Government intervention in the market for electronic nicotine delivery systems (ENDS). The known, the unknown and challenges

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Abstract

Purpose – *This paper aims to describe the various government measures that regulate the market for novel tobacco harm reduction products (THRPs), with an emphasis on e-cigarettes [electronic nicotine delivery systems ("ENDS")], and evaluates the public health impact of excise taxes levied on these products.*

Design/methodology/approach – *The paper reviews the economic research on the impact ENDS. Using cited evidence, the paper compares the tax treatment of ENDS and cigarettes and provides a simulation of potential lives that can be saved under alternative tax treatment of ENDS.*

Findings – *ENDS are considerably less harmful than cigarettes. Imposing the same tax burden on them (per unit of "harm") as on cigarettes leads to poorer health outcomes. Differential tax treatment of ENDS will encourage more cigarette smokers to switch to ENDS and could save millions of lives worldwide.*

Research limitations/implications – *Country experiences with regulatory measures on ENDS are limited to those with high THRP penetration. The paper's simulation analysis used evidence from a limited number of studies. Rigorous economic analysis is needed to understand how ENDS could save lives and could prevent expected one billion premature deaths by the end of this century.*

Originality/value – *The paper uses research evidence in its analysis of the impact that the differential taxation of cigarettes and ENDS would have. It also provides a rough estimate of the number of lives that could be saved if more smokers who are trying to quit can make the switch to ENDS.*

Keywords *Price elasticity, Cost and benefit analysis, Cross price elasticity, ENDS, Excise taxes, Tobacco harm reduction products (THRPs), Electronic nicotine delivery systems, Market failure*

Paper type *General review*

Introduction

After 50 years of policy development, the World Health Organization (WHO) Framework Convention on Tobacco Control (FCTC) became international treaty in 2003 and came into force in 2005 (Yach, 2014). Although 181 countries made a commitment to implement its measures, the average implementation rates, specifically on demand-reduction measures, are still uneven (WHO FCTC, 2012, 2016, 2018), and the pace of reducing smoking prevalence and averting premature tobacco deaths is slower than expected (Warner, 2014; US Department of Health and Human Services (US DHHS), 2014; Levy *et al.*, 2018).

Tobacco and tobacco products are deeply integrated into world economies, and the political commitments to FCTC have not been strongly linked to economic, social and legislative reforms (L'Hirondel and Yach, 1998). As things stand, estimates show that tobacco will claim a total of one billion lives by the end of this century (Jha *et al.*, 2015). Governments who committed to implementing demand-reduction measures at full scale

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may also need to sustain innovation and promote alternative harm-reduction products to avoid the tobacco-related diseases and deaths predicted by the end of this century.

Electronic nicotine delivery systems (ENDS) are relatively new products, and their long-term health risks remain unknown; however, recent evidence from sources like the US National Academies of Science, Engineering and Medicine (2018), the UK Royal College of Physicians (2016), Farsalinos *et al.* (2014) and Farsalinos and Polosa (2014) reveals that ENDS are approximately 95% less harmful than cigarettes. They have successfully assisted numerous smokers with quitting (Action on Smoking and Health (ASH), 2017; Bullen *et al.*, 2013; Hajek *et al.*, 2019; Brown *et al.*, 2014; Caponnetto *et al.*, 2013 and Polosa *et al.*, 2011), and they have helped smokers reduce their daily number of cigarettes (Polosa *et al.*, 2011). ENDS lowered daily cigarette count for smokers who did not want to quit (Caponnetto *et al.*, 2013), with great life-saving potential (Levy *et al.*, 2018).

In this paper, we briefly review emerging economic research on the ENDS regulatory environment. Then we compare ENDS and cigarette taxes in countries where ENDS are popular and/or where data are available. Finally, we apply selected results to the first wave of Global Adult Tobacco Survey (GATS) countries (2008–2014) to demonstrate potential public-health benefits of switching to ENDS.

Methodology

This paper reviews economic studies on selected ENDS regulatory measures – specifically, taxation, youth access and marketing restrictions. We gather data from ECigIntelligence, Euromonitor and regulation databases (Vapor Products Tax (VPT), 2020, Johns Hopkins School of Public Health IGTC website and the Public Health Law Center at Michell Hamline School of Law), the CDC GTSS database on GATS, the EU Commission Excise Tax database, and the World Bank, Health, Nutrition and Population (HNP) database. Simulation analysis uses results from existing evidence, underlying assumptions and available data.

Background

Harm reduction theory and evidence on e-cigarettes (electronic nicotine delivery systems)

Harm reduction (HR) theory asserts that minimizing damage from risky behaviors enhances public health more effectively than efforts at behavior elimination. Economists argue that HR should focus on "safer", rather than "safe"; HR policies on bicycle helmet use, automobile seat belts, needle-exchange programs, etc., minimize risky behavior and expected harm rather than eliminating all harm (Fruits, 2018). Economists also argue that imposing a "ban" on ENDS sales is not optimal (Marlow, 2014). Experts debate which ENDS regulatory framework is needed to maximize public-health benefits while minimizing risks (Smith and Malone, 2019; Saitta *et al.*, 2014; Lindblom, 2017 and Caponnetto *et al.*, 2015).

Government interventions and regulations on e-cigarettes (electronic nicotine delivery systems)

Market intervention on the part of governments via regulatory measures for combustible tobacco products is justified in detail in the World Bank's 1999 report, "Curbing the Epidemic" (World Bank, 1999).

Extant economic evidence justifies government intervention for ENDS in two areas: first, governments can correct information failure to help educate smokers about ENDS to determine informed choices. Second, regulations can deter non-smoking youth from adopting ENDS. In a 2016 study, Viscusi (2016) found that people greatly overestimate the risk levels of ENDS and suggests that overestimating a product's riskiness is a form of market failure warranting government intervention through health communication. In 2017, just over half of

European smokers thought ENDS were harmful (European Commission, 2017). Globally, half the 2019 population believed that ENDS were equally or more harmful than cigarettes [Foundation for a Smoke-Free World (FSFW), 2020]. ENDS risk perception in the USA has increased dramatically since (Majeed *et al.*, 2017). This indicates a worldwide market failure based on ENDS misinformation. Lindblom (2017) suggests that governments providing transparency on ENDS benefits and encouraging smokers to switch should be done carefully to minimize initiation risks by non-smokers and non-users or reducing cessation.

Studies have examined regulations on ENDS characteristics and product restrictions. A flavor ban on ENDS should reduce youth vaping, a concern in many countries. But the Buckell *et al.* (2017) study found that this was not the case for adult smokers; that a comprehensive flavor ban on ENDS and a menthol ban on cigarettes would increase cigarette demand among US smokers, encourage the switch back to cigarettes and yield only small (3%), incremental abstinence from ENDS and cigarettes. Some studies have found that cigarettes and ENDS are substitutes – age restrictions on ENDS increase adolescent cigarette smoking (Friedman, 2015; Pesko *et al.*, 2016a and Dave *et al.*, 2019a). As the Dave *et al.* (2019b) study reveals, ENDS advertising increases the probability that adult smokers will quit. Pesko *et al.* (2016b) study likewise finds that severe warning labels may discourage adult smokers from switching to ENDS.

Economic studies examine various aspects of ENDS tax policy. A number of these studies examine the tax principle within an HR framework. For example, Fruits (2018) argues that ENDS should be subject to a lower "sin" tax, as they pose less direct harm to users and lower externalities to third parties. Chaloupka *et al.* (2015) suggest that cigarette-related HR could be achieved by imposing different taxes on nicotine products.

Further, recent economic studies have shown relatively high price elasticity on ENDS demand, and positive cross-price elasticity (economic substitution) between ENDS and cigarettes. Price elasticity of demand for ENDS is found between −0.78 and −2.1 (Huang *et al.*, 2014; Pesko *et al.*, 2016b, 2019; Stoklosa *et al.*, 2016; Zheng *et al.*, 2016; Cotti *et al.*, 2020) – so a 10% increase in ENDS pricing could reduce demand by 7.8 to 21%. Saffer *et al.* (2019) found that a 10% increase in ENDS pricing would decrease the prevalence of vaping by 12%. Excepting the Cotti *et al.* (2018) finding that tax increases on cigarettes reduce household ENDS consumption – other economic studies have found that ENDS and cigarettes are economic substitutes; that is, as the price of one increases, the demand for the other decreases. So, as the cross-price elasticity of ENDS prices on cigarette demand is found in a range of 0.004 (Zheng *et al.*, 2016) and 0.97 (Cotti *et al.*, 2020), the cross-price elasticity of cigarette prices on ENDS demand is found within 1.9 (Zheng *et al.*, 2016), 1.19 (Cotti *et al.*, 2020) and 4.6 (*Stoklosa et al.*, 2016). Thus, a 10% increase in cigarette price will increase demand for ENDS by 19, 12 and 46%.

Researchers found that higher ENDS taxation in Minnesota reduces ENDS use, increases cigarette use among adolescents (Pesko and Warman, 2019) and reduces quitting among adult smokers (Saffer *et al.*, 2019). Similar taxation would have a more negative impact if applied overall, as Saffer and colleagues note that, if ENDS were taxed like cigarettes, this would lead to a 62% increase in ENDS pricing, increase smoking by 8.1%, and deter approximately 2.75 million smokers from quitting in the USA [1].

High sensitivity of demand for ENDS, potential substitutability of cigarettes, and tax policies on ENDS pose challenges for governments trying to balance public-health objectives while preserving cigarette tax revenues. These challenges could increase should this evidence hold for ENDS.

Findings

The e-cigarette (electronic nicotine delivery systems) market

Since 2005, the innovation of nicotine and tobacco technologies has accelerated. The market value of ENDS increased 37-fold – from $491m in 2008 to $19bn by 2019 worldwide

(Euromonitor, 2020). North America and the European Union increased their share from 13 to 85% of global ENDS sales between 2008 and 2019 (Figure 1).

Regulatory environment

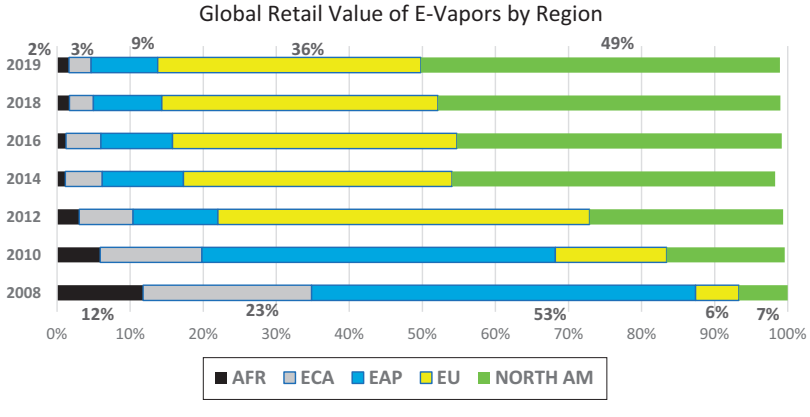
By 2020, the number of countries that impose some form of regulations on ENDS increased to 99 (IGTC, 2020). ENDS are often subject to policies similar to those of other tobacco products, including excise taxes, age requirements and indoor use and marketing restrictions (Kennedy *et al.*, 2017; IGTC, 2020; Public Health Law Center at Mitchell Hamline School of Law, 2020; ECigIntelligence, 2020; The regulation of E-Cigarettes; International, European and National Challenges, 2019) and restrictions on product characteristics – US bans on flavored ENDS are underway in local and state jurisdictions, and federal enforcement was expected as of February 2020 [2].

Some countries banned ENDS (e.g. India, Iran, Ethiopia, Turkey and Thailand), some consider them medicinal – and so ENDS have virtually no affordable market access (e.g. Australia, Chile, Japan, parts of Latin America and Singapore) and some classify them as consumer goods under a tobacco regulatory framework (EU Member States and the USA) (IGTC, 2020; Public Health Law Center at Mitchell Hamline School of Law, 2020; ECigIntelligence, 2020).

Country experiences and responses

Recently, some countries have experienced cigarette demand shifts towards ENDS. In some places, these changes became part of countries' tobacco-control programs. The UK (ONS, 2019; ASH, 2017) and New Zealand (New Zealand Ministry of Health, 2019) have already applied HR principles with ENDS. These countries have consequently achieved significant reductions in smoking and cigarette demand through strong tobacco-control measures and enabling access to ENDS. In the UK, an estimated 2.9 million adults used ENDS in 2017. Of these, 1.5 million stopped smoking cigarettes (ASH, 2017), and tobacco-related health-care costs and hospital admissions have been reduced (ONS, 2019) [3].

Figure 1 Global retail value of E-Cigarettes by region



Sources: Euromonitor database; Last accessed in January 2020; AFR: Africa Region; ECA: East and Central Asia Region-excludes EU, EAP: East Asia and Pacific Region; EU: European Union, North AM: North America (US and Canada)

Revenue-generating potential of cigarettes and e-cigarettes

Historically, cigarettes have been taxed to generate revenue and reduce consumption, with perhaps the former weighted more heavily in political decision-making. Cigarettes are considered the best candidate for higher taxes and revenues given low price sensitivity of smokers (low price elasticity), having low to zero close substitutes (as the tax-induced price increases, there is no close, alternative to switch) and keeping manufacturing limited to just a few companies (minimizing revenue-collection costs) (World Bank, 1999).

Although evidence suggests that ENDS could challenge important revenue-generating characteristics of cigarettes (as close substitutes), ENDS do not possess these characteristics themselves. They do, however, have significant health benefits over cigarettes. These revenue characteristics thus may pose additional challenges for governments with respect to regulation, specifically with respect to taxation.

The loss of government revenue in a low-tax ENDS regime could be made up by increasing the rate on a general consumption tax – namely, the value-added tax in most countries – or by increasing the rate on cigarettes as the availability of reduced risk alternatives makes it politically easier to raise taxes on cigarettes. Moreover, imposing a low tax on ENDS would signal that these products are less harmful than cigarettes and counter the increasingly common perception that they are as harmful as cigarettes.

Current tax policies on e-cigarettes

ENDS are subject to either a specific rate based on e-liquid per milliliter (like in EU member states, some US states and the Republic of Korea), or an *ad valorem* excise (as in some US states, Indonesia, Bahrain, Jordan and Saudi Arabia) or a mixture of both (in the Russian Federation and some US states) (VPT, 2020; ECigIntelligence, 2020; Euromonitor, 2020).

It is difficult to find a comparable measure between cigarettes and ENDS. Here, we consider 3.55 mL of e-liquid in ENDS comparable to a pack of 20 cigarettes, as suggested by Cheng *et al.* (2019)[4]. We calculate the ENDS tax equivalent to a pack of 20 cigarettes (Figure 2), which reveals that ENDS excise is 32 to 83% lower than that on cigarettes in Western Europe.

In the USA, we see a similar pattern in states that levy a specific excise per milliliter, where ENDS excise taxes are 37 to 96% lower than those on cigarettes (Figure 3).

Shortly after imposing strict ENDS regulations, some countries reconsidered their policies. For example, the United Arab Emirates (UAE), Saudi Arabia (SA), Jordan and Lebanon reverted the ENDS ban and imposed excise tax (ECigIntelligence, 2020). A few countries also adjusted their tax policies by significantly reducing tax rates (e.g. Italy, Hungary and Portugal) (VPT, 2020).

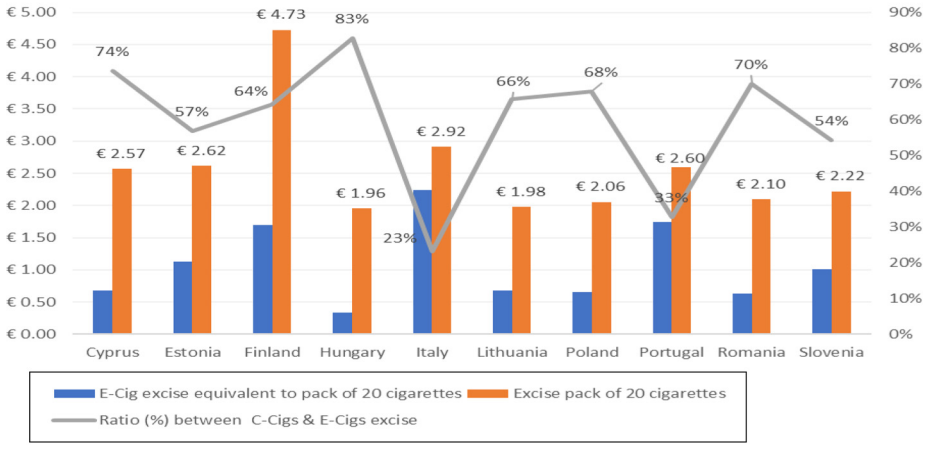
Encouraging companies to reduce harmful components

Tobacco harm reduction product (THRP) innovation must continue, and markets and governments should encourage entrepreneurs to improve existing products and develop new ones with increasing efficiency, effectiveness and safer product structure (e.g. packaging and content). There is no existing evidence that examines how extant and proposed THRP regulations would influence innovation; however, product introduction bans clearly impact innovation. Marlow (2014) argues that suppressing the ENDS market would devastate product innovation and discourage companies from developing safer and more effective THRPs.

Potential lives saved

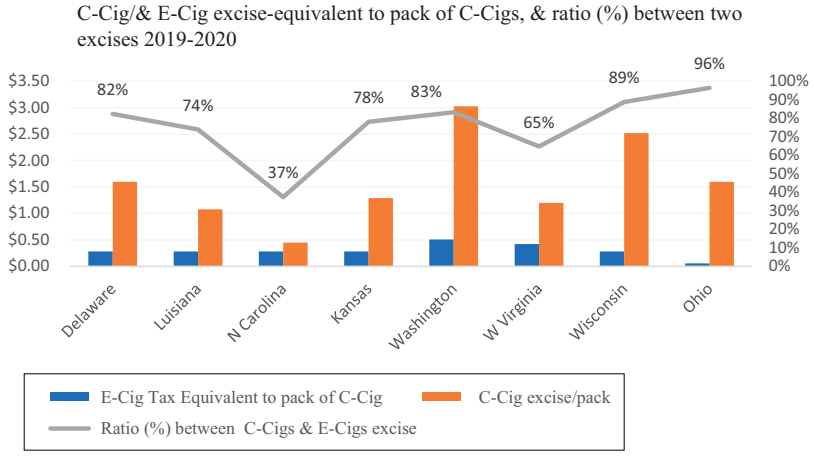
Further research with new measures to compare products will shed more light on how harm-reduction policies influence excise policies and the impact of tax policies on

Figure 2 Excise taxes for combustible and electronic cigarettes in select EU member state, 2019-2020



Source: Vapor Tax Centers, Euromonitor and European Commissions, Directorate-General Taxation and Customs Union. Indirect taxation and tax administration

Figure 3 Excise taxes for combustible and electronic cigarettes in select states in US, 2020



Source: Public Health Law Center and Sales Tax Handbook; Cigarette Price/Tax Map

quitting and mortality reduction. GATS reveal that, while a significant percentage of smokers express no immediate, or no intention whatsoever, to quit smoking (CDC/GATS 2019), one-third to one-half of smokers attempted to quit at least once in the past year (Table 1). However, these attempts were undertaken without support, and consequently failed.

We conducted a hypothetical simulation to estimate the potential number of lives saved if smokers in GATS Wave 1 countries[5] (2008–2014) with at least one quit

Table 1 Daily smokers, quit attempts GATS Wave 1 countries 2008–2014

		Daily tobacco Smokers (%)	*Quit attempt past 12 months (%)*			*Daily tobacco Smokers (%)*	*Quit attempt past 12 months (%)*
Argentina	2012	17.1	48.6	Pakistan	2014	11.5	24.7
Bangladesh	2009	20.9	47.3	Philippines	2009	22.5	47.9
Brazil	2008	15.1	45.6	Poland	2009	27.0	35.1
China	2010	24.1	14.4	Romania	2011	24.3	37.8
Egypt	2009	18.5	41.1	Russia	2009	33.8	32.1
India	2009	10.7	38.4	Ukraine	2010	25.5	40.5
Indonesia	2011	29.2	30.4	Uruguay	2009	20.4	48.6
Kazakhstan	2014	19.1	29.5	Thailand	2011	21.5	36.7
Malaysia	2012	20.9	48.6	Turkey	2012	23.8	46.0
Mexico	2009	7.6	49.9	Vietnam	2010	19.5	55.3
Nigeria	2012	2.9	45.4				

attempt in the past year had used ENDS; we conclude that some of them would have succeeded (Table 1).

Between 2008 and 2014, the global adult population was approximately 3.2 billion, with 609 million (19%) daily smokers. In total, 171.2 million smokers had tried to quit at least once in the past year. We applied three successful quit rates – 7.5% by Bullen *et al.* (2013), 10% by Caponnetto *et al.* (2013) and 20% by Brown *et al.* (2014) as used in Marlow's (2014) study. We assumed that if smokers with at least one quit attempt had used ENDS, and 7.5, 10 and 20% of them were able to quit, there would be between 12.5 and 34 million fewer smokers (Table 2).

The World Bank (1999) report argued that one-quarter of long-term smokers will die prematurely. Other studies have revealed that two of three long-term smokers will die prematurely (Banks *et al.*, 2015; Jha *et al.*, 2013). Applying cited evidence on the simulation, we predict that ENDS could have saved from 3.1 to 8.6 million lives under the one-quarter assumption, and 8.3 to 22.8 million under the two-thirds assumption. This is a rough estimate, assuming that ENDS are affordable and that all daily smokers are long-term smokers, have access to ENDS, are well informed about ENDS health outcomes, and that existing evidence on smokers' ENDS quitting success applies globally. Nevertheless, cited evidence and our hypothetical analyses show how important it is for progressively less risky ENDS to be encouraged through taxation, communication and innovation.

Conclusion

This paper provides a brief overview of main regulatory challenges on ENDS and the results of recent economic studies examining consequences of select ENDS regulations (e.g. taxation) on smokers' behaviors and potential health outcomes if ENDS are added through government-sponsored measures to the toolkit of smoking cessation products. However, one must assess these measures carefully, as demand and revenue are concerned. For example, it is not clear how consumers subjectively value ENDS, considering the reduced harm perception constant. For ENDS, it is common practice to base tax on ml of e-liquid, and the comparability argument holds. Current cited evidence just scratches the surface with respect to ENDS: as the types of THRPs vary, substitutability options increase for the smokers. Consequently, there are many questions with respect to differential taxes, such as tax rate adjustment on ENDS and their level of substitutability among other THRPs and with cigarettes (cross-price elasticities). Although cited research provides evidence on ENDS and cigarettes through available data, further research is needed to understand consumers' demand behavior and how they value health when choosing between nicotine products. Furthermore, given global information failure, future research must evaluate how information

Table 2 Hypothetical lives saved due by quitting via ENDS use

	Population (15+ age) (Mil)	*Daily smoker & (Prevalence %)*	*Quit attempts last 12 months (Mil.) & (% of smokers)*	*Quit rates (%)*	*No, quitters (000)*	*Potential lives saved (000) (one-third)*	*Potential lives saved (000) (two-third)*
GATS 2008	142.4	21.5 (15%)	9.8 (46%)	7.3	714.7	178.6	476.3
				10	978.7	244.7	652.5
				20	1,957.4	489.4	1,305.0
GATS 2009	1,286.2	189.9 (15%)	74.1 (39%)	7.3	5,410.1	1,352.5	3,606.9
				10	7,411.1	1,852.8	4,941.0
				20	14,822.2	3,705.6	9,882.0
GATS 2010	1,194.7	285.2 (24%)	48.9 (17%)	7.3	3,572.5	893.1	2,381.8
				10	4,893.8	1,223.5	3,262.7
				20	9,787.6	2,446.9	6,525.4
GATS 2011	246.9	67.1 (27%)	21.4 (32%)	7.3	1,564.2	391.0	1,042,8
				10	2,142.7	535.7	1,428.5
				20	4,285.4	1,071.3	2,857.1
GATS 2012	210.0	29.0 (14%)	12.6 (44%)	7.3	922.7	230.7	615.2
				10	1,264.0	316.0	842.7
				20	2,528.0	632.0	1,685.4
GATS 2014	137.3	16.8 (12%)	4.3 (25%)	7.3	311.4	77.9	207.6
				10	426.6	106.7	284.4
				20	853.2	213.3	568.8
GATS 2008–14	3,217.4	609.3 (19%)	171.2 (28%)	7.3	12,496.3	3,123.8	8,330.6
				10	17,117.9	4,279.2	11,411.8
				20	34,233.7	8,558.4	22,823.6

failure influences the demand for ENDS and its consequences on public health. Last, but not least, these findings suggest that additional research should be conducted to understand the potential impact of innovation in more effective cessation products, and to address the unexplored opportunity for governments to provide incentives to the private sector to innovate in this space. These significant research gaps must be addressed to understand the full benefits and costs of regulatory measures and government support of ENDS by considering their impact on whole populations, especially on vulnerable smokers (e.g. people of limited economic means, and women) and other stakeholders.

Existing research clearly shows that current ENDS regulations, especially ENDS tax policies, are not a win–win policy for public health, and not a win for higher revenues. Although these studies do not directly examine progression to smoking by non-smoking youth, they do provide clear evidence that ENDS offer significant potential for public-health benefits. ENDS regulation requires careful consideration to avoid jeopardizing maximum public-health gains, and evidence calls for governments to upgrade their existing tobacco-control policies by taking the foregone HR into account and exploring the question of whether governments should also take responsibility for incentivizing innovation into more effective cessation products to maximize harm-reduction opportunities.

Notes

1. Authors suggested that public health benefits of not taxing ENDS must be weighed against effects of this decision on efforts to reduce vaping by youth.
2. www.fda.gov/media/133880/download (accessed 2 February 2020).
3. www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/adultsmokinghabitsingreatbritain/2018
4. Italian custom also used a formula to determine the equivalent sticks of c-Combustibles for 1ml of liquid consumption and estimated that 1 ml of liquid required 5.63 times the average time to

consume a conventional cigarette. https://vaporproductstax.com/wp-content/uploads/2016/09/Determining-excise-rate-for-e-Combustibles-in-Italy-VPT.pdf They estimated that tax value the following. (Tax per Combustibles unit* equivalence) * 50% discount. That is Tax per ml= €0.39327 = (0.139706*5.63)/2

5. Brazil in 2008, Bangladesh, Egypt, India, Mexico, Philippines, Poland, Russian Federation, Uruguay in 2009, China, Ukraine, Vietnam in 2010, Indonesia, Romania, Thailand in 2011, Argentina, Malaysia, Nigeria, Turkey in 2012, Kazakhstan and Pakistan 2014.

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