Nicotine & Tobacco Research, 2016, 1973–1980
doi:10.1093/ntr/ntw109
Original investigation
Advance Access publication April 16, 2016

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Prices and E-Cigarette Demand: Evidence From the European Union

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Abstract

Introduction: Many European Union (EU) Member States have expressed the need for EU legislation to clarify the issue of e-cigarette taxation, but the economic evidence to inform creation of such policies has been lacking. To date, only one study—on the United States only—has examined responsiveness of e-cigarette demand to price changes.

Methods: We used 2011–2014 pooled time-series data on e-cigarette sales, as well as e-cigarette and cigarette prices for six EU markets (Estonia, Ireland, Latvia, Lithuania, Sweden, and the United Kingdom). We utilized static and dynamic fixed-effects models to estimate the own and cross-price elasticity of demand for e-cigarettes. In a separate model for Sweden, we examined the effects of snus prices on e-cigarette sales.

Results: Based on static models, every 10% increase in e-cigarette prices is associated with a drop in e-cigarettes sales of approximately 8.2%, while based on dynamic models, the drop is 2.7% in the short run and 11.5% in the long run. Combustible cigarette prices are positively associated with sales of e-cigarettes. Snus prices are positively associated with sales of e-cigarettes in Sweden.

Conclusions: Our results indicate that the sales of e-cigarettes are responsive to price changes, which suggests that excise taxes can help governments to mitigate an increase in e-cigarette use. E-cigarettes and regular cigarettes are substitutes, with higher cigarette prices being associated with increased e-cigarette sales. Making combustible cigarettes more expensive compared to e-cigarettes could be effective in moving current combustible smokers to e-cigarettes, which might have positive health effects.

Implications: This study is an exploratory analysis of the issues around e-cigarette taxation in Europe. Our results suggest that taxation is a measure that could potentially address the concerns of both opponents and proponents of e-cigarettes: taxes on e-cigarettes could be used to raise prices so as to deter e-cigarette initiation by never users, while concomitant greater tax increases on regular cigarettes could incentivize switching from combustible products to e-cigarettes. The estimates from our models suggest that e-cigarette demand is possibly more responsive to price than cigarette demand. Policymakers who consider implementing excise taxes on e-cigarettes should take this difference in price responsiveness of demand for these two products under consideration.

Introduction

E-cigarettes are rapidly gaining popularity in the European Union (EU) but there is little research that describes—let alone, helps to explain—some of the key economic dynamics surrounding use of these products. According to a pan-European survey, the percentage of the EU population aged 15 and above who tried e-cigarettes or other electronic nicotine delivery systems (ENDS) at least once increased from 7% in 2012 to 12% in 2014. France had the highest prevalence of e-cigarette ever use (21%), followed by Cyprus (17%)

and Estonia (15%).[1] Euromonitor, a market research company, estimates that in just 5 years the EU market for ENDS increased more than tenfold from 0.2 billion euro in 2010 to 2.2 billion in 2014. The largest EU e-cigarette markets were the United Kingdom (0.6 billion euro in 2014), Italy, Poland, and France (0.3 billion euro each in 2014).[2] Most European surveys find that the prevalence of e-cigarette use is highest among youth and current combustible tobacco users.[1,3–8]

The EU is among the pioneers in e-cigarette control. In early 2014, Members of the European Parliament adopted a revision of the Tobacco Products Directive (TPD), which includes provisions to regulate certain aspects of the e-cigarette market in the 28 EU Member States. By May 2016, e-cigarette manufacturers will be required to disclose all ingredients and toxicological data, and also provide a description of the production process. Additionally, the amount of nicotine in e-cigarettes and refill containers will be limited, products will be required to carry health warnings and be child-proof, and e-cigarette advertising will be banned, unless companies seek approval and licensure to sell their products as a medicine.[9,10]

One potential future step in the EU's control of e-cigarettes could be inclusion of e-cigarettes in the next revision of its Tobacco Tax Directives (TTD). In June 2014, the European Commission held a stakeholder consultation where it provided the first draft report on TTD implementation.[11] E-cigarette taxation is among the identified areas of improvement in the existing Directive. The report states that many Member States have expressed the need for EU legislation to clarify the issue of e-cigarette taxation and some of the Member States have reported that they would welcome the application of excise taxes, on both budgetary and health protection grounds.[11] A report issued by the European Commission in December 2015 further called for analyzing the possibility of including e-cigarettes in the scope of excise duty on tobacco products in the upcoming revision of the Tobacco Tax Directive.[12]

There remains, however, insufficient evidence to predict the effects of e-cigarette taxation in the EU. Some preliminary data suggest that price influences decisions on e-cigarette use, both within the e-cigarette product category, as well as among e-cigarettes and other nicotine-containing products. Europeans who had tried e-cigarettes reported that price (38%) was the second most important factor, after flavor (39%), considered when choosing their electronic cigarette.[1] To date, only one study from the US estimates the price elasticity of demand for disposable and reusable e-cigarettes, based on sales data from 52 US markets.[13] Estimated price elasticities for disposable and reusable e-cigarettes were −1.2 and −1.9, respectively. Another study surveyed a small sample (N = 210) of current cigarette smokers in New Zealand to estimate cross-price elasticity between e-cigarettes and regular cigarettes.[14] The estimated cross-price elasticity was 0.16, suggesting that e-cigarettes and regular cigarettes are substitutes. This study, however, excluded current and past e-cigarette users from the sample and smokers' preferences were measured based on hypothetical, rather than actual, cigarette and e-cigarette price increases.

Additionally, there is an important related dynamic occurring in Sweden, where e-cigarettes were introduced to a market that already had a popular form of smokeless tobacco, called snus. Similar to e-cigarettes, snus is being promoted as a reduced-risk product compared to combustible tobacco and a product that can be used even when the use of combustible tobacco is prohibited. We should note, however, that unlike e-cigarettes where data about harm are still lacking, the data on health benefits of switching from cigarettes to Swedish snus are plentiful.[15]

There is currently no evidence on how changes in the relative prices of e-cigarettes and other tobacco products, for example through the introduction of e-cigarette taxes and increased tobacco products taxation, would influence e-cigarette sales in the EU. In this study we aim to shed light on the potential impact of e-cigarette tax policies in the EU, by examining the effects of e-cigarette and cigarette prices on e-cigarette sales. In addition, we analyze the effects of snus prices on e-cigarette sales in Sweden. The results are a starting point for a discussion to inform the EU Tobacco Tax Directive and to provide more general evidence for any government considering e-cigarette taxation.

Methods

Data

We obtained data on e-cigarette and regular cigarette sales for six EU markets (Estonia, Ireland, Latvia, Lithuania, Sweden, and the United Kingdom) from the Nielsen Company. These six countries were the only countries for which reliable data on e-cigarette sales were available. The company collected the data directly from electronic scanners in participating retail outlets. In most countries, the participating stores include hypermarkets, supermarkets, grocery stores, convenience stores, and gas stations. According to Nielsen's estimates, this method allows the company to cover the vast majority of the market for regular cigarettes (from 75% in Sweden to 91% in Latvia). Nielsen's coverage of the e-cigarette market is weaker (coverage estimates at 34% in Ireland, 20%–30% in Estonia, Latvia, and Lithuania, 1% in Sweden, and are not provided for the United Kingdom) because a significant proportion of sales are online or in vape shops, and are not covered by Nielsen or any other consumer data collection organization. The data cover the period from November 2012 to October 2014 for Estonia, Latvia, and Lithuania, from January 2012 to November 2014 for Sweden and Ireland, and from December 2011 to October 2014 for the UK.

The Nielsen data are aggregate monthly or 4-week period data on the number and value of e-cigarette and cigarette sales in Nielsen-participating stores in each of the six countries. The average price per item for both e-cigarettes and regular cigarettes is calculated by dividing the value of sales by the number of items sold in a given country in a given period of time. Unlike regular cigarettes, e-cigarettes are not a homogenous product and the number of products that fit into Nielsen's e-cigarette category is large. The e-cigarette category ranges from 103 (Baltic States) to 382 (the United Kingdom) different product types and includes both disposable and reusable e-cigarettes, as well as e-liquids and cartridges, which serve to refill reusable e-cigarettes. However, we asked Nielsen to remove the sales of e-liquids and cartridges from the data, so that we could focus on the electronic nicotine delivery devices only. E-liquids and cartridges constituted a small part of what Nielsen captured in their e-cigarette category (only 2% of sales volume in the six countries), which was not enough to perform a separate analysis for the e-liquids and cartridges.

Where there is particularly poor coverage, we removed observations with less than 50 instances of e-cigarette purchases captured by Nielsen in a given 4-week period in a given country (15 observations removed: 14 from Lithuania and one from Estonia). These were mainly observations from Lithuania, where a major Nielsen-affiliated chain dropped e-cigarettes from their stores in June 2013.

For countries with monthly data, we converted monthly sales volume into 4-week (28 days) sales volume, so that the time intervals for each market and each data point were equal in duration. To calculate per capita e-cigarette sales, we used countries' population data obtained from Eurostat.[16] We used monthly exchange rates to convert cigarette and e-cigarette average prices in Lithuanian litai, British pounds, and Swedish kronas to euros,[17] and monthly consumer price indices to adjust these prices for inflation.[16] Monthly unemployment rates were also obtained from Eurostat.[16] Annual weighted-average price of snus in Sweden was obtained from Euromonitor.[2] Nielsen scanner data have previously been used to analyze cigarette demand,[18–20] as well as demands for nicotine replacement therapy[21] and e-cigarettes,[13] and are widely regarded as the best available consumer data of this nature.

Model

We use pooled time-series data to estimate the effects of e-cigarette prices on per capita e-cigarette sales in the six European countries. We use fixed effects models to control for stable characteristics of the countries, such as social acceptability of tobacco use or the general level of tobacco control regulations. These estimation methods are commonly used in analysis of demand for regular cigarettes[22] and have previously been utilized in analyzing US e-cigarette sales.[13] Other studies, such as the PPACTE Project, used similar data to estimate price elasticities by country in Europe.[23] However, since the aim of our study is to inform the EU-level policies, we decided that the pooled setup is more appropriate.

If a unit root exists in the panel data, the results are suspect.[24] We performed Fisher-type tests for panel data based on the augmented Dickey-Fuller tests and found that both the dependent variable (per capita e-cigarette sales) and the main explanatory variable (e-cigarette price) are stationary.

The model is first estimated in a static form after which dynamic specifications are estimated. The panel is not balanced due to the availability of Nielsen data. The baseline fixed-effects model was specified as follows:

$$\ln\text{ (per capita ecig sales)}_{it} = \beta_0 + \beta_1 \ln\text{ (ecig price)}_{it} + \beta_2\text{ Year}_{it} + \beta_3\text{ Quarter}_{it} + \alpha_i + \varepsilon_{it}$$

where β_0 is an intercept, α_i is a set of fixed constants, and ε_{it} is the error term. The dependent variable in this model is a logarithm of per capita e-cigarette sales volume in a given country (i) in a given 4-week period (t). The key independent variable is the inflation-adjusted average e-cigarette price in a given country (i) in a given 4-week period (t). Year and Quarter are vectors of dichotomous variables. The estimated coefficient β_1 represents price elasticity of demand for e-cigarettes. Coefficients β_2 and β_3 capture time trend and seasonality in e-cigarette sales, respectively, a method used by Huang and colleagues.[13] In the second model specification we introduce the inflation-adjusted average price of regular cigarettes to capture the effect of cross-price elasticity between regular cigarettes and e-cigarettes. Standard demand functions control for income. Typical candidates for the income variable, such as wages and salaries, are not available on a monthly basis in the EU and therefore could not be used in our model. Therefore, to capture the effect of economic conditions that might have influenced e-cigarette purchases, in the third model specification we included an unemployment variable. In a fourth specification, we control for both the price of regular cigarettes and unemployment. Specifications five through eight include a dynamic term—a lagged e-cigarette sales measure—in order to control for the addictive nature of e-cigarettes (a myopic addiction model).[22]

We also estimate a separate model for Sweden (Supplementary Appendix 1). In addition to e-cigarette and regular cigarette prices, the model controls for snus prices to capture the effects of snus prices on e-cigarette sales. It this case, we used the Engle and Granger Two-Step Error Correction Model to address data nonstationarity.[25]

Results

The summary statistics for the key variables are presented in Table 1. On average, Nielsen captured 4.5 e-cigarette sales per 1000 people per 4 weeks, with the highest sales volume, 18 e-cigarette sales per 1000 people, in Ireland in January 2014. Figure 1 shows trends in e-cigarette sales in the Nielsen countries. Within the time frame of our analysis, Nielsen-captured e-cigarette sales increased substantially in Estonia, Latvia, Ireland, and the UK, but remained relatively stable in Lithuania and Sweden. In 2014, the growth showed signs of slowdown in Estonia, Ireland, and the United Kingdom, where at the end of the year e-cigarette sales were lower than in January.

Table 2 summarizes findings from our models. All eight model specifications indicate that an increase in e-cigarette prices significantly decreases e-cigarette sales. In the static models, the estimated e-cigarette price elasticity varies from −0.79 to −0.84, while in the dynamic models the short-run elasticity varies from −0.26 to −0.27 and the long-run elasticities vary from −1.13 to −1.18 (based on the long-run multiplier). This suggests that a 10% increase in e-cigarette prices is associated with a drop in e-cigarette sales of about 8.2% based on static models, and in the dynamic models, a 2.7% drop in the short run and 11.5% in the long run. The models also indicate that an increase in regular cigarette prices is associated with increased e-cigarette sales, which suggests that regular cigarettes and e-cigarettes are substitutes. This effect is significant at the conventional levels in specifications two and six, while the *P*-values for the estimated coefficients are .065 and .052 for specifications four and eight, respectively. The estimated cross-price elasticity is 4.55 and 3.6 in the static models, while the long-run multipliers in the dynamic models are 6.46 and 6.54. This implies that a 10% increase in regular cigarette prices is associated with about a 40% increase in e-cigarette sales based on static models and a 60% increase in the long run based on dynamic models.

Only in one of the models controlling for unemployment was the coefficient for that variable significant. That model suggests that a one percentage point increase in unemployment rate is associated with a drop of 0.16% in e-cigarette sales. Finally, results from all model specifications show that the year 2013 was significantly associated with an increase in the e-cigarette market. The coefficients for other time trend and seasonality dummies were significant in some, but not in all model specifications.

The model for Sweden also confirmed a negative relationship between e-cigarette prices and sales and a positive relationship between regular cigarette prices and e-cigarette sales, in the long run. This model suggests that in the long run snus prices are also positively associated with e-cigarette sales, which suggests that snus and e-cigarettes are substitutes. The effect of snus prices on e-cigarette sales is stronger than the effect of regular cigarette prices. A small sample size, however, makes the confidence intervals for the coefficient estimates vey wide (Supplementary Appendix 1).

Discussion

Our study consistently shows that e-cigarette demand is responsive to price, which suggests that tax policies that alter e-cigarette

Table 1. Descriptive Statistics

Variable	All countries	Estonia	Ireland	Latvia	Lithuania	Sweden	United Kingdom
	Mean (*SD*) [Minimum; Maximum]						
E-cigarette sales per 1000 people per 4-week period	4.45 (6.09)	0.23 (0.13)	10.50 (6.28)	0.29 (0.20)	0.05 (0.03)	0.10 (0.03)	8.94 (5.00)
	[0.02; 17.79]	[0.07; 0.55]	[0.05; 17.79]	[0.05; 0.56]	[0.02; 0.09]	[0.05; 0.17]	[0.80; 15.77]
E-cigarette price (in 2011 euros)	13.84 (10.74)	29.99 (19.47)	8.13 (0.61)	8.99 (3.45)	8.36 (6.26)	19.89 (2.40)	8.35 (0.68)
	[1.42; 75.82]	[10.51; 75.82]	[7.16; 9.79]	[5.27; 15.12]	[1.42; 18.99]	[14.39; 23.47]	[5.96; 9.46]
Regular cigarette price (in 2011 euros)	5.57 (2.48)	2.56 (0.10)	8.85 (0.19)	2.42 (0.09)	2.28 (0.10)	5.43 (0.17)	6.99 (0.29)
	[2.21; 9.42]	[2.40; 2.72]	[8.60; 9.42]	[2.33; 2.60]	[2.21; 2.45]	[5.03; 5.76]	[6.44; 7.52]
Unemployment rate	9.74 (2.61)	8.21 (0.95)	13.11 (1.55)	11.69 (1.01)	11.73 (1.90)	7.97 (0.61)	7.32 (0.75)
	[6.1; 15.5]	[6.9; 10.2]	[10.4; 15.5]	[10.6; 13.9]	[8.6; 13.4]	[7.1; 9.2]	[6.1; 8.2]
Number of observations	174	23	39	24	10	39	39

prices will be effective in affecting e-cigarette use. Similar to Huang and colleagues,[13] we found e-cigarette demand to be possibly more price responsive than the demand for regular cigarettes. Estimates of the price elasticity of demand for regular cigarettes in high-income countries, based mainly on static models, range from −0.2 to −0.6,[22] while our estimates of price elasticity demand for e-cigarettes from the static models at around −0.8. Policymakers who consider implementing excise taxes on e-cigarettes should take this difference in price responsiveness of demand for these two products under consideration.

Though we could not estimate price elasticities for any sub-populations separately, it is well established that youth and lower-income individuals are particularly responsive to cigarette price policies.[22] We anticipate that the same is likely true for e-cigarettes, and that e-cigarette taxes would be particularly effective in deterring e-cigarette initiation among youth.

Since we focus here only on e-cigarette demand, we have no direct evidence on the effects of e-cigarette prices on sales of regular cigarettes. However, consistent with Grace et al.,[14] we find some evidence that e-cigarettes and regular cigarettes are substitutes, with higher cigarette prices being associated with increased e-cigarette sales. This finding might suggest that increasing price differences between regular cigarettes and e-cigarettes by further increases in taxes on regular cigarettes could be effective in driving current smokers of combustible cigarettes to e-cigarette use, which potentially could have beneficial effects on their health. Our estimated cross-price elasticities seem high, but that is probably a reflection of the relatively small size of the e-cigarette market, compared to the market for regular cigarettes.

Limitations

Whilst the findings are clear, they can only be used to inform or justify policy decisions with a close consideration of the limitations of the study. First, our data capture only e-cigarette sales made in Nielsen-participating stores. In several of the countries in the sample, the majority of sales occur online and in specialty type shops (eg, vape shops)—outlets not covered by Nielsen's data collection. When comparing our 2013 data with estimates from Euromonitor, which are supposed to include all retail settings, the e-cigarette market captured by Nielsen is at between 34% in Ireland to only 1% in Sweden of that estimated by the Euromonitor.[2] It should be noted, though, that while Nielsen captures actual sales, there might be a large margin of error around Euromonitor estimates, since internet and vape shop sales are extremely difficult to track. There is a possibility that the purchasing behavior of customers who shop online and in specialty stores is different than the behavior of those who shop in the traditional outlets covered by our data. If this is the case, our findings would not be generalizable to the entire e-cigarette market. Future research will need to examine if there is a significant difference.

Second, the combined population of the six countries covered in this research is 80.5 million, which represents 16% of the EU population. However, among those six countries, there are three long-time EU Member States, as well as three new Member States that joined the EU after 2004, making the sample a useful mix of old and new Members.

A third limitation of the study is the fact that the data are aggregate reflecting what Nielsen captures in the entire e-cigarette category, including both disposable and reusable e-cigarettes. Any structural change in the e-cigarette market (eg, a shift from reusable

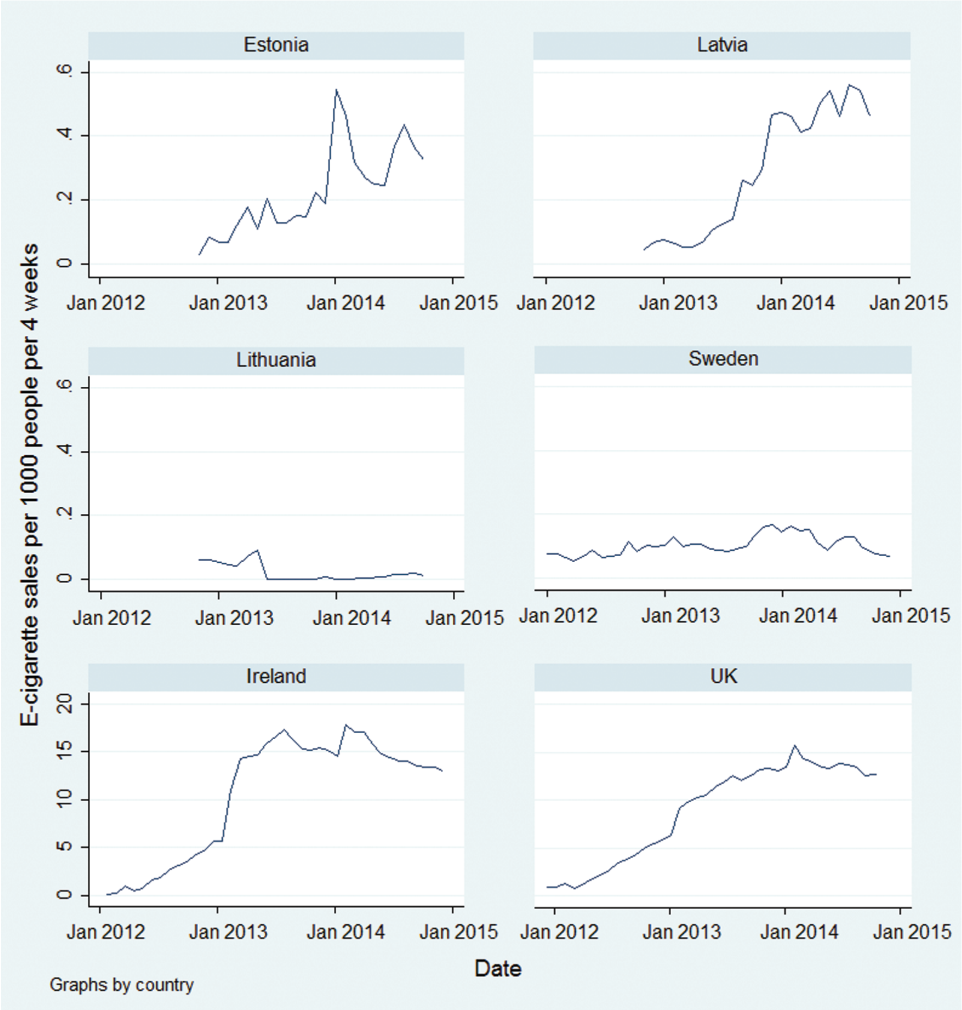

Figure 1. E-cigarette sales. *Note*: E-cigarette sales volumes presented in this figure are for Nielsen-affiliated vendors only.

to disposable e-cigarettes) is being picked up by the year dummies in our models. Further analyses using more disaggregated data when they become available are needed to investigate differences in price responsiveness for different types of e-cigarettes.

Our choice of analytical method is largely driven by data availability. Because we analyze aggregate data, we have no information on demographic and socioeconomic characteristics of customers who purchase e-cigarettes. Therefore, we are unable to determine the impact of price on the decision to use e-cigarettes or on differences in the price sensitivity of key population subgroups (eg, whether or not youth are more responsive to changes in e-cigarette prices than other age groups, as consistently seen for cigarettes). Again, this is a logical direction of future research when these data become available.

A typical issue in estimating demand for cigarettes is simultaneity. Because consumers choose the quantity of cigarettes consumed based on the product's price, while the manufacturers choose the price based on the quantity consumed by the market, estimating just the demand side of the market could yield biased estimates of price effects. With only few major tobacco companies dictating cigarette prices on the market for regular cigarettes (oligopoly), this simultaneity is a problem when estimating demand for regular cigarettes. However, we believe that this issue is not a concern of e-cigarette market analysis. With literally hundreds of small companies producing (or importing) e-cigarettes, the market seems to be closer to a perfect competition model. In a perfect competition, the manufacturers do not choose their price, but they are rather price takers and, therefore, simultaneity does not occur.

Last, the small data sample makes the statistical tests, especially the unit-root tests, less powerful. Further, the lack of monthly data on snus prices makes the results of the Swedish model less accurate.

Our results are admittedly preliminary and based on problematic data, but the results are nonetheless compelling because they are derived from standard econometric methods (both in the static and dynamic models) and the estimates are consistent across all models.

Conclusions

Measures to control e-cigarette use currently are a matter of extensive study and debate.[26] One part of the tobacco control community argues that regulators should not treat electronic cigarettes the same way they treat traditional tobacco products because e-cigarettes are a potentially lower-risk alternative to cigarette smoking.[27] Because e-cigarette aerosol appears to be less harmful than cigarette smoke,[28] e-cigarettes may substantially reduce health risks for those who

Table 2. E-cigarette Demand: A Pooled Time-Series Models

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lagged logarithm of e-cigarette sales					0.78***	0.76***	0.77***	0.76***
Own price elasticity	−0.79***	−0.80***	−0.84***	−0.83***	−0.26***	−0.27***	−0.27***	−0.27***
Logarithm of unemployment			−0.16**	−0.12			−0.02	0.00
Cross price elasticity with regular cigarettes		4.55**		3.6*		1.57**		1.55*
Year = 2013	1.22***	1.16***	1.09***	1.08***	0.17***	0.18***	0.16**	0.18***
Year = 2014	1.45***	1.24***	1.14***	1.06***	0.14**	0.10	0.12	0.1
Quarter = 2	0.16	0.11	0.08	0.06	0.03	0.01	0.02	0.01
Quarter = 3	0.31**	0.18	0.16	0.09	0.05	0.00	0.03	0.00
Quarter = 4	0.55***	0.46***	0.38**	0.35**	0.05	0.02	0.03	0.02
Constant	−6.49***	−13.58***	−4.61***	−10.7***	−1.05***	−3.59***	−0.87**	−3.55**
Number of observations	174	174	174	174	167	167	167	167
Adjusted overall R^2	0.18	0.64	0.15	0.65	0.98	0.94	0.98	0.94

Because there was only one observation from 2011 in our dataset, this observation has been assigned the 2012 dummy. We performed the analysis without Lithuania, a country with a poor data coverage, and the results were nearly identical.

$*P < .1$, $**P < .05$, $***P < .01$.

switched from regular cigarettes to e-cigarettes, but cannot quit nicotine-based products altogether. Also, some types of e-cigarettes might eventually prove to be an effective cessation aid for current smokers of combustible cigarettes.[29,30] Some scholars even argue that a public health policy encouraging current smokers of combustible cigarettes to switch to e-cigarettes could rapidly reduce tobacco-related death and disease[31] and that such a public health breakthrough would more likely occur if e-cigarette prices were sufficiently lower than prices of combustible cigarettes, so that the users of harmful combustible cigarettes are incentivized to shift to using less harmful e-cigarettes.[32]

Others, however, emphasize the possible negative health effects of electronic cigarettes and their potential for being a gateway to combustible cigarettes, and call for including e-cigarettes in existing tobacco control regulatory frameworks.[33] The use of e-cigarette might have adverse health effects, which include potential harms associated with long time exposure to propylene glycol and other compounds in e-liquids.[34,35] Additionally, nicotine itself has multiple adverse health effects: it is addictive, poisonous in large doses, can affect the cardiovascular system adversely, may precipitate or aggravate diabetes, and promote cancer growth or spread under certain conditions.[36] Nicotine exposure also impairs brain development from fetal through adolescent developmental stages.[37] Some preliminary evidence suggests that some e-cigarette-using teenagers would have never became addicted to nicotine if e-cigarettes had not been so readily available.[38] Once addicted to nicotine with e-cigarettes, there is a risk that those teenagers (and generally non-smokers) could initiate combustible tobacco use with e-cigarettes.[39]

The American Heart Association (AHA) recently proposed a comprehensive strategy for e-cigarette taxation, which suggests that the e-cigarette taxation is a measure that can potentially address the concerns of both groups: taxes on e-cigarettes and other ENDS could be used to raise prices to deter initiation by never smokers, while concomitant greater tax increases on regular cigarettes could incentivize switching from combustible to non-combustible products.[40]

This study provides an exploratory analysis of the issues around e-cigarette taxation in Europe while at the same time illuminates the complexities of the issue. Future research should first establish a better measure of product quantity. For example, Pagano and colleagues in research in this journal examined three characteristics of e-cigarettes: nicotine content, number of puffs obtained before depletion, and portion of nicotine delivered via aerosolization.[41] Each of these characteristics is a potential candidate for a product volume equivalence measure. The next step would require identifying the dose of e-cigarettes that would be equivalent to a regular combustible cigarette, which would allow comparing use and prices of regular cigarettes and e-cigarettes. A recent study reveals that combustible tobacco cigarettes cost less to purchase than equivalent amounts of e-cigarettes in 44 of 45 countries sampled around the world.[42] Third, there is a need for better surveillance of e-cigarette purchasing and use. Individual-level data would allow to analyze the influence of e-cigarette prices on e-cigarette initiation, cessation, and switching behaviors specifically, as well as to study the differences in price sensitivity among different subpopulations. Finally, the question on how to tax e-cigarettes remains open. Some jurisdictions are just beginning to experiment with different tax structures: ad-valorem tax (eg, Minnesota),[43] specific tax on nicotine content (eg, Maine proposal),[44] and specific tax on the volume of e-liquid (eg, Italy).[45] Given that the levels and structures of the e-cigarette taxes in those jurisdictions are very different, it will be important to monitor how these taxes influence e-cigarette use in coming years.

Although harm reduction strategies in tobacco control are relatively uncommon and often controversial, there are some success stories from countries that have reduced tobacco-related harm by introducing different tax rates on different types of tobacco products. For example, Sweden's low rates of tobacco-related diseases have been linked to the country's efforts to incentivize current combustible cigarette smokers to switch to snus by keeping snus taxes at lower levels than those for cigarettes and other forms of smoking tobacco.[31] Such differential taxation for different nicotine-containing products may make sense from a harm-reduction perspective, but only when calibrated carefully to discourage never tobacco users, particularly youth, from initiating use of any nicotine product, and in combination with other effective tobacco control measures.[46] In the context of differential tax rates for e-cigarettes and regular cigarettes, it appears particularly important to include other measures, such as to ensure that e-cigarettes are safe to use and that they satisfy the needs of combustible tobacco smokers who would like to switch to e-cigarettes. Provisions of the revised Tobacco Product Directive provide guidelines for such further policies, while allowing countries to go beyond the Directive's minimum requirements.

Supplementary Material

Supplementary Appendix 1 can be found online at http://www.ntr.oxfordjournals.org

Funding

The American Cancer Society (ACS) (contract number 20512) provided the funds to purchase the data analyzed in the article. The contents of this article are the sole responsibility of the authors and cannot be regarded as reflecting the positions of ACS.

Declaration of Interests

None declared.

Acknowledgments

The authors would like to thank Alex Liber for his valuable comments and John Daniel for editing assistance.

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