

## **Vapor products, harm reduction, and taxation**

Principles, evidence, and a research agenda

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October 1, 2018

## Summary

More than 20 countries have introduced taxation on e-cigarettes and other vapor products. In the United States, several states and local jurisdictions have enacted e-cigarette taxes.

Most of the harm from smoking is caused by the inhalation of toxicants released through the combustion of tobacco. Non-combustible nicotine delivery systems, including e-cigarettes, “heat-not-burn” products, smokeless tobacco and other nicotine delivery systems, are generally considered to be significantly less harmful than combustible cigarettes.

Policymakers face a wide range of strategies regarding the taxation of vapor products. On the one hand, principles of harm reduction suggest vapor products should face no taxes or low taxes relative to conventional cigarettes, to guide consumers toward a safer alternative to smoking. On the other hand, the precautionary principle as well as principles of tax equity point toward the taxation of vapor products at rates similar to conventional cigarettes.

Analysis of tax policy issues is complicated by divergent—and sometimes obscured—intentions of such policies. Some policymakers claim that the objective of taxing nicotine products is to reduce nicotine consumption. Other policymakers indicate the objective is to raise revenues to support government spending. Often missed in the policy discussion is the effect of fiscal policies on innovation and the development and commercialization of harm-reducing products. Also, often missed are the consequences for current consumers of nicotine products, including smokers seeking to quit using harmful conventional cigarettes.

Policy decisions regarding taxation of vapor products should consider both long-term fiscal effects, as well as broader economic and welfare effects. These effects might (or might not) suggest very different tax policies to those that have been enacted or are under consideration.

Our research concludes the economics of harm reduction with respect to vapor products is an area in need of reliable empirical research.

- Within a harm reduction framework, some policy objectives overlap and others conflict. For example, an objective to encourage current

smokers to switch to less harmful e-vapor products largely is consistent with an objective to discourage dual use. On the other hand, policies that encourage switching may conflict with an objective to discourage youth uptake of vapor products. The extent of the net economic benefits of vapor products in a harm reduction framework are empirical matters of degree that require reliable research. To date, there is no peer-reviewed published research quantifying the net economic benefits of vapor products with respect to harm reduction.

- The small body of research on consumer demand response to e-cigarette pricing finds a wide range of estimates of e-cigarette own-price elasticity and cross-price elasticity with respect to conventional cigarettes, even among studies using the same set of data. Without reliable empirical research, policymakers face great uncertainty regarding whether specific tax proposals will achieve—or confound—their stated policy goals.
- Despite the innovations that gave rise to the market for vapor products, virtually no empirical research has evaluated the impacts of taxation and regulation on innovation in the industry. Differential taxation of vapor products would likely induce a supply-side response, but there is no quantitative research on supply at this time.

Principles of harm reduction recognize that every proposal has uncertain outcomes as well as potential spillovers and unforeseen consequences. Nevertheless, the basic principle of harm reduction is a focus on safer rather than safe. Policymakers must make their decisions weighing the expected benefits and expected costs. With such high risks and costs associated with cigarette and other combustible use, taxes and regulations must be developed in an environment of uncertainty and with an eye toward a net reduction in harm, rather than an unattainable goal of zero harm. ●

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Most of the harm from smoking is caused by the inhalation of toxicants released through the combustion of tobacco. Non-combustible nicotine delivery systems, including e-cigarettes, “heat-not-burn” products, smokeless tobacco and other nicotine delivery systems, are generally considered to be significantly less harmful than combustible cigarettes.

Many experts believe that the best option for smokers who are unable or unwilling to quit smoking is to switch to a less harmful alternative activity that has similar attributes, such as using non-combustible nicotine delivery products. Policies that encourage smokers to switch from more harmful combustible tobacco products to less harmful non-combustible products would be considered a form of “harm reduction.”

Harm reduction refers to private or public actions taken to lessen the expected negative social or physical consequences associated with various human behaviors. For example, laws requiring all vehicles be fitted with seatbelts are public actions to reduce the expected harm from accidents. A rider’s choice to wear a seatbelt is a private action. Mandating vehicles be fitted with seatbelts is no guarantee the passengers will wear one. Similarly, wearing a seatbelt is no guarantee that a passenger will not be

harmed in an accident. Nevertheless, there is widespread agreement that seatbelt use reduces the expected harm associated with driving.

Harm reduction policies are used to manage a wide range of behaviors including recreational drug use and sexual activity. Needle-exchange programs reduce the spread of infectious diseases among users of heroin and other injected drugs. Opioid replacement therapy replaces an illegal opioid, such as heroin, with a longer acting but less euphoric opioid. Safer sex education and condom distribution in schools are designed to reduce teenage pregnancy and reduce the spread of sexually transmitted infections. None of these harm reduction policies stop the risky behavior, nor do the policies eliminate the potential for harm. Nevertheless, the policies intend to reduce the expected harm.

The concept of tobacco harm reduction began in 1976 when Michael Russell, a psychiatrist and lecturer at the Addiction Research Unit of Maudsley Hospital in London, wrote: “People smoke for nicotine but they die from the tar.”<sup>1</sup> Russell hypothesized that reducing the ratio of tar to nicotine could be the key to safer smoking.

Since then, much of the harm from smoking has been well-established as caused almost exclusively by toxicants released through the combustion of tobacco.<sup>2</sup> Combustible tobacco and smoking include cigarettes, roll-your-own, cigars, pipe tobacco, bidis, kreteks, hookah tobacco, and any other product that burns tobacco for human consumption.<sup>3</sup> The U.S. Surgeon

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<sup>1</sup> Russell, M. A. (1976). Low-tar medium-nicotine cigarettes: a new approach to safer smoking. *British Medical Journal*, 1 (6023):1430–3.

<sup>2</sup> Nitzkin, J. L. (2014). The case in favor of e-cigarettes for tobacco harm reduction. *International Journal of Environmental Research and Public Health*, 11(6):6459–6471. <http://doi.org/10.3390/ijerph110606459>

<sup>3</sup> Douglas, C. E., Henson, R., Drope, J., and Wender, R. C. (2018). The American Cancer Society public health statement on eliminating combustible tobacco use in the United States. *CA: A Cancer Journal for Clinicians*. In press.

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General concludes that combustion is the main element of harm from tobacco use:<sup>4</sup>

*The burden of death and disease from tobacco use in the United States is overwhelmingly caused by cigarettes and other combusted tobacco products; rapid elimination of their use will dramatically reduce this burden.*

It is for this reason Public Health England and the American Cancer Society have concluded non-combustible tobacco products as well as pure nicotine products are considerably less harmful than combustible products.

While the regulatory framework for vapor products (as well as the overall “tobacco harm reduction” concept) has been widely discussed, there has been little analysis of optimal tax policy for non-combustible nicotine products. In particular, there is a lack of economic and policy work identifying, prioritizing, and evaluating the tradeoffs among the principles that should guide tax-policy formulation for such products. In addition, there is a dearth of analysis evaluating the nexus between the differences in health risk between cigarettes and non-combustible alternatives and the economic and welfare effects of smokers switching between the two.

In the absence credible estimates of the net economic, fiscal, and welfare effects resulting from people switching to non-combustible products, tax authorities at various levels of government likely will focus (and already are focusing) excessively on (1) the potential revenues from imposing or increasing taxes on non-combustible alternatives and/or (2) the expected short-term revenue losses that might result from decreased cigarette consumption as people switch to non-combustible alternatives. As a result, policymakers may consider taxing these products at rates equivalent to or higher than combustible tobacco products in hopes of preserving or increasing tax revenues.

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<sup>4</sup> U.S. Department of Health and Human Services (2014). *The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Analysis of tax policy issues is complicated by divergent—and sometimes obscured—intentions of such policies. On the one hand, policymakers claim that the objective of taxing nicotine products is to reduce nicotine consumption. On the other hand, the objective is to raise revenues to support government spending. Often missed is the effect of fiscal policies on innovation and the development and commercialization of harm-reducing products. Also, often missed are the consequences for current consumers of nicotine products, including smokers. Research is needed to address the potential conflicts between these objectives and identify how different policy choices would likely further (or impede) the objectives.

Policy decisions regarding taxation of vapor products should take into account both long-term fiscal effects, as well as broader economic and welfare effects. These effects might (or might not) suggest very different tax policies to those that have been enacted or are under consideration.

For instance, the U.K. House of Commons Science and Technology Committee released a report recommending government action on e-cigarettes and heated tobacco products. Conclusions and recommendations section of the report mentions that:<sup>5</sup>

*The level of taxation on smoking-related products should directly correspond to the health risks that they present, to encourage less harmful consumption. Applying that logic, e-cigarettes should remain the least-taxed and conventional cigarettes the most, with heat-not-burn products falling between the two.*

The remainder of this paper will examine existing research on harm reduction, with a focus on tobacco harm reduction principles and policies. The paper then discusses taxation principles within a harm reduction framework and surveys existing taxes on vapor products. We also review existing empirical research on the relationship between the demand and pricing of

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<sup>5</sup> U.K. House of Commons Science and Technology Committee (2018), E-cigarettes: Seventh Report of Session 2017-2019, August 17, 2018. <https://publications.parliament.uk/pa/cm201719/cmselect/cmsctech/505/505.pdf>

vapor products and combustible products. The paper concludes with a proposed research agenda to guide policymaking and taxation regarding e-cigarettes and other vapor products.

## Existing research on harm reduction

In 2015, Public Health England published a comprehensive review of the research finding that vapor products are 95 percent less harmful than cigarettes and should be promoted as a tobacco-cessation method.<sup>6</sup> In December 2017, the United Kingdom's government Committee on Toxicity stated in its toxicological evaluation of heat-not-burn products that:<sup>7</sup>

*[T]here is a likely reduction in risk for smokers switching to heat-not-burn tobacco products, a risk remains and it would be more beneficial for smokers to quit smoking entirely.*

In February 2018, Public Health England released a new report on evidence review of e-cigarettes and heat-not-burn products and concluded:<sup>8</sup>

*[T]he available evidence suggests that heated tobacco products may be considerably less harmful than tobacco cigarettes and more harmful than e-cigarettes.*

In 2018 American Cancer Society shifted its position on e-cigarettes, recommending that individuals who do not quit smoking:<sup>9</sup>

*... should be encouraged to switch to the least harmful form of tobacco product possible; switching to the exclusive*

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<sup>6</sup> McNeill, A., Brose, L. S., Calder, R., Hitchman, S. C., Hajek, P., and McRobbie, H. (2015). E-cigarettes: An evidence update. *Public Health England*.

<sup>7</sup> Committee on Toxicity (2017). Statement on the toxicological evaluation of novel heat-not-burn tobacco products. United Kingdom Food Standards Agency. December 11, 2017.

<sup>8</sup> McNeill, A., Brose, L. S., Calder, R., Bauld, L., and Robson, D. (2018). *Evidence Review of E-Cigarettes and Heated Tobacco Products 2018*. A report commissioned by Public Health England.

<sup>9</sup> American Cancer Society (2018). American Cancer Society position statement on electronic cigarettes. <https://www.cancer.org/healthy/stay-away-from-tobacco/e-cigarette-position-statement.html>.



*use of e-cigarettes is preferable to continuing to smoke combustible products.*

The American Heart Association identifies several ways in which the use of e-cigarettes may improve public health by reducing overall tobacco-related harm, including:<sup>10</sup>

1. Complete cessation or reduction of the number of cigarettes smoked;
2. Reduction in prevalence of use of combustible products (especially cigarettes); and
3. Reduction of secondhand smoke exposure.

Proponents of harm reduction strategies recognize the impossibility of eliminating risky behaviors and, in turn, eliminating risk. Instead, the focus of harm reduction is to reduce harm or the potential for harm. Put simply, the intent is to make the risky behavior *safer* (lower risk, lower harm), rather than *safe* (no risk, no harm).

Proponents of the use of vapor products as a harm reduction strategy to reduce tobacco smoking argue that such products can serve as an “exit ramp” enabling users to transition away from smoking. Opponents argue that misperceptions about the safety of vapor products may induce those who would otherwise have not smoked cigarettes to vape and thereby become addicted to nicotine. Worse, rather than serving as an “exit ramp,” some claim that vapor products might be a “gateway” to smoking traditional cigarettes.

These opposing views are not a matter of either-or or right-and-wrong, rather the effects are empirical matters of degree. For example, Kozlowski and Abrams (2016) explain that from a harm reduction standpoint, what matters is how many alternative nicotine delivery system users become smokers (“gateway effect”) *relative* to the number of smokers who quit by

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<sup>10</sup> Bhatnagar, A., Whitsel, L. P., Ribisl, K. M., Bullen, C., Chaloupka, F., Piano, M. R., Robertson, R. M., McAuley, T., Goff, D., and Benowitz, N. (2014). Electronic cigarettes: A policy statement from the American Heart Association. *Circulation*, 130:1418–1436.

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using an alternative (“off-ramp”).<sup>11</sup> They conclude the evidence unambiguously shows that the off-ramp is far bigger than the gateway, indicating a considerable net benefit.

A comprehensive review of more than 800 peer-reviewed scientific studies on the health effects of e-cigarettes by the National Academies of Science, Engineering, and Medicine Report highlights the importance of understanding empirically the harm reduction trade-offs:<sup>12</sup>

*The net public health effect, harm or benefit, of e-cigarettes depends on three factors: their effect on youth initiation of combustible products, their effect on adult cessation of combustible products, and their intrinsic toxicity. If e-cigarette use by adult smokers leads to long-term abstinence from combustible tobacco cigarettes, the benefit to public health could be considerable. Without that health benefit for adult smokers, e-cigarette use could cause considerable harm to public health in the short- and long-term due both to the inherent harms of exposure to e-cigarette toxicants and to the harms related to subsequent combustible tobacco use by those who begin using e-cigarettes in their youth.*

In January 2018 a Food and Drug Administration advisory panel, the Tobacco Products Scientific Advisory Committee (TPSAC), unanimously concluded that Philip Morris International demonstrated a “low” likelihood that former smokers would re-initiate tobacco use with the company’s electronic IQOS heat-not-burn system.<sup>13</sup> Research published by the American Association of Pediatrics finds that adolescent e-cigarette-only users have

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<sup>11</sup> Kozlowski, L. T. and Abrams, D. B. (2016). Obsolete tobacco control themes can be hazardous to public health: The need for updating views on absolute product risks and harm reduction. *BMC Public Health*, 16:432.

<sup>12</sup> National Academies of Sciences, Engineering, and Medicine (2018). *Public Health Consequences of E-cigarettes*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/24952>.

<sup>13</sup> The only options for the committee were “low,” “medium,” and “high.”  
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significantly lower exposure to toxic volatile organic chemicals than adolescents who use combustible cigarettes as well as e-cigarettes.<sup>14</sup>

## Taxation principles

The typical justifications for taxation fall into three broad categories:

1. To generate revenues to fund government services,
2. To reduce or offset the costs consumers impose on others, and/or
3. To satisfy a paternalistic impulse to reduce or eliminate unpopular or antisocial behaviors.

Historically, taxes had the sole purpose of raising revenues. The “best” taxes would be on goods with few substitutes (i.e., inelastic demand) and on goods deemed to be luxuries. Adam Smith notes, “Sugar, rum, and tobacco are commodities which are nowhere necessities of life, which are become objects of almost universal consumption, and which are therefore extremely proper subjects of taxation.”<sup>15</sup> In the U.S., from 1868 until 1913, 90 percent of all federal revenue came from taxes on liquor, beer, wine and tobacco.<sup>16</sup>

Over time, the rationale for these taxes has shifted. The Temperance movement argued for higher taxes to discourage alcohol consumption. Since the Surgeon General’s warning on the dangers of smoking, tobacco tax increases have been justified as a way to get smokers to quit. More recently, a perceived obesity epidemic has led to several jurisdictions imposing taxes on sugar-sweetened beverages to reduce sugar consumption.

Toll roads and gas taxes were initially imposed to fund road improvements. For example, in many U.S. states, gas tax revenues must be used only for road construction and maintenance. Because the charges are paid by road-way users, they more closely align who pays for the roads and who benefits

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<sup>14</sup> Rubinstein, M. L., Delucchi, K., Benowitz, N. L., and Ramo, D. E. (2018). Adolescent exposure to toxic volatile organic chemicals from e-cigarettes. *Pediatrics*. March 2018, e20173557.

<sup>15</sup> Smith, Adam. (1776). *The Wealth of Nations*. New York: Modern Library, 1937.

<sup>16</sup> U.S. Internal Revenue Service (2018). Historical highlights of the IRS. <https://www.irs.gov/newsroom/historical-highlights-of-the-irs>.

from the roads. During the inflation and energy crises of the 1970s, increases in the gas tax were justified as way to reduce fuel consumption, to balance the federal budget, and to slow inflation. More recently, congestion charges are seen as a way to encourage drivers to avoid driving, choose less congested routes, or drive at less congested times.

Apart from being a significant source of revenue, the excise tax on cigarettes has been promoted as a “sin tax” to discourage consumption either because of externalities caused by smoking (increased costs for third-party health payers and health consequences) or paternalism. According to Centers for Disease Control and Prevention in U.S., smoking-related illness in the U.S. costs more than \$300 billion each year, including; (1) nearly \$170 billion for direct medical care for adults and (2) more than \$156 billion in lost productivity, including \$5.6 billion in lost productivity due to secondhand smoke exposure.<sup>17</sup>

While some jurisdictions earmark a portion of tobacco taxes for prevention and cessation efforts, in practice most tobacco taxes are treated by policy-makers as general revenues to be spent in whatever way the legislative body determines. State and local governments in the U.S. collect more than \$18 billion a year in tobacco taxes.<sup>18</sup>

The CDC’s cost estimates raise important questions regarding who bears the burden of smoking related illness. For example, much of the cost is borne by private insurance, which charge steeper premiums for customers who smoke. In addition, the CDC estimates reflect costs imposed by people who have smoked for decades—many of whom have now quit. A proper accounting of the costs vis-à-vis tax policy is the discounted costs imposed by today’s smokers.

Several governments, including the U.S., have argued smoking raises the costs of public health expenditures. Assuming that smoking cigarettes in-

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<sup>17</sup> Centers for Disease Control and Prevention (2018). Economic trends in tobacco. May 4, 2018. [https://www.cdc.gov/tobacco/data\\_statistics/fact\\_sheets/economics/econ\\_facts/index.htm](https://www.cdc.gov/tobacco/data_statistics/fact_sheets/economics/econ_facts/index.htm).

<sup>18</sup> U.S. Census Bureau (2017). 2015 Annual Survey of State and Local Finances.

creases costs of public health programs, then switching consumers from cigarettes to reduced risk alternatives such as vapor products could represent a health cost benefit.

Vapor products that have lower externalities or cause less direct harm should be subject to a lower “sin” tax. A cost-benefit analysis of the desired excise tax rate on vapor products would include reduced health spending as an offset against excise tax revenue that was foregone by putting a lesser rate on those products.

According to Levy et al. (2017), a strategy of replacing cigarette smoking with e-cigarettes would yield substantial life year gains, even under pessimistic assumptions regarding cessation, initiation, and relative harm.<sup>19</sup> Increased longevity does not simply extend the individual’s years of retirement and reliance on government transfers but has impact on greater work effort and productivity together with higher tax payments on consumption.

Proponents of taxing vapor products at a lower rate than combustible products identify the following overlapping—and sometimes conflicting—public health goals:<sup>20</sup>

1. Maximize the number of current users of combustible products switching to a less harmful non-combustible alternative;
2. Discourage combustible and non-combustible dual use;
3. Discourage initiation of any nicotine containing product, especially among youth.
4. Reduce smoking related health spending.

In spite of these reasonable justifications for imposing low—or zero—taxes on vapor products, many jurisdictions have imposed high taxes on these

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<sup>19</sup> Levy, D. T., Borland, R., Lindblom, E.N., Goniewicz, M. L., Meza, R., Holford, T. R., Yuan, Z., Luo, Y., O’Connor, R. J., Niaura, R., and Abrams, D. B. (2018). Potential deaths averted in USA by replacing cigarettes with e-cigarettes. *Tobacco Control*, 27:18-25.

<sup>20</sup> Chaloupka, F. J. (2015). Taxing e-cigarettes: Options and potential public health impact. Presentation to E-Cigarette Tax Policy Research Meeting. January 22, 2015. <http://www.trdrp.org/files/e-cigarettes/frank-e-cigs.pdf>.

products. The typical justifications for vapor products taxation fall into three broad categories:

1. To generate revenues to fund government services, including tobacco use prevention and cessation efforts;
2. To improve public health by discouraging youth from initiating nicotine consumption; and/or
3. To satisfy a paternalistic impulse to reduce or eliminate vaping.

The taxation of tobacco is based on an understanding that inhaling combusted tobacco harms the health of the consumer. With approximately one-third of the U.S. population covered by some form of government funded health insurance, such as Medicare or Medicaid, the private costs of healthcare have been transformed into a public cost. Evidence of harm associated with second-hand smoke indicates that tobacco consumers generate health spillovers on non-consumers. The World Health Organization concludes, “Price and tax measures are an effective and important means of reducing tobacco consumption.”<sup>21</sup>

In the long-run, the goals of reducing or eliminating consumption of the taxed good and generating revenues are in conflict. If the tax is successful in reducing consumption, it falls short in generating revenue. Similarly, if the tax succeeds in generating revenues, it falls short in reducing or eliminating consumption.

Substitutability is another consideration. An increase in the tax on spirits will result in an increase in beer and wine purchases. A high toll on a road will divert traffic to untolled streets that may not be designed for increased traffic volumes. A spike in tobacco taxes in one jurisdiction will result in a spike in sales in bordering jurisdictions as well as increase illegal cross-jurisdiction sales or smuggling.<sup>22</sup>

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<sup>21</sup> World Health Organization. WHO Framework Convention on Tobacco Control. 2003.

<sup>22</sup> Prieger, J. E. and Kulick, J. (2018). Cigarette taxes and illicit trade in Europe. *Economic Inquiry*, 56(3):1706-1723.

Researching, developing, and bringing to market new technologies is costly. Typically, such costs are fixed in that the costs do not vary with the anticipated volume of sales. In many cases, firms incur research and development costs for products that never make it to market. With high fixed costs of research and development, taxes can slow the diffusion of new technologies and products.<sup>23</sup> For example, a 1977 law reducing the federal excise tax on beer produced by small brewers has been recognized as sparking the growth and proliferation of “craft” breweries and brewpubs in the U.S.<sup>24</sup>

Consider a hypothetical market for vapor products shown in Figure 1. In standard economic analysis, imposing a tax—a shift from  $MC_L$  to  $MC_H$ —would reduce the quantity sold and create a deadweight loss that depends on the elasticity of demand. Without taxes, the firm produces an amount  $Q_L$  such that marginal revenue equals marginal cost; consumers pay a price  $P_L$ . The producer surplus is shown by the shaded area  $DEFGHI$ .

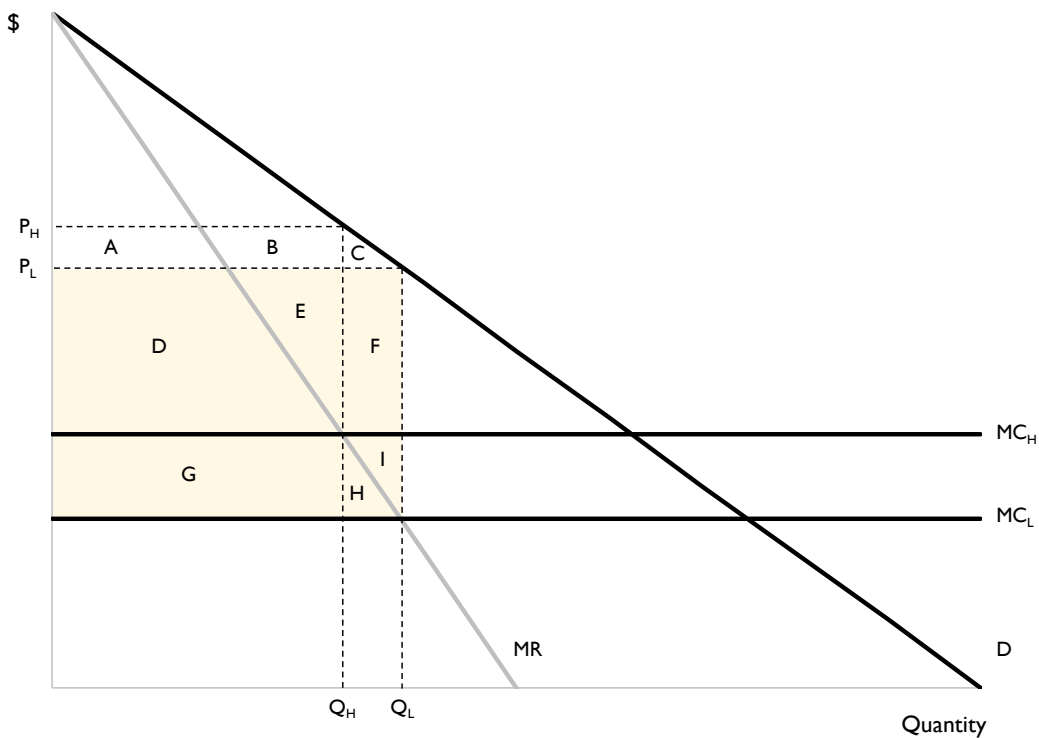
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LaFaive, M. and Nesbitt, T. (2018). High cigarette taxes have led to thriving black market across America. *The Hill*. March 15, 2018. <http://thehill.com/opinion/campaign/378601-high-cigarette-taxes-have-led-to-thriving-black-market-across-america>.

<sup>23</sup> See, for example, Romer, P. (1994). New goods, old theory, and the welfare costs of trade restrictions. *Journal of Development Economics*, 43:5-38.

<sup>24</sup> Tremblay, C. and Tremblay, V. (2011). Recent economic developments in the import and craft segments of the US brewing industry. In *The Economics of Beer*. Oxford University Press.

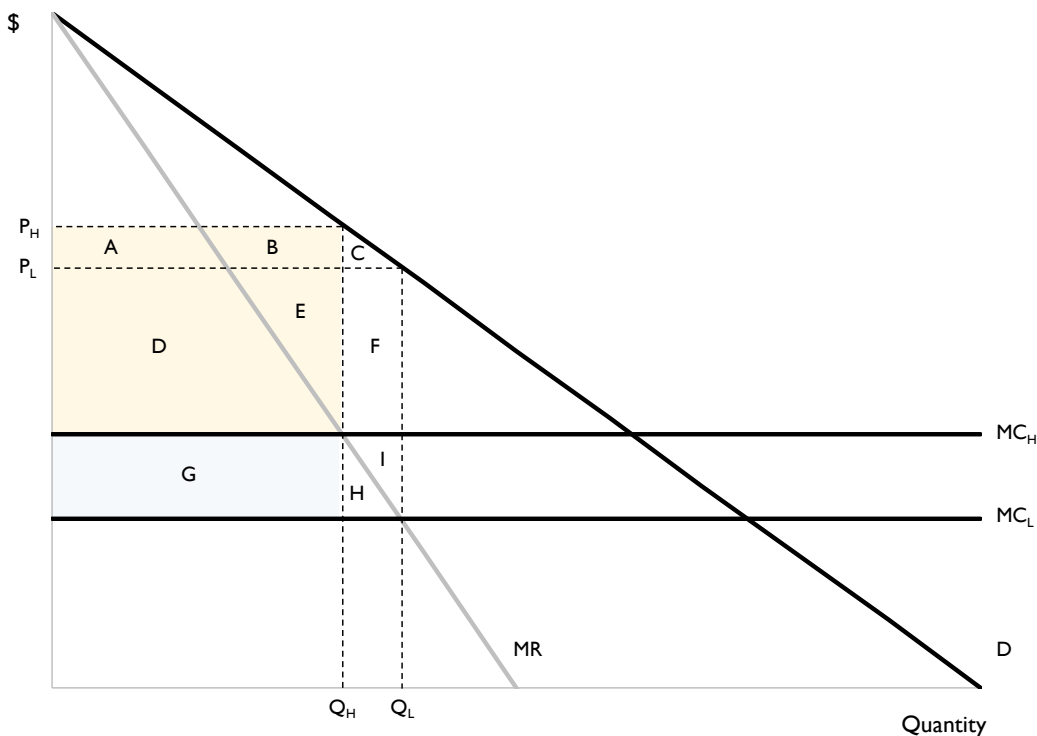
Figure 1: Producer surplus for hypothetical firm with market power, pre-tax



In Figure 2, a per-unit tax, paid by the producer, raises the marginal cost to  $MC_H$ . As a result, output is reduced to  $Q_H$  and the price rises to  $P_H$ . Producer surplus shown by the shaded area  $ABDE$ , which is smaller than the pre-tax producer surplus  $DEFGHI$ . The government collects tax revenues shown by the shaded area  $G$ .



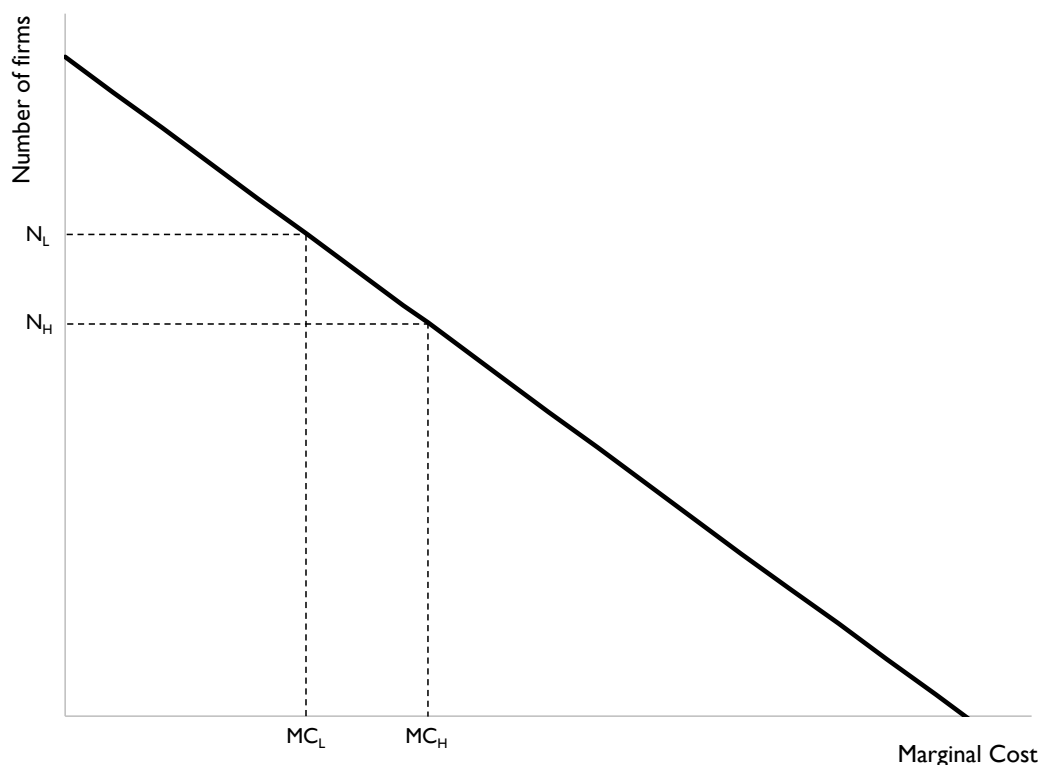
Figure 2: Producer surplus and tax revenues for hypothetical firm with market power, post-tax



Consider a market with many potential producers. Before entering the market, a firm must incur fixed costs to develop its product. Without taxes, a firm will enter if its producer surplus exceeds its fixed cost of entry,  $DEFGHI$ . After the tax, however, the potential producer surplus is the smaller area  $ABDE$ . Firms will continue to enter the market after the taxes, but the smaller producer surplus suggests that fewer firms would find entry profitable. Similarly, increased fixed costs of bringing the product to market—such as regulatory delay—would dampen entry.

Figure 3 shows that as the taxes raise the marginal cost from  $MC_L$  to  $MC_H$ , the number of firms in the market decreases from  $N_L$  to  $N_H$ . Thus, the taxes not only reduce the amount sold and increase the price paid, the taxes also reduce the number of products sold in the market, thereby stifling innovation.

Figure 3: Per unit tax reduces equilibrium number of firms



## Mechanics of taxation

There is widespread support among health policy experts for maintaining differential tax rates between cigarettes and non-combustible alternatives. The American Heart Association, for example, supports taxing e-cigarettes at a rate high enough to discourage youth use, while retaining or increasing differentials with combustible products by increasing taxes on combustibles.<sup>25</sup> An editorial by a prominent tobacco economist (and outspoken tobacco critic) and health policy experts in the *New England Journal of*

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<sup>25</sup> Bhatnagar, A., Whitsel, L. P., Ribisl, K. M., Bullen, C., Chaloupka, F., Piano, M. R., Robertson, R. M., McAuley, T., Goff, D., and Benowitz, N. (2014). Electronic cigarettes: A policy statement from the American Heart Association. *Circulation*, 130:1418–1436.

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*Medicine* also advocates a differential tax rate, including “sharply increased” taxes on combustible products.<sup>26</sup> The authors argue that such differential taxation would increase incentives for tobacco users to switch from the most harmful products to the least harmful ones. These theoretical arguments, however, may not be supported by empirical evidence, as discussed below.

As of March 2018, nine U.S. states have enacted taxes on e-cigarettes:<sup>27</sup>

California	65.08% on wholesale price
Delaware	0.05 USD/ml
DC	70% on wholesale price
Kansas	0.05 USD/ml
Louisiana	0.05 USD/ml
Minnesota	95% of wholesale price
North Carolina	0.05 USD/ml
Pennsylvania	40% of wholesaler price
West Virginia	0.075 USD/ml

In addition, several local jurisdictions—including counties in Maryland and Illinois as well as the cities of Chicago, Illinois and Aspen, Colorado—have enacted e-cigarette taxes. Their methods and levels of taxation vary widely. Some governments level an excise tax ranging from 5 cents to 20 cents per milliliter of nicotine containing material; others charge an ad valorem tax ranging from 40 percent to 95 percent of the wholesale price.

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<sup>26</sup> Chaloupka, F. J., Sweanor, D., and Warner, K. E. (2015). Differential taxes for different risks-toward reduced harm from nicotine-yielding products. *New England Journal of Medicine*, 373(7):594-597.

<sup>27</sup> Tobacco Control Legal Consortium (2018). *U.S. E-Cigarette Regulation: A 50-State Review*. March 15, 2018. <http://www.publichealthlawcenter.org/sites/default/files/E-Cigarette-Legal-Landscape-50-State-Review-March-2018.pdf>.

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As of September 2018, 22 countries outside of U.S. introduced taxation on e-cigarettes:<sup>28</sup>

Bahrain	100% of pre-tax price
Croatia	0 HRK/ml
Cyprus	0.12 EUR/ml of liquid
Estonia	0.2 EUR/ml
Finland	0.30 EUR/ml of liquid
Greece	0.10 EUR/ml of liquid
Hungary	55 HUF/ml of liquid
Indonesia	57% of retail selling price
Italy	50% discount on cigarette excise on prior year's weighted average price (0.3976 EUR /ml of any e-liquid)
Kazakhstan	0 KZT/ml <sup>29</sup>
Kenya	3,000 SHS /unit of ENDS and 2,000 SHS/unit of cartridge
Latvia	0.01 EUR/ml of e-liquid and 0.005 EUR/mg of nicotine
Lithuania	0.12 EUR/ml of any e-liquid
Montenegro	0.9 EUR/ml

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<sup>28</sup> Vapor Products Tax (2018). Tax data center. <https://vaporproductstax.com/taxation-database/>. Sweden's taxes are effective July 2018; Poland's taxes are effective January 2019.

<sup>29</sup> Although Kazakhstan has zero tax rate, taxpayers registered by the tax authorities to trade in these products must submit periodic excise tax reports. This requirement puts in place a mechanism to facilitate tax collection and enforcement in the future. It also enables the tax authorities to monitor developments in the vapor products category such as market size, pricing and volume trends.

Poland	PLN 0.5/ml of any e-liquid
Portugal	0.30 EUR/ml of nicotine containing liquid
Romania	0.50 RON/ml (0.13 EUR/ml) of nicotine containing liquid
Russia	44 RUB/unit and 11 RUB/ml of e-liquid which contains nicotine of 0.1 mg/ml or higher
Serbia	4.24 RSD/ml of liquid
Slovenia	0.18 EUR/ml of nicotine containing liquid
South Korea	1,799 KRW/ml of nicotine containing liquid (combination of taxes) and KRW 24.46 per 20 cartridges
Sweden	2 SEK/ml of nicotine containing liquid

When we look at the twenty countries which established dedicated excise tax categories for heat-not-burn products, we see that these products are consistently treated differently when compared to cigarettes; and they are treated in general in a similar way to so called “other manufactured tobacco products” (OTP).<sup>30</sup>

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<sup>30</sup> Vapor Products Tax (2018). Tax data center. <https://vaporproductstax.com/taxation-database/>. Sweden's taxes are effective July 2018; Poland's taxes are effective January 2019.

*Table 1: Taxation of heat-not-burn products relative to cigarettes and other manufactured tobacco products*

<b>Country</b>	<b>Heat-Not-Burn Tax System</b>	<b>Excise Rates on Heat-Not-Burn vs. Cigarettes</b>	<b>Excise rates on Heat-Not-Burn vs. OTP</b>
Bulgaria	Specific	Below	Similar
Croatia	Specific	Below	Similar
Cyprus	Specific	Below	Similar
Denmark	Specific	Below	Similar
Greece	Specific	Below	Below
Hungary	Specific	Below	Below
Italy	Specific	Below	Similar
Japan	Specific + ad valorem	Below	Similar
Kazakhstan	Specific	Below	Below
Korea	Specific	Below	Not comparable
Latvia	Specific	Below	Similar
Lithuania	Specific	Below	Similar
Montenegro	Specific	Below	Similar
Poland	Specific	Below	Similar
Portugal	Specific + ad valorem	Below	Similar
Romania	Specific	Below	Similar
Russia	Specific	Below	Above
Serbia	Specific	Below	Below
Slovakia	Specific	Below	Similar
Slovenia	Specific	Below	Below

Chaloupka (2015) discusses advantages and disadvantages of ad valorem tax on e-cigarettes.<sup>31</sup> He highlights list of disadvantages of ad valorem on e-cigarettes such as valuation problems, tax depending on industry pricing strategies, larger price gaps between high priced and low priced products and high tax on devices could discourage use. In addition, an ad valorem tax on e-cigarettes would not be eroded by inflation.

An ad valorem tax hits high quality/high cost products and disposable e-cigarettes harder than does a nicotine-specific tax because the price of disposables includes the value of the device itself, not just the fluid, in its sale price. Because single-use e-cigarettes do not require the prior purchase of a personal vaporizer device, they tend to be favored by initial users. Their smaller size is more convenient for travelers and users who are out-and-about. An ad valorem tax on devices may discourage uptake and continued use by smokers considering switching to vapor products. In the context of vapor products, the taxation should not provide any disadvantage to products which focus on reducing risk. Thus, applying taxes to nicotine may be preferable to applying it to devices.

The mechanics of taxation can have significant impacts on the sales and pricing of e-cigarettes. The basic questions are: What to tax and how to tax? Should the tax be applied on liquids only, or also on devices and accessories? Should the tax system be ad valorem or specific tax?

When we look at the current implementations, we see a growing consensus to tax all liquids for e-cigarettes (with or without nicotine) at specific tax rate per milliliter of the liquid. For the case of heat-not-burn products, a specific tax on the weight of tobacco is applied by almost all countries. On the other hand, value added tax or sales tax is already applied on such devices. An excise tax on the device and accessories is avoided as it is not common to tax electronic devices and also probably would represent an additional tax burden, discouraging consumer switching from cigarettes to e-cigarettes where the consumable elements of e-cigarettes (i.e., e-liquids) and heat-not-burn tobacco are already taxed.

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<sup>31</sup> Chaloupka, F. J. (2015). Taxing e-cigarettes: Options and potential public health impact. Presentation to E-Cigarette Tax Policy Research Meeting. January 22, 2015. <http://www.trdrp.org/files/e-cigarettes/frank-e-cigs.pdf>.

Other basic questions must also be addressed in relation to tax administration, such as where in the supply chain—manufacturer, wholesale, or retail—the tax is levied. Every U.S. state but one that currently levies a tax on e-cigarettes also requires retailers to be licensed. Thus, policymakers considering taxing e-cigarettes would likely have to weigh the benefits and costs of licensing of e-cigarette retailers.

### Existing research on pricing and taxes

The effects of different types of taxation on usage and thus economic outcomes varies. Research to date finds the following range of own price and cross price elasticities for e-cigarettes.<sup>32</sup>

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<sup>32</sup> Grace, R. C., Kivell, B. M., and Laugesen, M. (2015). Estimating cross-price elasticity of e-cigarettes using a simulated demand procedure. *Nicotine & Tobacco Research*, 17(5):592–598.

Huang, J., Gwamnicki, C., Xu, X., Caraballo, R. S., Wada, R., and Chaloupka, F. J. (2018). A comprehensive examination of own- and cross-price elasticities of tobacco and nicotine replacement products in the U.S. *Preventive Medicine*. In press.

Huang, J., Tauras, J., and Chaloupka, F. J. (2014). The impact of price and tobacco control policies on the demand for electronic nicotine delivery systems. *Tobacco Control*, 23:iii41–iii47.

Johnson, M. W., Johnson, P. S., Rass, O., and Pacek, L. R. (2017). Behavioral economic substitutability of e-cigarettes, tobacco cigarettes, and nicotine gum. *Journal of Psychopharmacology*, 31(7):851–860.

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(cont.)



Table 2: Published estimates of own-price and cross-price elasticities for e-cigarettes

Publication	Data Year	Region	Obs.	Elasticity Estimates			Data
				Own	Cross (chg. in cigarette price)	Cross (chg. in e-cig price)	
Huang, et al. (2014)	2009-2012	United States	459-569	-1.84	0.81	n/a	Retail stores, sales scanner
Grace, et al. (2015)	2013	New Zealand	210	n/a	0.16	n/a	In-person interviews, hypothetical price differences
Pesko, et al. (2015)	2014-2015	United States	1,020	-1.80	n/a	n/a	Survey, hypothetical price differences
Stoklosa, et al. (2016)	2011-2014	Estonia, Ireland, Latvia, Lithuania, Sweden, United Kingdom	10-174	-0.82	5.51	n/a	Retail stores, sales scanner
Zheng, et al. (2016)	2009-2013	United States	1,284	-1.95	2.50	0.0004	Retail stores, sales scanner
Johnson, et al. (2017)	n/a	United States	102-331	n/a	0.13	0.07	Online survey, hypothetical price differences
Snyder, et al. (2017)	n/a	United States	385	-0.02	1.03	n/a	Online survey, hypothetical price differences
Zheng, et al. (2017)	2009-2013	United States	1,284	-2.05	1.86	0.004	Retail stores, sales scanner
Huang, et al. (2018)	2007-2014	United States	1,130	-1.36	1.98	n/a	Retail stores, sales scanner, rechargeable
"	"	"	1,228	-1.56	0.15	n/a	Retail stores, sales scanner, disposable

Price elasticity estimates vary widely and may also correlate with certain demographic or other characteristics and likely vary with research methodology. For example, scanner data from U.S. markets finds a wide range of own price elasticities, depending on product type and store type. One study found own-price elasticities for disposable e-cigarettes centered around -1.2, while elasticities for reusable e-cigarettes were approximately -1.9.<sup>33</sup> Another study found own price elasticity associated with disposable e-cigarette sales at food, drug, and mass merchandise stores was -1.56, while the elasticity at convenience stores was -1.83.<sup>34</sup>

A survey of U.S. smokers estimated an ENDS own-price elasticity of -1.8 among adult smokers, with greater price responsiveness among adult

<sup>33</sup> Huang, J., Tauras, J., and Chaloupka, F. J. (2014). The impact of price and tobacco control policies on the demand for electronic nicotine delivery systems. *Tobacco Control*, 23:iii41–iii47.

<sup>34</sup> Huang, J., Gwamnicki, C., Xu, X., Caraballo, R. S., Wada, R., and Chaloupka, F. J. (2018). A comprehensive examination of own- and cross-price elasticities of tobacco and nicotine replacement products in the U.S. *Preventive Medicine*. In press.

(cont.)

smokers 18-24 years of age, smokers who have vaped over the last month, and smokers with above the median quitting interest.<sup>35</sup>

Elasticities may vary widely from the short-run to the long-run. For example, convenience store scanner data found that the own-price elasticity for e-cigarettes is -1.1, with a short-run elasticity of -0.5 and a long-run elasticity of -2.8.<sup>36</sup>

There is very little research on the cross-price elasticity between e-cigarettes and conventional cigarettes. Published research to date reports a wide range of estimated cross-price elasticities. For example, a survey of New Zealand smokers estimated a cross-price elasticity for e-cigarettes of 0.16, indicating that e-cigarettes were partially substitutable for regular cigarettes.<sup>37</sup> Estimated own-price elasticity for tobacco cigarettes is lower when e-cigarettes are available (-0.28) than when they are not (-0.90), likely due to the large reduction in overall demand with e-cigarettes.

Other peer-reviewed research finds e-cigarettes are a substitute for cigarettes (cross-price elasticity of tobacco cigarettes with respect to e-cigarette price = 0.004) and vice versa (cross-price elasticity = 1.859).<sup>38</sup> That is, a 10 percent increase in the price of e-cigarettes results in a 0.04 percent increase in conventional cigarette demand (conditional on fixed grouped expenditure on tobacco products), and a 10 percent increase in the price of conventional cigarettes results in an 18.59 percent increase in conditional

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<sup>35</sup> Pesko, M. F., Kenkel, D. S., Wang, H., and Hughes, J. M. (2015). The effect of potential electronic nicotine delivery system regulations on nicotine product selection. *Addiction*, pages 734–744.

<sup>36</sup> Zheng, Y., Zhen, C., Nonnemaker, J. M., and Dench, D. (2016). Advertising, habit formation, and U.S. tobacco product demand. *American Journal of Agricultural Economics*, 98(4):1038–1054.

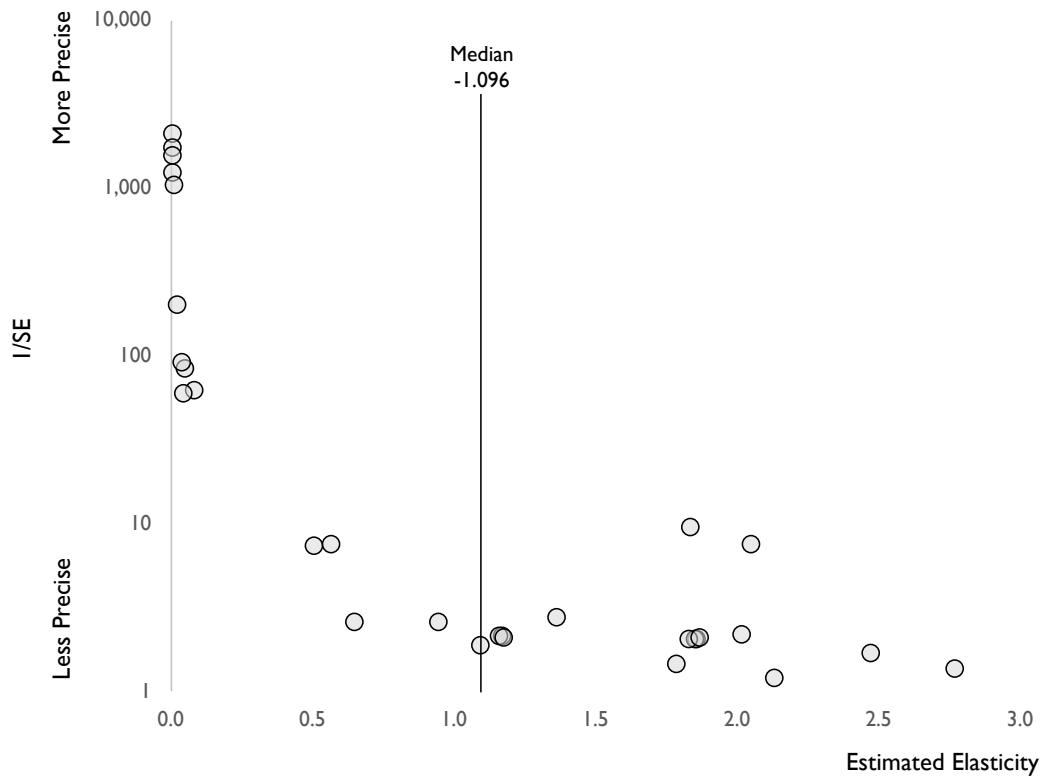
<sup>37</sup> Grace, R. C., Kivell, B. M., and Laugesen, M. (2015). Estimating cross-price elasticity of e-cigarettes using a simulated demand procedure. *Nicotine & Tobacco Research*, pages 1–7.

<sup>38</sup> Zheng, Y., Zhen, C., Dench, D., and Nonnemaker, J. M. (2017). U.S. demand for tobacco products in a system framework. *Health Economics*, 26:1067–1086.

e-cigarette demand. The study used U.S. scanner data from convenience stores, food stores, drug stores, and mass merchandisers.<sup>39</sup>

The wide range of estimated elasticities calls into question the reliability of published estimates. As a nascent area of research, the policy debate would benefit from additional research that involves larger samples with better statistical power, reflects the dynamic nature of this relatively new product category, and accounts for the wide variety of vapor products.

*Figure 4: Own price elasticity for e-cigarettes*



<sup>39</sup> Differences in the estimated cross-price elasticity between e-cigarettes and conventional cigarettes may be due to research design (*e.g.*, surveys vs. scanner, hypothetical vs. actual price differences) and/or data (*e.g.*, convenience stores vs. mass merchandisers). But this is among the questions that merit more systematic, reliable analysis.

Figure 4 summarizes the research to date by plotting estimated own price elasticities and a measure of each estimate's precision (the inverse of the standard error for the elasticity estimate). Some studies did not report sufficient information to calculate the precision estimate.

The figure shows the studies with higher estimated own price elasticities tend to have less precise estimates, suggesting the larger estimates are from underpowered studies.

Even in the face of uncertainty, the current evidence indicates the demand for e-cigarettes is more own-price elastic than for cigarettes.

*Figure 5: Cross-price elasticity for e-cigarettes with respect to a change in combustible cigarette price*

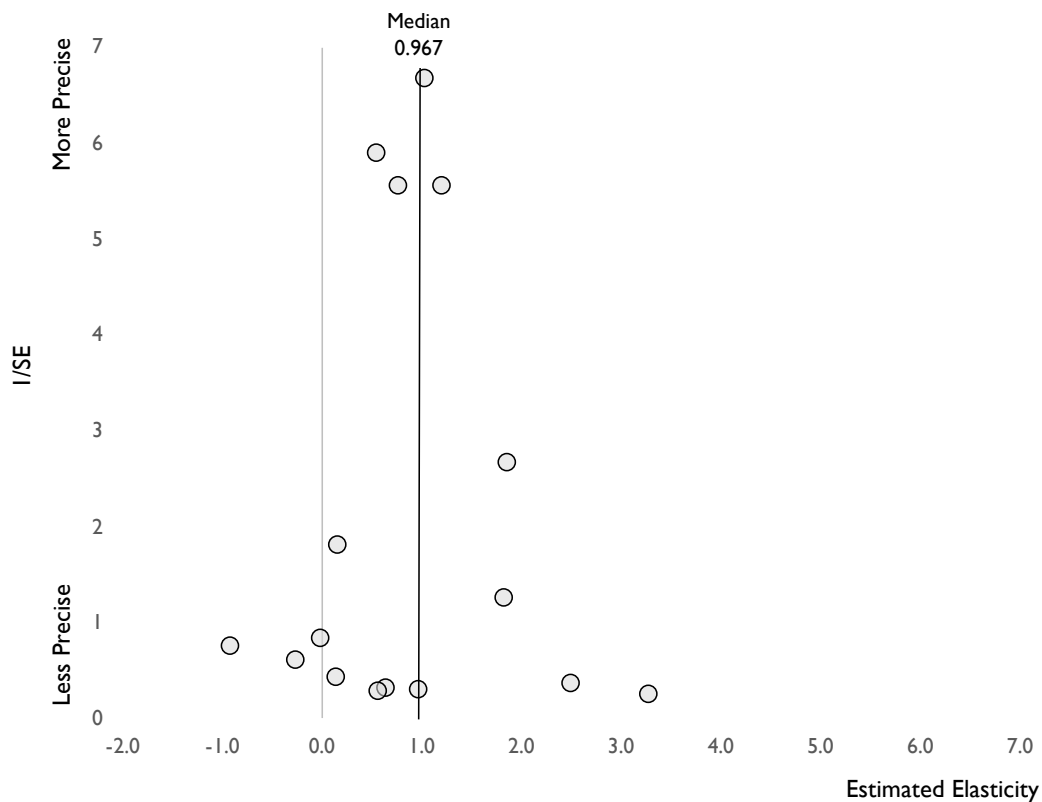


Figure 5 plots estimated cross price elasticities of e-cigarettes with respect to cigarette prices and a measure of each estimates precision. Some studies did not report sufficient information to calculate the precision estimate.

The figure shows that cross-price estimates are much less precise than own-price estimates. Nevertheless, the data suggest that studies with higher estimated cross price elasticities and those with negative cross-price elasticities (i.e., suggesting e-cigarettes are complement rather than substitutes) tend to have less precise estimates.

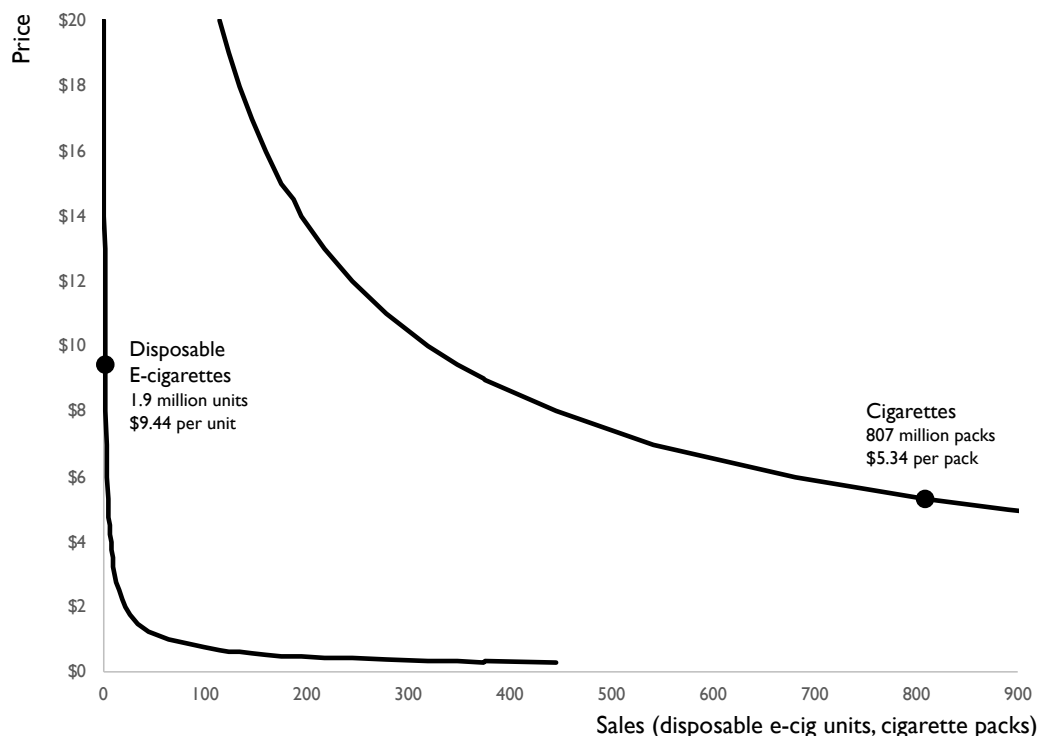
## Implications for tax policy

Zheng, et al (2016) estimate an own price elasticity for cigarettes of -0.5 and for e-cigarettes of -2.8. The estimated cross elasticity for e-cigarettes with respect to a change in price of cigarettes is 2.5, while the cross-elasticity for cigarettes for a change in price of e-cigarettes is 0.0004. This implies a tax that increases the price of cigarettes by 10 percent would reduce the quantity of cigarettes demanded by 5 percent and increase the quantity demanded of e-cigarettes by 25 percent.

A narrow focus on elasticities ignores the crucial fact of market share. In the research of Huang, et al. (2018), scanner data from U.S. food, drug, and mass merchandise stores and convenience stores indicates cigarette sales (in dollars) are about 165 times higher than e-cigarette sales; Zheng, et al. (2016) indicate the budget share for cigarette purchases is 295 times higher. Other research suggests the ratio is 64-to-1. Other countries, such as the U.K., France, and Poland, have a larger share of vapor product use; in other countries, vapor product uptake is smaller than in the U.S.

Figure 6 uses information from Huang, et al. (2018) to illustrate the differences in market shares. Elasticity estimates from Zheng, et al. (2016) are used to draw the hypothetical demand curves. The studies use scanner data from food, drug, and mass merchandise stores and convenience stores and, therefore, do not represent the entire market for either product. Dollar sales of cigarettes outnumber dollar sales of disposable e-cigarettes by 165-to-1; unit sales of cigarettes (assumed to be 20 cigarette packs) outnumber disposable e-cigarette units by more than 400-to-1.

For a tax that increases the price of cigarettes by 10 percent, applying the elasticity estimates from Zheng, et al. (2016) to the sales information from Huang, et al. (2018) indicates cigarette sales would decline by approximately 40 million packs and disposable e-cigarette sales would increase by 475,000 units.

*Figure 6: Estimated demand curves for e-cigarettes and cigarettes*

Source: Author's calculations, from Huang, et al. (2018) and Zheng, et al. (2016).

This relatively simplistic analysis suggests an increase in cigarette taxes would not shift a significant number of cigarette users to e-cigarettes. In fact, the elasticities and budget shares in Zheng, et al. (2016) indicate much of the decline in cigarette purchases would be attributed to reduced purchases of any tobacco product.

In addition to e-cigarettes, little cigars and smokeless tobacco are also potential substitutes for cigarettes. The results from Zheng, et al. (2016) suggest increases in sales of little cigars and smokeless tobacco products would account for about 14 percent of the decline in cigarette sales associated with a hypothetical 10 percent increase in the price of cigarettes. On the other hand, another study using a seemingly identical data set (Zheng, et al., 2017), suggests that sales of little cigars and smokeless tobacco would *decrease* in the face of an increase in cigarette prices.

Based on published research to date, it is not obvious that an increase in cigarette taxes—even a “sharp” increase—would result in a significant shift in demand from combustible products to less harmful products such as e-cigarettes, at least at the current levels of e-cigarette market penetration. Moreover, a differential tax may induce a supply-side response, but there is no empirical research on supply at this time.

Similarly, given the relatively small size of the e-cigarette and heated tobacco product market, it is unlikely any level of taxation of e-cigarettes and heated tobacco products would generate significant tax revenues to the taxing jurisdiction. The current market for e-cigarettes as well as heat-not-burn products in the range of 0-10 percent of the cigarette market likely represents early adopters and higher income consumer groups. As such, the current empirical data based on total market size and price/tax levels are likely to be far from indicative of the “actual” market for these products.

Because the market for e-cigarettes and other vapor products is small and nascent, the tax bearing capacity of these new product segments are untested and unknown. Moreover, current tax levels and prices could be also misleading based on the relatively sparse empirical data, in which case more data points and evaluation is needed. One can argue, given the slow growth rates of these segments in many markets, that current prices of e-cigarettes and heat-not-burn products are relatively high when compared to cigarettes and a tax or an increase on existing tax would slow down the segment growth or even lead to a decline.

Separately, the challenges in assessing a tax on ENDS products indicate the costs of collecting the tax, especially an excise tax, may be much higher than similar taxes levied on combustible cigarettes. In addition, as discussed above, heavy taxation of this relatively new industry would likely stifle innovation in a way that is contrary to the goal harm reduction.

The fact that two studies published a year apart by the same authors and using virtually identical data can generate such wildly different results raises serious questions about the reliability of existing research on the degree of substitutability between cigarettes, e-cigarettes, and other tobacco products.

It is important to note that the two studies discussed above rely on scanner data from food, drug, and mass merchandise stores and convenience stores. Although these retail channels account for the largest share of the tobacco market among all retail channels, research should account for sales and potential substitutions among a wider range of retailer types, such as vape shops and online retailers.

More importantly, demand and supply conditions for e-cigarettes, heated tobacco products and other ENDS products have been changing rapidly over the past few years—and are expected to rapidly change into the foreseeable future. Thus, estimates of demand parameters, such as elasticity and cross-price elasticity estimates, are almost certain to vary over time as users gain knowledge and experience and as products and suppliers enter the market.

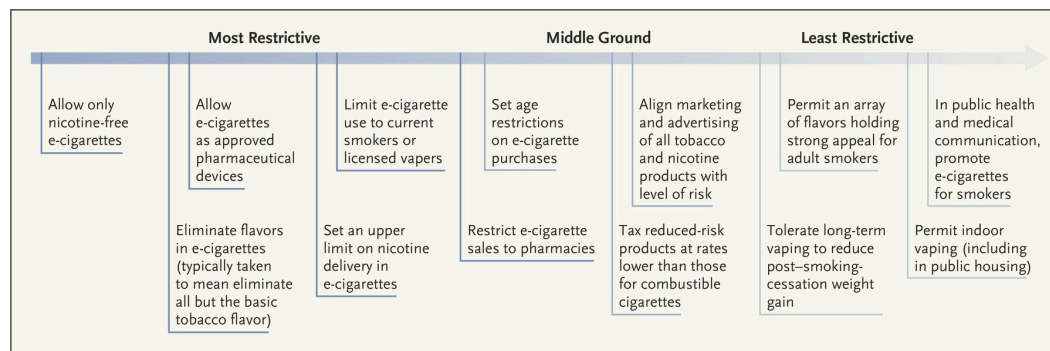
### **Demand, supply, and policy: A proposed research agenda**

This paper focuses on taxation as a key factor in developing e-cigarette and heat-not-burn tobacco product policies in a harm reduction framework. Fairchild, et al. (2018) identify a continuum of potential policies regarding ENDS regulation.<sup>40</sup> They note that the most restrictive policies would effectively eliminate e-cigarettes as a viable alternative to smoking, while the most permissive may promote e-cigarette usage and potentially encourage young people—who would not do so otherwise—to take-up e-cigarettes. In between these extremes include policies that may discourage young people from initiating use of e-cigarettes, while encouraging current smokers to switch to less harmful e-cigarettes.

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<sup>40</sup> Fairchild, A. L., Lee, J. S. Bayer, R., Curran, J. (2018). E-Cigarettes and the harm-reduction continuum. *New England Journal of Medicine*, 378:216–219.



*Figure 7: Fairchild, et al. ENDS harm reduction continuum*

Within a harm reduction framework, some objectives overlap and others conflict. For example, an objective to encourage current smokers to switch to less harmful e-vapor products largely is consistent with an objective to discourage dual use. On the other hand, policies that encourage switching may conflict with the objective to discourage youth uptake of vapor products. The extent of the net benefits of vapor products in a harm reduction framework are empirical matters of degree that require reliable research.

While there is a growing body of research regarding the chemistry, toxicology, and clinical aspects of vapor products, there is little research quantifying how existing or potential policies advance or stifle the objective of harm reduction. Policies that demand further research include:

1. Taxation and pricing of vapor products, especially relative to combustible products;
2. Quantification of the economic impact of increased longevity;
3. Quantification of the impact of vapor products on smoking related health expenditures

Research should be targeted on evaluating which policies would advance harm reduction objectives at the lowest cost to consumers and producers and thereby provide superior net benefits to the public. In particular policy impacts should be evaluated on empirical evidence demonstrating the extent to which the policy would:

1. Increase the number of current users of combustible products who switch to a less harmful non-combustible alternative;
2. Decrease the number of dual use consumers;

3. Discourage youth uptake of nicotine containing products; and/or
4. Encourage investment and innovation in developing safer vapor products and related devices.

Principles of harm reduction recognize that every proposal has uncertain outcomes as well as potential spillovers and unforeseen consequences. Nevertheless, the basic principle of harm reduction is a focus on *safer* rather than *safe*. Policymakers must make their decisions weighing the expected benefits and expected costs. With such high risks and costs associated with cigarette and other combustible use, taxes and regulations must be developed in an environment of uncertainty and with an eye toward a net reduction in harm, rather than an unattainable goal of zero harm. Even a small reduction in the number of cigarette smokers can have a big impact on public health, health expenditures, and labor productivity.

Progress in science and the social sciences is incremental. Research on e-cigarettes is nascent, but promising. Increased and improved research on the nexus between policy decisions and harm reduction will go far to inform public policy, reduce harm, and improve economic outcomes. ●

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