use a gravity model to test the effect of differences in tobacco regulations between trading partners on tobacco imports. The empirical results provide evidence for the extent to which domestic regulations have spillover effects on other countries. We also simulate the spillover effects of differences in tobacco regulations on mortality and morbidity from imported tobacco use by combining our estimates with complementary results from studies the literature. Our main contribution is to determine empirically if differences in tobacco regulations between bilateral trading partners significantly affect tobacco trade, which would imply spillover effects from unilateral changes in tobacco regulations. The presence of spillover effects implies the need for policies that increase the local and global effectiveness of tobacco regulations.

Several strands of literature have investigated the spillover effects of regulations on trade patterns. In the context of food safety, Disdier, Fontagné, and Mimouni (2008) find that sanitary and phytosanitary regulations have no significant impact on agricultural trade between OECD countries but have a significant impact on developing countries, where regulations are more lax. In terms of environmental pollution, the pollution haven hypothesis suggests that if a country has very strict regulations, firms' environmental regulation compliance costs are high, giving firms an incentive to relocate to countries with less stringent environmental regulations (Grossman and Krueger, 1993, 1995). The mechanism driving the impact of regulations on trade in these strands of literature is supply-oriented. However, the underlying mechanisms driving the effects of tobacco regulations on trade stems from both supply- and demand-side factors.

Several studies have analyzed the effects of trade policies on tobacco consumption and production. Regional trade agreements significantly affect tobacco firms' marketing, lobbying, and organizational strategies (Holden et al., 2010) as well as their market shares (Chaloupka and Laixuthai, 1996). Eliminating tobacco production subsidies in response to trade agreements initially decreases tobacco consumption, but tobacco production shifts to other countries and tobacco imports significantly increase (Stoforos and Mergos, 2004). These changes in production, exports, and imports highlight the need to investigate any potential effect of tobacco regulations on trade flows.

To examine the trade and health implications of tobacco regulations, we incorporate four categories of tobacco regulations—marketing regulations, counter-advertising and education mandates, smoking-location regulations, and age restrictions—into a gravity model. Marketing regulations restrict where and to what audience tobacco can be advertised. Tobacco counter-advertising includes health warnings or advertising campaigns designed to reduce smoking or, more broadly, any form of media or message contrary to the messages promoted by tobacco companies. Smoking-location regulations prohibit smoking in specific public areas. Age restrictions are restrictions on the minimum age of tobacco-product purchasers. Tobacco marketing regulations and counter-advertising programs affect demand for the entire market, while age and smoking-location regulations affect only specific consumer types in the market.

Differences in tobacco regulations between trading partners may either increase or decrease tobacco trade. Members of a trade group may have similar preferences regarding public health protection and therefore may adopt similar tobacco regulations, which in turn may lead to more balanced tobacco trade. The European Union is one example, where member states have taken various tobacco control measures in the form of legislation, recommendations, and information campaigns such as advertising restrictions for tobacco products or anti-smoking campaigns (Institution for European Environmental Policy, 2012).[1] Alternatively, large differences

[1] Even though EU member states adopt similar legislation, implementation may vary from country to country.

in regulations between trading partners could lead to an influx of goods to countries where regulations are relatively lax since it is easier for some firms to penetrate markets with fewer regulations. This type of relationship has been studied in the pollution haven literature (Levinson and Taylor, 2008). A similar relationship may occur with tobacco regulations, in which tobacco trade flows away from developed and toward developing countries, where tobacco regulations are less stringent.

Our main variables of interest are cross-country differences in a set of tobacco regulations between bilateral trading partners. Tobacco regulations are likely to be endogenous because demand for imported tobacco could influence regulations affecting its consumption and suppliers of tobacco are incentivized to influence trade conditions to their benefit. The relative position and lobbying effectiveness across countries could therefore impact the difference in tobacco regulations between trading partners.

We use several instruments to identify the effect of tobacco regulations on net imports, including a measure of the susceptibility of the government to lobbying, average asbestos production, and an environmental sustainability index. Lobbying affects the marginal stringency of tobacco regulation, which affects supply of tobacco regulations. Average asbestos production affects the perceived marginal damages from tobacco-related illnesses, which influences the demand for tobacco regulations. Finally, the environmental sustainability index is included to account for a general propensity for environmental and health regulation that is overall exogenous with respect to the tobacco market. None of the variables influence tobacco imports directly, only indirectly through tobacco regulations.[2]

The hypotheses we test elucidate the effects of differences in tobacco regulations on tobacco trade and, consequently, consumer health. We find two important results. First, tobacco imports increase when an exporter's tobacco regulations are stringent relative to the tobacco regulations of its importing trade partner *and* if the exporting country is rich and the importing country is poor. The driver of this result may be the difference in tobacco marketing and counter-advertising regulations between bilateral trading partners. When the exporting country is faced with constraints on advertising or is countered with vigorous anti-smoking campaigns, it may respond by exporting tobacco products to countries with lax marketing regulations and counter-advertising regulations. Second, the simulated spillover health effects can be significant. For example, given an income gap of $25,000 per capita between trading partners, when an exporting country adopts counter-advertising tobacco regulations, the importing country experiences an increase in mortality from tobacco-related cancer of four smokers per million people annually. This mortality rate is equivalent to the number of female deaths from alcohol use disorder worldwide (World Health Organization, 2004).

Our results have important policy implications. Harmonizing tobacco regulations among trading partners, especially between rich exporters and poor importers, may increase their effectiveness in reducing tobacco imports, tobacco consumption, and health-related illnesses. Thus, our results support the idea of lobbying to increase tobacco regulations in low- and middle-income countries. Doing so not only reduces consumption of domestic tobacco products but also prevents an influx of international tobacco products from high-income countries.

Conceptual Framework

We present a model that yields an estimable empirical equation linking the effect of differences in tobacco regulations on tobacco trade flows by modifying Anderson and van Wincoop's 2003 gravity model. This model helps identify variables that need to be included in our empirical estimation and allows us to correctly interpret our results.

[2] Since we use the difference in tobacco regulations in our regressions, we use the difference in government response to lobbying, the difference in average asbestos production, and the difference in environmental sustainability index between bilateral trading partners as instruments in our model.

Tobacco Regulations and the Gravity Model

We assume n countries exist, each of which produces differentiated tobacco products that are either consumed domestically or exported. The utility function for a representative consumer in country j is given by

$$U_{ij}(c_{ij}) = \left[\sum_{i=1}^{n}\left(\frac{c_{ij}}{\beta_i}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where c_{ij} is consumer j's consumption of country i's goods, β_i is the share parameter for country i's good, and σ is the elasticity of substitution. The consumer's budget constraint is $y_j = \sum_{i=1}^{n} p_{ij}c_{ij}$, where y_j is country j's total income and p_{ij} is the price country j's consumers face for country i's goods. The consumer maximizes utility subject to a budget constraint.

The price of foreign goods takes the form $p_{ij} = p_i t_{ij}$, where p_i is the exporter's supply price on the world market and t_{ij} is the per unit trade costs between country i and country j. The prices country j faces are different from the domestic prices in country i because they include trade costs, defined as all costs (other than production costs) sustained in moving a good to its final nondomestic use. Trade costs are directly affected by regulations and policy barriers, and they are indirectly affected by geographic and cultural variables through transportation costs (Gallup, Sachs, and Mellinger, 1999; Anderson and van Wincoop, 2004).

We incorporate the difference in tobacco-regulation stringency between trading partners into trade costs by defining trade costs as

$$t_{ij} = e^{\alpha\left(r_i - r_j\right)} e^{\mathbf{C_{ij}B}} d_{ij}^{b}\left(1 + v_{ij}\right), \tag{2}$$

where α is a parameter associated with differences in tobacco regulations between each bilateral trade partner, r_i is an aggregate tobacco-regulation index for the exporting country and r_j is an aggregate tobacco-regulation index for the importing country, $\mathbf{C_{ij}}$ is a row vector of cultural and geographic characteristics, $\mathbf{B}$ is a column vector of associated cultural and geographic parameters, d_{ij} is the distance between countries i and j, b is a trade elasticity of distance, and v_{ij} is country j's *ad valorem* import tariff on country i's goods.

We also construct a disaggregate measure based on the difference in each tobacco regulation affecting the market. We re-write equation (A2) as

$$t_{ij} = e^{\beta\left(r_i^{mc} - r_j^{mc}\right) + \gamma\left(r_i^{sa} - r_j^{sa}\right)} e^{\mathbf{C_{ij}B}} d_{ij}^{b}\left(1 + v_{ij}\right), \tag{3}$$

where r^{mc} is an index of marketing and counter-advertising tobacco regulations, r^{sa} is an index of smoking-location and age regulations, and β and γ are parametric weights associated with each country pair for each regulation type.[3]

The solution to the model yields the following import demand equation weighted by the product of GDP between country trading pairs (see Appendix A for details):

$$\frac{x_{ij}}{y_j y_i} = \frac{1}{y_w}\left(\frac{e^{\alpha\left(r_i - r_j\right)} e^{\mathbf{C_{ij}B}} d_{ij}^{b}\left(1 + v_{ij}\right)}{P_j \pi_i}\right)^{1-\sigma}, \tag{4}$$

where y_w is world income, $P_j \equiv \left(\sum_{i=1}^{n} \frac{y_i}{y_w}\left(e^{\alpha\left(r_i - r_j\right)} e^{\mathbf{C_{ij}B}} d_{ij}^{b}\left(1 + v_{ij}\right)/\pi_i\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ is a measure of inward multilateral resistance, and $\pi_i \equiv \left(\sum_{i=1}^{n} \frac{y_j}{y_w}\left(e^{\alpha\left(r_i - r_j\right)} e^{\mathbf{C_{ij}B}} d_{ij}^{b}\left(1 + v_{ij}\right)/P_j\right)^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$ is a

[3] Ideally, we would disaggregate regulations further into four types, but since we only have two main instruments we can only just identify the equation for two types of tobacco regulations. Disaggregating further would create an underidentified system.

measure of outward multilateral resistance. Multilateral resistance terms account for barriers to trade affecting both countries i and j in their trade with all trading partners and come in the form of differing price indices (inward) or competition (outward) (Anderson and van Wincoop, 2003).

We find that tobacco regulations have two separate effects on a country's tobacco import demand. The first is the direct effect, which is found in the term $e^{(1-\sigma)\alpha(r_i-r_j)}$ in equation (4). The second is the indirect effect, through the two multilateral resistance terms.

Empirical Model

Estimating equation (4) presents three challenges. First, our regulatory variables may be endogenous because a unilateral change in tobacco regulations by an importer in response to tobacco imports will alter the difference in tobacco-regulation stringency between bilateral trading pairs. We use a conceptual framework developed by Keohane, Revesz, and Stavins (1998) that classifies political economy determinants of regulations to identify potential instruments. Assume that $\mathbf{t}$ is the level of tobacco-regulation stringency. Demand for tobacco regulations, $\mathbf{t^D}$, can be formulated as $\mathbf{t^D}$ (marginal benefit of tobacco regulations, public preferences) while supply of tobacco regulations, $\mathbf{t^S}$, can be formulated as $\mathbf{t^S}$ (marginal cost of tobacco regulations, institutional factors). In equilibrium, the marginal value of tobacco regulations occurs when its marginal benefit equals its marginal cost. Here, both the tobacco-regulation stringency level and the marginal value of tobacco regulations are endogenous. The equilibrium level of tobacco-regulation stringency depends on the marginal value of tobacco regulations, public preferences, and institutional factors. Thus, a reduced-form equation specifying the determinants of tobacco-regulation stringency includes institutional factors and public preferences, which are exogenous supply- and demand-side factors, respectively.

We identify two main instruments—one is a proxy for institutional factors and the other is a proxy for public preferences. Neither of the factors directly influences tobacco imports. The supply of tobacco regulations is affected by lobbying and the political process. A government more susceptible to lobbying contributions from a consumer lobbying group (tobacco manufacturer) is likely to establish stringent (lax) tobacco regulations. We use an index of corruption control as a proxy for government influenceability[4] and calculate the difference in corruption control between trading partners as an instrument for the difference in tobacco regulations. Demand for tobacco-regulation stringency is affected by consumers' perception of the marginal damage from tobacco use. Exposure to asbestos increases the marginal damages from tobacco (McFadden et al., 1986), thereby changing the perceived marginal damages from tobacco-related illnesses (Li et al., 1984). Asbestos exposure exacerbates tobacco-related illnesses, leading to an increase in perceived marginal damages if the user attributes most of the illness to tobacco use. Alternatively, perceived marginal damages can decrease if the user attributes the illness more to asbestos exposure. We use a measure of asbestos production per capita as a proxy for asbestos exposure and determine the difference in asbestos production per capita between trading partners as an instrument for the difference in tobacco regulations. Both of the main instruments are unlikely to affect tobacco imports directly but may affect them through the difference in tobacco regulations.

We also include an additional instrument that captures the effectiveness of environmental regulations, which may correlate with how governments protect the health of the populace. We use the difference in environmental sustainability index between countries as an added instrument to check robustness of our results.

Second, gravity equations are typically estimated using a log-linear specification. Using a dataset with all possible trading partner combinations results in a large number of zero trade flows. Taking the log of trade would create missing values for these observations and ignore a large amount of important information. Two common estimation strategies involve either dropping observations

[4] This is not to suggest that the political influence of lobby activity implies corruption. However, given availability of these data, it is not unreasonable to hypothesize that a corruption index is correlated with propensity to be influenced by interest group lobby effort. We retain the definition of corruption from the International Country Risk Guide.

with zero trade or adding a small positive number to the dependent variable and taking its log and, consequently, estimating via ordinary least squares. Neither approach is desirable because both produce inconsistent parameter estimates.

Other empirical strategies have been developed to address the zeros problem.[5] Santos Silva and Tenreyro (2006) proposed a Poisson pseudo-maximum likelihood (PPML) estimator as a solution, in part because of its superior performance in the presence of heteroskedasticity.[6] Using the PPML estimator, we estimate our gravity equation in levels rather than the log-linearized form. Rewriting equation (4) in levels yields

$$\text{(5)} \qquad \frac{x_{ij}}{y_i y_j} = \exp\left(\mathbf{Z}_{ij}\boldsymbol{\Theta}\right) = \exp\begin{pmatrix} (1-\sigma)\,\alpha\,(r_i - r_j) + (1-\sigma)\,\mathbf{C_{ij}B} - \ln y_w \\ +(1-\sigma)\,b\ln d_{ij} - (1-\sigma)\ln P_j - (1-\sigma)\ln \pi_i \end{pmatrix},$$

where $\mathbf{Z}_{ij}$ is a vector of covariates for each country pair and $\boldsymbol{\Theta}$ is a vector of parameters. The resulting Poisson log-likelihood function is

$$\text{(6)} \qquad \ln L = \sum_{k}^{n(n-1)} \left(-\exp\left(\mathbf{Z}_{ij}\boldsymbol{\Theta}\right) + \frac{x_{ij}}{y_i y_j}\mathbf{Z}_{ij}\boldsymbol{\Theta} - \ln \frac{x_{ij}}{y_i y_j}! \right),$$

where n is the number of countries. The PPML estimator represented by equation (6) can be calculated by selecting the parameters that equate the following score equations equal to 0:

$$\text{(7)} \qquad \sum_{k}^{n(n-1)} \left(\frac{x_{ij}}{y_i y_j} - \exp\left(\mathbf{Z}_{ij}\boldsymbol{\Theta}\right) \right) z_{ij}^{h} \; \forall\, h = 1, 2, \ldots, H,$$

where H is the number of covariates and z_{ij}^{h} is the hth covariate. As the score equations suggest, the response data can include nonintegers and need not be Poisson distributed for consistency as long as the conditional mean of trade is correctly specified as $E\left[\frac{x_{ij}}{y_i y_j}\middle|\mathbf{Z}_{ij}\right] = \exp\left(\mathbf{Z}_{ij}\boldsymbol{\Theta}\right)$ (Santos Silva and Tenreyro, 2010).

Finally, the multilateral resistance terms are not directly measurable from the data. Because Anderson and van Wincoop (2004) were concerned with the parameter estimates of the multilateral resistance terms, they implemented a complex algorithm to simulate them. Rather than simulating, they can be proxied using a fixed effects approach by including country-specific dummies (Anderson and van Wincoop, 2003; Feenstra, 2004). This approach allows us to easily control for multilateral resistance—such as tariff and nontariff barriers—from other trading partners, but there are two tradeoffs. First, we are not able to measure the indirect effect of tobacco regulations through the multilateral resistance terms. Second, since we allow for country fixed effects, only variables specific to the bilateral trading pair can be included as regressors.

We test the following hypothesis on the effect of tobacco regulations on tobacco imports: The effect of aggregate tobacco regulation differences between the exporter and importer is to increase tobacco imports. Affirmation requires $(1-\sigma)\,\alpha > 0$ in equation (5). In general, more stringent tobacco regulations in the exporting country are likely to lead to a reduction in domestic production (Chapman et al., 1999); instead, firms will sell to other jurisdictions with less stringent tobacco regulations. One possible mechanism that allows this effect is that stringent tobacco regulations in exporting countries may free up resources that otherwise would have been spent in the domestic economy, allowing exporting firms to market in countries with less stringent regulations. For

[5] Felbermayr and Kohler (2006) set up a Wooldridge (2002) style corner solutions model and used a Tobit regression for estimation. Using a Heckman-style selection process, Helpman, Melitz, and Rubinstein (2008) developed a two stage estimation procedure. However, both studies estimated a log-linear form of the gravity equation.

[6] Using Monte Carlo simulations, the PPML estimator is favorable over the Tobit estimator when data are generated using a constant elasticity model and the probability of observing zero is not independent of the regressors (Santos Silva and Tenreyro, 2011).

example, there is evidence showing that advertising spending for UK tobacco firms did not change significantly after more stringent domestic tobacco regulations were implemented (Elliott, Wei, and Lenton, 2010). If the regulations across exporters and importers are the same, there is no spillover effect from the exporter's regulations on tobacco imports. The policy implication is that matching tobacco regulatory stringency between trading partners will reduce tobacco-related spillover effects.

Differences in counter-advertising and marketing regulations between countries may have a different effect on tobacco trade than differences in age or smoking-location regulations. Counter-advertising and marketing regulations have the potential to affect the entire population of current and potential tobacco users, while age and smoking-location regulations affect only specific groups of consumers. Difference in particular tobacco regulations between exporter and importer may also increase trade instead of decreasing it. For instance, if member countries within a trade bloc require specific regulations before trade, we may see more trade occur as the difference in particular tobacco regulations becomes smaller.

Data Description

We compile cross-sectional data from the year 2000,[7] including tobacco import value, gross domestic product (GDP), country-specific tobacco regulations, and bilateral distances and country-pair characteristics. Appendix B lists the data sources.

The trade data include total import values in millions USD of manufactured and unmanufactured tobacco between two bilateral trading partners from the year 2000. There are 97 countries with data on tobacco regulations in our sample, so we build a trade dataset including all possible trading partners, providing $97 \times 96 = 9,312$ total observations.

We created four tobacco regulatory indices: a counter-advertising regulation index, a marketing regulation index, an age regulation index, and a smoking-location regulation index. Each index was calculated based on a country's adherence to a subcategory (Appendix C). A country may indicate either complete restriction, partial regulation, or no regulation for a particular subcategory. We assign a score of 1 when a country indicates complete restriction and a score of 0 for partial or no regulation. Then we add the scores for all subcategories and divide by total subcategories to arrive at an aggregate tobacco index. A country that adopts all subcategory criteria for a tobacco regulation has the highest level of regulation, with an index of 1. In contrast, a country with zero regulations adopted has an index of 0.[8]

Our main variable of interest is the difference between exporter and importer aggregate tobacco index, so we calculate the aggregate tobacco index for an exporter and subtract the aggregate index from its importing trade partner. We also create two other tobacco regulation measures. One shows the difference in marketing and counter-advertising regulations and the other is the difference in smoking-location and age regulations between exporter and importers. Both indices are created by taking the average of the two relevant indices to arrive at an index between 0 and 1. We then subtract the importer's index from the exporter's index.

Bilateral distances were calculated based on the shortest distances measured on the earth's surface, regardless of actual transportation routes. The cultural and geographic characteristics include three dummy variables indicating whether the countries share a border, a common language, or a colonial link. We also include a trade treaty dummy in some empirical specifications in addition to our multilateral resistance dummies.

[7] Ideally, we would compile a panel dataset to account for cross-country and time variation, but we are limited by our tobacco regulation variables, which are not surveyed annually by the World Health Organization and show little variation, if any, from when they were first collected in 2000. More importantly, since we do not have annual data for our instruments, we would not be able to identify our endogenous tobacco regulations.

[8] For example, there are four age regulation subcategories: sales to minors, age verification for sales, vending machines sales, and free tobacco products. If a country bans sales to minors, partially adheres to age verification for sales, allows vending machine sales, and disallows free tobacco products, we assign a score of 1, 0, 0, and 1, respectively. Therefore, the resulting index for age regulation for that country is 0.5 given a sum of 2 out of a maximum of 4.

The first instrumental variable is the difference in average asbestos production per capita between trading partners and is collected from the U.S. Geological Survey. Sixty-one countries had produced asbestos between 1930 and 1970. Historical population demographics from these countries were gathered to obtain asbestos production per capita for years where data is available, and the average was derived. The long lag in asbestos production per capita not only reduces any potential direct effect on tobacco imports during our sample time period, but the time frame was also chosen to avoid years in which asbestos regulations started in the 1970s. Other countries in our sample either do not produce asbestos or produce a negligible amount and therefore do not report, so we assign a value of 0.

The second instrumental variable is the difference in corruption control index from the International Country Risk Guide, which has been widely used since its introduction by Knack and Keefer (1995). The index measures the extent to which financial corruption (such as bribes for protection) and insidious forms of corruption (such as lobbying to affect policy) are prevalent in the country. The index captures instability of the political process as well as distortions in economic competition from nepotism or favoritism from those in power. Scores range from 0 to 6, where a high index indicates more corruption control or less government influenceability by lobby groups.[9] We take the average of the available corruption control index data from 1984 to 1995 and obtain seventy-eight country observations, then we take the difference in the corruption control index between importer and exporter. If only seventy-eight countries are used, our total observations is reduced by one-third since we are left with $78 \times 77 = 6,006$ observations. We employ multiple imputation using twenty imputations to fill in missing observations for the nineteen countries, assuming a normal distribution.

Aside from our two main instruments, we also use the difference in environmental sustainability indices between country pairs from Yale University's Center for Environmental Law and Policy. The composite index ranges from 0 to 100 and is based on various measures that reflect pollution levels, natural resource endowments, and environmental regulations (World Economic Forum, 2001). In our sample, Finland had the highest value while Saudi Arabia scored the lowest. Thirteen countries from our sample do not have an index value, so we also use multiple imputation here to complete our sample.

Table 1 presents summary statistics of our data. The mean level of tobacco imports was $1.5 million USD in 2000. For developed countries (those with per capita GDP above $4,085), the mean tobacco import level is higher, at $2 million, while for developing countries (those with GDP per capita lower than $4,085), mean tobacco import is lower, at $0.25 million. Across our four measures of tobacco regulation indices, developed economies have more stringent tobacco regulations than developing economies. Finally, the mean tobacco regulation difference between unique bilateral pairs is 0.215. The mean difference between unique bilateral pairs in marketing and counter-advertising regulations is 0.289, slightly larger than the mean difference between unique bilateral pairs in age and smoking-location regulations at 0.248.[10]

Results

We estimate model parameters for the full sample and include exporter/importer pairs with large income gaps. We compare the results with and without instrumental variable (IV) estimates using

[9] The ratings are from subjective assessments by ICRG staffers based on available information from in-depth country assessments.

[10] The mean difference in regulations for all country pairs is always 0 since the regulation difference of one exporter-importer pair will be the negative value of the regulation difference when looking at the same two countries with the roles are reversed. This is why the mean differences of regulations in table 1 for all data are 0.

Table 1. Summary Statistics

	All				Countries with GDP Per Capita ≥ \$4,085)	Countries with GDP Per Capita < \$4,085)
Variable	**Mean**	**St. Dev**	**Min**	**Max**	**Mean**	**Mean**
Tobacco trade imports (in millions USD)	1.528	31.022	0.000	2,539.341	2.046	0.251
Log of total GDP	3.501	2.066	−0.184	9.239	3.494	1.881
Contiguous	0.024	0.153	0.000	1.000		
Common language	0.132	0.338	0.000	1.000		
Common colony	0.018	0.135	0.000	1.000		
Trade Treaty dummy	0.461	0.498	0.000	1.000		
Log of trade distance	8.687	0.848	4.088	9.894		
Counter-advertising regulations	0.340	0.474	0.000	1.000	0.362	0.286
Marketing regulation index	0.330	0.253	0.000	1.000	0.384	0.196
Age regulation index	0.291	0.282	0.000	1.000	0.337	0.179
Smoking-location regulation index	0.281	0.234	0.000	0.923	0.300	0.234
Tobacco regulation difference (exporter minus importer)	0.000	0.264	−0.702	0.702		
Marketing and counter-advertising regulation difference (exporter minus importer)	0.000	0.359	−0.875	0.875		
Age and smoking-location regulation difference (exporter minus importer)	0.000	0.306	−0.808	−0.808		
Corruption control index	3.658	1.501	0.016	6.000	4.004	2.654
Average asbestos production per capita from 1930 to 1970 (metric tons per capita)	0.003	0.014	0.000	0.100	0.004	0.00002
Environmental sustainability index	52.230	11.428	29.800	80.500	44.209	55.301

Notes: The mean tobacco regulation difference, marketing and counter-advertising regulation difference, and age and smoking-location regulation difference for unique bilateral pairs are 0.215, 0.289, and 0.248, respectively.

PPML. We include imputed values for our instrumental variables in all specifications.[11] We then combine these estimates with existing parameters in the literature to simulate the health effects of tobacco consumption and examine the trade-mediated effects of tobacco regulations on health.

[11] Appendix D shows the PPML and IV-PPML results without imputed values for the instruments. The sample size without imputed values is 2/3 of the sample with imputed values. The results of the regressions that exclude observations with imputed values for the instrument are similar in sign and significance with specifications (1) and (2) of the PPML regressions in table 3 that include imputed values. Thus, if there is little to no endogeneity, results are consistent with and without imputed values. However, the significance is statistically weaker with IV PPML relative to specifications (1) and (2) of the IV PPML results in table 3. The loss in statistical power with the IV estimates is because the set of countries lost in the no-imputation case are mostly developing countries, which leads to a loss of observations representing trade between developed and developing countries that tend to have significant differences in tobacco regulations.

Table 2. Determinants of Tobacco Regulations: First-Stage Regression Results

Dependent Variable	Tobacco Regulation Difference	Marketing and Counter-Advertising Regulation Difference	Age and Smoking-Location Regulation Difference	Tobacco Regulation Difference	Marketing and Counter-Advertising Regulation Difference	Age and Smoking-Location Regulation Difference
Difference in corruption control index	−0.800***	−0.340***	−1.259***	−0.539***	0.0003	−1.078***
(exporter minus importer)	(0.044)	(0.065)	(0.056)	(0.044)	(0.064)	(0.058)
Difference in asbestos production per capita	0.863***	0.372***	1.354***	0.566***	−0.016	1.148***
(exporter minus importer)	(0.046)	(0.068)	(0.058)	(0.047)	(0.068)	(0.061)
Difference in environmental sustainability index				0.005***	0.006***	0.003***
(exporter minus importer)				(0.0002)	(0.0003)	(0.0003)
Contiguous	−0.001	−0.003	0.001	−0.001	−0.002	0.001
	(0.019)	(0.026)	(0.020)	(0.019)	(0.026)	(0.020)
Common language	−0.0004	−0.001	0.0002	−0.0003	−0.001	0.0003
	(0.009)	(0.014)	(0.009)	(0.009)	(0.014)	(0.009)
Common colony	0.0003	0.001	−0.0002	0.0002	0.001	−0.0002
	(0.023)	(0.034)	(0.023)	(0.023)	(0.033)	(0.023)
Log of distance	−0.001	−0.002	0.0004	−0.0004	−0.001	0.0005
	(0.004)	(0.006)	(0.005)	(0.004)	(0.006)	(0.005)
Constant	0.006	0.016	−0.004	0.005	0.014	−0.005
	(0.056)	(0.089)	(0.058)	(0.058)	(0.092)	(0.058)
Multilateral resistance dummies	Yes	Yes	Yes	Yes	Yes	Yes
F-test for excluded instruments	287***	38***	448***	362***	163***	352***
N	9,312	9,312	9,312	9,312	9,312	9,312

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 15%, 10%, and 5% level. Standard errors (in parentheses) are robust to heteroskedasticity. The dependent variables are Exporter minus Importer index differences.

Table 3. Estimating the Effect of Differences in Aggregate Tobacco Regulations on Tobacco Import Value Weighted by Exporter and Importer GDP Product Using a Gravity Equation

	PPML				IV PPML			
Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
Contiguous	1.899***	1.955***	1.915***	1.973***	1.815***	4.675***	1.956***	6.835***
	(0.077)	(0.077)	(0.077)	(0.077)	(0.468)	(1.055)	(0.546)	(2.541)
Common language	0.415***	0.379***	0.412***	0.372***	0.457*	1.081***	0.466*	3.418***
	(0.039)	(0.039)	(0.039)	(0.039)	(0.287)	(0.474)	(0.303)	(0.940)
Common colony	0.672***	0.635***	0.610***	0.558***	1.571***	1.371*	1.888***	−3.326**
	(0.086)	(0.086)	(0.0865)	(0.086)	(0.457)	(0.938)	(0.508)	(1.767)
Log of distance	−0.924***	−0.937***	−0.914***	−0.929***	−2.485***	−4.495***	−2.708***	−9.795***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.155)	(0.644)	(0.248)	(1.394)
Tobacco regulation difference	−0.116***	−0.087***	−0.085***	−0.049	−3.698***	−14.253***	−7.454***	−24.775***
(exporter minus importer)	(0.039)	(0.039)	(0.039)	(0.039)	(1.178)	(3.980)	(2.325)	(4.364)
Tobacco regulation difference ×		0.448***		0.488***		11.235***		41.106***
bilateral GDP difference		(0.039)		(0.039)		(3.210)		(8.354)
Trade treaty dummy			0.450***	0.534***				
			(0.048)	(0.046)				
Constant	−19.475***	−20.069***	−19.959***	−20.268***	−7.684***	13.951***	−4.853*	66.102***
	(0.235)	(0.206)	(0.239)	(0.206)	(1.811)	(6.837)	(2.964)	(13.569)
Multilateral resistance dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9,312	9,312	9,312	9,312	9,312	9,312	9,312	9,312

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 15%, 10%, and 5% level. Standard errors (in parentheses) are robust to heteroskedasticity. Specifications (1) and (2) of IV PPML are just identified, while specifications (3) and (4) are over-identified.

Empirical Link between Differences in Tobacco Regulations, Tobacco Trade, and Health

We provide two sets of estimates of first-stage regressions for three endogenous variables (table 2). The first set includes only two instruments—the corruption control index and asbestos production—which lead to just-identified estimates for most of the second-stage specifications. The second set of instruments includes the environmental sustainability index, which overidentifies our second-stage estimates. In most specifications, the instruments are significant and have consistent signs. An increase in the difference between exporter and importer average asbestos production per capita leads to a larger difference in exporter and importer tobacco regulations. This may be explained by an increase in perceived marginal damages from tobacco use leading to more demand for stringent regulations and a larger tobacco regulation gap between the bilateral partners. On the other hand, a larger difference in the corruption control index between exporters and importers leads to smaller differences in tobacco regulations between exporters and importers. One potential explanation is that when the government can be lobbied to influence regulations, consumer advocacy groups have greater influence on the government than tobacco firms, leading to more stringent tobacco regulations and a larger difference in tobacco regulations. The difference in environmental sustainability index is also positive and significant, suggesting that countries that implement stringent environmental regulations are also likely to implement more stringent tobacco regulations. All F-stats for excluded instruments are greater than 10, illustrating that our instruments are not weak.

Tables 3 and 4 present coefficient estimates of the determinants of tobacco imports using the PPML and IV-PPML models. Standard errors are robust to heteroskedasticity. There are four specifications for each type of estimation. Specifications (1) and (2) for the PPML estimates do not include trade treaties, while specifications (3) and (4) include them on top of the multilateral resistance dummies. Specifications (1) and (2) for the IV PPML estimates use the difference in asbestos production and the difference in corruption control as instruments, while specifications (3) and (4) also include differences in the environmental sustainability index.

Our theory suggests that trade costs—in the form of distance between countries, trade barriers, cultural differences, geographic locations, and regulations—affect trade flows. Our empirical results show that the distance effect is negative and significant in most models, suggesting that longer distances reduce tobacco imports. Having a common language, being in the same colony or trade treaty, or sharing a border have a positive effect on tobacco imports in most specifications.

The absolute value of the coefficient on the difference in tobacco regulations is smaller in the PPML model than the IV-PPML model. Without accounting for endogeneity of the regulations, we expect a bias in the PPML estimates relative to the IV-PPML values. One possibility is that a large difference in tobacco regulations may lead to more tobacco imports between trading pairs. However, more tobacco imports could induce more stringent regulations in the importing country leading to a smaller difference in tobacco regulations and, therefore lower tobacco imports. This may be a reason why the PPML estimates are lower in absolute value than the IV-PPML estimates when not controlling for endogeneity.

We find support for our hypothesis regarding the effect of difference in aggregate tobacco regulations between exporters and importers on tobacco import value in the case where the income gap between exporter and importer is positive and large. From table 3, as the difference between aggregate tobacco regulations between exporters and importers increases, tobacco import value significantly decreases. However, when we include an interaction term between differences in tobacco regulations and differences in GDP per capita, the magnitude of the coefficient related to the interaction term is positive and significant. This implies that when trade occurs between a rich exporter and poor importer, a larger gap in tobacco regulations leads to more tobacco imports.

Table 4. Estimating the Effect of Differences in Disaggregated Tobacco Regulations on Tobacco Import Value Weighted by Exporter and Importer GDP Product Using a Gravity Equation

Variable	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Contiguous	1.915***	1.955***	1.920***	1.972***	2.464***	2.862*	3.236***	2.437**
	(0.077)	(0.077)	(0.077)	(0.077)	(0.827)	(1.848)	(1.325)	(1.361)
Common language	0.410***	0.390***	0.408***	0.381***	0.209	−0.715	0.187	−2.519**
	(0.039)	(0.039)	(0.039)	(0.039)	(0.314)	(2.039)	(0.354)	(1.435)
Common colony	0.693***	0.632***	0.628***	0.565***	1.645***	1.763	1.933***	3.730**
	(0.086)	(0.086)	(0.086)	(0.086)	(0.551)	(1.400)	(0.864)	(1.941)
Log of distance	−0.922***	−0.939***	−0.917***	−0.932***	−2.331***	−4.775***	−2.270***	−7.288***
	(0.017)	(0.017)	(0.017)	(0.018)	(0.188)	(2.231)	(0.170)	(2.152)
Marketing and counter-advertising regulation difference (exporter – importer)	0.070***	0.084***	0.073***	0.091***	1.492	−3.250	3.732	−4.159
	(0.030)	(0.030)	(0.030)	(0.030)	(1.935)	(3.711)	(2.661)	(3.307)
Age and smoking-location regulation difference (exporter – importer)	−0.220***	−0.211***	−0.191***	−0.179***	−2.819***	−5.007***	−3.289***	−5.977***
	(0.035)	(0.035)	(0.035)	(0.035)	(0.929)	(1.635)	(1.082)	(2.073)
Marketing and counter-advertising × bilateral GDP difference regulation difference (exporter – importer)		0.056**		0.114***		12.323		23.372***
		(0.030)		(0.030)		(12.957)		(7.244)
Age and smoking-location regulation difference (exporter – importer) × bilateral GDP difference		0.459***		0.422***		−1.756		−2.637
		(0.035)		(0.035)		(6.354)		(3.409)
Trade Treaty Dummy			0.441***	0.485***				
			(0.048)	(0.046)				
Constant	−20.210***	−20.134***	−19.935***	−20.296***	−10.025***	11.141	−10.563***	34.375**
	(0.205)	(0.206)	(0.239)	(0.206)	(2.030)	(20.194)	(1.814)	(19.708)
Multilateral Resistance Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	9,312	9,312	9,312	9,312	9,312	9,312	9,312	9,312

Notes: Single, double, and triple asterisks (*, **, ***) indicate significance at the 15%, 10%, and 5% level. Standard errors (in parentheses) are robust to heteroskedasticity.

The mean tobacco import value response to differences in tobacco regulations is inelastic and, based on the mean difference in tobacco regulations between unique country pairs, equal to -0.8 from the IV-PPML estimates in table 3.[12] However, as the income gap increases, the elasticity decreases in absolute value and eventually becomes positive.[13] Based on our estimates, if the difference in GDP per capita between exporter and importer is at least $13,000, the elasticity of tobacco imports given differences in tobacco regulations is positive. Approximately 20% of our sample, 1,723 observations, have this income gap.

To illustrate the role of income differences between exporter and importer, consider the United States, the largest exporter of cigarettes, and Greece, the largest consumer of cigarettes per capita.[14] The per capita income difference between the United States and Greece is approximately $25,000, which is associated with an elasticity of tobacco imports due to differences in regulation equal to 2.97. If the United States adopts one more marketing regulation, the difference in tobacco regulation indices increases by 0.03, which is a 14.5% increase relative to the mean difference. This implies that tobacco imports to Greece from the United States will increase by 43%, which is equal to an annual increase of $0.7 million in tobacco import value.

We disaggregate tobacco regulations into two groups—marketing and counter-advertising regulations versus age and smoking-location regulations—and summarize their effect on tobacco imports in table 4. We find that as the difference in counter-advertising and marketing regulatory stringency between exporters and importers of tobacco increases, more tobacco is imported by countries with less stringent regulations. Furthermore, the effect is magnified when the exporting country has a significantly larger income than the importing country in some specifications. The effect is significant with the PPML specifications and when including the difference in environmental sustainability indices between countries as an instrument in the IV-PPML specification.

Interestingly, differences in age and smoking-location regulations between exporters and importers have a consistent negative effect on overall imports. In this case, countries that adopt and enforce similar age restrictions and limits on smoking locations are more likely to engage in tobacco trade between one other. Such an effect could be a reflection of the institutional similarity between trading partners or may show a need for synchronizing regulations as a precursor for trade, similar to the synchronization found in the EU.

These two results hint at marketing and/or counter-advertising regulations as the main tobacco regulations that incentivize rich exporters to send tobacco products to poor importers since the effect of age and smoking-location regulations on tobacco imports is negative. A reallocation of advertising and marketing spending, similar to that shown by Elliott, Wei, and Lenton (2010) from UK tobacco firms, may be the underlying mechanism leading to this result. This hints at a reallocation of advertising spending by tobacco firms away from countries with stringent regulations toward countries with lax regulations. The policy recommendation for effective tobacco consumption reduction is to harmonize tobacco regulations across trading partners such that countries with lax regulations adopt more stringent policies similar to their trading partners to mitigate the spillover effects.

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[12] The elasticity is calculated as $\frac{\partial x_{ij}}{\partial (r_i - r_j)} \cdot \frac{(r_i - r_j)}{x_{ij}} = (1-\sigma)\,\alpha\overline{(r_i - r_j)}$, where $(1-\sigma)\,\alpha = -3.698$ in the IV-PPM model and the mean difference in tobacco regulation for a unique country pair, $\overline{(r_i - r_j)}$, is 0.215.

[13] When examining how the elasticity changes with a change in the income gap, we use the results from specification (2) of the IV PPML in table 3, where the elasticity is now $\frac{\partial x_{ij}}{\partial (r_i - r_j)} \cdot \frac{(r_i - r_j)}{x_{ij}} = (1-\sigma)\,\alpha\overline{(r_i - r_j)} + (1-\sigma)\,\beta\overline{(r_i - r_j)}\,(GDP_i - GDP_j)$, where $(1-\sigma)\,\alpha = -14.253$ and $(1-\sigma)\,\beta = 11.235$.

[14] We also conduct PPML for high-income importing countries only, thereby reducing income gaps and tobacco regulation differences between bilateral pairs. As with the results from the full sample, we find that the interaction effect of tobacco regulation differences and GDP differences is positive and significant with magnitudes that are slightly smaller. Results are available from the authors upon request.

Table 5. The Elasticity of Tobacco-Related Mortality Across Different Income Gaps Between Trading Partners

GDP Per Capita Difference between Exporter and Importer ($)	Elasticity of Tobacco-Related Mortality with Respect to Tobacco Regulation Difference
-50,000	-0.058^{**}
	(0.034)
-25,000	-0.035^{**}
	(0.021)
-15,000	-0.026^{**}
	(0.015)
-5,000	-0.016^{**}
	(0.010)
0	-0.012^{**}
	(0.007)
5,000	-0.007^{**}
	(0.004)
15,000	0.002
	(0.002)
25,000	0.011^{**}
	(0.007)
50,000	0.034^{**}
	(0.021)

Notes: Single and double asterisks (*, **) indicate significance at the 15% and 10% level. The elasticity is derived using the following formula: $\varepsilon_R^M = \theta_{i/j}^R \times \varepsilon_I^C \times \varepsilon_C^D \times \varepsilon_C^M$, where $\theta_{i/j}^R$ is the elasticity of the value of tobacco imports with respect to regulations by the importer or exporter, ε_I^C is the elasticity of tobacco import market share from the value of tobacco imports, ε_C^D is the elasticity of tobacco consumption per capita from the tobacco import market share, and ε_C^M is the elasticity of mortality from per capita tobacco consumption. We convert the regulation coefficients in table 2 into elasticities by multiplying them by mean regulations. Based on the existing literature, we adopt the following values: ε_C^M = 0.3409 with a standard error of 0.0602 (Escario and Molina, 2004), ε_C^D = 0.031 with a standard error of 0.017, and ε_I^C = 0.366 in the latest value of their sample in 1995 (Hsieh, Hu, and Lin, 1999). We use the formula for the variance of a nonlinear univariate function $g(A)$ to calculate the variance of each estimate, which is equal to $V\left(g\left(\mathbf{A}\right)\right) = \left(\frac{\partial g}{\partial \mathbf{A}}\right)^T \mathbf{V}(\mathbf{A}) \left(\frac{\partial g}{\partial \mathbf{A}}\right)$, where $\frac{\partial g}{\partial \mathbf{A}}$ is a vector whose *i*th element is partial derivative with respect to g and $\mathbf{V}(\mathbf{A})$ is the variance-covariance matrix of parameters (Kennedy, 1998). The corresponding standard error (in parentheses) is the square root of this variance.

Difference in Tobacco Regulations, Trade, and Mortality

Using our estimates and those in the literature, we simulate the effect that differences in tobacco regulations have on mortality and morbidity rates in an importing country. We use the estimates from two studies along with our own to obtain an elasticity measure of mortality given a change in the difference in tobacco regulations between country pairs with different income gaps. Escario and Molina (2004) estimated the effect of per capita tobacco consumption on mortality rates for tobacco-related cancer (including cancer of the lung, trachea, and bronchi) in select EU countries. They found that a 1% increase in per capita tobacco consumption led to a 0.34% increase in total tobacco-related cancer mortality. Hsieh, Hu, and Lin (1999) estimated the effect of import market shares of tobacco on tobacco consumption to show that a 1% increase in import market shares led to a 0.031% increase in tobacco consumption per capita. Using their estimates and our own estimates from specification (2) of the IV PPML in table 3, we derive an approximate elasticity of tobacco-related mortality brought about by a change in the difference in tobacco regulations between trading partners across different income gaps (table 5).

Assuming an income gap between exporter and importer of $25,000 (similar to the United States and Greece), we find that when an exporter adopts more stringent counter-advertising tobacco regulations, the difference in the aggregate tobacco index increases by 0.25, which leads to a 1.28% increase in imported tobacco-related cancer mortality in the importing country.[15] The average mortality rate from twelve European Union countries due to tobacco-related cancer is 309 deaths per million people (Escario and Molina, 2004). The adoption by an exporter of counter-advertising translates to an increase in imported tobacco cancer-related deaths of four smokers per million people annually. Approximately twenty smokers suffer from tobacco-related diseases for every one tobacco-related death (Centers for Disease Control and Prevention, 2003). Assuming this ratio of tobacco-related diseases to deaths, the importing country also experiences an increase in morbidity of eighty smokers per million people annually due to an increase in the exporter's counter-advertising regulation stringency. The effect is larger as the income gap increase. For a large developing country such as Indonesia, with a population of 242 million, the regulatory effects can be significant.

As a point of comparison, four females per million people worldwide die annually from alcohol use disorders (World Health Organization, 2004). Thus, the spillover effects from adopting counter-advertising regulations, all else equal, are comparable to female deaths from disorders from alcohol use. These effects hint at the potential health benefits of coordinating tobacco regulatory policies across countries.

Concluding Remarks

Given that tobacco consumption is projected to increase worldwide (especially in developing countries), tobacco-related disease is likely to remain a public health policy concern. Although there has been much analysis regarding the efficacy of tobacco-related regulation in own-country tobacco consumption, no one has investigated the difference in tobacco regulations between bilateral trading partners and its effect on tobacco trade.

In this article, we empirically estimate the effects of differences in tobacco regulations on tobacco trade. We find these effects to be significant in determining the flow of tobacco imports. There are two striking results with important policy implications. First, tobacco imports increase when an exporter's tobacco regulations are stringent relative to the tobacco regulations of its importing trade partner and when the income per capita gap between the exporting country and the importing country is at least $13,000. Differences in marketing and counter-advertising tobacco regulations between bilateral trading partners may drive the results, especially if rich exporting countries target poor importing countries with lax marketing regulations. This may hint at a potential "tobacco disease haven" where developing countries experience a rise in tobacco-related illnesses due to increased tobacco-regulation stringency in developed countries.

Second, the spillover health effects are significant because when a rich exporting country adopts counter-advertising tobacco regulations, leading to a larger difference in tobacco regulations, the poor importing country experiences an increase in mortality and morbidity. When the exporter adopts one additional marketing regulation there is an increase in tobacco-related cancer and morbidity of four and eighty smokers per million people annually in the poor importing country, respectively, if the income gap between exporter and importer is $25,000. This makes a case for coordinated increases or harmonization in tobacco regulations to internalize the spillover effect and further decrease trade flows of tobacco. Our results also support the idea of lobbying to increase tobacco regulations in developing countries, not only to reduce consumption of domestic tobacco products, as shown in the previous literature, but also to prevent an influx of international tobacco products from developed countries, as shown in this study.

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[15] The elasticity of tobacco-related mortality is 0.011 in table 5 when the income gap is 25,000. An increase of 0.25 implies a 14.25% increase in the difference in tobacco regulations between exporter and importer.

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Appendix A: Deriving Import Demand

The first-order conditions that maximize equation (1) subject to the budget constraint are

$$\text{(A1)} \qquad \left(\frac{\sigma}{\sigma-1}\right)\left[\sum_{i=1}^{n}\left(\frac{c_{ij}}{\beta_i}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}-1}\left(\frac{1}{\beta_i}\right)^{\frac{\sigma-1}{\sigma}}\left(\frac{\sigma-1}{\sigma}\right)c_{ij}^{\frac{1}{\sigma}}-p_{ij}=0\ \forall\ i=1\ldots n,$$

$$\text{(A2)} \qquad y_j-\sum_{i=1}^{n}p_{ij}c_{ij}=0,$$

where λ is the marginal utility of income. Solving the first-order conditions and defining the nominal value of imports to j from i as $x_{ij}\equiv p_{ij}c_{ij}$ yields country j's demand for country i's goods:

$$\text{(A3)} \qquad x_{ij}=y_j\left(\frac{\beta_i p_{ij}}{\sum_{i=1}^{n}\beta_i p_{ij}}\right)^{1-\sigma}.$$

When markets clear, we have the following condition:

$$\text{(A4)} \qquad y_i=\sum_{j=1}^{n}y_j\left(\frac{\beta_i p_i t_{ij}}{\sum_{i=1}^{n}\beta_i p_i t_{ij}}\right)^{1-\sigma}.$$

We control for the endogeneity of prices by solving equation (A4) for the scaled prices:

$$\text{(A5)} \qquad y_i=(\beta_i p_i)^{1-\sigma}\sum_{j=1}^{n}y_j\left(\frac{t_{ij}}{\sum_{i=1}^{n}\beta_i p_i t_{ij}}\right)^{1-\sigma},$$

which when rearranged yields

$$\text{(A6)} \qquad \beta_i p_i=\left(y_i\left(\sum_{j=1}^{n}y_j\left(\frac{t_{ij}}{\sum_{i=1}^{n}\beta_i p_i t_{ij}}\right)^{1-\sigma}\right)^{-1}\right)^{\frac{1}{1-\sigma}}.$$

Multiplying the numerator and denominator of equation (A6) by world income, defined as $y_w\equiv\sum_i y_i$, yields

$$\text{(A7)} \qquad \beta_i p_i=\left(\frac{y_i}{y_w}\left(\sum_{j=1}^{n}\frac{y_j}{y_w}\left(\frac{t_{ij}}{\sum_{i=1}^{n}\beta_i p_i t_{ij}}\right)^{1-\sigma}\right)^{-1}\right)^{\frac{1}{1-\sigma}}.$$

Substituting equation (A2) into equation (A7) yields

$$\text{(A8)} \qquad \beta_i p_i=\left(\frac{y_i}{y_w}\left(\sum_{j=1}^{n}\frac{y_j}{y_w}\left(\frac{e^{\alpha(r_i-r_j)}e^{\mathbf{C_{ij}B}}d_{ij}^{b}(1+v_{ij})}{\sum_{i=1}^{n}\beta_i p_i e^{r_{ij}}e^{\mathbf{C_{ij}B}}d_{ij}^{b}(1+v_{ij})}\right)^{1-\sigma}\right)^{-1}\right)^{\frac{1}{1-\sigma}}.$$

Finally, substituting equation (A8) into equation (A3) yields equation (4):

$$\frac{x_{ij}}{y_j y_i}=\frac{1}{y_w}\left(\frac{e^{\alpha(r_i-r_j)}e^{\mathbf{C_{ij}B}}d_{ij}^{b}(1+v_{ij})}{P_j\pi_i}\right)^{1-\sigma}.$$

Appendix B: Data Sources

Variable	Description of Variables	Source
Tobacco trade value	Value of manufactured and unmanufactured tobacco in thousands USD from exporter to importer	World Bank's COMTRADE dataset
GDP	Per capita gross domestic product for 2000 in USD	World Bank
Tobacco regulations	All tobacco regulation information	World Health Organization Tobacco Control Country Profiles, 2000
Contiguous borders	Dummy variable indicating whether the trading pair share a border	Centre d'Etudes Prospectives et d'Informations Internationales
Common language	Dummy variable indicating whether the trading pair shares an official language	Centre d'Etudes Prospectives et d'Informations Internationales
Common colonizer	Dummy variable indicating whether the trading pair has ever shared a colonial link	Centre d'Etudes Prospectives et d'Informations Internationales
Trade distance	A measure of distance between the trading pair's largest cities. Calculated using the great circle formula and the cities' longitude and latitude coordinates	Centre d'Etudes Prospectives et d'Informations Internationales
Trade Treaty Dummy	1 if countries have a bilateral trade treaty or belong to the same trade union, 0 otherwise	World Trade Organization 2001 Annual Report.
Average asbestos production per capita	Average of asbestos production per capita from 1930–1970	Data for asbestos is derived from the U.S. Geological Survey and population data is from www.populstat.info
Corruption control index	An indicator of corruption within the political system, characterized by financial corruption and insidious corruption. A score of 0 (low corruption control) to 6 (high corruption control) is assigned	International Country Risk Guide published by The PRS Group, Inc.
Environmental Sustainability Index	A composite index that evaluates if a country is on a path that is environmental sustainability relative to other countries using various measures that reflect pollution levels, natural resource endowments and environmental regulations. The index ranges from 0 to 100	Yale University's Center for Environmental Law and Policy

Appendix C: Tobacco Regulation Subcategories

Counter-Advertising Regulation Index	Marketing Regulation Index	Age Regulation Index	Smoking-Location Regulation Index
Mandated education	Marketing in certain media	Sales to minors	Smoking in government buildings
Mandated health warnings	Marketing to certain audiences	Age verification for sales	Smoking in private worksites
	Marketing in certain locations	Vending machines sales	Smoking in educational facilities
	Sponsorship or promotion for certain audiences	Free tobacco products	Smoking in health care facilities
	Sponsorship marketing of events		Smoking on buses
	Brand stretching		Smoking on trains
	Misleading information on packaging		Smoking in taxis
	Package health warning/ message		Smoking on ferries
			Smoking on domestic air flights
			Smoking on international flights
			Smoking in restaurants
			Smoking in nightclubs and bars
			Smoking in other public places

Appendix D: Deriving the Determinants of Tobacco Imports Using a Gravity Model and No Imputed Values

	PPML		IV-PPML	
Variable	**(1)**	**(2)**	**(1)**	**(2)**
Contiguous	1.737***	1.797***	1.412***	60.671
	(0.093)	(0.093)	(0.517)	(52.540)
Common language	0.538***	0.503***	0.607***	2.031
	(0.045)	(0.045)	(0.261)	(6.158)
Common colony	−0.198***	−0.176**	0.165	15.665*
	(0.101)	(0.101)	(0.335)	(10.732)
Log of distance	−0.802***	−0.827***	−1.548***	−32.942
	(0.021)	(0.021)	(0.116)	(24.766)
Tobacco regulation difference (exporter minus importer)	−0.632***	−0.554***	1.741	−2.008
	(0.052)	(0.052)	(1.349)	(8.264)
Tobacco regulation difference × bilateral GDP difference		0.593***		262.370
		(0.049)		(210.758)
Constant	−21.073***	−20.962***	−17.146***	315.899
	(0.230)	(0.232)	(1.416)	(270.288)
Multilateral resistance dummies	Yes	Yes	Yes	Yes
N	6,006	6,006	6,006	6,006

Notes: Single, double, and triple asterisks (*, **, ***) indicate [statistical] significance at the 15%, 10%, and 5% level. Standard errors (in parentheses) are robust to heteroskedasticity.