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An Economic Study of the Effect of Reduced Risk Products on Smoking Prevalence

A report for British American Tobacco

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Glossary

Term	Definition
2022 Report	Initial report commissioned by BAT in 2022 and entitled "An Economic Study of the Effect of Reduced Risk Products on Smoking Prevalence"
Base model	Model that seeks to explain variation in current smoking prevalence as a function of the price of tobacco, the extent of non-price tobacco restrictions, and various demographic and socio-economic factors
CBDS	Cross-border distance sales
Cigarette-price test	The first of two economic tests for whether RRPs and cigarettes are substitutes, based on how RRP use is affected by changes in the price or availability of cigarettes
Confounding factor	A factor that is related to both the outcome and intervention, and therefore needs to be taken into account (i.e. controlled for), to produce a reliable estimate of the effect of the intervention
Control variable	As above
Cross price elasticity of demand	Percent change in demand for product A resulting from a percent increase in the price of product B.
Current smoking prevalence	The proportion of respondents who report being current smokers of traditional burning tobacco products
Dependent variable (or outcome variable)	A measure of the outcome of interest (the primary outcome of interest in this study is current smoking prevalence)
Difference-in-difference	A statistical technique that studies the differential effect of a treatment on a treatment group versus a control group
EC	The European Commission
EC report	The Support Study to the report on the application of Directive 2014/40/EU – an independent report commissioned by the European Commission to provide evidence for assessing the application of the EU Tobacco Products Directive 2014
E-cigarette hostility index	Index that measures regulatory hostility towards e-cigarettes, on a scale from 0 (least hostile) to 7 (most hostile)
Eurobarometer	Polling instrument used by European Union institutions to monitor the state of public opinion in Europe
FCTC	The World Health Organization's Framework Convention on Tobacco Control
GBDS	The Global Burden of Disease Study
Hicksian symmetry	A result of economic theory, that implies that RRPs are substitutes for cigarettes if and only if cigarettes are substitutes for RRPs
IEA	Institute of Economic Affairs

ITC	International Tobacco Control
Multivariate regression analysis	Statistical technique used in empirical studies that aim to measure the causal effect of a treatment variable on an outcome variable, where there are multiple other factors at play
Odds ratio	The ratio of the probability that a given binary effect occurs divided by the probability that the effect does not occur. Commonly used as the dependent variable in logistic regression. A measure of association between an exposure and an outcome. The odds ratio represents the odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure.
OLS	Ordinary Least Squares, a means of drawing a line of best fit through data points, and the most commonly employed technique in multivariate regression analysis
Preferred model	Extension of the base model to include a measure of regulatory hostility towards e-cigarettes
Reference groups	168 groups of individuals defined by age category, gender, country of residency in the Eurobarometer surveys
RRP-price test	The second of two economic tests for whether RRPs and cigarettes are substitutes, based on how smoking outcomes affected by the prices or availability of RRPs
RRPs	Reduced-risk products, such as e-cigarettes, heated tobacco products and oral tobacco and nicotine products
RYO	Roll-your-own tobacco
Statistical power	The probability that a test of significance will detect a deviation from the null hypothesis, should such a deviation exist given the alternative hypothesis is true
TCS	Tobacco Control Scale, published by the Association of European Cancer Leagues and used in the analysis to construct a variable measuring non-price tobacco control regulations
The Finnish Tobacco Act	Comprehensive e-cigarette legislation passed in Finland in May 2016
Tobacco HICP	Harmonized Index of Consumer Prices for Tobacco, published by Eurostat
TPD	Generic term for the current EU Tobacco Products Directive.
TPD1	Tobacco Products Directive 2001/37/EC. Used when discussing different versions of the legislation
TPD2	Tobacco Products Directive 2014/40/EU. Used when discussing different versions of the legislation.
TPD3	Collective term for the potential changes to the TPD2 currently considered by The European Commission

Treatment variable	A measure of the intervention whose causal effect is under investigation (the primary treatment variable of interest in this study is the e-cigarette hostility index)
WAP	Weighted Average Price

1. Introduction

1.1 I understand that the European Commission (EC) has opened a public consultation seeking feedback on the performance of the current EU Tobacco Products Directive (2014/40/EU) (**"TPD2"**) legislative framework for tobacco products, and ways that the legislation could be updated. While the contemplated provisions of a potential new Tobacco Products Directive 3 (**"TPD3"**) are not yet known, I understand that some market participants anticipate that TPD3 could impose a variety of further restrictions on both cigarettes and reduced-risk products (RRPs), including e-cigarettes.

1.2 In this regulatory context, BAT has asked me to present and update an existing report I prepared for BAT in 2022 with support from a team at FTI Consulting led by Dr. Meloria Meschi and Ravi Kanabar, entitled "An Economic Study of the Effect of Reduced Risk Products on Smoking Prevalence" (**"2022 Report"**).

1.3 By way of background, my 2022 Report examined the relationship between e-cigarette regulations and smoking prevalence across the UK and the EU, using the public data contained in the Eurobarometer covering the period 2006 to 2020. The analysis in my 2022 Report is relevant to the TPD3 consultation insofar as the TPD3 may contemplate imposing tighter restrictions on RRPs, including e-cigarettes.

1.4 Whether and to what extent the availability and use of RRPs reduce smoking prevalence is ultimately an empirical question, the answer to which depends on whether RRPs and cigarettes are economic substitutes or complements.

1.5 This question is one that currently divides the public health community, with some public health authorities, for example, raising concerns that RRPs might be complements for smoking among youth and young adults and with smokers choosing to both smoke and use RRPs, while other public health authorities, including Public Health England and the Office for Health Improvement and Disparities in the UK, have advocated for greater access to RRPs and lighter regulatory restrictions of RRPs as a form of tobacco harm reduction.

1.6 This ongoing public health debate has led to authorities in some jurisdictions implementing (or at least contemplating) various combinations of indoor vaping bans, flavor bans, sales and cross-border sales bans, age restrictions, packaging restrictions, advertising restrictions, and higher excise taxes, while other regulators have taken a more restrained approach that aims to reduce youth access to e-cigarettes while still allowing these products the regulatory space needed to compete effectively with cigarettes to facilitate tobacco harm reduction.

1.7 To help provide further empirical evidence to inform these public health and regulatory discussions and debates, in my 2022 Report I conducted an economic analysis of whether RRPs—specifically e-cigarettes which represent the most widely used category of RRPs—are economic substitutes or complements to cigarettes, and ultimately whether greater access to e-cigarettes results in reduced smoking prevalence.

1.8 My economic analyses, focusing on European countries, found that e-cigarettes are substitutes for cigarettes and demonstrated that allowing greater access to RRPs (specifically e-cigarettes) will *reduce* rates of smoking and conversely, regulatory policies that discourage or seek to outright prohibit e-cigarette use will *increase* rates of smoking.

1.9 Specifically, the data show that in Europe, for each additional regulatory restriction (of the type considered in the study) which is imposed on consumer access to e-cigarettes, there is a 0.39-percentage-point increase in smoking prevalence. This increase, while small at face value, represents 1.7 *million* additional smokers in Europe who otherwise would not be smoking.

1.10 Moreover, in reality, many EU countries imposed more than one additional regulation of e-cigarettes over the period of my study (2014–2020). For example, Germany imposed not one, but *three* new regulatory restrictions on access to e-cigarettes during this period, which my study indicates would produce a 1.17-percentage-point increase in smoking prevalence. The result is more than 800,000 additional smokers in Germany due to this increased regulation. Or said differently: had Germany not imposed these three additional e-cigarette regulations, my study indicates that there would have been 800,000 fewer smokers in Germany.

1.11 In my 2022 Report, I also took a closer look at the effect of e-cigarette flavor bans on smoking prevalence rates. I found that, while there is limited data to directly assess the effect of flavor bans, based on the weight of available evidence, including my own cigarette-price test (which gauges how changes in the price or availability of cigarettes affects RRP use) and review of Eurobarometer data, banning flavored e-cigarettes (which are preferred by the vast majority of e-cigarette users) likely will lead to increased smoking, assuming flavor bans are well-enforced.

1.12 BAT has now asked me to extend my empirical work, again using EU data from Eurobarometer, concerning the impact, if any, of non-price cigarette regulations[1] on smoking prevalence, given that some market participants anticipate that a potential TPD3 could extend existing regulations and impose further non-price regulations on cigarettes.

1.13 To that end, I have conducted an economic analysis, using Eurobarometer data, to determine whether certain TPD2 non-price cigarette regulations had any effect on cigarette smoking rates in the EU and the UK. This research builds on the economic analysis I already performed in my 2022 Report, which found that in the context of examining the effect of e-cigarette regulations on smoking rates, non-price cigarette regulations had no statistically significant effect on smoking rates in the EU and the UK. The impact of non-price cigarette regulations on cigarette smoking was not the principle focus of my 2022 Report, so I draw out that analysis more clearly and explicitly in this updated report.

1.14 In addition, I have conducted a new empirical analysis of the TPD2 requirement to include picture warnings on cigarette / roll-your-own packs and the TPD2 ban on cross-border sales, and found that these non-price TPD2 measures did not discernibly reduce smoking rates in the EU and the UK. In fact, through comparisons of trends in smoking rates between countries which differed in the timing and/or extent of their implementation of the picture warnings and cross-border distance sales measures included in the TPD2, my empirical analysis found that smoking rates may have *increased* following the enactment of the TPD2 non-price cigarette regulations.

[1] Non-price cigarette regulations would be regulations other than those, like excise tax, intended to raise the price of cigarettes. Non-price cigarette regulations, for example, could include regulations on marketing, ingredients, sales and labeling of products.

1.15 In sum, my empirical analyses suggest that implementing more non-price cigarette regulations is unlikely to reduce rates of smoking, whereas allowing e-cigarettes (and other RRPs) the regulatory freedom to grow market share will continue to reduce rates of smoking.

Structure

1.16 This report is organized as follows:

1.16.1 In **Section 2**, I present a brief and non-technical summary of my study and the conclusions found.

1.16.2 In **Section 3**, I introduce some key economic and statistical principles that provide a framework for considering these issues, and guide my approach to the empirical analysis that follows.

1.16.3 In **Section 4**, I introduce the Eurobarometer data used in my analysis, and examine the association between the advent and growth of e-cigarettes and the decline in smoking prevalence rates across European countries, using two formal "tests" for whether smoking and RRPs are substitutes or complements in demand: a "cigarette-price test" and an "RRP-price test". The cigarette-price test demonstrates that countries with high cigarette prices subsequently experienced significantly more growth in e-cigarette usage than countries with low cigarette prices did and had lower rates of cigarette smoking (1–2 percentage points lower), which corresponded to these countries' higher rates of e-cigarette use (1–2 percentage points higher).[2] These test results and their symmetry with the RRP-price tests that follow provide strong evidence that cigarettes and e-cigarettes are substitutes rather than complements.

1.16.4 In **Section 5**, I use the Eurobarometer data to implement the RRP-price tests, which examine the effect on smoking prevalence of increasing regulatory hostility towards e-cigarettes, controlling for other determinants of smoking prevalence that may confound the relationship such as cigarette prices, cigarette tax rates, cigarette regulatory policies, and consumer demographic and socio-economic factors such as gender, age, education, and employment status. This RRP-price test result agrees with the results of the cigarette-price tests: smoking and e-cigarettes are substitutes, meaning as regulatory hostility toward e-cigarettes increases, smoking prevalence increases, and conversely, as regulatory hostility toward e-cigarettes decreases, smoking prevalence decreases.

1.16.5 In **Section 6** I consider the effect on smoking of e-cigarette flavor bans, a regulatory issue of focus at the moment in Europe and in other countries around the world. In particular:

(a) I provide background on arguments made by proponents and opponents of e-cigarette flavor bans, and then use the Eurobarometer surveys to shed light on the associations between flavored e-cigarette use and smoking, and on people's motivations for starting to vape.

[2] Figure 4-1 and Figure 4-2.

Although concerns about youth vaping initiation are of course legitimate, I show that the data suggests that flavor bans likely will be harmful to people attempting to quit smoking (who represent the vast majority of flavor vapers).

(b) Application to flavor bans of the same economic and statistical principles introduced earlier suggests that e-cigarettes and cigarettes are substitutes, and therefore, banning the type of e-cigarette most consumers prefer (flavored e-cigarettes) likely will lead to increased smoking given this substitution relationship. Moreover, I present my own analysis using Eurobarometer data of whether flavored e-cigarettes and smoking are complements or substitutes. I find that flavored e-cigarettes and traditional cigarettes are typically economic substitutes. This, in turn, suggests (by Hicksian symmetry) that policies that restrict access to flavors (such as a robustly enforced ban on flavored e-cigarettes) should be expected to increase smoking.

(c) I comment on research and commentary produced by others in relation to the potential effect of e-cigarette flavor bans on smoking – which relates in the main to a flavor ban implemented in San Francisco, and a package of regulations (including relating to flavors) implemented in Finland. The empirical evidence does not support claims cited by the European Commission that flavor bans will reduce vaping and not lead to increased smoking, including claims that Finland's 2016 flavor bans reduced smoking while at the same time keeping e-cigarette use low. The Finnish experience does not justify evidenced-based flavor bans in other jurisdictions because in many ways it supports the view that RRPs (such as snus) help to reduce smoking. The rest of the academic literature focuses on restrictions introduced in San Francisco. These studies do not reach definitive conclusions.

1.16.6 In **Section 7**, I consider the effect on smoking of non-price restrictions on cigarettes.

1.16.7 In **Section 8**, I draw my analyses together, present my conclusions, and identify the implications for policy makers.

1.17 The Appendices contain the details underlying my analysis:

1.17.1 In Appendix A: Bibliography, I present a bibliography of the academic papers referred to in my report.

1.17.2 In Appendix B: Data, I list and explain my data sources.

1.17.3 in Appendix C: Dataset Construction, I explain how I have constructed the dataset used for my analysis.

1.17.4 In Appendix D: Regression Analysis, I present the results of my multivariate regression analysis of the effect of regulatory hostility on smoking in full, alongside the various checks I have made for the robustness of my results.

1.17.5 In appendices Appendix E: Associations Between Flavored E-Cigarette Use and Smoking, and Motivations for Starting to Vape; Appendix F: Cigarette-Price Test for Flavored E-Cigarettes; and Appendix G: Feasibility of a RRP-Price Test for Flavored E-Cigarettes , I present the details of my analysis of the effect of e-cigarette flavor bans.

1.17.6 Finally, in Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking, I present details of my analysis of the effects of non-price regulations for cigarettes.

2. Non-Technical Summary of Approach and Conclusions

Fundamental Principles

2.1 There are some fundamental principles in economics and statistics that offer specific and clear guidance as to how one might establish empirically (using data) whether RRPs encourage or discourage smoking, and therefore, what effect placing regulatory restrictions on access to RRPs might have on smoking rates. I describe these principles in Section 3, and explain that, according to these principles, if RRPs and cigarettes are substitutes, one should expect to observe in the data that: (1) RRP use increases when the price of cigarettes increases or the availability of cigarettes is otherwise reduced, and (2) cigarette use increases when the price of RRPs increases or RRPs are not as readily available. While this may seem like a simple relationship to test, these observations may not be apparent from a cursory and high-level look at RRP and smoking prevalence data, because the RRP and cigarette markets are both rapidly evolving and both can be affected by a range of changing supply- and demand-side factors. Accordingly, a more precise empirical analysis is required to reach a reliable causal conclusion.

Data

2.2 To execute such an analysis, I first select a dataset that is rich enough to detect complementarity or substitution, given that (i) RRP markets are relatively new, and (ii) RRP use is not particularly widespread in most markets. Both of these factors make it challenging for researchers to test the effect on smoking of RRP price and availability. I describe my data requirements in Section 4, where I explain that to see a range of outcomes for RRPs and to have enough observations to detect at least a 1–2 point change in smoking prevalence in either direction,[3] this likely requires consistent data drawn from multiple countries. It should be possible to measure both smoking and RRP use for these countries. Ideally the data would also permit measurement of other time-varying determinants of smoking prevalence, such as prices, tax rates, regulatory policies, and consumer demographics. I find that the repeated Eurobarometer surveys of "Attitudes of Europeans toward tobacco and electronic cigarettes," which are used by the European Commission, the European Parliament, and other EU institutions, fulfill these criteria. Accordingly, this data is the core data used in my empirical analyses.

My Analysis

2.3 I describe my analysis of the Eurobarometer in Section 4 and 5, and also in Section 6, which focuses on the particular issue of e-cigarette flavor bans. Overall, I find across all the economic tests I conducted that the entry and growth of RRPs reduced smoking generally in the population, with a particularly pronounced effect among those aged 24 years and under, and that tax and regulatory policies that discourage RRP use result in additional smoking. In other words, RRPs and cigarettes are typically substitutes.

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[3] By way of example, if smoking prevalence in a population were 10%, a 1-point smoking prevalence change would mean that smoking prevalence decreased to 9% or increased to 11%. While a one-point change may seem small, when considered across a population of millions or hundreds of millions of people, the real-world impact would be significant.

2.4 In particular, I find that there is wide variation between European countries and (over time) within countries in the stance that regulators have taken towards RRPs (and in particular, e-cigarettes, which are the class of RRP that have been available for the longest and have seen the greatest use, and are thus the focus of the available data). For example, on one end of the spectrum is the United Kingdom, which has "embraced" e-cigarettes for more than a decade based on advice received as early as 2010 from the government's "nudge unit" (a team set up within the Cabinet Office to deploy insights from behavioral economics and psychology),[4] and where the National Health Service now even recommends using e-cigarettes to stop smoking. On the other end of the spectrum is Estonia, which by 2020 had introduced indoor vaping bans, flavor bans, age restrictions, cross border sales bans, advertising and packaging restrictions, and an e-cigarette excise tax (see Table 10-9 in Appendix B: Data for details).

2.5 My empirical analysis measures this variation in regulatory hostility within and across countries on a simple scale from 0 (no regulations) to 7 (where e-cigarettes are subject to restrictions on (1) indoor vaping, (2) flavors, (3) cross border sales, (4) age of use, (5) packaging, and (6) advertising, as well as (7) an excise tax). I find that a 1-point increase (e.g., from three to four regulations, with each regulation worth 1 point on this regulatory hostility scale) is estimated to cause a 0.39-percentage-point increase in smoking prevalence. For example, if rates of smoking were 10%, rates would increase to 10.39% with a 1-point increase on the e-cigarette regulatory hostility scale described above. This is not a small effect in terms of its potential impact on human health: a 0.39-percentage-point increase in the prevalence rate corresponds to 1.7 million additional smokers across Europe.[5] In Germany, for example, regulatory hostility toward e-cigarettes actually increased by three points between 2014 and 2020. I estimate that this would have caused an estimated 1.17-percentage-point increase in current smoking prevalence (relative to what it would otherwise have been), and more than 800,000 additional current smokers in Germany (relative to the number that there otherwise would have been).[6]

2.6 I also find that the effect of regulatory hostility is particularly pronounced with respect to its effect on current smoking prevalence of those aged 24 and under (the youngest age cohort in the Eurobarometer studies), as current smoking prevalence in this age group is more than twice as sensitive to regulatory hostility. To the extent that people rarely start to

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[4] In its 2010 annual report, the Behaviour Insights Team stated the rationale for a laissez faire approach to RRP regulation: "*products that deliver nicotine quickly in a fine vapour instead of as harmful smoke could prove an effective substitute for 'conventional smoking'. It will be important to get the regulatory framework for these products right, to encourage new products, which smokers can use as safer nicotine alternatives, to be made available in the UK. A tenet of behaviour change is that it is much easier to substitute a similar behaviour than to extinguish an entrenched habit (an example was the rapid switch from leaded to unleaded fuel). If more alternative and safe nicotine products can be developed which are attractive enough to substitute people away from traditional cigarettes, they could have the potential to save tens of thousands of lives a year*". See: gov.uk, "Behavioural Insights Team Annual update 2010-11".

[5] The EU27 and UK population aged 15+ was around 430 million in 2019. See europea.eu/eurostat, "Population on 1 January by broad age group and sex" and sum 15–64, and 65+ populations.

[6] The German aged 15+ population in 2019 was about 72 million. See europea.eu/eurostat, "Population on 1 January by broad age group and sex" and sum 15–64 and 65+ populations.

smoke as they reach their mid-to-late twenties and beyond, my results provide evidence suggesting that the availability of e-cigarettes may prevent individuals who would otherwise have smoked from starting to smoke. This suggests that RRPs serve as a substitute for many aged 24 and under who, if not for RRPs, would have smoked instead. This contradicts the "gateway" hypothesis that predicts that allowing RRPs to grow will serve as a gateway for youth and young adult initiation to smoking.

Flavor Bans

2.7 Of the seven categories of e-cigarette restrictions considered in my earlier analysis, e-cigarette flavor bans are currently the subject of debate and consideration by policy makers. In principle, empirical analyses similar to those discussed above can be used to test whether flavored e-cigarettes and smoking are complements or substitutes, and therefore whether policies that reduce the availability of flavored e-cigarettes (such as an effectively enforced flavor ban) have the effect of decreasing or increasing smoking (respectively). While there are, to be sure, data limitations that restrict the ability of researchers to directly assess the effect of flavor bans, based on the weight of available evidence, including my own cigarette-price test and review of Eurobarometer data, banning flavored e-cigarettes (which are the type of e-cigarette preferred by most e-cigarette users) likely will lead to increased smoking, assuming bans are well-enforced.

2.8 As explained in Section 6 in more detail, I take a closer look at the Eurobarometer data in relation to e-cigarette flavors. I find that while (as expected) there is currently not enough data to detect directly the effect on smoking of the e-cigarette flavor bans already implemented in Europe, there is still indirect evidence that these flavor bans should be expected to increase smoking rates, because:

2.8.1 High-cigarette price countries experienced above trend growth of flavored e-cigarette use, while the low-cigarette price countries showed below trend growth of flavor use. This simple finding (supported by more detailed regression analysis) indicates that flavored e-cigarettes are substitutes for traditional smoking, and suggests that reducing the availability of flavored cigarettes should be expected to increase smoking.

2.8.2 Other (more subjective) data on flavor use from the Eurobarometer survey suggests that e-cigarette flavor bans are likely to affect current smokers attempting to quit traditional cigarettes the most; that flavor e-cigarette use in non-smokers is rare; and that desire to reduce traditional smoking is cited much more commonly as motivation for starting to vape, than for wanting to experience e-cigarette flavors.

2.9 Moreover, the experience of Finland deserves special mention because proponents of e-cigarette flavor bans (and indeed even a supposedly independent study commissioned by the European Commission, to assess the application of the EU Tobacco Products Directive 2014) hold the country's experience up as an example of how to reduce smoking without increasing vaping. It is potentially misleading to attribute Finland's recent reduction in smoking prevalence to e-cigarette flavor bans, for a number of reasons – including because the Finnish Tobacco Act of 2016 may have *increased* availability of e-cigarettes rather than reduce it, and because the fall in smoking may be at least in part due to smokers switching

to snus (an alternative to smoking, which is increasingly popular in Nordic countries).

Non-price Restrictions on Cigarettes

2.10 In parallel to the regulation of e-cigarettes, public health authorities continue to introduce new regulations intended to discourage smoking directly. The European Commission is currently consulting on a potential update to the TPD2. Although the precise provisions expected in a potential new TPD3 are not yet known, some market participants expect continued hardening of regulations meant to discourage the use of both cigarettes (e.g., mandatory plain packaging for cigarettes) and reduced risk products (e.g., blanket bans on non-tobacco e-cigarette flavors).

2.11 In Section 7 of this report, I describe the non-price regulations of cigarettes contained in the TPD2, and analyze whether these regulations affected smoking prevalence. I address this question using two approaches: first, using regression analysis of Eurobarometer data, and second, by showing intercountry comparisons of trends in smoking rates between countries which differed in the timing and/or extent of their implementation of the picture warnings and cross-border distance sales measures included in the TPD2.[7] Both approaches lead to me to the same conclusion, namely: there is no evidence that these policies reduced smoking rates. This is consistent with economic theory that implies that such restrictions may by themselves have the unintended effect of causing higher rates of smoking by encouraging smokers to consume cigarettes in "quantity" rather than 'quality'.

Policy Implications

2.12 My various empirical analyses suggest that e-cigarettes reduce smoking prevalence. E-cigarettes are informally used by smokers to stop smoking, or as an alternative to smoking initiation, or both. Less hostile regulation towards e-cigarettes, therefore, could further reduce the number of smokers in Europe by a million or more under current market conditions. My analyses also suggest that while price regulation is effective (consumers smoke less when cigarettes are more expensive), non-price regulations such as those contained in TPD2 have not reduced smoking. Further non-price regulations of cigarettes (such as those which the EC might be considering as part of a potential new TPD3) are unlikely to meaningfully reduce rates of smoking.

2.13 Furthermore, introducing hostile e-cigarette regulations such as flavor bans while e-cigarettes are still a new and emerging product category can be expected to reduce investment by RRP manufacturers in making RRPs more responsive to consumer preferences and demand. In this respect, the ability of RRPs to become a more significant tool for tobacco harm reduction in the future may be compromised by overregulating the market now. While this does not mean that RRP markets should be free from any and all regulation (e.g., regulations precluding sales to minors are sensible to stop youth from using e-cigarettes), it does mean that regulations designed to discourage use by adults

[7] Member states were required to transpose most of the TPD2 provisions into national law by May 2016. However, there is some variation over time and between countries in the implementation of two measures: (a) picture warnings (which a subset of countries already had in place, even before TPD2) and, (b) bans on cross-border distance sales (which were optional and which a subset of countries elected to implement). My empirical analysis can therefore consider these measures.

(such as high excise taxes, flavor bans, extreme packaging and advertising restrictions, and outright bans on sales or importation of products) likely will lead to more smoking both now and in the future as incentives to innovate more consumer-acceptable RRPs are reduced.

3. Economic and Statistical Principles that Guide Measurement

Introduction

3.1 Economic and statistical principles offer specific and clear guidance as to the type of data and statistical tests best suited for estimating whether RRPs encourage or discourage smoking. These principles stem from the relationships between substitutes and complements, and data that most directly reveals those relationships. In this section, I

3.1.1 Introduce these principles, and the tests they lead to; and

3.1.2 Explain how these tests guide the empirical analysis in the rest of the report.

Economic and Statistical Principles

3.2 Phrased in terms of demand theory—the relationship between consumer demand for a given product and its market price—much of the policy debate around RRP regulation is whether RRPs and cigarettes are substitutes or complements. If they are substitutes, that means that consumers treat them as alternatives. The products are competitors in the market in the sense that selling more of one will reduce sales of the other. If instead, RRPs and cigarettes are complements, the sale of one will reinforce the sales of the other.

3.3 The concepts of substitution and complementarity are binary and symmetric.[8] They are binary because they describe the relationship between a pair of products, such as cigarettes and RRPs. They are symmetric because, for two products to be considered substitutes or complements, each product's price must affect sales of the other product in the same way. For example, RRPs are substitutes for cigarettes if and only if cigarettes are substitutes for RRPs. In practice, this means that (i) demand for RRPs increases when cigarettes become more expensive (less available) *and* (ii) demand for cigarettes increases when RRPs become more expensive (less available). By the same logic, when two products are complements, increasing the price of either one reduces demand for the other.

3.4 This binary and symmetric relationship, known among economists as "**Hicksian symmetry**," lends itself to two different tests for the existence of a substitution or complementary relationship between cigarettes and RRPs:

3.4.1 A "**cigarette-price test**" that looks at RRP use as it is affected by the price or availability of cigarettes.

3.4.2 An "**RRP-price test**" that looks at cigarette use as it is affected by the price or availability of RRPs.

3.5 Either test by itself is adequate to determine substitution or complementarity. Both tests together must agree up to statistical variability and specification residuals.[9] When the two tests agree in practice, such a finding adds confidence to the determination.

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[8] Jaffe et al. (2019); Jehle and Reny (2011), Theorem 1.14.

[9] That is, with enough good-quality data and a model that includes the relevant demand factors, the two tests should agree. In practice, as with any statistical test, assessments of substitution and complementarity could result in conflicting test results if the statistical sample is not representative of the population or is missing relevant control variables.

3.6 As explained in Sections 4 and 5 below, all of the tests I have done consistently support the substitution hypothesis over the complementarity hypothesis, i.e., regulation that increases price/reduces access for one product will increase use of the other.

3.7 There are some further principles that are particularly relevant to my analysis of e-cigarette flavor bans. I explain these in Section 6, from paragraph 6.10.

Implementing These Tests

3.8 A test for substitution or complementarity often expresses results in terms of "**cross-price elasticities of demand**", which measures the responsiveness of demand for one good to a change in the price of another good. The cross-price elasticity of smoking prevalence with respect to the price of RRPs, a result of the RRP-price method, is measured by the percent change in smoking prevalence that results from each percent increase in the price of RRPs.[10] In the substitutes (complements) case, this cross-price elasticity is positive (negative), respectively. Positive cross-price elasticity, in lay terms, means that as RRP prices increase, demand for cigarettes increases (suggesting the two products are substitutes). As explained below, my tests show positive cross-price elasticity.

3.9 Hicksian symmetry is quantitative. Applied to cigarettes and RRPs, it says that the cross-price elasticities of cigarette demand and RRP demand are inversely proportional to their sales.[11] More simply stated, while the smaller (RRP) and larger (cigarette) market segments have the same qualitative effects on each other, the magnitude of the effect of the smaller RRP segment on the larger cigarette segment, measured as a percentage, is less than the effect of the larger segment on the smaller.

3.10 Here, this quantitative aspect of Hicksian symmetry matters because cigarettes continue to sell in far greater volumes than RRPs. Accordingly, assuming reliable data is available, it will be easier to detect substitution or complementarity by measuring the effect of cigarette prices on RRP sales (the cigarette-price test) than by measuring the effect of RRP prices on cigarette sales (the RRP-price test). To provide a simple example, suppose there is a hypothetical population of 100 vapers and 300 smokers. An increase in the price of smoking that causes 5% of smokers (15 smokers) to switch to vaping would result in 15 additional vapers: a 15% increase in RRP sales. Conversely, an increase in the price of vaping that causes 5% of vapers (5 vapers) to switch to smoking would result in 5 additional smokers: a 1.7% increase in cigarette sales. Not surprisingly, a 1.7% increase in cigarette sales is more difficult to detect with statistical significance than a 15% increase in RRP sales; the change in cigarette sales is a "weaker signal".

3.11 In this report, I implement both the cigarette-price test and the RRP-price test. All test results support the conclusion that cigarettes and RRPs are substitutes rather than complements, suggesting that regulations that reduce the availability of e-cigarettes should be expected to increase smoking prevalence.

3.12 The cigarette-price test finds that the parts of Europe with higher cigarette prices had

[10] More precisely, the percentages are calculated with natural logarithms so that positive and negative magnitudes are more readily comparable. The cigarette-price method also yields a cross-price elasticity, but it is the cross-price elasticity of RRP use with respect to cigarette prices.

[11] Jaffe et al. (2019), p. 37.

greater e-cigarette usage by 2020 than previous trends in rates of smoking would have predicted. This suggests that the cross-price elasticity of e-cigarette demand with respect to cigarette prices is positive and that cigarettes and e-cigarettes are substitutes.

3.13 I test for substitutes versus complements in two ways: cigarette-price tests and RRP-price tests.

3.13.1 As explained in detail in Section 4, I find that, as e-cigarettes entered countries with high cigarette prices, smoking prevalence fell below previous trends, even though cigarette prices in those countries increased less than they did in countries with low cigarette prices (something that, all other things being equal, would cause the rate of smoking prevalence decline to slow compared to the previous trend in countries with high cigarette prices). These results suggest that the cross-price elasticity of cigarette demand with respect to e-cigarette prices is positive and that cigarettes and e-cigarettes are substitutes.

3.13.2 As explained in detail in Section 5, I find that as countries become more restrictive of e-cigarettes by making them more expensive or less available than they otherwise would be, smoking increases relative to what it would be with less restrictive regulation. This also suggests that the cross-price elasticity of cigarette demand with respect to e-cigarette prices is positive and that cigarettes and e-cigarettes are substitutes.

3.14 I now address these tests and their results in greater detail in Sections 4 and 5, after first explaining in more detail in Section 4 the Eurobarometer data used for implementing the statistical tests I conducted.

4. E-cigarette Entry Patterns in the Eurobarometer Surveys

Introduction

4.1 In this section, I introduce the primary dataset that I use for my empirical analysis, which is obtained from the European Commission's Eurobarometer surveys of 28 European countries. I use this data to describe the trends in smoking and RRP use across these countries and over time, using the aforementioned cigarette-price and RRP-price tests to distinguish substitutes from complements. The trends across all tests I conducted suggest that cigarettes and RRPs (and in particular, e-cigarettes) are substitutes, and that increasing regulatory hostility to e-cigarettes is likely to increase smoking prevalence.

Data Requirements

4.2 For the purpose of an empirical analysis, the questions in this study can be framed as questions of causal inference—i.e. the extent to which a particular intervention causes a particular outcome.[12] Here, the primary causal question is whether and to what extent regulatory hostility to e-cigarettes increases smoking prevalence.

4.3 Such analyses require data relating to three aspects:

4.3.1 **First, the "outcome" or "dependent variable", which is a measure of the outcome of interest.** In this study, the primary outcome of interest is smoking prevalence, which is one of the simplest and most commonly reported measures of smoking behavior and indicates the proportion of individuals in a given population who are smokers.[13]

4.3.2 **Second, the "treatment variable", which is the intervention whose causal effect is under investigation.** In this study, the intervention could be framed as the arrival of RRPs in the market (here e-cigarettes), or more precisely as the extent to which RRPs are available to consumers. However, we want to distinguish RRP arrivals that might be due to a general interest in smoking and its substitutes from RRP arrivals based on economic considerations. In practice, economists measure the latter by reference to the overall cost to the consumer of obtaining a product. That is, a measure of cost is the treatment variable. This overall cost is affected by the (pre-tax) price of purchasing the product, and the taxes levied on top of this price. Cost can also be affected by other non-financial restrictions that reduce access to RRPs, such as bans or restrictions on flavors or cross-border sales and restrictions on RRP use in certain settings.

4.3.3 **Third, and of critical importance for making reliable, evidence-based causal inferences, "control variables" or "confounding factors", which are factors that are related to both the outcome (smoking) and intervention (RRP**

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[12] The "potential outcomes framework" of Rubin (1974) underlies empirical work in economics on questions of causal inference. According to this framework, the causal effect of an intervention is estimated by comparing the actual outcome (which is observed) to the potential outcome (which is not observed) had that intervention not been made (i.e. "but-for" that intervention). In practice, this is estimated using multivariate regression analysis, which is the subject of Section 5.

[13] Another outcome of interest is RRP use (e-cigarette) prevalence.

price/availability), and therefore need to be taken into account (i.e. controlled for), to produce a reliable estimate of the effect of the intervention on the outcome. Studies that do not take confounding factors into account risk erroneously concluding that the intervention caused the outcome when it did not, or reaching an inaccurate (or statistically "biased") estimate of the direction and magnitude of the causal effect. In this study, there are many factors—other than the availability of RRPs—that can affect smoking prevalence, and there is an extensive empirical literature that identifies and studies these factors. At a high level, these factors relate to the tobacco price, non-price related tobacco restrictions, and other demographic and socio-economic factors (such as gender, age, employment status, and education).

4.4 The cigarette-price test requires reliable measures of both cigarette prices (or availability) and RRP use in enough markets to have low-price markets that can be compared with high-price markets.

4.5 The RRP-price test requires reliable measures of both RRP prices (or availability) and smoking prevalence in enough markets to have some markets that have significantly more availability (or lower prices) of e-cigarettes compared to others.

4.6 All of these requirements must be met to implement both methods, as I do in this report. Samples should be large enough to keep statistical variability low. Finally, in a study funded by a tobacco company (such as this), I require the data to be publicly available and free of limitations on its use for commercial purposes.

4.7 I find that the Eurobarometer surveys fulfill all of these criteria and are thus well suited for my empirical analyses.[14]

The Eurobarometer Surveys

4.8 The Eurobarometer is described as "*the polling instrument used by the European Commission, the European Parliament and other EU institutions and agencies to monitor regularly the state of public opinion in Europe on issues related to the European Union as well as attitudes on subjects of political or social nature. Eurobarometer provides quality and relevant data for experts in public opinion, researchers, media and the public.*"[15] The surveys are regularly administered to random, representative samples of people aged 15 and older, in each of the 27 EU member states and the UK. The so-called "Special Eurobarometer" surveys focus on in-depth thematic issues, and I focus on waves of the survey that measure attitudes towards tobacco and electronic cigarettes over a period of

[14] Other datasets may meet enough of the criteria to implement either the cigarette-price test or the RRP-price test and may cover more countries. One example is the Global Burden of Disease Study (**"GBDS"**), which contains data on annual smoking prevalence and cigarette consumption for over 200 countries from 1990 to 2019. Another example is the International Tobacco Control (**"ITC"**) Policy Evaluation Project, which is the first-ever international cohort study of tobacco use and consists of surveys conducted across approximately 30 countries. Neither of these datasets, however, appears to be available for use with this study insofar as they seem to require non-commercial uses and/or preclude access for research conducted on behalf of a tobacco company.

[15] See: europa.eu/eurobarometer, "About Eurobarometer"

15 years, between 2006 and 2020.[16]

4.9 The Eurobarometer data fulfills my data requirements. Its primary advantage is that it provides high quality data at an individual level that is both comparable across countries (because the same base questions are asked in each country) and over time (because similar questions are asked in each wave). It can also be supplemented, as I do, with data on cigarette and tobacco prices and taxes from other reliable sources such as Eurostat and the European Commission, and information on non-financial restrictions on access to smoking and e-cigarettes collated from research and review of a range of sources (including the Association of European Cancer Leagues, the Vapor Tax Datacentre, Institute for Global Tobacco Control, and the Campaign for Tobacco-Free Kids). My data sources are explained in full in Appendix B: Data.

4.10 As with all data, the Eurobarometer has certain limitations. The most relevant of these are that: (a) questions on the use of RRPs are generally focused on e-cigarettes and are not available at all prior to 2012, and (b) there is no information on prices and taxes for smoking or e-cigarettes.

4.11 I address the limitation of lack of information on prices and taxes for smoking or e-cigarettes by using pricing and tax data from other reliable sources.

4.12 I address the limitation that questions on RRP use are focused on e-cigarettes by focusing my own analysis of RRPs on e-cigarettes. These are the only category of RRPs where consistent data on usage, taxes, and non-tax restrictions is available going back to 2014 (i.e. the first wave of the Eurobarometer survey used in the study).[17]

4.13 E-cigarettes also generally have been around longer than other RRPs,[18] and are more widely used in the countries in my dataset than other RRPs. For example, in the 2020 Eurobarometer, 5% of respondents said they regularly used e-cigarettes currently or in the past (with individual country use rates ranging between 1 and 15%), while only 2% answered the same about heated tobacco (with individual country use rates ranging between 1 and 6%).[19,20] The higher use rates of e-cigarettes, while still low compared to smoking, allow for more precise measurement of any effects e-cigarette restrictions might have on traditional smoking than do other RRPs, such as heated tobacco and oral tobacco/nicotine products.

4.14 I present charts in Appendix B: Data of the trends in current smoking prevalence and e-

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16 I provide further details in Appendix B: Data from paragraph 10.3.

17 I identify the specific questions used for e-cigarette usage in Appendix B: DataTable 10-2, and regulatory restrictions in Appendix B: Data from paragraph 10.28.

18 The first modern e-cigarette came out in 2003, see PHE (2014), while IQOS, an early heated tobacco product, came out only in 2014. See: pmi.com, "Philip Morris launches revolutionary heated tobacco product – first in UK"

19 Figures taken from the Volume A factsheet at data.europa.eu, "Special Eurobarometer 506: Attitudes of Europeans towards tobacco and electronic cigarettes", Tabs T7 and T8 in the Excel spreadsheet.

20 There are individual countries, like Italy, where heated tobacco use is higher than e-cigarette use, but these are the exceptions.

cigarette use prevalence for each European country covered by Eurobarometer, between 2006 and 2020.[21] The charts show a diverse range of trends and a complex (and inconclusive) set of relationships. In particular:

4.14.1 **Current smoking prevalence rates differ materially between countries and follow different trends.** While current smoking prevalence rates have fallen steadily in some countries (e.g. in the Netherlands from 29% in 2006 to 12% in 2020 and in the United Kingdom from 33% to 12%), they have stagnated and have even started increasing in other countries (e.g. in the Czech Republic where prevalence has increased from 29% to 30%, or in Greece, where its downward path from 40% in 2012 reversed to reach 42% in 2020). The diversity in these trends suggests that a range of factors (including but also beyond access to e-cigarettes) are likely to be at play, and will need to be taken into account systematically.[22]

4.14.2 **Around 12% of current smokers in my sample (2014–2020) reported using or trying e-cigarettes in the past but no longer using them.[23]** Whether e-cigarettes (and RRPs more generally) are complements or substitutes for traditional cigarettes, they are still relatively unpopular among smokers. This suggests more innovation is needed to make RRPs a viable alternative to smoking for more smokers.

4.14.3 **Current e-cigarette use rates also differ materially between countries, and follow different trends**, for example, being close to 1% in Sweden[24] and generally above 4% of the population (i.e. half as popular as smoking) in the United Kingdom in 2020. Moreover, since 2014, e-cigarette use has accelerated rapidly in some countries (e.g., in Austria, where prevalence has more than doubled from below 2% in 2014 to almost 4% by 2020) but has declined in others (e.g., in Portugal from just under 2% in 2014 to almost zero in 2020). Coupled with my measure of regulatory hostility towards e-cigarettes (introduced in the next section), these trends suggest that government policy could have a material effect

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21 See Figure 10-1 and Figure 10-2.

22 2006 percentages calculated from Eurobarometer 66.2 data. Also see Figure 10-1. Smoking related questions in 2006 were different to later waves. See Table 10-1 for my treatment. 2012 percentages are taken from Volume AP factsheet at data.europa.eu, "Special Eurobarometer 429: Attitudes of Europeans towards tobacco and electronic cigarettes", Tab QC1 in the Excel spreadsheet. 2020 percentages are taken from Volume A factsheet at data.europa.eu, "Special Eurobarometer 506: Attitudes of Europeans towards tobacco and electronic cigarettes", Tab T3 in the Excel spreadsheet.

23 Calculated from Eurobarometer 93.2, 87.1 and 82.4 data.

24 Snus tobacco products, a form of oral tobacco that is considered to be a less harmful alternative to smoking cigarettes (see Clarke et al, 2019), are popular in Sweden and have been for decades, which may explain why e-cigarettes are infrequently used as a cigarette substitute in Sweden. In other words, snus may be used by consumers as a substitute for smoking, similar to e-cigarettes. This potential substitution effect of snus is also discussed in Section 6, where I analyze the effect of e-cigarette flavor bans on smoking, and note the possibility that increasing snus use may have contributed to countries like Finland seeing reduced smoking prevalence without an accompanying increase in e-cigarette use.

on the use of these products undermining their harm reduction potential.[25]

The Cigarette-Price Test

4.15 If cigarettes and RRPs were typically substitutes,[26] there would be greater supply and demand pressures to establish and grow RRP shares in markets where cigarettes are expensive, because RRP manufacturers would stand to profit more when their competitors – the producers of cigarettes – are charging high prices. Consumers paying high cigarette prices would stand to save more if they could find and switch to an acceptable substitute.

4.16 If, instead, cigarettes and RRPs were typically complements, RRPs would perform better in countries with low cigarette prices. E-cigarettes are, in this view, a companion to smoking, and it would be easier to sell RRPs in a market where the companion products are less expensive. By way of example of two products that are complements, consider electric cars and electricity: it would be easier to sell electric cars in a market where electricity is cheap (because it is required to use the car), and there is a strong network of charging points (i.e. electricity is readily available).

4.17 Figure 4-1 below helps readers visualize the causes and consequences of e-cigarette entry with the Eurobarometer data, and is a graphical presentation of my cigarette-price test. For this purpose, I aggregate the data to the country-by-year level and then sort countries by their cigarette prices in 2012. The first 14 countries were put in the "low price" country group and the remaining 13 countries in the "high price" country group (Croatia is dropped as it is missing from the 2012 Eurobarometer).

4.18 The chart in Figure 4-1 displays the average e-cigarette usage (top panel) for each country group as a solid series, from 2006 to 2012. The dashed lines show how usage would have continued beyond 2012 if the 2006–12 trend remained constant.

4.19 By 2020, e-cigarette usage in the high-price countries was about 1.5 population-share points above the previous trend. 2020 e-cigarette usage in the low-price countries was about at the previous trend. This is a visual representation of the finding that e-cigarettes are substitutes for cigarettes, which means that e-cigarettes have higher rates of use where

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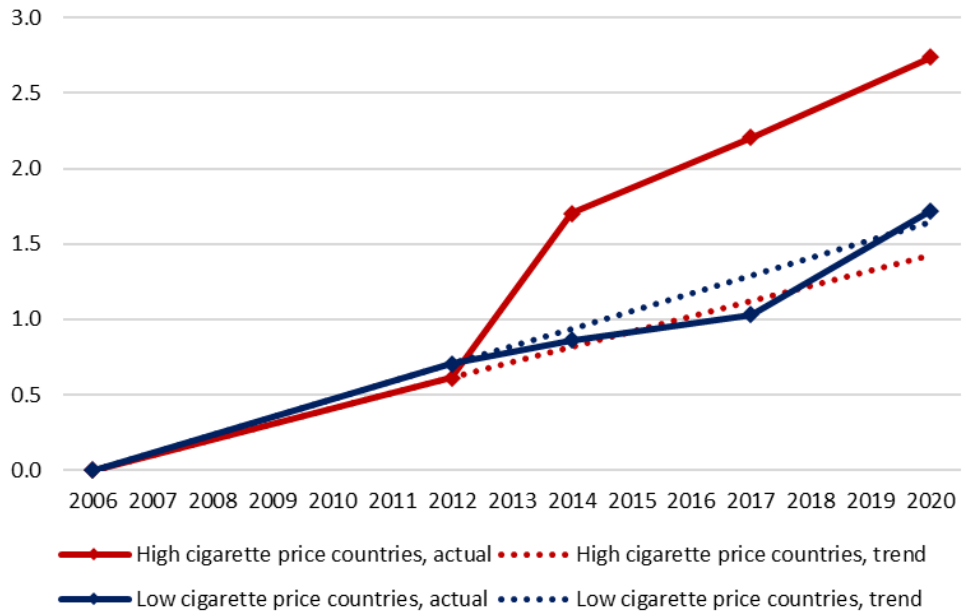
[25] 2014 percentages are taken from Volume A factsheet at data.europa.eu, "Special Eurobarometer 429: Attitudes of Europeans towards tobacco and electronic cigarettes", Tab QC9 in the Excel spreadsheet. 2020 percentages are taken from Volume A factsheet at data.europa.eu, "Special Eurobarometer 506: Attitudes of Europeans towards tobacco and electronic cigarettes", Tab T7 in the Excel spreadsheet.

[26] I use the word "typically" because complementarity and substitutability are assessed in overall terms, or on average. Products A and B may be substitutes for some individuals some of the time, and complements for other individuals or at other times. This study considers the overall, or typical situation. For example, at one point in time Apple iPhones and Blackberries might have been complements for business users (who would be provided with a Blackberry to use for work purposes, and also carry an Apple iPhone for personal use), but substitutes for non-business users (who would have chosen one product over the other, depending on their personal preferences and budget). However, taking the market as a whole, one might find the two products to be typically substitutes, if an increase in the price of Apple iPhones results in greater Blackberry sales, and an increase in the price of Blackberries also results in greater Apple iPhone sales (even if there are some consumers – such as business users – who continue to use both products in tandem, and for whom the products are complements).

cigarettes are more expensive.

4.20 I also confirm this conclusion by performing a more formal statistical test, using multivariate regression analysis (which is explained in more detail in paragraphs 12.28 and onward in Appendix D: Regression Analysis).[27]

Figure 4-1: Actual trends in e-cigarette use (current prevalence, %)



Notes: (1) the countries are split into high and low cigarette price countries, based on 2012 cigarette weighted average prices; (2) the high cigarette price countries are: Belgium, Cyprus, Germany, Denmark, Finland, France, Ireland, Italy, Luxembourg, Malta, Netherlands, Sweden, UK; (3) Croatia is dropped as it did not participate in the 2012 Eurobarometer; (4) the remaining countries are in the "Low cigarette price" group; (5) trend lines are obtained by a assuming constant rate of change; (6) e-cigarette use prevalence is assumed to be 0% in 2006.

The RRP-Price Test

4.21 The adoption of e-cigarettes in high cigarette-price countries presents an opportunity to consider the RRP-price test. This is my second test, and it looks for effects of the price or

[27] In particular, using the data disaggregated to demographic group by country and year 2014–2020, I regress per-capita e-cigarette usage on the 2012 weighted average cigarette price in each country, measured in EUR per 1000, as well as measures of non-price tobacco restrictions, unemployment, education, age, and gender of respondents, and year of survey wave. The coefficient on cigarette price is positive, with a two-sided p-value of 0.0018, indicating that e-cigarettes gained more share in the high-price countries than in the low-price countries. The point estimate indicates a cross-price elasticity (at the mean) of e-cigarette usage with respect to cigarette prices of around 0.7–0.8, with a two-sided p-value of 0.0018 relative to the null hypothesis of no cross-price effect. The elasticity point estimate is higher at the median. These findings are consistent with substitution between cigarettes and RRPs, rather than complementarity. I explain this analysis in more detail in Appendix D: Regression Analysis from paragraph 12.26.

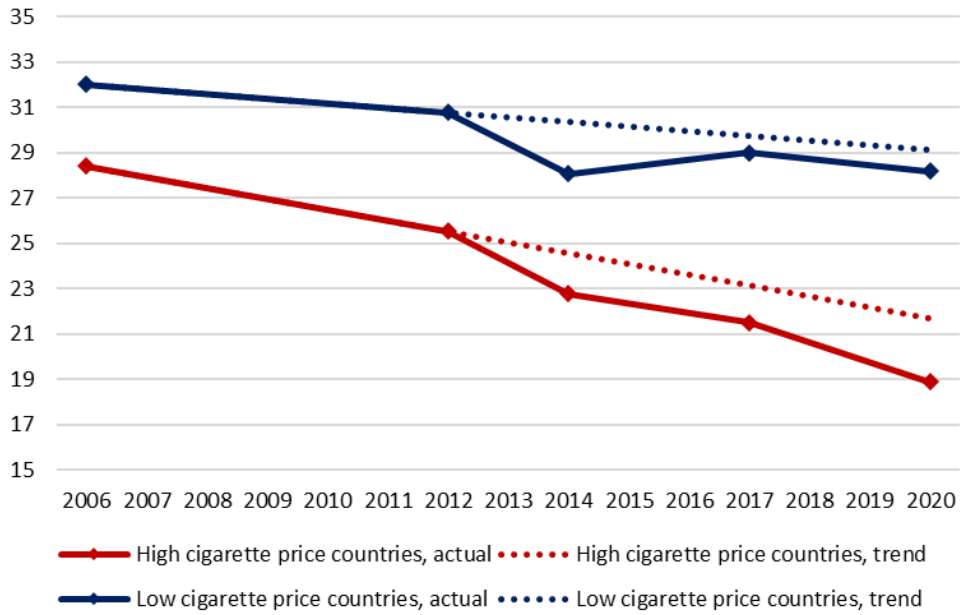
availability of RRPs on smoking rates in the population.

4.22 If we interpret the high-price countries as places where e-cigarettes were either less expensive or more available, then a graphical version of the RRP-price test is shown in Figure 4-2 (which is the companion chart to Figure 4-1). According to the substitutes hypothesis, the extra e-cigarette growth (about 1.5 population-share points as of 2020, and less in prior years) in the high-priced countries should be associated with correspondingly less smoking (i.e., smoking rates declining by similar population-share points). Indeed Figure 4-2 shows that smoking fell below prior trends in the high-priced countries after 2012, which is the same time that e-cigarettes began to penetrate the market. Meanwhile, smoking stayed close to prior trends in the low-price countries.

4.23 If e-cigarettes either discouraged or encouraged smoking, we would expect the magnitude of the effect in terms of percentage points of smoking prevalence to be on the order of the number of people using e-cigarettes. In the high-price countries, that is about an additional 1.5 percent of the population, as e-cigarette prevalence rates are about 1.5% in those populations. A reliable RRP-price test must therefore be able to distinguish rates of smoking prevalence within a tolerance of a percentage point or two, which is an important reason why I selected Eurobarometer for analysis.

4.24 This graphical version of the RRP-price test confirms this prediction of the substitutes hypothesis. A comparison of Figure 4-1 and Figure 4-2 begins to show how, as predicted by the substitutes hypothesis, a successful e-cigarette market helps reduce smoking by encouraging e-cigarette use instead.

Figure 4-2: Actual trends in smoking prevalence (current prevalence, %)



Notes: Recall from Figure 4-1 that countries with high cigarette prices (red) are those where e-cigarette use grew more. See also notes to previous figure.

Conclusion

4.25 This section presents the results of my cigarette-price test with the Eurobarometer data,

finding a cross-price elasticity of e-cigarette usage with respect to cigarette prices of 0.7–0.8, as explained in paragraph 12.30. A positive cross-price elasticity such as this means that cigarettes and e-cigarettes are typically substitutes rather than complements.

4.26 By symmetry, my RRP-price test suggests that regulations that make e-cigarettes more expensive or less available would increase the number of smokers in approximately the same numbers that it reduces e-cigarette usage. The following section conducts the RRP-price test more formally, using regression analysis of the Eurobarometer data, and provides further empirical support for the proposition that cigarettes and e-cigarettes are substitutes.

5. The Effect on Smoking of Regulations Hostile Towards E-Cigarettes

Introduction

5.1 In this section, I present my multivariate regression analysis of the effect of regulatory hostility towards e-cigarettes on smoking prevalence.

5.1.1 First, I give a brief explanation of the statistical technique that I deploy.

5.1.2 Second, I explain my approach to compiling a dataset and measuring the factors relevant to analysis of the effect of hostile regulation on smoking.

5.1.3 Finally, I present and interpret my regression analysis, and my checks on the robustness of my results.

5.2 The technical details and full results of my analysis are contained in Appendix B: Data, Appendix C: Dataset Construction, and Appendix D: Regression Analysis.

Multivariate Regression Analysis

5.3 "**Multivariate regression analysis**" is a standard statistical technique used in empirical studies that aim to measure the causal effect of a particular intervention or treatment variable (in this study, a measure of the cost of access to cigarettes or e-cigarettes), on an outcome variable of interest (prevalence of smoking or of e-cigarette use) in circumstances where multiple other factors also affect the outcome. Multivariate regression analysis, together with appropriate choice of treatment variables, helps avoid confounding the effect of the intervention from the effects of the other factors.

5.4 There are many different types of regression models, but the one of the most commonly used is an "**Ordinary Least Squares**" ("**OLS**") regression.

5.5 There are examples in the literature of studies that attempt to analyze the relationship between smoking and e-cigarettes using Eurobarometer data, but without considering other confounding determinants of smoking or e-cigarette use. For example, Kulik, Lisha and Glantz (2018) find correlations between being a former smoker and using e-cigarettes in the 2014 wave of the Eurobarometer. They find that *"[a]mong all ever smokers, any regular use of nicotine e-cigarettes was associated with a lower odds ratio of being a former smoker."* On the other hand, in a more recent study on e-cigarette use and smoking cessation using the 2017 Eurobarometer wave, Farsalinos and Barbouni (2019) conclude that "*[c]urrent daily e-cigarette use in the EU in 2017 was […] positively associated with recent (≤5 years) smoking cessation."* My study focuses on causal relationships, which were not examined in these other studies that focused on statistical associations and are not designed to make causal inferences.

My Approach to Compiling a Suitable Dataset

5.6 I begin by acquiring five separate datasets relating to the five most recent waves of the Eurobarometer survey. I combine these datasets into a single, large dataset that covers a total of approximately 140,000 individuals who were surveyed across 28 European

countries and at various points in time over 15 years (from 2006 to 2020).[28] I identify survey questions that correspond to my data requirements, relating to my dependent variable (current smoking prevalence)[29] and certain socio-economic factors that are often considered in the empirical economic literature, which I also use as control variables (respondents' age, gender, country of residence, employment status, and education status).

5.7 I then aggregate the individual-level dataset into 168 "**reference groups**" of individuals (defined according to their gender, age group, and country of residence),[30] where each reference group can be tracked over time.[31] For example, I track the current smoking prevalence rate for 25–54 year old males residing in Germany in each wave of the survey.[32] This degree of aggregation is appropriate in this case because the treatment variables are often common within each nation, although individuals are sometimes expected to respond to them differently based on demographic differences such as age and gender.

5.8 Next, I augment this dataset to include measures of the price of tobacco and the extent of other tobacco control regulations (i.e. beyond the effect of excise taxation on tobacco price), which according to economic theory, empirical economic literature, and the stated rationale for government tobacco control policy, may influence smoking prevalence. In particular, I include a real (i.e. inflation-adjusted) tobacco price index published by the European Commission's harmonized index of consumer prices ("**tobacco HICP**"),[33] as well as the Association of European Cancer Leagues' Tobacco Control Scale ("**TCS**"), which measures the extent to which countries have implemented and enforced certain tobacco control policies such as bans on smoking in public and workplaces, and assigns a score between 0 (least compliant) to 100 (most compliant).[34]

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28 The Eurobarometer dataset is explained in more detail in Appendix B: Data, from paragraph 10.1. My approach to combining and preparing the Eurobarometer data is explained in Appendix C: Dataset Construction.

29 I identify respondents who select the answer "*You currently smoke*" when asked "*Regarding smoking cigarettes, cigars, cigarillos or a pipe, which of the following applies to you?*". The precise wording of the question and possible answers varies slightly from year to year, and my selections are detailed in Appendix B: Data, Table 10-1.

30 These 168 groups correspond to the number of combinations of gender (which can take 2 values: male, or female), age group (which can take 3 values "15 – 24", "25 – 54", or "55+"), and country of residence (of which there are 28 covered by Eurobarometer). 2 x 3 x 28 = 168.

31 This is a common technique for analysing data from multi-wave surveys, where a different set of individuals are surveyed in each wave. My dataset is referred to as a "pseudo panel dataset."

32 To ensure that the current smoking prevalence rate of the individual survey respondents in each reference group is an accurate depiction of the corresponding individuals in the wider population (including those who were not included in the survey), I make use of the appropriate survey weights contained within the Eurobarometer dataset. I provide more detail on this in Appendix C: Dataset Construction.

33 I provide more detail in Appendix B: Data, from paragraph 10.20.

34 I provide more detail in Appendix B: Data, from paragraph 10.25. In practice, I focus on the non-price element of the TCS score to avoid 'double counting' in my analysis. The non-price element runs from 0 to 70.

Measuring Regulatory Hostility Towards E-Cigarettes

5.9 Finally, I develop a measure of regulatory hostility towards e-cigarettes. To begin with, I note that while there is rich and reliable data available on price and non-price regulatory measures for traditional tobacco products, this is not the case for RRPs in general—not even for e-cigarettes, which have now been available in Europe for 17 years.[35] For these relatively novel products, I find that there is a paucity of good-quality data, primarily because (i) there is wide variation in the different types of e-cigarettes, leading to difficulty in establishing a consistent unit of measurement;[36] (ii) there is a broad base of distribution channels leading to difficulty in obtaining data on prices;[37] and (iii) there is a patchwork of different price and non-price regulations being applied by governments across Europe.

5.10 Other researchers who have considered the relationship between smoking and e-cigarettes have addressed these data and measurement problems in different ways. Some acknowledge the potential importance of these restrictions but do not take some of them into account in their analyses.[38] Others use simplistic approaches that consider just one type of restriction, in imprecise terms.[39] Others have attempted to develop more sophisticated measures. For example, the Institute of Economic Affairs ("**IEA**") publishes a league table of "*the worst places in the European Union to vape*" based on its assessment of the relative importance of various restrictions that European countries may have implemented, going back to 2016.[40] Similarly, Shah, Britton and Bogdanovica (2021) also develop a regulatory scale to measure and compare e-cigarette regulations between European countries, albeit for just one year (2021).

5.11 My approach builds on the literature by developing an index of regulatory hostility towards

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35 *"Electronic cigarettes were first introduced to Europe in about 2005"* (PHE, 2014) PDF page 5.

36 As summarised in World Bank Group (2019), *"The first-generation e-cigarettes (known as cigalikes) look like traditional cigarettes, consisting of a battery, a compartment for the liquid product (e-liquid/e-juice), and an atomizer to aerosolize the liquid for inhalation. Depending on the brand, additional liquid could be added by purchasing a new e-liquid cartridge or disposing of the entire device and purchasing a new one. Second generation product (tank systems) have the advantage of not having to buy new cartridges or new devices since they can be refilled with the user's preferred eliquid. Third generation mods came with improved atomizers that allowed for user alteration. Accompanying the changes in devices was an increased variety in e-liquid flavors".*

37 As explained in Day et al. (2017), Nielsen scanner data does not cover a large portion of the e-cigarette market, as it does not cover vape/specialty stores.

38 For example, in Friedman (2015), the author acknowledges that pricing information is relevant but because *"neither representative data on e-cigarette prices nor a conversion factor allowing the prices of cigarettes and e-cigarettes to be compared"* were available in 2015, she does not control for the price or tax of e-cigarettes in her analysis.

39 For example, Pesko et al. (2020) conduct an analysis of the effect of e-cigarette taxes on adult tobacco product use in the USA, but note that e-cigarette taxes are levied in different ways across states, and "*[g]iven the difficulty of comparing the magnitudes of these different types of taxes, in our regression models we simply use an indicator for whether or not a locality has levied an e-cigarette tax.*"

40 See: nannystateindex.org

e-cigarettes, and retrospectively compiling it for the period from 2014 to 2020.[41] My approach is detailed in Appendix B: Data, from paragraph 10.28. In brief, I consider seven categories of e-cigarette restrictions: (1) indoor vaping bans, (2) flavor bans, (3) cross-border sales bans, (4) age restrictions, (5) packaging restrictions, (6) advertising restrictions, and (7) excise taxes.[42] I collate information from a variety of sources on whether each e-cigarette restriction was in place, [43] in each country, in each of the years covered by the three most recent waves of the Eurobarometer survey (2014, 2017, and 2020).[44] If the restriction was in place, I assign one "point," for a possible total of seven points. I treat each category of restriction in the same way (i.e. this is an unweighted or equally-weighted index) for simplicity and to avoid introducing complexity associated with looking to distinguish the relative effects of different types of regulations.[45]

5.12 The resulting e-cigarette hostility index is shown in Table 5-1 below, where the cells are color coded according to the value of the index (0 = least hostile, in green; 7 = most hostile, in red). The table shows:

5.12.1 That there have been (and still are) wide differences in regulatory stance between countries—for example, the United Kingdom has a relatively open stance towards e-cigarettes, in contrast with Finland, which is among the most hostile; and

5.12.2 While most of the countries analyzed have become more hostile between 2014 and 2020 (driven in part by implementing regulations prescribed in the EU's Tobacco Products Directive), some (such as Austria, Cyprus, and Estonia) have done so more rapidly and to a greater extent than others (such as Croatia or the Netherlands). It is this variation within countries and over time that is exploited in my regression analysis below.

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41 I compare the country rankings in my index to those published by the IEA and Shah, Britton and Bogdanovica (2021), and find that they generally agree.

42 These categories are selected based on my understanding of the equivalent tobacco restriction categories described in the Tobacco Control Scale reports, the WHO's Framework Convention on Tobacco Control ("**FCTC**"), and the EU Tobacco Products Directive ("**TPD**").

43 I obtain this information from three main sources (Vapor Tax Datacentre, Global Tobacco Control, which is a website maintained by Institute for Global Tobacco Control, and Tobacco Control Laws, which is website maintained by the Campaign for Tobacco-Free Kids). I also verified this information with BAT. Where I am unable to find a source that confirms a restriction was in place, I assume the restriction was not in place.

44 I focus on these three waves only, because information on the presence of these restrictions prior to 2014 is either not available or not sufficiently reliable.

45 In Appendix D: Regression Analysis, paragraph 12.19, I confirm that my results and conclusions are robust to using different weightings.

Table 5-1: Summary of e-cigarette hostility index by country and year

	2014	2017	2020
Austria	0	3	5
Belgium	6	4	5
Bulgaria	0	4	4
Cyprus	0	4	6
Czech Republic	0	3	3
Germany	0	3	3
Denmark	6	3	3
Estonia	0	3	7
Greece	6	6	6
Spain	1	3	4
Finland	6	7	7
France	0	3	3
Croatia	2	2	4
Hungary	6	7	7
Ireland	0	2	2
Italy	1	5	5
Lithuania	6	5	6
Luxembourg	0	3	5
Latvia	0	6	6
Malta	2	3	3
Netherlands	0	3	4
Poland	1	5	5
Portugal	0	6	6
Romania	0	4	4
Sweden	6	2	5
Slovenia	0	6	6
Slovakia	4	4	4
United Kingdom	0	3	3

Source: Table 10-11, Table 10-12, Table 10-13

My Regression Analysis

5.13 My regression analysis is informed by economic principles, knowledge of the empirical literature on determinants of smoking prevalence, understanding of the nature and contents of the dataset compiled, statistical testing, and analytical judgment.

5.14 For the purposes of conducting the RRP-price test, I begin by developing a model that seeks to explain variation in current smoking prevalence as a function of the price of tobacco, the extent of non-price tobacco restrictions, and various demographic and socio-economic factors.[46] I refer to this as my "**Base Model.**" The results of my Base Model are presented in

[46] My model is set out and explained in full in Appendix D: Regression Analysis, from paragraph 12.1.

summary form in Column (1) of Table 5-2 below,[47] and I find that they are generally consistent with economic theory and the empirical literature. I therefore extend the Base Model to include my measure of regulatory hostility towards e-cigarettes. These results are summarized in Column (2) of Table 5-2 below.[48] I refer to this as my "**Preferred Model**", and I find that increasing regulatory hostility towards e-cigarettes causes higher current smoking prevalence rates, which is consistent with smoking and e-cigarettes being substitutes. Both models have a dependent variable of smoking prevalence measured in percent.

5.15 More specifically, my Base Model and Preferred Model show that:

5.15.1 **Increases in the real price of cigarettes are associated with a material fall in current smoking prevalence.** The figure "-12.89*" in the second column represents the estimate from my Preferred Model of the effect of the real price of cigarettes on current smoking prevalence. The number itself is referred to as the "coefficient". It implies that holding all other variables unchanged, a 10% increase in the real price of cigarettes is associated with an approximately 1.23 percentage point fall in smoking prevalence (e.g., from 10% to 8.77%).[49] The direction of this estimate is consistent with economic theory of demand: the magnitude is comparable to similar estimates in the empirical literature.[50] The "*" after the number indicates that the estimate is also statistically significant by conventional criteria, which means that the estimated effect is unlikely to be due to chance (in other words, it is a "genuine" effect, rather than an incidental finding).[51] The estimates are also similar in my Base Model.

5.15.2 **There is inconclusive evidence that tighter non-price cigarette restrictions have any effect on current smoking prevalence.** The estimated coefficient in my Preferred Model is 0.07. Austria is the country with the largest increase in TCS score between 2014 and 2020, increasing by 19 points in this period (from 20 to 39). A 19-point increase on the TCS index is associated with an increase in current smoking prevalence of 0.07*19=1.33 percentage points. However, the estimate is not statistically significant, and by itself is not a strong indicator of what direction

[47] The full results are set out in Appendix D: Regression Analysis, Table 12-1.

[48] The full results are set out in Appendix D: Regression Analysis, Table 12-1.

[49] A 10% increase to the tobacco price index leads to (-12.89)*ln(110/100) = -1.23pp change in smoking prevalence, as tobacco price enters in natural log terms in my preferred model.

[50] I obtain the following lower and upper bound for the values of the tobacco price coefficient consistent with Flor et al. (2021): -0.35 and -0.13 (see Appendix D: Regression Analysis, paragraph 12.12). At -0.13, my estimate of the tobacco price coefficient falls near the upper bound of this range.

[51] The estimate has a p-value of 0.0193, or 1.93%, for the conventional two-sided test (i.e. where the null hypothesis is that the coefficient is zero). See paragraph 12.6.1 for further explanation of statistical significance in a matter like this where the conventional null hypothesis is not of particular interest.

non-price tobacco regulations affect smoking.[52]

5.15.3 **The socio-economic control variables have their expected signs.** In particular, I find that increases in the unemployment rate are associated with greater current smoking prevalence.[53] I also find that leaving school between the age of 16 and 18 (i.e., not continuing beyond compulsory education) is associated with greater current smoking prevalence.[54] These estimates are directionally consistent with the economic and empirical literature.[55]

5.15.4 **The demographic variables have their expected signs.** Similarly, I find that holding other variables unchanged, current smoking prevalence is approximately 8% higher for males than females. By age, it is 3% higher for 25–54 year olds than 15–24 year olds, and 9% lower for those aged 55+ than 15–24 year olds. There are also material differences between countries (even after accounting for differences in the other controls).

5.16 Finally, the effect of regulatory hostility towards e-cigarettes (the treatment variable and focus of my study) is indicated by the term "0.39+" in Column 2, which I interpret as follows:

5.16.1 **Smoking and e-cigarettes are substitutes.** In particular, the coefficient indicates that holding all other variables unchanged, a 1-point increase in regulatory hostility towards e-cigarettes (e.g., from 3 to 4 out of 7) is estimated to cause a 0.39-percentage-point increase in smoking prevalence. In other words, the more difficult and costly that governments make it to access and use e-cigarettes, the more likely consumers are to be smokers.

5.16.2 **The regression estimate is economically and statistically significant.** Reducing smoking prevalence by 0.39 percentage points in these countries means 1.7 million fewer smokers across the 28 European countries that were included in the Eurobarometer surveys.[56] I explain in Appendix D: Regression Analysis why the estimate of 0.39 percentage points is statistically significant and provides strong

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[52] The estimate has a p-value of 0.574, or 57%. This is not statistically significant because the p-value is greater than 5% and 10% (these are both commonly used standards for statistical significance), in a two-sided test (i.e. where the null hypothesis is that the coefficient is zero).

[53] The coefficient in my preferred model is 0.23**. This implies that holding all other variables constant a 10-percentage-point increase in the unemployment rate is associated with an approximately 2.3-percentage-point increase in the smoking prevalence.

[54] The coefficient in my preferred model is 0.17**. This implies that holding all other variables constant, a 10-percentage-point increase in the proportion of people leaving education between 16 and 18 years old is associated with an approximately 1.7-percentage-point decrease in smoking prevalence.

[55] See, for example, Worldbank.org, "Tobacco Control," which says, *"Smoking prevalence tends to be higher among men with less education and lower incomes, so they bear a greater health risk*," as well as Abouk and Adams (2017) table 3.

[56] See: europa.eu/eurostat, "Population on 1 January by broad age group and sex." Summing the latest (2019) population estimates for ages 15–64 and 65+ across the EU 28, I obtain a total EU 28, 15 years or older population of 433,370,637 (330,714,969 + 102,655,668). 433,370,637*0.39% = 1,690,145.

evidence in support of the substitutes hypothesis over the complements hypothesis.[57]

5.16.3 **Despite the seemingly small coefficient, the estimate is economically significant.** For example, when applied to the most populous country in Europe, Germany, a 0.39-percentage-point increase in current smoking prevalence would correspond to almost 300,000 people being current smokers, who otherwise would not have been.[58] In practice, Germany's regulatory hostility toward e-cigarettes actually increased between 2014 and 2020 by three points, which is estimated to represent a 1.17-percentage-point increase in current smoking prevalence (relative to what it otherwise would have been), and close to 1 million additional current smokers (relative to the number that there otherwise would have been). I present similar estimates for each country in Table 5-3 below.

Table 5-2: Regression results for base and preferred models of smoking prevalence

	(1)	(2)
Model:	**Base Model**	**Preferred Model**
Measure of access to e-cigarettes:		
Regulatory Hostility Towards E-Cigarettes		0.39+
Tobacco control variables:		
Non-Price Tobacco Control Index	0.14	0.07
Real Tobacco Price Index*100	-12.21*	-12.89*
Socio-economic control variables:		
Percentage Unemployed	0.21**	0.23**
Percentage Leaving Education at Age 16–18	0.17**	0.17**
Dummy variables for demographic factors:		
Age groups	Yes	Yes
Gender	Yes	Yes
Country	Yes	Yes
Regression statistics:		
Constant	70.36**	74.45***
Observations	504	504
R-squared	0.6610	0.6632
Adjusted R-squared	0.6365	0.6380

*Notes: (1) The dependent variable is the percentage of the demographic group that is a current smoker. (2) the statistical significance of each estimate is based on the conventional two-sided test and indicated as follows: + (at 10%), * at 5%, ** at 1% and *** at 0.1%; (3) the full regression results are presented in Appendix D: Regression Analysis, Table 12-1. See paragraph 12.5.4 for proper interpretation of the two-sided test.*

57 See paragraph 12.6.1. "Strong" evidence is used here as it is defined in the field of statistics.

58 The aged 15+ population of Germany at the end at 1 January 2021 was 72 million (53,405,595 + 18,271,636). See: europa.eu/eurostat, "Population on 1 January by broad age group and sex." 0.39% of this number is 0.0039 * 72 million = 280,800.

Table 5-3: Estimates of the effect of increased hostility

	2014	2017	2020	Increase in hostility between 2014 - 20	Increase in current smoking prevalence caused by this increased hostility
Austria	0	3	5	+5	+5 x 0.39 = 1.95 pp
Belgium	6	4	5	-1	-0.39pp
Bulgaria	0	4	4	+4	1.56pp
Cyprus	0	4	6	+6	2.34pp
Czech Republic	0	3	3	+3	1.17pp
Germany	0	3	3	+3	1.17pp
Denmark	6	3	3	-3	-1.17pp
Estonia	0	3	7	+7	2.73pp
Greece	6	6	6	0	0pp
Spain	1	3	4	+3	1.17pp
Finland	6	7	7	+1	0.39pp
France	0	3	3	+3	1.17pp
Croatia	2	2	4	+2	0.78pp
Hungary	6	7	7	+1	0.39pp
Ireland	0	2	2	+2	0.78pp
Italy	1	5	5	+4	1.56pp
Lithuania	6	5	6	0	0pp
Luxembourg	0	3	5	+5	1.95pp
Latvia	0	6	6	+6	2.34pp
Malta	2	3	3	+1	0.39pp
Netherlands	0	3	4	+4	1.56pp
Poland	1	5	5	+4	1.56pp
Portugal	0	6	6	+6	2.34pp
Romania	0	4	4	+4	1.56pp
Sweden	6	2	5	-1	-0.39pp
Slovenia	0	6	6	+6	2.34pp
Slovakia	4	4	4	0	0pp
United Kingdom	0	3	3	+3	1.17pp

5.17 My Preferred Regression provides further statistical support for the causal inference that increasing regulatory hostility to e-cigarettes increases smoking prevalence.

5.18 The regression does not directly address the question of whether regulatory hostility towards e-cigarettes affects smoking prevalence through its effect on smoking cessation (i.e., by restricting access to an important aid to quitting smoking), smoking initiation (i.e., preventing or postponing smoking initiation), or a combination of both. The Eurobarometer data is not capable of providing a direct answer to these questions because the surveys do not ask sufficiently detailed questions on initiation and cessation behavior. However, I find

evidence that the overall effect of regulatory hostility towards e-cigarettes (identified in my Preferred Model) arises though its effect on current smoking prevalence of those aged 24 and under, as current smoking prevalence in this age group is more than twice as sensitive to regulatory hostility towards e-cigarettes (i.e., with each 1-point increase in the index leading to an almost 1 percentage point increase in smoking prevalence).[59] Because most smoking initiation occurs among those aged 24 years and under (i.e. people rarely start to smoke as they reach their late twenties and beyond), my results provide evidence that the availability of e-cigarettes may prevent individuals who would otherwise have smoked from starting to smoke, contrary to the hypothesis that e-cigarettes act as a gateway to smoking.

Conclusion

5.19 Overall, my analysis in this section demonstrates smoking and e-cigarettes are substitutes, meaning that as regulatory hostility toward e-cigarettes increases, smoking prevalence increases, and conversely, as regulatory hostility toward e-cigarettes decreases, smoking prevalence decreases. I now turn to a focused analysis of a particular type of regulation: the e-cigarette flavor ban.

[59] I present and explain these regression results in Appendix D: Regression Analysis, Table 12-1. I also present a separate model for those aged 25 and older. Its coefficient on the regulatory hostility variable is positive, which also supports the substitutes hypothesis over the complements hypothesis. The model's two-sided 95% confidence interval also includes zero effect, which is to be expected in a group where e-cigarette usage is materially lower for those aged 25 and older, making it is more difficult to detect the effect of e-cigarettes using the data available.

6. E-Cigarette Flavor Bans and Smoking Behavior: Principles and Existing Research

Introduction

6.1 Of the seven categories of e-cigarette restrictions considered in my earlier analysis, e-cigarette flavor bans are currently the subject of particularly intense debate and consideration by policy makers. I have been asked by BAT to consider the effect of these bans on cigarette smoking, and I do so as follows:

6.1.1 **First, I provide background on e-cigarette flavor bans.** I explain the rationale behind the policy, the arguments made by its proponents and opponents, and those e-cigarette flavor bans that have been implemented or proposed across Europe and the United States.

6.1.2 **Second, I use the Eurobarometer surveys to shed light on the associations between flavor e-cigarette use and smoking, and on people's motivations for starting to vape.** Making a product less acceptable to consumers likely reduces the number of consumers who use it. Moreover, because cigarettes and e-cigarettes are substitutes based on my various analyses described in previous sections of this report, any regulation that makes e-cigarettes a less effective substitute for cigarettes would, all else equal, be expected to *increase* rates of smoking. The Eurobarometer surveys further point to substitution because most flavor vapers are current or former smokers, which means that flavor bans might also be harmful to people attempting to quit smoking.

6.1.3 **Third, I apply the economic and statistical principles introduced earlier to flavor bans.** Specifically, these principles reveal that a large amount of data would be required to draw conclusions from RRP-price tests – that is – detecting the sign of the effect of flavor regulation on the prevalence of smoking. Less data is required to draw conclusions from a cigarette-price test about substitution or complementarity that looks for effects of cigarette prices on flavored cigarette usage.

6.1.4 **Fourth, I present my own analysis guided by these principles.** It uses Eurobarometer data to assess whether flavored e-cigarettes and smoking are complements or substitutes (and therefore whether e-cigarette flavor bans are likely to decrease or increase smoking). My empirical analysis comprises a version of the cigarette-price test on flavored e-cigarette use, where I find evidence that higher cigarette-prices are associated with greater increases in flavored e-cigarette use (and vice-versa), consistent with the two products being economic substitutes. Were there enough data to perform an RRP-price test, I would therefore expect to find direct evidence that e-cigarette flavor bans increase smoking. I explain at paragraph 6.16 that this cannot currently be verified, because there is not enough data available to do so.

6.1.5 **Fifth, I identify and address research produced by others in relation to the potential effect of e-cigarette flavor bans on smoking.** Because that literature conducts what are essentially RRP-price tests, it is little surprise that it fails to reach a consensus as to whether these bans increase or decrease smoking.

However, two flavor-regulation episodes warrant additional investigation.

(a) I consider Finland's experience with e-cigarette flavor bans, introduced as part of the Finnish Tobacco Act of 2016. Some proponents of flavor bans cite the 2016 legislation as the reason Finland saw smoking prevalence reductions in recent years, without a corresponding increase in e-cigarette flavor use.[60] I show how these claims of success are not supported by available data, and ignore other factors (such as the increasing use of snus, an alternative to smoking) that might have played a role.

(b) Next, I consider three early studies that contain empirical economic analysis relating to the effect of flavors or flavor bans on smoking behavior in San Francisco. I explain that around the time of a flavor ban in San Francisco, samples of data on youth smoking prevalence are large enough for it to be reasonably possible in principle to measure the effect of the ban on smoking.

Background to E-cigarette Flavor Bans

6.2 E-cigarettes are currently available for sale in many markets in a variety of different flavors, including food and drink inspired flavors such as fruits, desserts, and mint, as well as more traditional tobacco-based flavors. Policymakers in several jurisdictions are considering banning the sale of flavored e-cigarettes, while some cities, states, and countries have already implemented such bans, sometimes with "carve outs" for certain flavors such as tobacco or menthol.

6.3 Proponents of flavor bans make three primary arguments:

6.3.1 Flavors are supposedly an important reason that youth start vaping, and banning flavors is expected to prevent youth from starting to vape and suffering harm from vaping.[61]

6.3.2 Vaping facilitates smoking initiation. Banning flavors will close this potential "gateway to smoking".[62]

6.3.3 The long-term effects of vaping may be worse than the short-term effects, and, as a precaution, vaping should be discouraged, especially in youth. This can be accomplished by banning flavors.[63]

6.4 Opponents of flavor bans counter that:

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60 See: Euro.who, "Strong legislation help defeat e-cigarettes in Finland"

61 For example, the draft for the flavor ban in the Republic of Lithuania states that the bill aims to reduce the attractiveness of e-cigarettes, *"especially for young people who are particularly attracted to flavored smoking products, which becomes particularly relevant due to the worrying trend towards the increase of the use of electronic cigarettes (especially among young people) in Lithuania".* See: Europa.eu, "Draft Law No XIIIP-3849(3)".

62 See: Europa.eu, "Draft Law No XIIIP-3849(3)".

63 See: Euro.who, "Strong legislation helps defeat e-cigarettes in Finland".

6.4.1 Flavored e-cigarettes play an important role in successful adult smoking cessation: a blanket flavor ban will "*have negative impacts on adult smokers by eliminating an alternative to tobacco*".[64]

6.4.2 If a flavor ban is successful in discouraging youth vaping, this may have the unintended consequence of increasing youth smoking: there is evidence suggesting youth vaping has a diversionary effect on smoking (the opposite of the "gateway argument").[65]

6.4.3 Smoking is 20 times more harmful than vaping:[66] even a small increase in smoking as a result of a flavor ban will more than outweigh the health benefits coming from reduced vaping.[67]

6.5 The debate is ongoing and has led to variation in policy across the world. In the EU, for example, four Member States (Estonia, Finland, Denmark, and Hungary) have imposed a flavor ban, but the majority of Member States, to date, have not. In the US, there is a patchwork of federal, state, and city or county-level regulation of flavors, with some states (e.g., Massachusetts) and municipalities (e.g., San Francisco) implementing a ban on the sale of flavored e-cigarettes, whereas the vast majority of US jurisdictions have not.

Associations Between Flavored E-cigarette Use and Smoking, and Motivations for Starting to Vape

6.6 Making a product less acceptable to consumers likely reduces the number of consumers who use it.[68] Moreover, because cigarettes and e-cigarettes are substitutes based on my various analyses described in previous sections of this report, any regulation that makes e-cigarettes a less effective substitute for cigarettes would, all else equal, be expected to *increase* rates of smoking. Smoking increases when the substitutes for smoking become more expensive or less available.

6.7 Here, Eurobarometer survey data indicates that a large majority of e-cigarette users prefer e-cigarettes with flavors to tobacco flavored e-cigarettes, including smokers and ex-smokers (who represent the vast majority of vapers) trying to quit smoking. In particular, the 2017 and 2020 waves of the Eurobarometer survey include several questions covering

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64 *"For all these reasons, it seems to us that banning vaping flavours is a very bad idea… it is certain that it will have negative impacts on adult smokers by eliminating an alternative to tobacco"* See: Observatoireprevention.org, "Banning flavoured vaping liquids? A very bad idea"

65 See: clivebates.com, "Netherlands Response Jan 2021", p13

66 Rcplondon.ac.uk, "Nicotine without smoke: Tobacco harm reduction"

67 See: clivebates.com, "Netherlands Response Jan 2021"

68 More precisely, usage of the product is reduced by regulations that reduce consumer willingness to pay more than the regulations reduce marginal cost. Health regulations sometimes unintentionally increase usage of harmful products by significantly reducing marginal cost, as with regulation of prescription opioids in the U.S. (Mulligan (2020) and the references cited therein) and perhaps also regulations that change cigarettes from expensive branded products to essentially generic commodities (Davidson and de Silva, 2014). See also Jaffe et al (2019) p. 57. My discussion of e-cigarette regulation accepts for the sake of argument that stricter e-cigarette regulations will not have the unintended consequence of increasing e-cigarette usage.

the motivations and flavor preferences of flavored e-cigarette users. I use these questions to shed light on the associations between e-cigarette flavor use and smoking behavior, as well as to explore the reasons stated by respondents for why they started to vape. The data I use for this analysis is drawn mainly from subjective questions, where respondents are asked to provide subjective answers (such as to identify their *reasons* for starting to vape, rather than objectively whether they vape or not) and has key advantages that make it useful for informing policy.[69] In particular, the data is collected from the people who will be most affected by flavor bans (i.e., flavored e-cigarette users), whose motivations and opinions are informative for policymakers.

6.8 Using simple but effective cross-tabulations to tease out associations and patterns, I find that the data shows that:[70]

6.8.1 **Flavor bans would overwhelmingly affect current or ex-smokers, who represent 92% of flavor vapers.**[71, 72] Thus, while concerns about youth vaping are legitimate, the Eurobarometer data suggests that in reality, the overwhelming majority of consumers who use flavored e-cigarettes are current or ex-smokers, for whom vaping can confer substantially reduced risk compared to continuing smoking.

6.8.2 **Flavored vapers are more likely to have tried to quit smoking than exclusive tobacco flavored vapers.** This suggests that flavored e-cigarettes are a tool that many current and former smokers may be using to quit smoking.[73]

6.8.3 **Indeed, the most popular reason for starting to vape is not the presence of flavors, but desire to reduce smoking.**[74] Again, this suggests that users of flavored e-cigarettes are often using them as a means to reduce tobacco consumption (perhaps to zero).

6.9 Overall, I conclude that the subjective data is a warning that flavor bans might be harmful to people attempting to quit smoking and to youth deciding whether to start smoking or not. Empirical economics deals especially with determining whether hypotheses such as this are borne out in objective behavioral data. I now turn to the principles that guide the application of economic and statistical methods to behavioral data to assess whether combustible cigarettes and flavored e-cigarettes are in fact substitutes.

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69 I note however that such data is somewhat less reliable than market data on actual behavior, or answers to more simple and objective questions, such as whether one smokes or not.

70 The detailed cross-tabulations are presented in Appendix E: Associations Between Flavored E-Cigarette Use and Smoking, and Motivations for Starting to Vape from paragraph 13.8.

71 For the numbers underlying this calculation, see Table 13-5 92% = (410 + 344) / 817; that is, out of 100 flavor vapers, 92 are either smokers or ex-smokers.

72 I define "flavor vapers" as respondents who reported using non-tobacco flavored e-liquids, possibly in addition to tobacco flavored e-liquids. See Table 13-2 for details.

73 See Table 13-6 for details.

74 I note that the Eurobarometer data is less helpful and reliable for analyzing smoking initiation or gateway effects, due to inconsistent answers. I have therefore not used it for this purpose.

Economic and Statistical Principles Applied to Flavored E-Cigarettes

6.10 The economic and statistical principles discussed in Section 3 apply with equal force to flavored e-cigarettes as they do to e-cigarettes generally. The effects of flavor bans relate to whether flavored e-cigarettes are substitutes for or complements to traditional cigarettes. If the two products are substitutes, a policy that makes flavored e-cigarettes more expensive or less available will, all else being equal, increase smoking. If they are complements, a flavor ban would reduce smoking.

6.11 Three principles in particular are relevant:

6.11.1 **First, knowing the *direction* of a change in availability of a product is a basic pre-requisite.** Substitution or complementarity can be measured either with cigarette-price tests or RRP-price tests (more precisely flavored-RRP-price tests). Both tests are predicated on a directional change in consumer "access" to the relevant product, expressed in terms of price (e.g., as a result of a change in taxation), or physical availability as a result of regulation, or a change in supply (e.g., through a total ban or a ban on flavors).

6.11.2 **Second, either test can be used in principle, but in practice, one test can be more precise than the other.** Consumer demand theory says that the cross-price elasticities, whose signs indicate substitution or complementarity, are proportional to market shares (see paragraph 3.9). Flavor market shares are smaller than the shares for all e-cigarettes, which themselves are less than cigarette shares. Therefore *flavored*-RRP-price tests are especially disadvantaged in terms of being able to distinguish substitution versus complementarity. Cigarette-price tests have the advantage that price (or availability) changes originate in a much larger market.

6.11.3 **Third, there are additional complications when considering three related products.** In particular, another challenge facing flavored-RRP-price tests is that flavored and nonflavored RRPs may be close substitutes. That is, while some flavored e-cigarette consumers react to a higher price (or less availability) by changing their use of cigarettes, others react by switching to nonflavored RRPs. By contrast, the RRP-price tests conducted in Section 5 of this report emphasize restrictions that apply to all RRPs and therefore leave smoking behavior as the only one of the aforementioned two possible adjustments that consumers may take.

6.12 Simply put, the effect on smoking of e-cigarette regulations limited to flavors is expected to be less – and therefore require additional data to all RRPs. The small effect results both from the lesser market share of flavored e-cigarettes compared to RRPs generally and the possibility of substitution between flavor and non-flavor RRPs. A reliable RRP-price test must therefore involve enough of a higher price, or less availability, of RRPs that consumers meaningfully reduce their use of RRPs. Regulations that are poorly enforced or easily evaded will not produce a price increase (or availability decrease) of the magnitude required to reliably estimate the direction of the regulation's effect on smoking. I explain later in this section that this limitation currently applies in Europe, and with the Eurobarometer data.

6.13 In practice, this means that with the data currently available, one must rely on a cigarette price test.

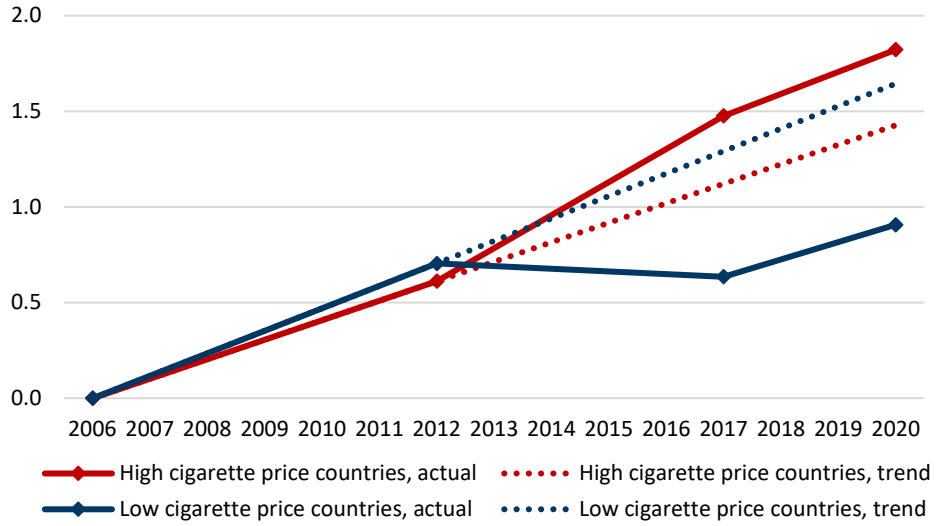
Cigarette-Price Test (Modified for Flavor E-cigarette Use)

6.14 Here, I conduct a modified cigarette price test to determine whether flavored e-cigarettes and traditional cigarettes are substitutes following a similar methodology to that described in Section 4 by first dividing the Eurobarometer countries into two groups – high and low cigarette price countries (based on the cigarette weighted-average price (WAP) in 2012, around the time when e-cigarettes started to become popular) and then plotting flavored e-cigarette use prevalence over time in each of the two groups of countries. If flavored e-cigarettes and cigarettes are substitutes, I would expect high-cigarette price countries to experience higher-than-trend increases in flavor e-cigarette use, and vice versa for low-cigarette price countries.

6.15 Figure 6-1 shows that indeed, high-WAP countries experienced above-trend growth of flavor use, while the low-WAP countries show below-trend growth of flavor use. This is consistent with flavored e-cigarettes being substitutes for traditional cigarettes, in line with the results of the general cigarette-price test,[75] and suggests that reducing the availability of flavored e-cigarettes should be expected to increase smoking.

[75] I confirm this conclusion by performing a more formal statistical test, using multivariate regression analysis (which is explained in more detail from paragraph 14.2 in Appendix F: Cigarette-Price Test for Flavored E-Cigarettes.

Figure 6-1: Actual trends in flavor e-cigarette use (current prevalence, %)



Notes: (1) the countries are split into high and low cigarette price countries, based on 2012 cigarette weighted average prices; (2) the high cigarette price countries are: Belgium, Cyprus, Germany, Denmark, Finland, France, Ireland, Italy, Luxembourg, Malta, Netherlands, Sweden, UK; (3) Croatia is dropped as it did not participate in the 2012 Eurobarometer; (4) the remaining countries are in the "Low cigarette price" group; (5) trend lines are obtained by a assuming constant rate of change; (6) flavor e-cigarette use prevalence is assumed to be 0% in 2006; (7) Because flavor e-cigarette use data is available only in 2017 and 2020, I assume that all e-cigarette use in 2012 was flavored use. This is consistent with observations that the vast majority of e-cigarette users in 2017–2020 were flavor users; "However, of the roughly 1,000 people who answered the flavor question, 75% use flavors" - paragraph 13.10.1 in Appendix E: Associations Between Flavored E-Cigarette Use and Smoking, and Motivations for Starting to Vape for details.

RRP-Price Test (Modified for Flavor E-cigarette Use)

6.16 My general RRP-price test provides statistical evidence that increasing regulatory hostility towards e-cigarettes increases smoking. In principle, my earlier RRP-price test analyzing multiple e-cigarette regulations including but not limited to flavor bans can be modified to measure the effect of e-cigarette flavor bans, separately from other e-cigarette measures. However, in practice, it is unlikely to be possible to detect the effect of e-cigarette flavor bans in Europe using the 2014–2020 Eurobarometer data for a number of reasons:

6.16.1 **First, flavor bans are only one part of a package of legislations.** The general e-cigarette hostility index discussed in previous sections measures the combined effect of 7 different anti-e-cigarette policies, of which a flavor ban is one. The effect of any one of these measures in isolation, is likely to be smaller than in combination. Precise measurement of smaller effects requires more data.

6.16.2 **Second, I would be restricted to use a materially reduced dataset** because, during the period for which I have data, only three out of the 28 Eurobarometer countries introduced e-cigarette flavor bans, while all 28 countries can be

assigned an e-cigarette hostility index.[76]

6.16.3 **Third, there is evidence that flavor bans were not well enforced in at least two of the countries that have so far introduced them**. In Finland, flavored e-cigarettes continued to be available for sale through Facebook, even after the Finnish Tobacco Act came into effect in 2016.[77] In Estonia, the number of Eurobarometer respondents saying they use flavors actually increased after the 2019 ban.[78] This lack of enforcement further reduces the effect that a RRP-price test would attempt to measure.

6.16.4 Indeed, if there is a thriving black market for flavored e-cigarettes or consumers can readily purchase them in other ways (e.g., by going to nearby EU countries without such a ban or buying the products online), then e-cigarettes purchased through these other channels could still help to reduce rates of smoking, although government would be unable to tax and regulate e-cigarettes bought through these other channels.

6.16.5 **Fourth, another challenge facing flavored-RRP-price tests is that flavored and nonflavored RRPs may be, for at least some consumers, close substitutes.** That is, while some flavored e-cigarette consumers react to a higher price (or less availability) by switching to cigarettes, others react by switching to nonflavored RRPs. By contrast, the RRP-price tests conducted in Section 5 of this report emphasize restrictions that apply to all RRPs, and therefore leave smoking behavior as the only one of the two possible adjustments that consumers may make.

6.17 Overall, because of the aforementioned limitations, *flavored*-RRP-price tests are especially disadvantaged in terms of being able to distinguish substitution versus complementarity. In order for the effect of a flavor ban to be detectable in a statistically significant way using the same data as that used for the general RRP-price test (Section 5 of this report), the flavor ban would need to increase or decrease traditional smoking by more than 4 percentage points.[79] Four percentage points is an implausibly large effect size requirement, especially given my finding that a one-point increase in e-cigarette hostility (the equivalent of introducing or removing a flavor ban on my seven-point hostility index) causes a 0.4-percentage-point change in smoking prevalence over time. Nonetheless, given the strong symmetry found in my earlier tests, one would expect to find such symmetry here too, if sufficient data were available to do an RRP price test specifically for flavored e-cigarettes.

E-cigarette Regulation in Finland

6.18 The *Support Study to the report on the application of Directive 2014/40/EU* ("**EC report**") is an independent report commissioned by the European Commission to provide evidence for

[76] See Table 15-1 for details on e-cigarette flavor bans in Europe.

[77] See Table 15-2 in Appendix G: Feasibility of a RRP-Price Test for Flavored E-Cigarettes for detail

[78] See Table 15-2 in Appendix G: Feasibility of a RRP-Price Test for Flavored E-Cigarettes for details.

[79] My calculation of this 4-percentage-point figure is in Appendix G: Feasibility of a RRP-Price Test for Flavored E-Cigarettes, from paragraph 15.5.

assessing the application of the EU Tobacco Products Directive 2014 (which did not ban e-cigarette flavors, or attempt to harmonize flavor regulations among member states, but instead allowed member states to introduce their own e-cigarette flavor regulations). The report was written between 2019-2021 by teams from policy consultancies ICF S.A.[80] and RAND Europe.[81] Section 5.10 in Appendix 9 of the EC Report discusses the experience of Finland and Estonia with introducing flavor bans, and it provides a summary of parts of the relevant literature at the time. I understand that the report is held up as providing evidence of how Finland managed to reduce smoking without increasing vaping, through e-cigarette legislations which included e-cigarette flavor bans.

6.19 This conclusion appears to be based in the main on the following two second-hand empirical claims:

> *"… Finland has managed to reduce smoking to 14% in 2018 while keeping e-cigarette use at just 1% according to the 2018 Euromonitor survey. WHO [*in a news article, not an empirical report[82]*] attributes this success to Finland's focus on preventing nicotine addiction and the use of all tobacco and related products (rather than just smoking) through measures such as the flavour ban". [83]*
>
> *"Other sources [*paywalled news articles from Bloomberg and The Times*][84] have also attributed the low e-cigarette use rate in Finland, especially among adolescents (with only 1% of high school students using e-cigarettes daily), to Finland's e-cigarette flavour ban, and have reported that Finland is on track to meet their 2030 smoke-free goal" [85]*

6.20 I have the following six concerns with this analysis:

6.20.1 First, the EC case study does not provide any empirical evidence that e-cigarette flavor bans in Finland (or Estonia) caused reduced smoking, taking into account the effect of other factors such as increases in cigarette taxes and prices, and existing time trends are also consistent with the opposite conclusion.

6.20.2 Second, the EC report does not consider that the Finnish Tobacco Act of 2016 may have actually *increased* availability of e-cigarettes rather than reducing it by legalizing purchase of e-cigarettes as consumer products for the first time.

6.20.3 Third, the EC report does not consider the role of snus.

6.20.4 Fourth, the authors do not sufficiently develop the argument that e-cigarette flavor bans will cause reduced youth vaping initiation.

6.20.5 Fifth, the authors do not address compelling evidence that bans may have

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80 See: icf.com, "About"

81 rand.org, "About"

82 See: Euro.who, "Strong legislation helps defeat e-cigarettes in Finland"

83 EC report, PDF page 344

84 See: Bloomberg.com, "In world's happiest nation teens don't want to vape anymore" and Thetimes.co.uk, "Finland set to stub out smoking by 2030",

85 EC report, PDF page 344.

negative effects on public health through youth and adults switching to traditional smoking, or the related point that the rate of decline in smoking in Finland could have accelerated had an e-cigarette flavor ban not been imposed.

6.20.6 Sixth, the EC case study does not bring any evidence to support a gateway effect from vaping to smoking.

6.21 I further explain each of these concerns below.

6.22 First, the EC report does not provide any empirical evidence that e-cigarette flavor bans in Finland (or Estonia) caused reduced smoking, and existing time trends are also consistent with the opposite conclusion. The authors simply comment on the time-trends in smoking (reducing) and vaping (stable) in Finland and imply that these trends were caused by the Finnish Tobacco Act of 2016. However, the EC authors do not use any original data analysis or cite any empirical papers to support their claim.

6.23 Second, the EC report does not consider that the Finnish Tobacco Act of 2016 may have actually *increased* availability of e-cigarettes rather than reducing it. This is because the law legalized the domestic sale of nicotine-containing tobacco flavored e-cigarettes for the first time, concurrently with officially banning all non-tobacco e-liquid flavors (both nicotine-containing and nicotine-free ones).[86] Thus, any before-after analysis of the effect of a flavor ban in 2016 would need to also account for contemporaneous liberalization of access to e-cigarettes by making tobacco flavored e-cigarettes available for purchase as consumer products for the first time. The EC report does not address this important issue.

6.24 Third, the EC report does not consider snus, which may be an important factor regardless of what happened to e-cigarette regulation. Snus is an oral, smokeless tobacco product, usually distributed in small "pouches" and delivering nicotine by being placed under the lip.[87] It is accepted to be a reduced risk product compared to cigarettes.[88] Though retail sales of snus are prohibited in Finland,[89] snus imports have increased and snus use has grown in recent years.[90]

6.24.1 Although I have not conducted my own empirical tests, snus products appear to be substitutes for smoking.[91] It is possible, therefore, that some of the reduction in smoking cited in the Finnish case study is the result of smokers switching to snus. Indeed, Figure 6-2 below shows that even though e-cigarette use remained

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86 See Ruokolainen et al. (2022).

87 See: Wikipedia.org, "Snus".

88 See: fda.gov, "FDA grants first-ever modified risk orders to eight smokeless tobacco products".

89 See: Suomenash.fi, "Snus".

90 See Salokannel and Ollila (2021).

91 Maki (2014) compares the change in the smoking rate between Sweden and Finland – two countries which joined the EU in 1995, when Sweden received an exemption from the EU snus ban while Finland did not – finding that the smoking rate in Finland increased relative to Sweden. In the post-ban period, smoking was 3.47 percentage points higher in Finland relative to what it would have been in the absence of the ban. The availability of snus, a less harmful alternative to smoking, appears to have reduced the smoking rate and demonstrates the importance of offering acceptable alternatives to cigarettes to reduce smoking prevalence. See also Clarke et al. (2019).

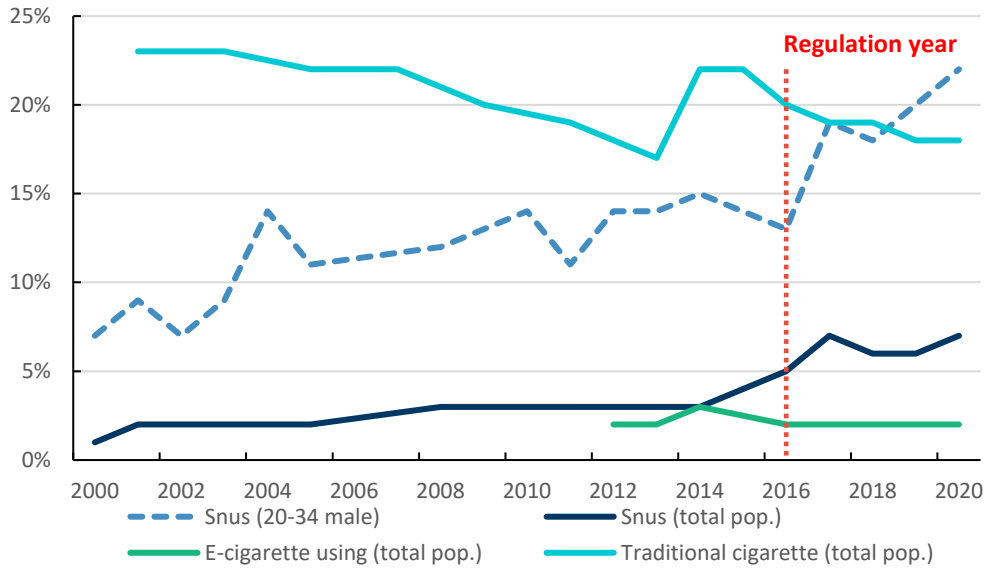
stable after the Finnish Tobacco Act of 2016, use of snus (especially among 20-34-year-old males) increased sharply.

6.24.2 It is possible that Finnish smokers quit smoking only because they used an alternative product such as snus (and more smokers might have quit if flavored e-cigarettes were more easily available). In other words, the success experienced by Finland in reducing rates of smoking could well have been the result of a thriving RRP market for snus – consistent with my overall view that RRPs and cigarettes are economic substitutes such that increasing availability of RRPs should lead to reductions in smoking.

6.25 Moreover, smoking prevalence was falling in Finland even before the 2016 e-cigarette flavor ban, and the fall in smoking prevalence after 2016 may simply be a continuation of an existing trend, rather than caused by the ban or other parts of the Finnish Tobacco Act of 2016.

6.26 The EC report does not consider these possibilities.

Figure 6-2: Current snus, e-cigarette and smoking prevalence in Finland (% of population)



Source: julkari.fi, "Tupakkatilasto 2020".[92]

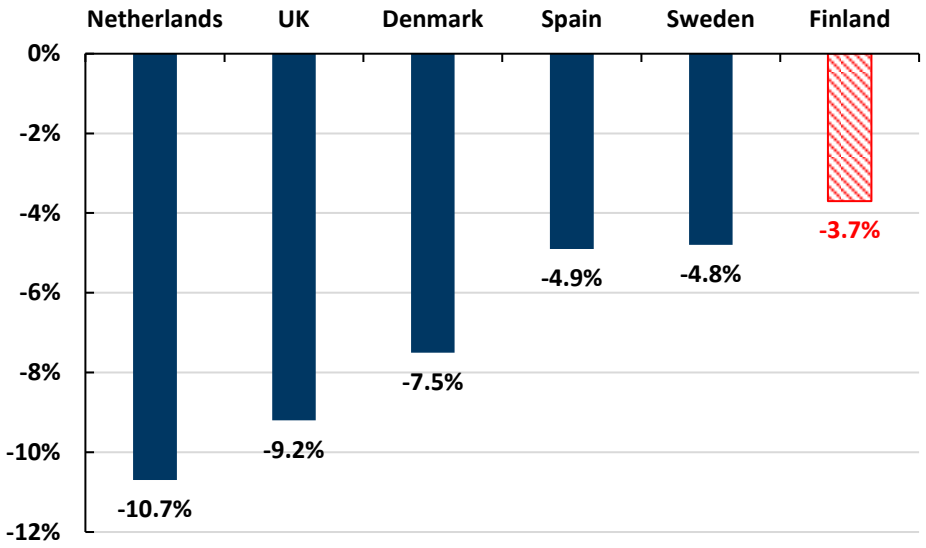
6.27 Fourth, the authors do not sufficiently develop the argument that e-cigarette flavor bans will cause reduced youth vaping initiation. The authors cite two empirical papers showing that flavors are an important factor for youth trying e-cigarettes, but they do not provide evidence that flavors *cause* youth vaping initiation (i.e., that in the absence of flavors, they would not simply have another reason to start), or that a flavor ban will be sufficient to prevent vaping initiation.

6.28 Fifth, the authors do not address compelling evidence that bans may have negative effects on public health through increased rates of cigarette smoking by former smokers, current smokers, and / or potential future smokers. Notably, the EC report does not acknowledge,

[92] The Eurobarometer does not provide data on current snus use before 2017. This is why I use an alternative data source.

let alone take into account, the most recent empirical papers suggesting that flavor bans might be associated with increased smoking (in particular, Friedman (2021) and Yang et al (2020)), despite at least one of those studies being available at the time.[93] In fact, while it is true that smoking prevalence did decline in Finland after the Finnish Tobacco Act of 2016, it is also true that smoking prevalence declined *faster* in other jurisdictions without flavor bans (e.g., UK). This is shown clearly in Figure 6-3 below, which compares Finland to the five EU countries that saw largest smoking prevalence reductions between 2014 and 2020: none of these five countries had e-cigarette flavor bans over the relevant period. The simple time trends presented in this figure are also consistent with the argument that the Finnish Tobacco Act of 2016 resulted in slower smoking reductions than would have been achieved in the absence of an e-cigarette flavor ban. Proponents of the Finnish case study must consider and address this possibility. They do not.

Figure 6-3: Reduction in smoking prevalence between 2014 and 2020, in Finland and other Eurobarometer countries without a flavor ban (percentage points)



Source: Eurobarometer waves 93.2 and 82.4.

6.29 Sixth, the EC case study does not bring any evidence to support a gateway effect from vaping to smoking (though the term "gateway" is mentioned). Indeed, the main justification for flavor bans is a desire to prevent youth vaping as a harm in itself, rather than any references to the assumed relationships between vaping and smoking.

6.30 Even though the EC report is held out as providing an independent and objective assessment, the authors overstate the strength of evidence in favor of flavor bans. A more balanced and objective analysis is required to inform evidenced base policy – and I address this earlier in this section.

[93] The EC report was published in May 2021, which is around the time of the Friedman (2021) paper (published on 17 May 2021) and after Yang et al. (2020) (published on 1 April 2020).

Evidence from the US

6.31 The empirical economic literature on the effect of flavor bans on smoking behavior is currently scant.[94] However, aside from the section of the EC report citing Finland, I am aware of only three early studies that contain empirical economic analysis relating to the effect of flavors or flavor bans on smoking behavior.[95] Each of the studies conducts an RRP-price test: attempting to measure a smoking effect of an e-cigarette flavor ban.

6.32 In San Francisco, the sale of all flavored tobacco products (except tobacco flavor) was banned, with the regulations composed and implemented over a protracted time frame. At one point, regulations were written to take effect in early 2018, but retailers were concerned that they would not have enough time to sell their inventories of flavored e-cigarettes.[96] Ultimately the regulations went into effect in July 2018[97] and full enforcement started in early 2019.[98] The ban covered both flavored combustible tobacco and e-liquids.

6.33 Two aspects of the San Francisco ban present challenges for conducting a RRP-price test that would reliably indicate whether flavored e-cigarettes are complements or substitutes with smoking.

6.33.1 First, depending on the relative popularity of flavored combustible tobacco, it might be difficult to distinguish the effect of the tobacco flavor ban from the effect of the e-cigarette flavor ban.[99]

6.33.2 Second, in light of the protracted implementation process, a before-after analysis must determine when flavored e-cigarettes became less available (or more costly to obtain). As discussed further below, it is unclear whether enough "after" data has yet become available. When sufficient data does become available, the analysis may be complicated to the extent that other factors significantly changed smoking behavior over the intervening time frame.

6.34 An advantage of RRP-price tests based on the San Francisco ban is the large samples that

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94 This is to be expected given how recently the bans have been implemented (there is naturally a time delay between the implementation of the policy, and the public availability of data to analyze its effect), and the measurement difficulties described above.

95 These studies are: (1) Yang et al. (2020): The impact of a comprehensive tobacco product flavor ban in San Francisco among young adults; (2) Friedman and Xu (2020): Associations of flavored e-cigarette uptake with subsequent smoking initiation and cessation; and (3) Friedman (2021): A difference-in-difference analysis of youth smoking and a ban on sales of flavored tobacco products in San Francisco, California. See also a fourth related study, Gammon et al. (2021), cited below. Regarding Finland, see also Ruokolainen et al. (2022), which focuses on e-cigarette use rather than traditional smoking and finds that e-cigarette use remained roughly stable at around 2% between 2014 and 2018. I have not conducted a comprehensive review of the literature, as this was outside of the scope of my study.

96 See Vyas et al. (2020).

97 See: Sfdph.org, "Flavored tobacco"

98 See: Filtermag.org, "San Francisco vape flavor ban teen smoking"

99 If we can assume that the combustible flavor ban by itself does not encourage smoking, and it is found that the combined San Francisco policy increased smoking, then we could conclude that (1) the e-cigarette flavor ban increased smoking and (2) smoking and flavored cigarettes are substitutes.

are and will be available. The large samples permit reliable assessment of complements versus substitutes from RRP price changes that only affect smoking rates to the order of a percentage point or two.

6.34.1 In particular, the Youth Risk Behaviors Surveillance System surveys in the US provide data relating to large samples of youth.[100] Friedman (2021) analyses these data through the 2018-19 wave, assembling San Francisco samples of about 2,000 youth per wave as well as larger comparison samples of youth residing elsewhere in the U.S. She is able to estimate youth prevalence in San Francisco within about two percentage points (with a 95 percent confidence interval), which could be accurate enough to identify the direction of the effect of the e-cigarette flavor ban on smoking, at least if it were enforced enough to meaningfully reduce youth e-cigarette flavor use.

6.34.2 There is some evidence that the San Francisco flavor ban was effectively enforced in the sense that it led to material reductions in both flavored e-cigarette use and flavored e-cigarette sales. For example, Yang et al (2020) estimate (albeit based on their small sample) that "any flavors" e-cigarette use fell by around 8-10pp after the ban (but still over 45% of people surveyed used flavored e-cigarettes after the ban).[101] Gammon et al (2021) estimate that flavored e-cigarette *sales* fell by almost 100% after the ban.[102]

6.34.3 However, it appears that all or most of the data from the 2018-19 wave of YRBSS was collected before the ban was fully enforced (early 2019), albeit after the ban took effect (July 2018).[103]

6.34.4 Friedman shows a two-percentage point increase in youth smoking rates in 2018-19 relative to the previous wave, following at least three consecutive decreases. Something sharply increased youth smoking, although as of now it is difficult to know whether and how much of the smoking was due to the implementation of the flavor ban.

(a) Under the substitution hypothesis, it is possible that the elevated youth smoking was a response to declining availability of flavored e-cigarettes leading up to full enforcement.

(b) Substitution also predicts that elevated youth smoking would also be observed after full enforcement began, at least to the extent that other variables where not changing smoking enough in the other direction. An opportunity to assess this prediction (and account for other variables) is expected later in 2023 when the 2020-21 wave of

100 See: Cdc.gov, "YRBSS"

101 See Yang et al. (2020), Table 2.

102 See Gammon et al. (2021), Table 1.

103 See: Profglantz.com, "Study claiming SF flavor ban increased youth smoking dissolves it is not based on any data collected after enforcing the ban."

YRBSS data becomes available.[104]

6.35 Other early studies also provide mixed and inconclusive results – primarily due to: (a) an insufficient amount of data with which to measure an effect in either direction, and (b) the fact that other policies were implemented contemporaneously with e-cigarette flavor bans. In particular:

6.35.1 Yang et al (2020) survey a small sample of adults (247 of them, aged 18-34) living, working or studying in San Francisco. The authors ask respondents about their current (after the ban) and past (before the ban) smoking behaviors, and compare the responses before and after. The authors find that consumption of e-cigarettes fell after the ban, and that traditional combustible cigarette use increased. This analysis suffers from the same limitation as Friedman's, in that it does not pick apart the effect of each element of the flavor ban (although to the extent that the combustible element of the flavor ban is not expected to increase smoking, the increase that was observed is more likely to be due to the *vaping* element of the flavor ban), but is also based on a small sample of individuals.

6.35.2 Finally, Friedman and Xu (2020) use data from the PATH survey in the US (which tracks the same individuals over time) to study how initiating vaping using flavored vs unflavored cigarettes is associated with subsequent smoking initiation and cessation (of combustible cigarettes). They find that, of the non-smoking underage youth who started vaping first, using flavors is not more strongly associated with subsequent smoking initiation than using unflavored e-cigarettes (though starting vaping of any kind is strongly associated with subsequent youth smoking initiation). However, of the smoking adults, flavored e-cigarettes users were twice as likely to subsequently quit smoking vs users of tobacco flavored e-cigarettes.

6.36 Although these early studies do not provide a direct and definitive answer as to whether e-cigarette flavor bans cause increased or reduced smoking, they do not claim to have done so, and they all acknowledge the need for further data.

Conclusion

6.37 My main conclusions from this section are:

6.38 Cigarettes and e-cigarettes are substitutes, so policies designed to reduce the acceptability of e-cigarettes as a substitute for smoking will, all else equal, result in increasing rates of smoking.

6.38.1 Here, my review of Eurobarometer survey responses confirms that most consumers prefer e-cigarettes with flavors, and the vast majority of consumers of flavored e-cigarettes are current or former smokers for whom e-cigarettes could be a substitute for smoking, with many of them reporting they use flavored e-

[104] See: cdc.gov, "YRBSS FAQ" – *"Most YRBS's are conducted during the spring of odd-numbered years and results are released in the summer of the following year".* Further analysis of the San Francisco episode with 2021 data should also include assessment of tax, regulatory, and other cigarette market changes between 2019 and 2021.

cigarettes to quit smoking.

6.38.2 The modified cigarette-price test provides further empirical evidence that flavored e-cigarettes and traditional cigarettes are economic substitutes. This suggests that reducing the availability of flavored e-cigarettes, such as through well-enforced flavor bans, likely will cause increased smoking.

6.38.3 As few European countries have yet introduced e-cigarette flavor bans (and those that have, have done so fairly recently and with limited success) there is not sufficient data to directly examine the effects of European flavor bans on smoking (e.g., by using a modified RRP-price test).

6.38.4 The claims that Finland's recent reduction in smoking prevalence is caused by a 2016 e-cigarette flavor ban are not supported by empirical evidence.

6.38.5 There is currently scant empirical literature on this issue and the existing literature, due to data limitations and other challenges, does not provide a definitive answer to whether and to what extent e-cigarette flavor bans affect rates of smoking. Nevertheless, based on the weight of the available evidence, including my various analyses of Eurobarometer data explained in this report, bans on flavored e-cigarettes (assuming they are well-enforced) likely will lead to increased smoking.

7. The Effect on Smoking of Non-Price Restrictions on Cigarettes

Introduction

7.1 The EC is currently consulting on an evaluation of TPD2.[105] Although the precise provisions expected in a potential TPD3 are not yet known, some market participants expect continued hardening of regulations meant to discourage the use of both cigarettes (e.g., mandatory plain packaging for cigarettes) and reduced risk products (e.g., blanket bans on non-tobacco e-cigarette flavors). In this context, BAT asked me to consider the effect on smoking rates of the non-price regulations (by which I mean policies that do not seek to directly affect the monetary cost to consumers of smoking, through for example excise taxes) for cigarettes contained in the TPD2, using the Eurobarometer-based dataset I describe in Appendix B: Data. I present my analysis of the matter in this chapter.

7.2 The remainder of this chapter is structured as follows:

7.2.1 **First, I provide background on the non-price cigarette regulations contained in TPD2.** I explain what is required for tools from empirical economics to be able to identify the effect of such policies, and identify that these requirements are met in relation to two aspects of the TPD2 in particular: mandatory picture warnings, and cross-border distance sales bans.

7.2.2 **Second, I apply economic and statistical principles to the question of the effect of TPD2 non-price cigarette restrictions on smoking.** I explain why economic theory implies that such restrictions may by themselves cause, contrary to regulatory goals, *higher* rates of smoking by encouraging smokers to switch from "quality" to "quantity", and why detecting the direction and extent of the causal effect (if any) is an empirical question, requiring data to answer.

7.2.3 **Third, I address this empirical question using regression analysis of Eurobarometer data.** I find that tighter non-price cigarette restrictions did not have any statistically significant effect in reducing current smoking prevalence (and if anything, might have indirectly increased prevalence through the effect of packaging policies lowering the price of cigarettes consumed).

7.2.4 **Fourth, I use country-level analysis to visually examine if and how the picture warnings and cross-border sales bans components of the TPD2 package affected smoking prevalence.** I find no evidence that these policies reduced smoking rates.

7.2.5 **Finally, I conclude and highlight the implications for policy.** In particular, these results suggest that further (non-price) regulation of cigarettes is unlikely to meaningfully reduce rates of smoking, given the lack of such an effect through TPD2 regulations of cigarettes, and that lighter touch regulation of reduced risk products that allows these to compete more effectively as substitutes to cigarettes will result in meaningful reduction in rates of smoking.

[105] See: ec.europe.eu, "Evaluation of the legislative framework for tobacco control"

Background on Non-Price Regulations Contained in TPD2

7.3 The TPD2 is a piece of EU legislation governing the manufacture, sale and presentation of tobacco and related products across EU member states. It entered into force in May 2014, and member states were required to transpose most of its provisions into national law by May 2016. TPD2 repealed and replaced the previous Tobacco Products Directive 2001/37/EC ("**TPD1**").[106]

7.4 TPD2 introduced several non-price restrictions aimed at reducing smoking.[107] Notably, these included (for the first time) mandatory picture warnings, which together with text health warnings were required to cover at least 65% of the area of packs; the option for member states to ban cross-border distance sales; a ban on non-standard cigarette pack sizes (like 10-packs); and a ban on cigarettes and roll-your-own tobacco with characterizing flavors.[108]

7.5 Non-price restrictions on smoking, such as picture warnings, aim to reduce smoking by making the product less appealing. However, as I explain in paragraph 7.7, they may also have the opposite effect, and therefore the net causal effect of such policies on smoking rates is an empirical question. To answer it using tools from empirical economics, I ideally require:

7.5.1 **data on smoking prevalence** (the outcome variable);

7.5.2 **information on when different TPD2 policies were implemented in different member states** (dependent variable);

7.5.3 **information on other determinants of smoking** (control variables); and

7.5.4 **identifying variation**, i.e. variation across time and/or countries in the implementation of relevant TPD2 policies so that I can observe differences in smoking rates that (after controlling for other determinants of smoking) can be causally attributed to the TPD2 policies. Put another way, if all countries implement a given policy at the same time, the effect of this policy cannot be disentangled from other possibly confounding effects such the impact of other relevant contemporaneous policies (such as tax changes of tobacco products relative to substitutes).

7.6 The Eurobarometer-based dataset I describe in Appendix B: Data meets these first three requirements stated above, and I continue to use it. As for the identifying variation requirement, I review the implementation details of the TPD2, and find that while most of the TPD2 policy measures were implemented by all countries at the same time, two TPD2 policies in particular may have sufficient variation across time and countries for me to be able to study their effects.[109] These policies are:

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106 See: Health.europa.eu, "Revision of the Tobacco Products Directive"

107 TPD2 also included, for the first time, regulations on e-cigarettes. I discuss e-cigarettes regulations in the bulk of my report and do not focus on them in this chapter.

108 For a list of the different regulations introduced by the TPD2, see Table 16-1.

109 See Table 16-1 for my explanation on which TPD2 policies are, or are not, suitable for graphical analysis and why.

7.6.1 Mandatory "**picture warnings**": The TPD1 gave member states the option to implement requirements for picture warnings on cigarette and roll-your-own ("**RYO**") packages. As a result, some member states had picture warnings in place prior to the implementation of the TPD2 while others did not. However, the TPD2 made picture warnings mandatory (as part of an overall health warning coverage requirement of 65%), which lead to some member states adopting them for the first time in May 2016.[110]

7.6.2 **Optional cross-border distance sales ("CBDS") bans**: The TPD2 allowed (though it did not oblige) member states to prohibit cross-border distance sales of tobacco products (i.e. sales where the customer and seller are located in different countries at the point of purchase).[111] After May 2016, some countries chose to ban CBDS while others did not.

Economic and Statistical Principles Applied to Non-price Cigarette Regulations Contained in TPD2

7.7 From an economic perspective, packaging and other regulations of cigarette marketing or advertising may increase smoking even when intended to reduce it. Specifically, the regulations can encourage smokers to consume cigarettes in 'quantity' rather than 'quality'.

7.7.1 A variety of cigarette brands coexist in the market at different price points (e.g., premium, discount, etc.). As with other consumer products, premium brands charge substantially more than discount brands for what is at base the same product—a cigarette. Purchasers of premium-brand cigarettes may be willing to consume fewer cigarettes to offset the added cost of buying the premium brand, just as many consumers choose to purchase a designer handbag or a luxury car for those products' brand cache, even though similarly functioning handbags and cars are available from discount brands at lower prices.[112]

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110 See article 10.1 of the regulation here: Health.ec.europa.eu, "Directive 2014/40/EU of the European Parliament and of the Council of 3 April 2014 on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco and related products and repealing Directive 2001/37/EC"

111 See article 17.1 in Health.ec.europa.eu, "Directive 2014/40/EU"

112 For example, Underwood and Sun (2020) examine the effects of a plain packaging ban in Australia, and conclude that *"In response to the policy, smokers switched from more expensive to cheaper cigarettes and reduced their overall tobacco expenditure and expenditure intensity. However, as smoking became less costly, smokers consumed more cigarettes."* See also Davidson and de Silva (2014) who note that *"restricting branding could give rise to an increase in tobacco consumption"*, as smokers substitute quality for quantity.

7.7.2 Premium cigarette brands (like designers and luxury car manufacturers) distinguish themselves with signature packaging. If much of that packaging must be used for regulatory compliance rather than branding, sales of premium brands are likely to suffer, both because the premium products become less recognizable at the point of sale due to their diminished branding, and because the branding itself is essential for premium brands to command higher prices (imagine trying to market a Gucci bag or a Mercedes sedan at their elevated price points without the trademark "Gs" or three-pointed star). In response, some consumers may switch to discount brands, which encourages smoking more cigarettes due to their comparatively lower price. Premium brands may also reduce their prices to compete better, which encourages smoking (even among consumers who stay with premium brands) for the same reason.

7.7.3 Smoking effects like these might be offset by simultaneous excise tax increases, but that does not change the fact that the non-price regulations by themselves may increase smoking. Smoking would increase less or decrease more if the excise taxes were implemented without the regulation.

7.8 In principle, therefore, packaging regulations could have the unintended effect of indirectly encouraging smoking through lower prices. Ultimately, the effect on smoking, if any, of packaging regulations is an empirical question.[113]

7.9 Another TPD2 policy, the option to ban cross-border distance sales of tobacco, intends to reduce access to cheaper and / or non-TPD2 compliant tobacco products from abroad (as well as prevent minors from purchasing cigarettes online), requiring consumers to pay more for smoking cigarettes domestically. However, similar to packaging regulations, this policy can have its own unintended effects. For example, countries banning cross-border distance sales of tobacco may inadvertently incentivize *in-person* cross-border shopping, where consumers travel to neighboring countries to purchase and stockpile lower priced cigarettes (some of which may be illicit if relevant duties are not paid). This may, in turn, result in more smoking. Again, the effect of cross-border sales bans on smoking is unclear in principle, and requires empirical analysis to answer.

7.10 In particular, if the non-price regulations contained in TPD2 succeed in making it more difficult and / or less acceptable for consumers to smoke, then it should be possible to detect this effect through lower rates of smoking in those time periods and/or countries that have implemented those regulations, compared to those time periods and/or countries that have not (other factors held constant).

7.11 I test for this effect in two ways:

7.11.1 First, by using regression analysis.

7.11.2 Second, by showing intercountry comparisons of trends in smoking rates between countries which differed in the timing and / or extent of their implementation of the picture warnings and cross-border distance sales policies from TPD2.

[113] See Jstor.org, "The Plain Truth about Plain Packaging: An Econometric Analysis of the Australian 2011 Tobacco Plain Packaging Act".

My Regression Analysis

7.12 In Section 5, I present the results of my regression analysis of the determinants of smoking prevalence across Europe. Although I focus in that section on the effect of e-cigarette regulation, my analysis also controls for other factors, such as cigarette price and non-price restrictions on smoking, including the requirement for large picture warnings found in TPD2, and as a by-product, produces an estimate of the effect of these other factors on smoking rates too.[114] For non-price restrictions on smoking, I rely on the "Non-Price Tobacco Control Index", which uses data contained in the Association of European Cancer Leagues' Tobacco Control Scale. This index captures the picture warning requirements contained in the TPD2 and other non-price restrictions such as the presence of public space smoking bans and bans on advertising and promotion.[115,116] In almost every country in my dataset, the Non-Price Tobacco Control Index increased after the introduction of TPD2, reflecting tighter non-price regulation of smoking.

7.13 As I explain in Section 5, and report in Table 5-2, my regression analysis shows there is inconclusive evidence that, holding constant the cigarette price index, tighter non-price cigarette restrictions have *any* effect on current smoking prevalence, because the relevant coefficient is not statistically significant. In fact, the estimated coefficient in my Preferred Model, which seeks to explain the variation in current smoking prevalence as a function of the price of tobacco, the extent of non-price tobacco restrictions, various demographic and socio-economic factors, and a measure of regulatory hostility towards e-cigarettes, is 0.07, a *positive* number. In other words, my analyses using Eurobarometer data suggest that if anything, such non-price cigarette regulations *increase* smoking rates. For example, in the 2013 TCS (before TPD2), Austria had 0 points awarded for "pictorial health warnings" (e.g., Austria had no picture health warnings in 2013). In the 2016 TCS, (after TPD2 was implemented), Austria scored 3 points in in this category after requiring picture warnings on cigarette packs and on packs of roll-your-own tobacco.[117] This 3-point increase is associated with an *increase* in current smoking prevalence of 0.07*3=0.21 percentage

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114 I explain these estimates in paragraph 5.15.

115 More specifically, the non-price component of the TCS index assigns points for each of the following categories: smoke-free work and other public places, spending on public information campaigns, comprehensive bans on advertising and promotion, large direct health warning labels, treatment to help smokers stop, and (since 2019) treatment to help smokers stop, illicit tobacco trade measures, measures against tobacco industry interference, and whether or not a country has ratified the WHO Framework Convention on Tobacco Control.

116 The non-price TCS index does not perfectly overlap with TPD2 restrictions. It captures measures not included in the TPD2 (such as public space smoking bans), while it does not capture some TPD2 measures such as the ban on characterizing flavours. It therefore cannot precisely measure the causal effect of TPD2.

The details of how the TCS index relates to TPD2 are presented in Table 16-2 in Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking. In particular, the TCS index assigns up to 3 points for "Pictorial health warnings on cigarette packs" (2 points) and "Pictorial health warning on hand rolling tobacco" (1 point).

117 See Tobacco Control Scale Report 2013, page 18; and Tobacco Control Scale Report 2016, page 21.

points.[118] However, the estimate is not statistically significant, and by itself is not a definitive indicator of the extent to which non-price tobacco regulations affect smoking and in what direction.

7.14 To the extent that the regulations either encourage consumers to switch to cheaper brands or sellers to reduce the price of some of the brands, that would reduce the marginal price that those consumers pay. The preferred model shows that such price reductions would result in additional smoking, which is the opposite of the intended effect of TPD2, and is suggested even by the 0.07 point estimate of the effect on smoking prevalence of non-price cigarette regulations.

7.15 To cross-check the results of my preferred model, I test various alternatives to my preferred model to ensure my overall conclusions are robust, and in none of those do I find that Non-Price Tobacco Control Index reduces smoking.[119]

My Country-level Analysis

7.16 Variation in how and when different member states implemented picture warnings and cross-border distance sales allows me to graphically examine if either of these policies had large effects on smoking trends. I do so in the remainder of this subsection first focusing on picture warnings, and second on cross-border distance sales

Picture Warnings

7.17 TPD1 required mandatory text warnings on cigarette and RYO packaging and gave member states the option to also include picture warnings. As a result, ten countries from my dataset introduced some form of picture warnings *before* the TPD2 implementation deadline in May 2016. After TPD2, all member states (including the UK at the time) were required to include both picture and text warnings covering at least 65% of the packaging.[120] As a result, 18 countries that had no picture warning regulations before 2016 introduced picture warnings for the first time in 2016 or the year after. I use this variation to split the countries in my dataset in two groups, summarized in the table below.

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118 Calculated by multiplying the Non-Price Tobacco Control Index coefficient of 0.07 by the increase in this index due to picture warnings.

119 Two sets of sensitivity analysis are relevant here. First, as described, in Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking, paragraph 12.7, I conduct 7 sensitivities of my preferred model. The Non-Price Tobacco Control Index is statistically insignificant in 6 out of the 7. In the remaining sensitivity (see paragraph 11.11 and table 11.3), the index is statistically significant at the 5% level, but the coefficient (+0.32), goes in the opposite direction to that intended by the regulations, suggesting that a 4-point increase in the index is associated with 0.64 percentage points higher smoking prevalence. Second, I conduct a regression where I split out the "picture warning" element of the TCS index from other non-price elements and find the effect of "picture warnings" is not statistically significant (and in the "wrong direction"); see Table 16-4.

120 See: Eur-lex.europa.eu, "Directive 2001/37/EC of the European Parliament and of the Council of 5 June 2001 on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco products", and Health.ec.europa.eu, "Directive 2014/40/EU"

Table 7-1: Countries with and without picture warnings before the TPD2 implementation in May 2016

Early adopters (picture warnings already in place pre-2016)	Late adopters (no picture warnings pre-2016)
Belgium, Denmark, France, Hungary, Ireland, Latvia, Malta, Romania, Spain, UK.	Austria, Bulgaria, Cyprus, Czech Republic, Estonia, Germany, Greece, Finland, Italy, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Sweden.

Note: I exclude Croatia from my analysis as it did not participate in the 2012 Eurobarometer survey.

7.18 I examine the potential effects of TPD2 picture warnings on smoking by comparing smoking trends between these "early" and "late adopters" of picture warnings. If picture warnings materially reduce smoking rates, I would expect the smoking trends between these two groups to look different. Specifically, all else equal, I would expect to see:

7.18.1 the early adopters of picture warnings already experiencing some of the effects of picture warnings, perhaps exhibiting a steeper downward trend in smoking pre-2016 compared to the late group; and / or

7.18.2 the late adopter group seeing a downward turn in their trend in smoking prevalence after 2016, relative to the early adopter group.

7.19 Figure 7-1 below presents my comparison, with early adopters in red, and late adopters in blue. **The figure does not show any of evidence of picture warnings causing smoking rates to fall.** Instead, it shows that:

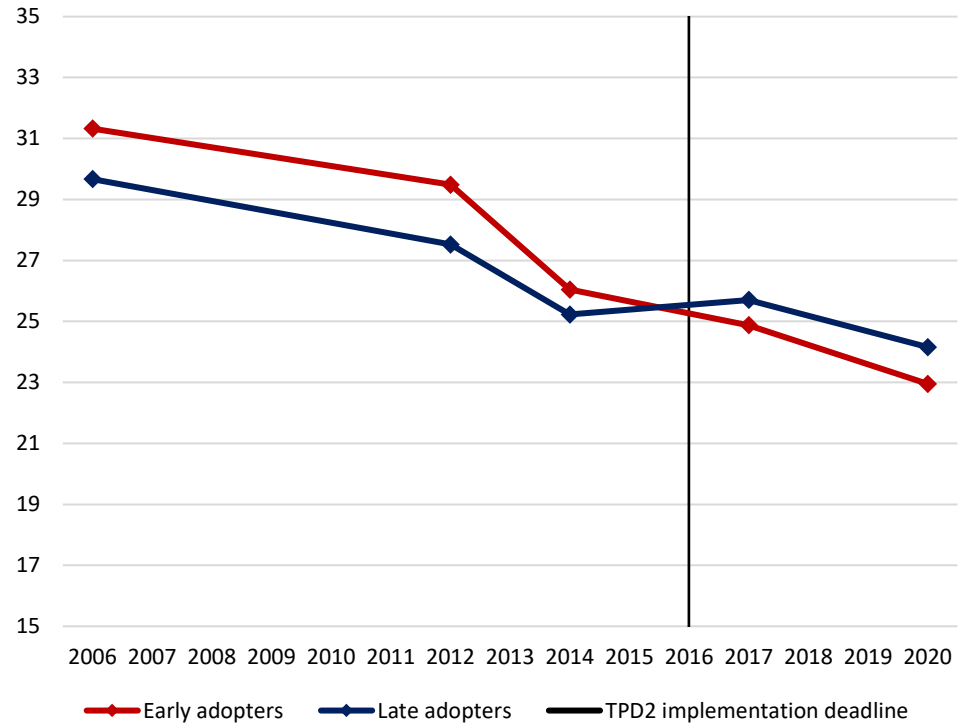
7.19.1 smoking trends pre-2016 are very similar between the early (red) and late (blue) groups of countries; and

7.19.2 there does not seem to be a clear downward change in the smoking trend for late adopters of picture warnings after 2016. If anything, the chart shows that smoking rates *increased* for late adopters after 2016,[121] which is consistent with the economic principles I explain above.

7.20 Note that some countries, like France and the UK, went beyond TPD2 picture warning requirements, and also implemented plain packaging (i.e., standardizing pack colors and brand name fonts across brands) on cigarettes in the period covered by my Eurobarometer data. I find that removing these countries from my analysis does not change my conclusions – see Figure 16-1 in Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking.

[121] However, this increase is not necessarily linked to TPD2 regulations backfiring and may be explainable by other factors (which current data does not allow exploring in detail).

Figure 7-1: Trends is smoking prevalence before and after picture warnings (current prevalence %)



Notes: (1) Country groupings as per Table 7-1. (2) Group smoking rates are calculated in the following way. First, I calculate average smoking rate per country, using the post-stratification weights by the Eurobarometer surveys. Second, I calculate the smoking rate in each group as the unweighted average of countries constituting the group. For more information on weights, see paragraph 11.5 in Appendix C: Dataset Construction.

Cross-Border Distance Sales (CBDS)

7.21 TPD2 also gave the option but not the obligation for member states to ban cross-border distance sales. According to the EC report (published in May 2021), 9 of the 28 countries in my dataset continue to allow cross-border distance sales, and 19 have banned them.[122] I assume the 19 countries which banned CBDS did so during or shortly after their TPD2 implementations in 2016 or 2017. The countries with and without CBDS bans over the period covered in my dataset (November 2006 to September 2020) are summarised in the table below.

[122] See: EC report, PDF page 99, and Table 16-3.

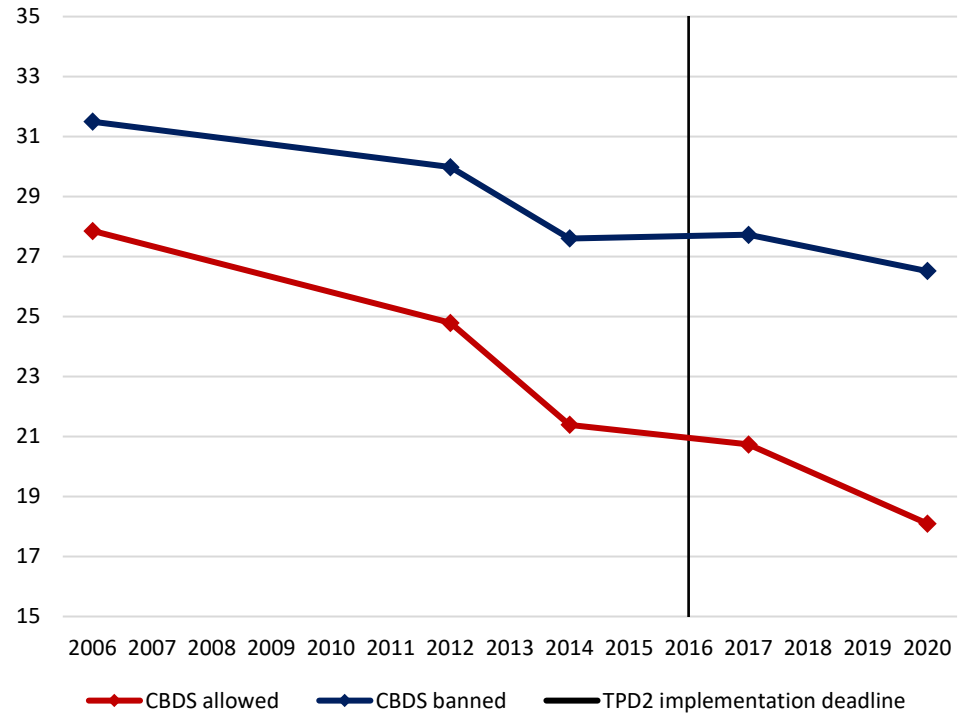
Table 7-2: Countries with and without cross-border distance sales bans in the as of May 2021 (post TPD2).

CBDS allowed	CBDS banned
Czech Republic, Denmark, Germany, Ireland, Malta, Netherlands, Slovakia, Sweden, UK	Austria, Belgium, Bulgaria, Cyprus, Estonia, Finland, France, Greece, Hungary, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Romania, Slovenia, Spain.

Note: I exclude Croatia from my analysis as it did not participate in the 2012 Eurobarometer survey.

7.22 I examine the potential effects of CBDS bans by comparing smoking trends before and after the introduction of the TPD2, and between the countries with and without a ban. If CBDS bans materially reduce smoking, I would expect this to be visible in smoking trends. Specifically, all else equal, the group of countries which banned CBDS during (or soon after 2016) should see a marked downward turn in their trend in smoking prevalence after 2016, relative to those countries which continued to allow cross-border sales. I present my comparison in Figure 7-2 below, with the group of countries which continued allowing cross-border distance sales in red, and the group which banned such sales following the TPD2 in blue. **The figure does not show any evidence of CBDS causing smoking rates to fall**. If anything, countries allowing CBDS saw faster declines in smoking post 2016 compared to countries banning CBDS (though this association not necessarily causal and may be due to other factors).

Figure 7-2: Trends in smoking prevalence before and after CBDS bans (current prevalence %)



Note: Country groupings as per Table 7-2.

7.23 Note that some late adopters of picture warnings continued allowing CBDS after 2016, and some of the countries who banned CBDS were early adopters of picture warnings. In theory, it is possible that the effect of introducing picture warnings while banning CBDS (and vice versa) go in opposite directions, complicating the comparisons presented in Figure 7-1 and Figure 7-2. To address this, I produce Figure 16-2 and Figure 16-3 in Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking which hold one policy constant while examining the possible effects of the other. Running these sensitivities does not change my conclusions, and therefore I continue to find no evidence that CBDS bans or picture warnings reduced smoking.

Conclusion

7.24 My empirical analysis does not find any evidence of reductions in smoking being caused by non-price cigarette regulations contained in the TPD2. Combined with my findings in earlier sections (which show that smoking and e-cigarettes are economic substitutes), I consider that (1) further (non-price) regulation of cigarettes is unlikely to meaningfully reduce rates of smoking, and (2) lighter touch regulation of RRPs, including e-cigarettes, that allows these products to compete more effectively as substitute products to cigarettes will result in meaningful reduction in rates of smoking.

8. Conclusions and Policy Implications[123]

8.1 RRP products are comparatively new, with low but growing market shares. In such an environment where newer products are still growing and gaining consumers, smoking data from several countries together with indicators of activity in the RRP market segment are essential for accurately determining whether RRPs are substitutes for or complements to cigarettes.

8.2 Eurobarometer provides such data. The Eurobarometer data through 2020 convincingly and consistently shows e-cigarettes and cigarettes to be substitutes. The use of e-cigarettes increases in markets where conventional cigarettes are expensive. Conventional smoking is more common in markets where regulations discourage the marketing, sale, and use of e-cigarettes. Similarly, there is evidence that flavored e-cigarettes and cigarettes are also substitutes and that restricting access to flavored e-cigarettes will increase rates of smoking.

8.3 Public health authorities have long understood that cigarette excise taxes discourage smoking, but illicit trade, increasing cigarette price-elasticities and other factors limit how high cigarette taxes can go. Authorities may then consider non-price cigarette regulations such as those contained in TPD2. However, my analysis does not find any evidence of reductions in smoking being caused by non-price cigarette regulations contained in the TPD2, and therefore, further non-price regulation of cigarettes is unlikely to meaningfully reduce rates of smoking. By definition, existing cigarette taxes are more effective at reducing smoking the more that consumers have nonsmoking substitutes available. The substitution findings in this report show that e-cigarettes are a prime example of such a substitute. The other side of the coin is that regulatory and tax constraints on e-cigarette sales diminish the amount by which existing cigarette taxes discourage smoking.

8.4 Based on the results of my analyses, less hostile RRP regulations could further reduce the number of smokers in Europe by at least 1 million people under current market conditions.

8.5 By 2020, e-cigarettes had gained many consumers, with many quitting smoking or choosing not to smoke in the first place. At the same time, the market has room to grow with many smokers who have yet to try e-cigarettes or who have tried e-cigarettes but have yet to find one they prefer to conventional cigarettes. Even aside from sustaining smoking by reducing the kinds of substitution documented in this report, hostile e-cigarette regulation risks preventing or delaying the entry of new RRPs that could do a better job convincing consumers to stop smoking or not to start smoking.

8.6 Put simply, regulatory hostility to e-cigarettes today will reduce the incentive of manufacturers to invest and innovate in developing more consumer-acceptable RRPs in the future and it will curb the opportunities for consumers to try these products. Thus, while the impact of strict regulations on the sale of e-cigarettes already can be seen in terms of increased prevalence of smoking, the impact on smoking prevalence over time and in the future may be even more significant as these regulations stifle product innovation and consumer choice.

[123] I reserve the right to supplement this report with further analyses and consideration of further data.

8.7 While the stakes of over-regulation stifling innovation are high in any industry, the stakes seem particularly high here given the enormous disease burden associated with smoking, and the opportunity for RRPs to reduce this disease burden by serving as substitutes for smoking, a substitution effect which my various analyses clearly and consistently demonstrate to be the case.

9. Appendix A: Bibliography

9.1 I list the books, papers, publications, and webpages referred to throughout this report below.

9.1.1 Abouk and Adams, Bans on electronic cigarette sales to minors and smoking among high school students, 2017

9.1.2 Bloomberg.com, "In world's happiest nation teens don't want to vape anymore", https://www.bloomberg.com/news/articles/2020-05-31/in-world-s-happiest-nation-teens-don-t-want-to-vape-anymore, Accessed May 2022

9.1.3 Business.gov.nl, "Amendment – Ban flavoured e-cigarettes", https://business.gov.nl/amendment/ban-flavoured-e-cigarettes/#:~:text=There%20will%20be%20a%20ban,a%20means%20to%20quit%20smoking., Accessed May 2022

9.1.4 cdc.gov, "YRBSS FAQ", https://www.cdc.gov/healthyyouth/data/yrbs/faq.htm, Accessed May 2022

9.1.5 Cdc.gov, "YRBSS" , https://www.cdc.gov/healthyyouth/data/yrbs/overview.htm, Accessed May 2022

9.1.6 Circabc.europa.eu, "Archived Excise Duty Tables", https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp, Accessed: March 2022

9.1.7 Clarke et al., Snus: a compelling harm reduction alternative to cigarettes, 2019

9.1.8 Clivebates.com, "Netherlands Response Jan 2021", https://clivebates.com/documents/NLFlavoursResponseJan2021.pdf, Accessed May 2022

9.1.9 Dailynewshungary.com, "Smoking and vaping rules in Hungary", https://dailynewshungary.com/smoking-and-vaping-rules-in-hungary/#:~:text=Advertising%20e%2Dcigarette%20is%20banned,border%20sale%20is%20also%20prohibited, Accessed May 2022

9.1.10 data.europa.eu, "Special Eurobarometer 429: Attitudes of European citizens towards tobacco and electronic cigarettes", https://data.europa.eu/data/datasets/s2033_82_4_429_eng?locale=en, Accessed: March 2022

9.1.11 data.europa.eu, "Special Eurobarometer 429: Attitudes of Europeans towards tobacco and electronic cigarettes", https://data.europa.eu/data/datasets/s2033_82_4_429_eng?locale=en, Accessed: May 2022

9.1.12 data.europa.eu, "Special Eurobarometer 468: Attitudes of European citizens towards the environment", https://data.europa.eu/data/datasets/s2156_88_1_468_eng?locale=en, Accessed: March 2022

9.1.13 data.europa.eu, “Special Eurobarometer 506: Attitudes of Europeans towards tobacco and electronic cigarettes”, https://data.europa.eu/data/datasets/s2240_506_eng?locale=en, Accessed: March 2022

9.1.14 Davidson and de Silva, The Plain Truth about Plain Packaging: An Econometric Analysis of the Australian 2011 Tobacco Plain Packaging Act, 2014

9.1.15 Day et al., Point of Sale Scanner Data for Rapid Surveillance of the E-cigarette Market, 2017

9.1.16 Ecigintelligence.com, “Finland takes a hard line banning all flavours except tobacco”, https://ecigintelligence.com/finland-takes-a-hard-line-banning-all-flavours-except-tobacco/#:~:text=Finland%20has%20gone%20further%20than,a%20characterising%20flavour%20or%20aroma%E2%80%9D., Accessed May 2022

9.1.17 Ec.europa.eu, “Evaluation of the legislative framework for tobacco control”, https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13481-Evaluation-of-the-legislative-framework-for-tobacco-control_en, Accessed April 2023

9.1.18 Eur-lex.europa.eu, “Directive 2001/37/EC of the European Parliament and of the Council of 5 June 2001 on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco products”, https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0037:EN:HTML, Accessed April 2023

9.1.19 Euro.who, “Strong legislation helps defeat e-cigarettes in Finland”, https://www.euro.who.int/en/countries/finland/news/news/2020/5/strong-legislation-helps-defeat-e-cigarettes-in-finland, Accessed May 2022

9.1.20 Eurobarometer, Special Eurobarometer 506: Attitudes of Europeans towards tobacco and electronic cigarettes, 2021

9.1.21 Europa.eu, “Draft Law No XIIIP-3849(3)”, https://ec.europa.eu/growth/tools-databases/tris/en/search/?trisaction=search.detail&year=2021&num=434, Accessed May 2022

9.1.22 Europa.eu/eurobarometer, “About Eurobarometer”, https://europa.eu/eurobarometer/about/eurobarometer, Accessed: March 2022

9.1.23 europa.eu/eurostat, “Glossary:Country codes”, https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Country_codes, Accessed: March 2022

9.1.24 europa.eu/eurostat, “HICP – monthly data (index) – All-items”, https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MIDX__custom_2146916/default/table?lang=en, Accessed: March 2022

9.1.25 europa.eu/eurostat, “HICP – monthly data (index) - Tobacco”, https://ec.europa.eu/eurostat/databrowser/view/PRC_HICP_MIDX__custom_214

6893/default/table?lang=en, Accessed: March 2022

9.1.26 Europa.eu/eurostat, “Population on 1 January by broad age group and sex”, https://ec.europa.eu/eurostat/databrowser/view/DEMO_PJANBROAD__custom_2178241/default/table?lang=en, Accessed: March 2022

9.1.27 europa.eu/eurostat, “Reference and Management of Nomenclatures”, https://ec.europa.eu/eurostat/ramon/nomenclatures/index.cfm?TargetUrl=DSP_NOM_DTL_VIEW&StrNom=HICP_2000&StrLanguageCode=EN&IntPcKey=37592681&IntKey=37592921&StrLayoutCode=HIERARCHIC&IntCurrentPage=1, Accessed: March 2022

9.1.28 European Commission, Compulsory Education in Europe, 2019/20

9.1.29 European Commission, Compulsory Education in Europe, 2020/21

9.1.30 European Commission, Tobacco Products Directive, 2014

9.1.31 Everitt and Skrondal, The Cambridge Dictionary of Statistics, Fourth Edition, 2010

9.1.32 Fda.gov, “FDA grants first-ever modified risk orders to eight smokeless tobacco products”, https://www.fda.gov/news-events/press-announcements/fda-grants-first-ever-modified-risk-orders-eight-smokeless-tobacco-products, Accessed May 2023

9.1.33 Feliu et al., Impact of tobacco control policies on smoking prevalence and quit ratios in 27 European Union countries from 2006 to 2014, 2018

9.1.34 Filtermag.org, “San Francisco vape flavor ban teen smoking”, https://filtermag.org/san-francisco-vape-flavor-ban-teen-smoking/#:~:text=In%20the%20summer%20of,the%20city%20was%20immediately%20compliant., Accessed May 2022

9.1.35 Flor et al., The effects of tobacco control policies on global smoking prevalence, 2021

9.1.36 Friedman and Xu, Associations of flavored e-cigarette uptake with subsequent smoking initiation and cessation, 2020

9.1.37 Friedman, A difference-in-difference analysis of youth smoking and a ban on sales of flavored tobacco products in San Francisco, California, 2021

9.1.38 Friedman, How does electronic cigarette access affect adolescent smoking, 2015

9.1.39 Gammon et al., Implementation of a comprehensive flavoured tobacco product sales restriction and retail tobacco sales, 2021

9.1.40 Gesis.org, “Eurobarometer 66.2”, https://search.gesis.org/research_data/ZA4527, Accessed: March 2022

9.1.41 Gesis.org, “Eurobarometer 77.1”, https://search.gesis.org/research_data/ZA5597, Accessed: March 2022

9.1.42 Gesis.org, “Eurobarometer 82.4”, https://search.gesis.org/research_data/ZA5933, Accessed: March 2022

9.1.43 Gesis.org, “Eurobarometer 87.1”, https://search.gesis.org/research_data/ZA6861, Accessed: March 2022

9.1.44 Gesis.org, “Eurobarometer 93.2”, https://search.gesis.org/research_data/ZA7739, Accessed: March 2022

9.1.45 Gesis.org, “Standard and Special Eurobarometer”, https://dbk.gesis.org/dbksearch/gdesc2.asp?no=0008&search=&search2=&db=e&tab=0%C2%ACabs=&nf=1&af=&ll=10, Accessed March 2022

9.1.46 Gesis.org, “Usage regulations”, https://www.gesis.org/fileadmin/user_upload/Usage_regulations.pdf, Accessed: March 2022

9.1.47 Gesis.org, “Weighting overview”, https://www.gesis.org/en/eurobarometer-data-service/survey-series/standard-special-eb/weighting-overview, Accessed: March 2022

9.1.48 ghdx.healthdata.org, “Global Tobacco Control and Smoking Prevalence Scenarios 2017, http://ghdx.healthdata.org/record/ihme-data/global-tobacco-control-and-smoking-prevalence-scenarios-2017, Accessed: March 2022

9.1.49 Globaltobaccocontrol.org, “Country Laws Regulating E-Cigarettes”, https://globaltobaccocontrol.org/en/policy-scan/e-cigarettes/countries?country=104, Accessed: March 2022

9.1.50 Gov.uk, “Behavioural Insights Team Annual update 2010-11”, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/60537/Behaviour-Change-Insight-Team-Annual-Update_acc.pdf, Accessed: March 2022

9.1.51 Gov.uk, “Cross-border distance sales of tobacco and e-cigarettes: registration guide”, https://www.gov.uk/government/publications/tobacco-products-and-e-cigarette-cross-border-sales-registration/guide-to-making-registrations, Accessed April 2023

9.1.52 Health.ec.europa.eu, “Directive 2014/40/EU of the European Parliament and of the Council of 3 April 2014 on the approximation of the laws, regulations and administrative provisions of the Member States concerning the manufacture, presentation and sale of tobacco and related products and repealing Directive 2001/37/EC”, https://health.ec.europa.eu/system/files/2016-11/dir_201440_en_0.pdf, Accessed April 2023

9.1.53 Health.ec.europa.eu, “Revision of the Tobacco Products Directive” https://health.ec.europa.eu/tobacco/product-regulation/implementing-tobacco-products-directive-directive-201440eu/revision-tobacco-products-directive_en, Accessed April 2023

9.1.54 Icf.com, “About”, https://www.icf.com/company/about, Accessed May 2022

9.1.55 IEA, Nanny State Index, 2016

9.1.56 Jaffe et al., Chicago Price Theory, 2019

9.1.57 Jeffreys, Sir Harold. The Theory of Probability. New York: Oxford University Press, 1961

9.1.58 Jehle and Reny Advanced Microeconomic Theory, 3rd edition, 2011

9.1.59 jhsph.edu, "About Us", https://www.jhsph.edu/research/centers-and-institutes/institute-for-global-tobacco-control/about-us/, Accessed: March 2022

9.1.60 Jstor.org, "The Plain Truth about Plain Packaging: An Econometric Analysis of the Australian 2011 Tobacco Plain Packaging Act", https://www.jstor.org/stable/43610634, Accessed April 2023

9.1.61 julkari.fi, "Tupakkatilasto 2020", https://www.julkari.fi/bitstream/handle/10024/143281/Tupakkatilasto%202020%20full.pdf?sequence=3&isAllowed=y, Accessed May 2022

9.1.62 juullabs.it, "Shop", https://www.juullabs.it/shop, Accessed: March 2022

9.1.63 Kennedy, P., A guide to econometrics, Wiley-Blackwell, 2008

9.1.64 Kulik et al., E-cigarettes Associated With Depressed Smoking Cessation: A Cross-sectional Study of 28 European Union Countries

9.1.65 Lavine and Schervish. "Bayes Factors: What They Are and What They Are Not." The American Statistician. 1999

9.1.66 Lee, Michael D. and Eric-Jan Wagenmakers. Bayesian Cognitive Modeling. Cambridge University Press, 2013.

9.1.67 Lidon – Moyano et al., Correlation between tobacco control policies, consumption of rolled tobacco and e-cigarettes, and intention to quit conventional tobacco, in Europe, 2017

9.1.68 Maki, The incentives created by a harm reduction approach to smoking cessation: Snus and smoking in Sweden and Finland, 2014

9.1.69 Marsman and Wagenmakers, Three Insights from a Bayesian Interpretation of the One-Sided P Value. Educational and Psychological Measurement, 2017.

9.1.70 Meanings.com, "How much liquid is in a Juul pod", https://meanings.co/def/know-how-much-liquid-is-in-a-juul-pod-93216/, Accessed: March 2022

9.1.71 Mulligan, Prices and Federal Policies in Opioid Markets, 2020

9.1.72 Nannystateindex.og, "Hungary 2017", http://nannystateindex.org/hungary-2017/, Accessed May 2022

9.1.73 Nannystateindex.org, "Estonia 2021", http://nannystateindex.org/estonia-2021/, Accessed May 2022

9.1.74 Nannystateindex.org, Accessed: March 2022

9.1.75 Ncbi.nlm.gov, "Tobacco control achievements and priority areas in the WHO Europe Region: A review". https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7205061/, Accessed April 2023

9.1.76 Net.jogtar.hu, “jogszabaly”, https://net.jogtar.hu/jogszabaly?docid=a1300039.kor#lbj80id8ad8, Accessed May 2022

9.1.77 NHS.uk, “Using e-cigarettes to stop smoking”, https://www.nhs.uk/live-well/quit-smoking/using-e-cigarettes-to-stop-smoking/, Accessed: March 2022

9.1.78 Observatoireprevention.org, “Banning flavoured vaping liquids a very bad idea”, https://observatoireprevention.org/en/2021/09/27/banning-flavoured-vaping-liquids-a-very-bad-idea/, Accessed May 2022

9.1.79 Official Journal of the European Union, Directives, 2014

9.1.80 Pesko et al, The Influence of Electronic Cigarette Age Purchasing Restrictions on Adolescent Tobacco and Marijuana Use, 2016

9.1.81 Pesko et al., The Effects of Traditional Cigarette and E-Cigarette Taxes on Adult Tobacco Product Use, 2020

9.1.82 PHE, Electronic cigarettes: A report commissioned by Public Health England, 2014

9.1.83 PMI.com, “Philip Morris launches revolutionary heated tobacco product – First in the UK”, https://www.pmi.com/markets/united-kingdom/en/news/detail/philip-morris-launches-revolutionary-heated-tobacco-product-first-in-uk, Accessed March 2022

9.1.84 Profglantz.com, “Study claiming SF flavor ban increased youth smoking dissolves it is not based on any data collected after enforcing the ban”, https://profglantz.com/2022/03/21/study-claiming-sf-flavor-ban-increased-youth-smoking-dissolves-it-is-not-based-on-any-data-collected-after-enforcing-the-ban/, Accessed May 2022

9.1.85 Rand.org, “About”, https://www.rand.org/randeurope/about.html, Accessed May 2022

9.1.86 Rcplondon.ac.uk, “Nicotine without smoke: Tobacco harm reduction”, https://www.rcplondon.ac.uk/projects/outputs/nicotine-without-smoke-tobacco-harm-reduction, Accessed May 2022

9.1.87 Rte.ie, “ Ban on ten-pack cigarettes in effect”, https://www.rte.ie/news/2007/0531/89559-cigarettes/, Accessed April 2023

9.1.88 Rubin, Estimating causal effects of treatments in randomized and nonrandomized studies, 1974

9.1.89 Ruokolainen et al., Correlates of e-cigarette use before and after comprehensive regulatory changes and e-liquid flavor ban among general population, 2022

9.1.90 Salokannel and Ollilia, Snus and snus-like nicotine products moving across Nordic borders: Can laws protect young people?, 2021

9.1.91 Sfdph.org, “Flavored tobacco”, https://www.sfdph.org/dph/eh/tobacco/flavoredtobacco.asp, Accessed May 2022

9.1.92 Shah, Britton and Bogdanovica, Developing a novel e-cigarette regulatory and policy control scale: results from the European Union, 2021

9.1.93 Stata.com, "How do you test the equality of regression coefficients that are generated from two different regressions, estimated on two different samples?", https://www.stata.com/support/faqs/statistics/test-equality-of-coefficients/, Accessed: March 2022

9.1.94 Statology.org, "Confidence Interval for the Difference in Proportions", https://www.statology.org/confidence-interval-difference-in-proportions/, Accessed: May 2022

9.1.95 Suomenash.fi, "Snus", https://suomenash.fi/en/facts-about-smoking/snus/, Accessed May 2022Thetimes.co.uk, "Finland set to stub out smoking by 2030", https://www.thetimes.co.uk/article/finland-set-to-stub-out-smoking-by-2030-9g7xmc8g3, Accessed May 2022

9.1.96 Tobacco Control Scale Reports 2013, 2016, 2019, 2021. https://www.tobaccocontrolscale.org/the-reports/. Accessed April 2023.

9.1.97 Tobaccocontrollaws.org, "Legislation", https://www.tobaccocontrollaws.org/legislation, Accessed: March 2022

9.1.98 Tobaccocontrolllaws.org, "Finland", https://www.tobaccocontrollaws.org/legislation/country/finland/summary, Accessed May 2022

9.1.99 Tobaccocontrolscale.org, "Home page", https://www.tobaccocontrolscale.org/, Accessed: March 2022

9.1.100 tobaccocontrolscale.org, "The Reports", https://www.tobaccocontrolscale.org/the-reports/, Accessed: March 2022

9.1.101 Tobaccofreekids.org, "About Us", https://www.tobaccofreekids.org/about/, Accessed: March 2022

9.1.102 Tobaccofreekids.org, "Belgium", https://www.tobaccofreekids.org/assets/global/pdfs/en/WL_country_Belgium_en.pdf, Accessed April 2023

9.1.103 Tobaccofreekids.org, "Lates News - 2020 through January 2022 – The Netherlands has implemented plain packaging laws for cigarettes, rolling tobacco, e-cigarettes, and cigars", https://www.tobaccofreekids.org/plainpackaging/news-and-updates#:~:text=The%20rules%20were%20to%20be,for%20e%2Dcigarettes%20and%20cigars, Accessed April 2023

9.1.104 Tobaccoinaustralia.org.au, "Health warnings used in other countries", https://www.tobaccoinaustralia.org.au/chapter-12-tobacco-products/attachment-12-1-health-warnings/12a-2-health-warnings-used-in-other-countries, Accessed April 2023

9.1.105 Tobaccoinduceddiseases.org, "Plain packaging on tobacco products in France: Effectiveness on smokers' attitudes one year after implementation",

http://www.tobaccoinduceddiseases.org/Plain-packaging-on-tobacco-products-in-France-Effectiveness-non-smokers-attitudes,146600,0,2.html, Accessed April 2023

9.1.106 Tobaccolabels.ca, “Denmark”, https://tobaccolabels.ca/countries/denmark/, Accessed April 2023

9.1.107 Tobaccolabels.ca, “France”, https://tobaccolabels.ca/countries/france/, Accessed April 2023

9.1.108 Tobaccolabels.ca, “Hungary”, https://tobaccolabels.ca/countries/hungary/, Accessed April 2023

9.1.109 Tobaccolabels.ca, “Ireland”, https://tobaccolabels.ca/countries/ireland/, Accessed April 2023

9.1.110 Tobaccolabels.ca, “Latvia”, https://tobaccolabels.ca/countries/latvia/, Accessed April 2023

9.1.111 Tobaccolables.ca, “Malta”, https://tobaccolabels.ca/countries/malta/, Accessed April 2023

9.1.112 Tobaccolabels.ca, “Romania”, https://tobaccolabels.ca/countries/romania/, Accessed April 2023

9.1.113 Tobaccolabels.ca, “Spain to require picture warnings”, https://tobaccolabels.ca/spain-to-require-picture-warnings/, Accessed 2023

9.1.114 Tobaccolabels.ca, “United Kingdom”, https://tobaccolabels.ca/countries/united-kingdom/, Accessed April 2023

9.1.115 Underwood and Sun, The effectiveness of plain packaging in discouraging tobacco consumption in Australia, 2020

9.1.116 Untobaccocontrol.org, “Slovenia passes law to require plain tobacco packaging from 2020”, https://untobaccocontrol.org/impldb/slovenia-passes-law-to-require-plain-tobacco-packaging-from-2020/, Accessed April 2023Vaping.trusticert.com, “Estonia softens the e-cig regulation”, https://vaping.trusticert.com/en/estonia-softens-the-e-cig-regulation/, Accessed May 2022

9.1.117 Vaping360.com, “Denmark will ban flavours and impose a huge e-liquid tax”, https://vaping360.com/vape-news/107594/denmark-will-ban-flavors-and-impose-a-huge-e-liquid-tax/, Accessed May 2022

9.1.118 Vaping360.com, “Sweden will prohibit vape flavours”, https://vaping360.com/vape-news/113411/sweden-will-prohibit-vape-flavors/#:~:text=The%20Swedish%20government%20has%20formally,1%2C%202023., Accessed May 2022

9.1.119 vaporproductstax.com, “About”, https://vaporproductstax.com/about/, Accessed: March 2022

9.1.120 Vyas et al., Compliance with San Francisco’s flavoured tobacco sales prohibition, 2020

9.1.121 WFP, Introduction to post-stratification, 2017

9.1.122 WHO, Framework Convention on Tobacco Control, 2003

9.1.123 WHO, Guidelines for implementation of Article 8, 2007

9.1.124 Wikipedia.org, “Snus”, https://en.wikipedia.org/wiki/Snus, Accessed May 2022

9.1.125 World Bank Group: E-cigarettes: Use and Taxation, 2019

9.1.126 Worldbank.org, “Tobacco Control”, http://web.worldbank.org/archive/website01213/WEB/0__CON-8.HTM, Accessed March 2022

9.1.127 Yang et al., The impact of a comprehensive tobacco product flavor ban in San Francisco among young adults, 2020

10. Appendix B: Data

10.1 The analyses presented in this report rely on freely and publicly available data collected from various sources. This Annex lists and describes all sources used in constructing the dataset underlying my analysis. The data sources are grouped into:

10.1.1 Data derived from the Eurobarometer surveys, which is used to construct the dependent variable (i.e. my measure of smoking prevalence), my measure of e-cigarette use, and various socio-economic control variables;

10.1.2 Data used to construct variables capturing price and non-price regulatory measures relating to traditional tobacco products; and

10.1.3 Data used to construct the variables measuring the hostility of regulation towards e-cigarettes, which determine restrictions on access to the products.

10.2 The remainder of the Appendix provides details on each of the above.

Data Derived from Eurobarometer

10.3 The Eurobarometer is described as "*the polling instrument used by the European Commission, the European Parliament and other EU institutions and agencies to monitor regularly the state of public opinion in Europe on issues related to the European Union as well as attitudes on subjects of political or social nature. Eurobarometer provides quality and relevant data for experts in public opinion, researchers, media and the public.*"[124]

10.4 The surveys are regularly administered to random, representative samples of people aged 15 and older, in each of the 27 EU member states and the UK. The raw underlying data from each Eurobarometer survey is maintained and published by GESIS.[125] The survey "*data and documents are released for everybody*", for all purposes including commercial.[126] The Eurobarometer surveys provide high quality data that is comparable across countries (since the same base questions are asked in each country) and over time (since similar questions are asked in each wave).

10.5 In addition to the "*Standard Eurobarometer*" biannual surveys, there are "*Special Eurobarometer*" surveys that are conducted less frequently but represent "*in-depth thematic studies*" of particular issues – including the attitudes of Europeans towards tobacco and electronic cigarettes.[127]

10.6 In particular, I use the following waves of the Special Eurobarometer survey measuring attitudes towards tobacco and e-cigarettes:

10.6.1 Wave 66.2. This survey was conducted in October – November 2006 and the data

[124] See: Europa.eu/eurobarometer, "About Eurobarometer"

[125] See here (a free account is required to download the data): Gesis.org, "Standard and Special Eurobarometer"

[126] See access category 0 on page 2 here: Gesis.org, "Usage regulations"

[127] Europa.eu/eurobarometer, "About Eurobarometer"

published in 2012.[128]

10.6.2 Wave 77.1. This survey was conducted in February-March 2012 and the data published in 2014.[129]

10.6.3 Wave 82.4. This survey was conducted in November-December 2014 and the data published in 2018.[130]

10.6.4 Wave 87.1. This survey was conducted in March 2017 and the data published in 2021.[131]

10.6.5 Wave 93.2. Survey was conducted in August-September 2020 and data published in 2021.[132]

10.7 Across these various surveys, questions on the use of traditional burning tobacco products (e.g., boxed and hand-rolled cigarettes, cigars and pipes) are available since 2002, while an increasing number of questions on the use of electronic cigarettes and other new "reduced risk" products start being included from 2012 onwards. Specifically:

10.7.1 The 2012 wave asks respondents if they have heard of, or are current or past users of, e-cigarettes, without distinguishing between current or past use.[133] There are no explicit questions about heat-not-burn products.

10.7.2 The 2014 and 2017 waves add questions on the frequency of use of e-cigarettes (still without explicitly asking about heat-not-burn products).

10.7.3 The 2020 wave adds explicit questions on the frequency of use of heat-not-burn products (separately from e-cigarettes questions).

10.8 In my analysis I focus only on e-cigarettes as this is the only category of emerging reduced risk products where consistent information is available since 2014.

10.9 For each wave, I obtain:

10.9.1 the survey questionnaire, in English;

10.9.2 a ".dta" file containing the raw, individual-level responses to the questionnaire and survey weights. The .dta file is a table where each row represents an individual respondent, and each column represents that respondent's answer to a survey question. There are additional columns containing survey weights for each individual; and

10.9.3 a 'codebook' describing the different columns in the dataset and explaining the

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128 Gesis.org, "Eurobarometer 66.2"

129 Gesis.org, "Eurobarometer 77.1"

130 Gesis.org, "Eurobarometer 82.4"

131 Gesis.org, "Eurobarometer 87.1"

132 Gesis.org, "Eurobarometer 93.2"

133 The question asked respondents is: "*Have you ever tried electronic cigarettes?*", and the possible answers are: "*Yes, you use or used it regularly*"; "*Yes, you use or used it occasionally*"; "*Yes, you tried it once or twice*"; "*No*".

different survey weights made available.

10.10 I use various Eurobarometer questions to construct measures of:

10.10.1 current smoking prevalence;

10.10.2 e-cigarette use prevalence; and

10.10.3 socio-economic control variables.

10.11 The specific questions I use are described below, along with how they are used to construct variables in my dataset, as described in Appendix C: Dataset Construction.

Current Smoking Prevalence

10.12 The dependent variable used in my analysis measures the proportion of respondents (in a given group) who report being current smokers of traditional burning tobacco products ("current smoking prevalence"). Table 10-1 below shows, for each wave, the question I used to determine whether an individual is a current smoker.

10.13 The 2006 wave asks respondents to separately identify each form of tobacco they use. To make this consistent with subsequent waves, a respondent is labelled a current smoker if they mention smoking at least one form of burning tobacco.

Table 10-1: Questions used to determine smoking status of respondents

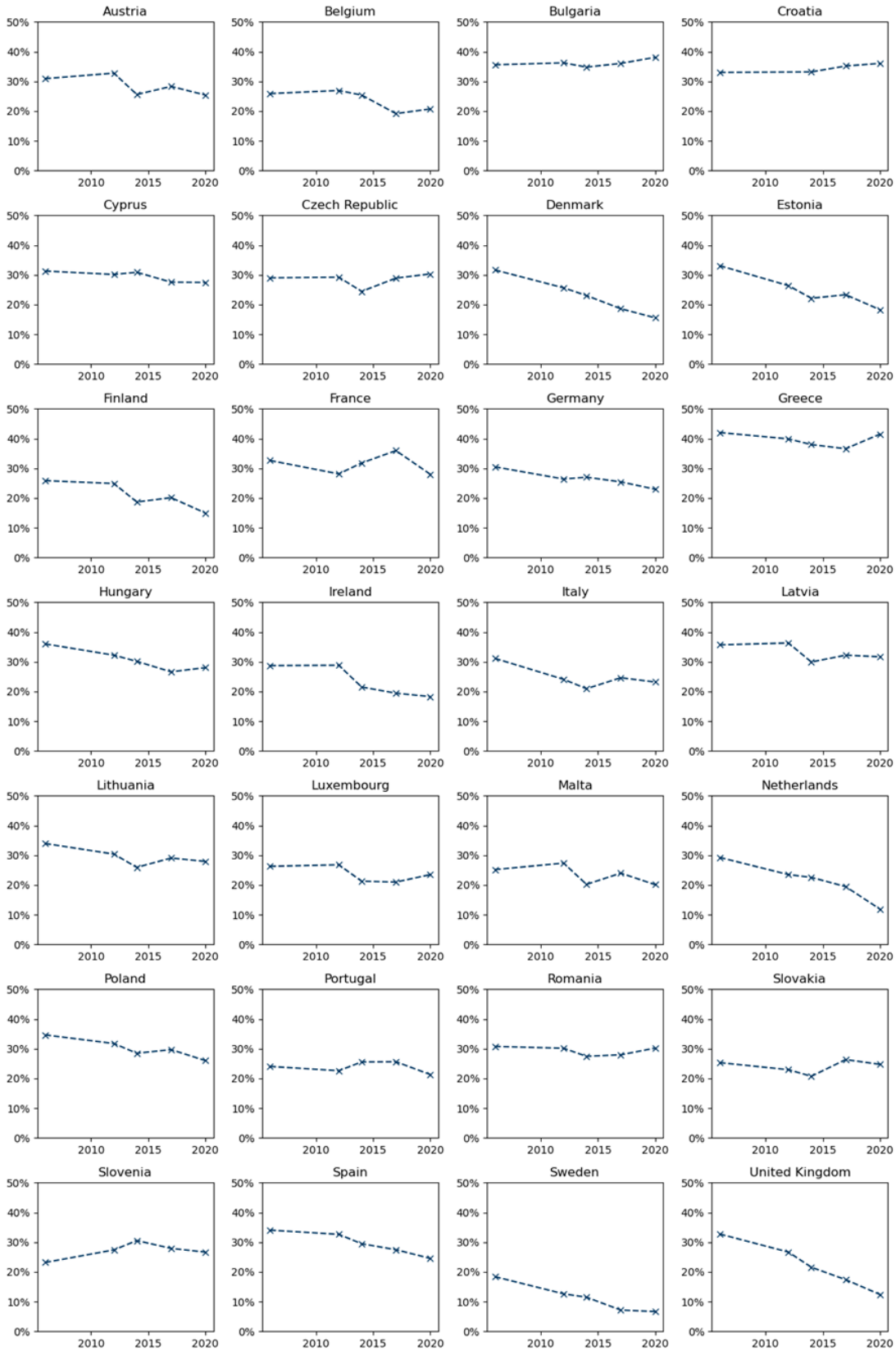
	Question	Possible Answers	Definition of Current Smoker
2006 wave	QB19 - Which of the following applies to you?	1. You smoke packed cigarettes 2. You smoke roll-up cigarettes 3. You smoke cigars or a pipe 4. You chew tobacco or take snuff 5. You used to smoke but you have stopped 6. You have never smoked 7. Other 8. Don't know	Answered at least one of 1, 2, 3.
2012 wave	QD1 - Regarding smoking cigarettes, cigars or a pipe, which of the following applies to you?	1. You currently smoke 2. You used to smoke but you have stopped 3. You have never smoked 4. Don't know	Answered 1 only.
2014 wave	QC1 - Regarding smoking cigarettes, cigars, cigarillos or a pipe, which of the following applies to you?	1. You currently smoke 2. You used to smoke but you have stopped 3. You have never smoked 4. Don't know	Answered 1 only.

	Question	Possible Answers	Definition of Current Smoker
2017 wave	QC1 - Regarding smoking cigarettes, cigars, cigarillos or a pipe, which of the following applies to you?	1. You currently smoke 2. You used to smoke but you have stopped 3. You have never smoked 4. Don't know	Answered 1 only.
2020 wave	QC1 - Regarding smoking cigarettes, cigars, cigarillos or a pipe, which of the following applies to you?	1. You currently smoke 2. You used to smoke but you have stopped 3. You have never smoked 4. Don't know	Answered 1 only.

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2

10.14 Figure 10-1 below shows the trends in current smoking prevalence for each European country covered by Eurobarometer, between 2006 and 2020.

Figure 10-1: Current smoking prevalence



Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2

Current E-cigarette Use Prevalence

10.15 In Section 4, I consider the association between smoking and e-cigarette use, for which I require a measure of current e-cigarette prevalence, comparable to the current smoking prevalence variable referred to above. Table 10-2 below shows, for each wave, the question I use to determine whether an individual is a current e-cigarette user.

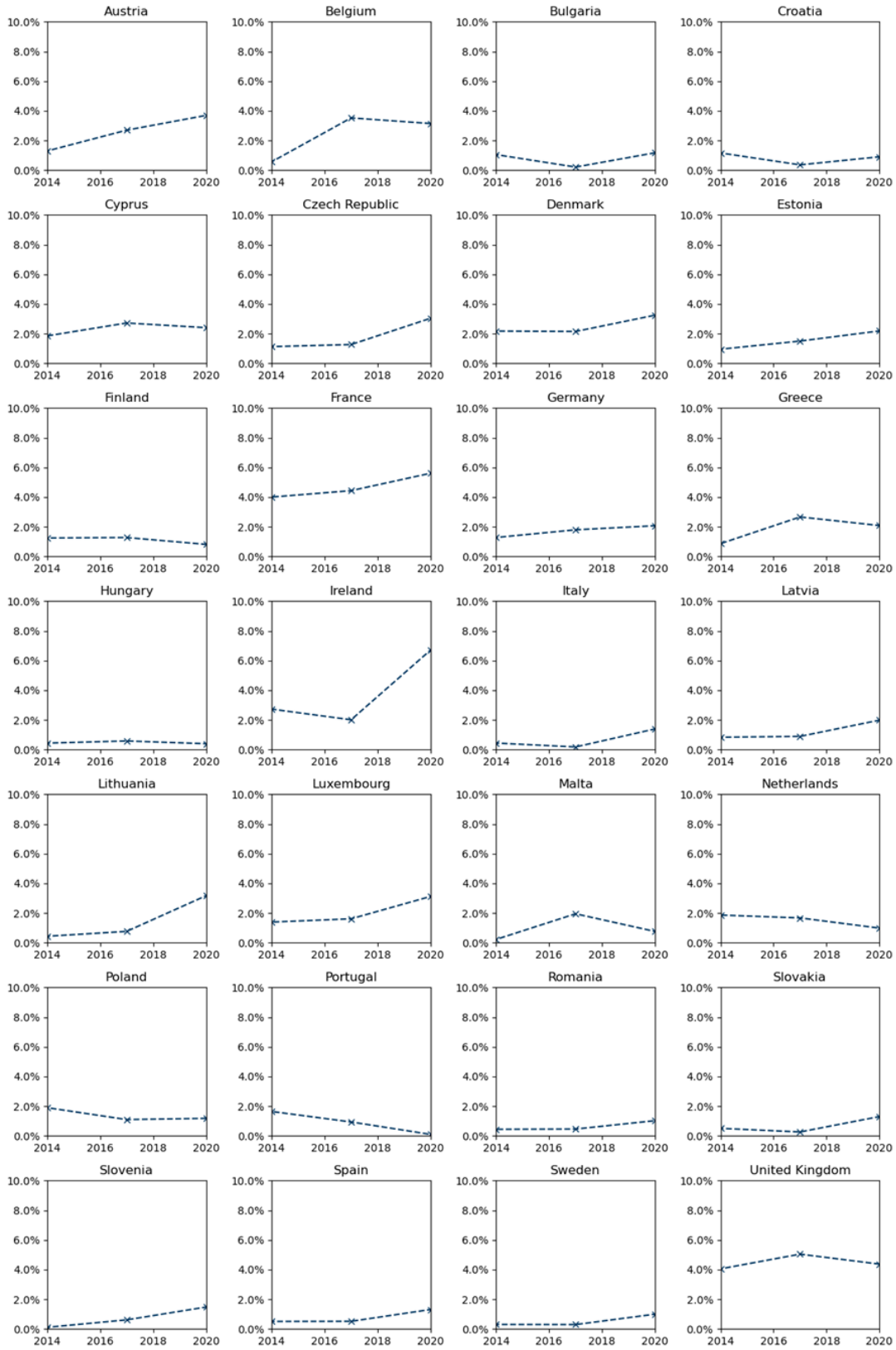
Table 10-2: Questions used to determine e-cigarette use status of respondents

	Question	Possible Answers	Definition of E-cigarette user
2006 wave	N/A	N/A	Missing data
2012 wave	QD4. Have you ever tried the following products? [Electronic cigarettes]	1. Yes, you use or used it regularly 2. Yes, you use or used to use it occasionally 3. Yes, you tried it once or twice 4. No 5. Don't know	Answered 1 only.
2014 wave	QC9. Regarding the use of electronic cigarettes or any similar electronic devices (e-shisha, e-pipe), which of the following statements applies to you?	1. You currently use electronic cigarettes or similar electronic devices (e.g. e-shisha, e-pipe). 2. You used them in the past, but no longer use them. 3. You tried them in the past but no longer use them 4. You have never used them 5. Don't know	Answered 1 only.
2017 wave	QB11. Which of the following statements about the use of electronic cigarettes or any similar electronic devices (e-shisha, e-pipe) applies to you?	1. You currently use electronic cigarettes or similar electronic devices (e.g. e-shisha, e-pipe). 2. You used them in the past, but no longer use them. 3. You tried them in the past but no longer use them 4. You have never used them 5. Don't know	Answered 1 only.
2020 wave	QC3. Thinking about the following products, which of the following applies to you? [E-cigarettes]	1. You currently use it 2. You used to use it but you have stopped 3. You have only tried it once or twice 4. You have never used it 5. Don't know	Answered 1 only.

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

10.16 Figure 10-2 below shows the trends in current e-cigarette use prevalence for each European country covered by Eurobarometer, between 2006 and 2020.

Figure 10-2: Current e-cigarette use prevalence



Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

Socio-economic Factors

10.17 The Eurobarometer surveys contain questions relating to socio-economic factors which are generally taken into account in economic studies of smoking demand. The questions that I use relate to:

10.17.1 **Age.** Respondents are asked how old they are. I group respondents into three age groups: those between 15 and 24 years old, those between 25 and 54 years old, and those 55 and older. These age categories represent a balance between being narrow enough to identify youth vs older individuals, and broad enough to ensure each category contains enough respondents and no category is too small or empty. The categories are consistent with the youngest/central/oldest age-group split the European Commission uses in its reports of the tobacco Eurobarometer surveys.[134] The specific questions and answers I use, in each wave, are identified in Table 10-3 below.

10.17.2 **Gender.** Respondents are asked to identify their gender. The specific questions and answers I use, in each wave, are identified in Table 10-4 below.

10.17.3 **Country of residence.** The data for each wave contains a column to indicate which country each survey was conducted in.[135]

10.17.4 **Employment status.** Respondents are asked their current occupation, from which I calculate a measure of unemployment. The specific questions and answers I use, in each wave, are identified in Table 10-5 below.

10.17.5 **Education status**: Respondents are asked how old they were when they left full-time education, from which I identify those who left formal education between the ages of 16 and 18. I define the category in this way because compulsory secondary education in most countries from my dataset ends between the ages of 16 and 18.[136] In its reports on the tobacco Eurobarometer, the European Commission defines a similar education category, but for people who left full-time education between the ages of 16 and 19.[137] I exclude the group of people who left education at 19 because this group is likely to contain a higher proportion of people who remained in education beyond what is required by law (and thus have a different 'level' of education compared to those who left between 16 and 18). I show in Appendix D: Regression Analysis, paragraph 12.25 that my overall conclusions are robust to changing this variable.

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134 See for example p15 in Eurobarometer (2021)

135 The country variable is used construct reference groups along with age and gender. The following alterations are made to the country variable: East and West Germany are grouped into a united Germany, and Norther Ireland and Great Britain are combined into the United Kingdom (see paragraph 11.13-11.14); and Northern Cyprus is dropped.

136 See table here in European Commission (2020/21)

137 See for example p20 in Eurobarometer (2021)

Table 10-3: Questions used to determine age categories for respondents

Wave	Question	Possible Answers	Definition of age category: 15–24	Definition of age category: 25–54	Definition of age category: 55+
2006 wave	D11 - How old are you?	Respondent answers two-digit age	Answered age >= 15 and <= 24	Answered age >= 25 and <= 54	Answered age >= 55
2012 wave	D11 - How old are you?	Respondent answers two-digit age	Answered age >= 15 and <= 24	Answered age >= 25 and <= 54	Answered age >= 55
2014 wave	D11 - How old are you?	Respondent answers two-digit age	Answered age >= 15 and <= 24	Answered age >= 25 and <= 54	Answered age >= 55
2017 wave	D11 - How old are you?	Respondent answers two-digit age	Answered age >= 15 and <= 24	Answered age >= 25 and <= 54	Answered age >= 55
2020 wave	SD5 - How old are you?	Respondent answers two-digit age	Answered age >= 15 and <= 24	Answered age >= 25 and <= 54	Answered age >= 55

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

Table 10-4: Questions used to determine gender of respondents

	Question	Possible Answers
2006 wave	D10 - Gender	1. Male 2. Female
2012 wave	D10 - Gender	1. Male 2. Female
2014 wave	D10 - Gender	1. Male 2. Female
2017 wave	D10 - Gender	1. Male 2. Female
2020 wave	SD4 - Gender	1. Male 2. Female 3. None of the above/ Non binary/ do not recognize yourself in above categories

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

Note: Response 3 from 2020 Is dropped from the data.

Table 10-5: Questions used to determine employment status of respondents

Wave	Question	Possible Answers	Definition of unemployed
2006 wave	D15a - What is your current occupation?	1. Responsible for ordinary shopping and looking after the home, or without any current occupation, not working	Answered 3 only.

Wave	Question	Possible Answers	Definition of unemployed
		2. Student 3. Unemployed or temporarily not working 4. Retired or unable to work through illness 5 -18. Employed [List of professions]	
2012 wave	D15a - What is your current occupation?	1. Responsible for ordinary shopping and looking after the home, or without any current occupation, not working 2. Student 3. Unemployed or temporarily not working 4. Retired or unable to work through illness 5 -18. Employed [List of professions]	Answered 3 only.
2014 wave	D15a - What is your current occupation?	1. Responsible for ordinary shopping and looking after the home, or without any current occupation, not working 2. Student 3. Unemployed or temporarily not working 4. Retired or unable to work through illness 5 -18. Employed [List of professions]	Answered 3 only.
2017 wave	D15a - What is your current occupation?	1. Responsible for ordinary shopping and looking after the home, or without any current occupation, not working 2. Student 3. Unemployed or temporarily not working 4. Retired or unable to work through illness 5 -18. Employed [List of professions]	Answered 3 only.
2020 wave	SD6 - What is your current occupation?	1. Responsible for ordinary shopping and looking after the home, or without any current occupation, not working 2. Student 3. Unemployed or temporarily not working 4. Retired or unable to work through illness 5 -18. Employed [List of professions]	Answered 3 only.

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

Table 10-6: Questions used to determine education status of respondents

Wave	Question	Possible Answers	Definition of – high school education only
2006 wave	D8 - How old were you when you stopped full-time education?	1. Age when left full-time education 2. Still studying 3. No full-time education 4. Don't know	Answered age >= 16 and <= 18

Wave	Question	Possible Answers	Definition of – high school education only
2012 wave	D8 - How old were you when you stopped full-time education?	1. Age when left full-time education 2. Still studying 3. No full-time education 4. Don't know	Answered age >= 16 and <= 18
2014 wave	D8 - How old were you when you stopped full-time education?	1. Age when left full-time education 2. Still studying 3. No full-time education 4. Don't know	Answered age >= 16 and <= 18
2017 wave	D8 - How old were you when you stopped full-time education?	1. Age when left full-time education 2. Still studying 3. No full-time education 4. Don't know	Answered age >= 16 and <= 18
2020 wave	SD3a - How old were you when you stopped full-time education?	1. Age when left full-time education 2. Still studying 3. No full-time education 4. Don't know	Answered age >= 16 and <= 18

Source: Eurobarometer 66.2, 77.1, 82.4, 87.1, and 93.2.

Data on price and non-price regulatory measures against relating to traditional tobacco products

10.18 For my regression analysis in Section 5 I source data in relation to tobacco price (which is overwhelmingly driven by taxation) and non-price tobacco restrictions.

Tobacco Price

10.19 I use two data sources: the Harmonised Index of Consumer Prices (HICP) for Tobacco ("**tobacco HICP**"), published by Eurostat,[138] and the weighted average price of cigarettes ("**cigarette WAP**") published by the European Commission. [139]

10.20 I use the monthly tobacco HICP for the purpose of my regression analysis, to control for the effect on current smoking prevalence of changes over time in the price of tobacco products. The monthly value of the tobacco HICP is taken for the first month of each Eurobarometer wave when the survey interviews were conducted.[140]

10.21 The tobacco HICP is defined as "*all purchases of tobacco by households, including purchases*

[138] See: europa.eu/eurostat, "HICP – monthly data (index) - Tobacco"

[139] See: circabc.europa.eu, "Archived Excise Duty Tables"

[140] For example, the 2014 wave interviews were conducted in the one-month period between November and December 2014. We use the November tobacco HICP to measure tobacco prices faced by respondents during this period.

of tobacco in restaurants, cafés, bars, service stations, etc."[141] The index is a broad measure of tobacco cost, including all forms of tobacco. I adjust the index for inflation, by dividing it by the corresponding monthly all-items HICP in each country.[142] The tobacco HICP captures price variation for a given country over time, but it does not capture differences in tobacco prices between countries, as the index for each country is rebased to the value 100 in 2015.

10.22 I therefore use the cigarette WAP for the purpose of my trend analysis in Section 4. In particular, I take the tax-inclusive weighted average price in EUR per 1000 cigarettes from the European Commission tables on tobacco excise duties.[143] Unlike the tobacco HICP, cigarette WAP can be compared directly both across countries and over time, so it allows me to split countries into high / low cigarette price groups and compare high-level trends as is done in Section 4. However, I opt to use tobacco HICP in my regression models because: (i) it covers a wider range of tobacco product prices than the cigarette WAP and is therefore a better measure of the cost of smoking,[144] (ii) it is available on a monthly basis and can therefore be better matched to the Eurobarometer data (WAP is only available biannually), and (iii) the regression model includes dummy variables for each country and therefore the model only exploits tobacco price variation over time (so it is not a problem that the tobacco HICP cannot be compared across countries).

10.23 Since the cigarette WAP data is only available on a biannual basis, I use the following cigarette WAP data for each wave of the Eurobarometer survey:

Table 10-7 : Weighted average price tables used for each wave of the Eurobarometer

Eurobarometer wave	Date of Eurobarometer Survey	Date of European Commission Excise Duty Tables
66.2	October - November 2006	Weighted average price data unavailable
77.1	February – March 2012	January 2012
82.4	November – December 2014	July 2014
87.1	March 2017	January 2017
93.2	August – September 2020	July 2020

Source: European Commission Excise Duty Tables on Manufactured Tobacco, see: circabc.europa.eu, "Archived Excise Duty Tables"

Non-price Tobacco Restrictions

10.24 Current smoking prevalence may also be affected by tobacco control regulations other than taxation. I account for these regulations in my analysis using data obtained from the

141 See: europea.eu/eurostat, "Reference and Management of Nomenclatures"

142 See: europa.eu/eurostat, "HICP – monthly data (index) – All-items"

143 See: circabc.europa.eu, "Archived Excise Duty Tables"

144 Cigarette WAP covers only the price of boxed cigarettes, while the tobacco HICP includes all tobacco purchases, including of rolling tobacco.

Tobacco Control Scale ("**TCS**"),[145] which is an index compiled and published by the Association of European Cancer Leagues, which in turn is co-funded by the Health Programme of the European Union. The TCS is used by other researchers in the literature, in their analyses.[146] The most recent iteration, published in 2020, describes the index as follows:[147]

> *The scale quantifies the implementation of tobacco control policies at country level, and is based on six policies described by the World Bank, which they say should be prioritised in a comprehensive tobacco control programme, namely:*
>
> - *Price increases through higher taxes on cigarettes and other tobacco products;*
> - *Bans/restrictions on smoking in public and workplaces;*
> - *Better consumer information, including public information campaigns, media coverage, and publicising research findings;*
> - *Comprehensive bans on the advertising and promotion of all tobacco products, logos and brand names;*
> - *Large, direct health warning labels on cigarette boxes and other tobacco products;*
> - *Treatment to help dependent smokers stop, including increased access to medications.*

10.25 I use the data contained in the 2013, 2016 and 2019 reports[148] to construct a variable measuring non-price tobacco control laws. In particular:

10.25.1 The non-price component of 2013 and 2016 TCS includes the following five categories: public place bans, public information campaign spending,[149] advertising bans, health warnings on packaging, and treatment to help smokers quit.

10.25.2 The non-price component of the 2019 TCS includes two additional categories for the countries in my dataset (for a total of seven categories): measures to combat illicit trade and measures to prevent tobacco industry interference in tobacco regulation (Art 5.3 of the WHO Framework Convention on Tobacco smoking is

[145] See: tobaccocontrolscale.org, "Home page"

[146] See for example, Lidon-Moyano et al. (2017), in which the authors use the TCS to analyse correlation between the implementation of tobacco control policies and tobacco consumption (particularly rolling tobacco, e-cigarette users and the intent to quit), and Feliu et al. (2018), in which the authors use the TCS to assess changes in smoking prevalence.

[147] Tobacco Control Scale Report (2019), PDF page 3.

[148] See: tobaccocontrolscale.org, "The Reports"

[149] How much government spending per capita is aimed at mass information campaigns, education programs and support for NGOs that aim to reduce smoking.

ratified).[150] In order to accommodate the new categories, the TCS authors reduce the points in the index allocated to public information campaign spending from 15 to 10, and they allocate those 5 points to the two new categories. This ensures the non-price component of the TCS in 2019 has the same relative weight as in 2016, allowing me to compare the indices over time.

10.26 To construct the index used in my analysis, these non-price categories are weighted and added up to construct a score between 0 and 70 (the total score including the price component is 100) for each country and year. The higher the score, the more stringent the non-price tobacco control restrictions.

10.27 Since the TCS reports are not available for 2014, 2017, and 2020 (the Eurobarometer waves I focus on in my econometric analyses), I use the following TCS data for each wave of the Eurobarometer survey. In effect, this means that my measure of non-price tobacco restrictions is lagged by approximately 1 year – i.e. my analysis measures the effect of changes in the index with a one year delay.

Table 10-8: TCS indices corresponding to each wave of the Eurobarometer

Wave of Eurobarometer Survey	Year of TCS Report
November – December 2014	2013
March 2017	2016
August – September 2020	2019

Source: Tobacco Control Scale Report (2013, 2016 and 2019)

Data on regulatory hostility towards e-cigarettes

10.28 As discussed in Section 5, I create an index that measures regulatory hostility towards e-cigarettes ("**e-cigarette hostility index**"). In this section, I first explain how the e-cigarette hostility index is constructed, and then set out the sources of data and assumptions that underly its construction.

How the Index is Constructed

10.29 The e-cigarette hostility index is constructed of seven categories of e-cigarette restrictions. These categories are defined based on my understanding of the equivalent tobacco restriction categories described in the Tobacco Control Scale reports,[151] the WHO's Framework Convention on Tobacco Control (FCTC),[152] and the EU Tobacco Products Directive (TPD):[153]

10.29.1 **Indoor vaping ban**: I assign one point where vaping is included in any 'clean air'

[150] The article obliges signatories protect public health policies from being influenced by the tobacco industry and related vested interests.

[151] See: tobaccocontrolscale.org, "The Reports"

[152] WHO (2003)

[153] European Commission (2014)

laws prohibiting tobacco smoking in indoor workplaces, public transport, indoor public spaces (like cafes and restaurants) and other public spaces. This is the electronic cigarette version of Article 8 of the FCTC [154] and the "Smoke free work and other public spaces" category in the Tobacco Control Scale reports on tobacco restrictions.[155]

10.29.2 **Flavor bans**: I assign one point where the country has imposed a ban on the sale of flavored e-cigarettes and e-cigarette liquids. The TPD bans flavored tobacco products but leaves it to member states to decide legislation on e-cigarette liquid flavors.[156] Flavor bans are a debated topic in e-cigarette regulation and there is some variation on flavor bans in my dataset. I include this in the e-cigarette hostility index, even though it is omitted in the TCS non-price tobacco control index.

10.29.3 **Cross border sales bans**: I assign one point where the country has enforced a ban on the cross-border distance sale of e-cigarettes. This prohibits businesses from selling e-cigarettes to customers located outside the country where the seller is located. Banning cross-border sales for e-cigarettes is left at member states' discretion in the TPD[157] and there is variation in when and whether countries in my dataset implement these. Banning cross-border sales can make e-cigarettes more difficult to obtain, especially in countries where fewer e-cigarette brands are available domestically. I include this in the e-cigarette hostility index, even though it is omitted in the TCS non-price tobacco control index.

10.29.4 **Bans on sales to minors:** I assign one point to countries where selling e-cigarettes and liquids to minors is prohibited. The age of majority is 18 for all countries in my dataset. In 2014, 10 countries had effective or explicit sales bans for minors, with that number rising to 26 by 2020. There are studies in the literature that suggest that banning e-cigarettes sales to minors has important effects on youth smoking prevalence, so I include this regulation in my index (though it is omitted in the TCS for tobacco).[158]

10.29.5 **Packaging:** I assign one point if there are mandatory rules on e-cigarette and liquid packaging. The TPD introduced mandatory packaging rules that all countries in my dataset need to implement into law by 2016. Thus, there is variation along this dimension between 2014 and later Eurobarometer waves. This restriction is similar to the "Large and direct warning labels" component of the TCS index for

154 WHO (2007)

155 See Tobacco Control Scale (2019), Table 2.

156 Official Journal of the European Union (2014)

157 Official Journal of the European Union (2014)

158 See, for example Pesko et al. (2016), where the authors find that e-cigarette bans for minors are associated with a large (3.1pp) increase in adolescent cigarette use, defined as at least one (or more) cigarette in the last 30 days. See also Friedman (2015), where the author estimates that bans on e-cigarette sales to minors resulted in a 0.9pp increase in youth smoking rates, reversing 70% of the decline observed over the 8 years up to 2010.

tobacco restrictions.

10.29.6 **Advertising**: I assign one point if there are any restrictions on advertising e-cigarettes, such as cross-border advertising restrictions or bans on point-of-sale advertising. Similar to packaging restrictions, the TPD harmonized some advertising regulations (cross-border advertising) for all member states from 2016, but there is variation between the 2014 and 2017 Eurobarometer waves. This is equivalent to the "Comprehensive bans on advertising and promotion" component of the TCS tobacco restrictions index.

10.29.7 **Tax**: I assign one point if there is an excise tax levied on e-cigarettes or e-cigarette liquids. This is not regulated by the TPD, and about half the countries in my dataset introduce excise taxes on e-cigarette liquids in the period between 2014 and 2020. In the case of tobacco, tax is the largest component of tobacco price, and the price of cigarettes is the main component of the TCS index on tobacco restrictions. Tax appears in my index as a 0/1 variable (rather than a continuous variable) for three reasons. First, this makes it directly comparable to other components of the e-cigarette hostility index. Second, the main variation in e-cigarette excise tax in my dataset usually comes when countries introduce the tax. Once the tax is introduced, it usually does not change again in the period 2014–2020; thus, it is appropriate to treat tax as a binary variable. Third, a similar approach has been adopted by other studies in the literature.[159]

10.30 The final e-cigarette hostility index is the sum of all points assigned to the seven categories above for a given country and Eurobarometer wave.[160] The index therefore varies between 0 (no restrictions on e-cigarette availability or use) and 7 (e-cigarette availability and use highly restricted, comparable to tobacco products restrictions in the UK). For example, Table 10-9 below shows the data compiled for Estonia:

[159] See for example Pesko et al. (2020) who note that *"Given the difficulty of comparing the magnitudes of these different types of taxes, in our regression models we simply use an indicator for whether or not a locality has levied an e-cigarette tax".*

[160] Four of the tobacco control measures present in the TCS index are not applicable to e-cigarettes and I exclude them from my e-cigarette hostility index. Specifically, spending on public education campaign and offering treatment to smokers to help them stop are not applicable because in some countries e-cigarettes themselves are advocated by national health authoritiesservices as a smoking cessation tool (e.g.eg the UK's National Health Service provides official advice on using e-cigarettes to stop smoking: See: NHS.uk, "Using e-cigarettes to stop smoking"). The measures relating to illicit trade and article 5.14 of the WHO Framework Convention on Tobacco Control are also not applicable to e-cigarettes: there is little information available on any illicit e-cigarette markets in Europe, and article 5.14 only relates to tobacco.

Table 10-9: E-cigarette hostility index, Estonia

	2014	2017	2020
Indoor Vaping Ban	0	0	1
Flavor Bans	0	0	1
Cross border sales	0	1	1
Sales ban for minors	0	0	1
Packaging	0	1	1
Advertising	0	1	1
Tax	0	0	1
Total	**0**	**3**	**7**

Source: Table 10-11, Table 10-12, Table 10-13

10.31 I treat each category of restriction in the same way (i.e. this is an unweighted, or equally weighted index) for simplicity and because I do not have prior information with which to rate the relative importance of the various restrictions. However, in Appendix D: Regression Analysis, paragraph 12.19, I also perform a sensitivity analysis on my regression results, using a variant of the e-cigarette hostility index that applies weights borrowed from the 2019 TCS report; the main conclusions are robust to the different weighting. The e-cigarette hostility index is summarized in Table 10-10 below, where I also include color coding (0 = green, 7 = red).

Table 10-10: Summary of e-cigarette hostility index

	2014	2017	2020
Austria	0	3	5
Belgium	6	4	5
Bulgaria	0	4	4
Cyprus	0	4	6
Czech Republic	0	3	3
Germany	0	3	3
Denmark	6	3	3
Estonia	0	3	7
Greece	6	6	6
Spain	1	3	4
Finland	6	7	7
France	0	3	3
Croatia	2	2	4
Hungary	6	7	7
Ireland	0	2	2
Italy	1	5	5
Lithuania	6	5	6
Luxembourg	0	3	5
Latvia	0	6	6
Malta	2	3	3
Netherlands	0	3	4
Poland	1	5	5
Portugal	0	6	6
Romania	0	4	4
Sweden	6	2	5
Slovenia	0	6	6
Slovakia	4	4	4
United Kingdom	0	3	3

Source: Table 10-11, Table 10-12, Table 10-13

Sources of Information on E-cigarette Restrictions

10.32 As I explain in Section 5, I collate e-cigarette restriction information corresponding to the relevant waves of the Eurobarometer surveys. I stop the hostility index in 2014, because e-cigarette restrictions data is either not available or not sufficiently reliable before this point.

10.32.1 **Vapor Tax Datacentre**: This is a website "*established to facilitate the search for current information on the taxation of vapor products*".[161] Though the website is not affiliated with a public institution (it is maintained by Philip Gambaccini), it is the de-facto source on vapor products taxes used in the academic literature – see

[161] See: vaporproductstax.com, "About"

for example (Pesko et al. 2020) and (Cotti al. 2020). The website contains information on the current and historic taxes adopted in the countries in my dataset.[162]

10.32.2 **Global Tobacco Control**:[163] This is a website maintained by the Institute for Global Tobacco Control, an organization within the John Hopkins Bloomberg School of Public Health.[164] The website provides a free database of country laws regulating e-cigarettes. I use the website to collect the non-tax e-cigarette restrictions for my hostility index.

10.32.3 **Tobacco Control Laws:**[165] This is a website created and maintained by the Campaign for Tobacco-Free Kids.[166] Similar to Global Tobacco Control, it provides a free database of country-specific legislation on e-cigarettes. Unlike Global Tobacco Control, it does not summarize the relevant legal information for all countries, but rather provides a "data dump" of relevant legislation documents. I have used the site to (i) corroborate e-cigarette restrictions obtained from Global Tobacco Control by referencing the primary legislation source, and (ii) to get more detail on the exact dates when some of these restrictions were implemented.

10.33 I focus on restrictions in place in the years relevant to my analysis: 2014, 2017 and 2020, corresponding to the relevant waves of the Eurobarometer surveys. For a given Eurobarometer wave and a given country, I determine that a given e-cigarette regulation applies only if I find a source confirming the regulation was effective at or before the period when the Eurobarometer survey was conducted, and if the restriction was not changed or superseded before the survey was completed. In the case of Belgium, Denmark, Finland, Greece, Hungary, Lithuania, and Sweden in 2014, I assume all 6 non-tax restrictions on e-cigarettes were effective as there were no approved e-cigarette products on sale in that country at that time. Where I am unable to find a source that confirms a restriction is in place, I assume the restriction was not in place.

10.34 For all restrictions, I have also verified my understanding with BAT and updated my data as appropriate. The e-cigarette restrictions dataset is provided verbatim in Table 10-11 to Table 10-13, and in all cases, the presence of restrictions is referenced to an external, publicly available source listed either in paragraph 10.32 above or below the tables. The tables list the restrictions which apply ("1" in the relevant cell) or not ("0" in relevant cell) for each country, separately for each relevant wave of the Eurobarometer (Table 10-11 relates to 2014, Table 10-12 to 2017, and Table 10-13 to 2020).

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162 If a country is not explicitly listed in the Vapor Tax Datacentre, I do brief online search on the country name and "e-cigarette tax". If no other sources explicitly mentioning a tax are found, I assume there is no effective tax on e-cigarettes or e-cigarette liquids.

163 See: globaltobaccocontrol.org, "Country Laws Regulating E-cigarettes"

164 See: jhsph.edu, "About Us"

165 See: tobaccocontrollaws.org, "Legislation"

166 See: tobaccofreekids.org, "About Us"

Table 10-11: Components of the e-cigarette hostility index for 2014

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Austria	0[a]	0[a]	0[a]	0[f]	0[a]	0[a]	0[a]	N/A
Belgium	1[e]	1[e]	1[e]	1[e]	1[e]	1[e]	0[a]	E-cigarettes were only sold as a consumer product from 2016 according to the source - therefore every non-tax restriction was assumed to be in place.
Bulgaria	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	No specific rules
Croatia	1[c]	0[a]	0[a]	0[d]	0[a]	1[g]	0[a]	N/A
Cyprus	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	No specific rules
Czechia	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	Parliament source says that there are no rules, while Medical Xpress refers to public places ban, and a sale-to-minors ban as of June 2013. Data reflects Parliament source.
Denmark	1[c]	1[c]	1[c]	1[c]	1[c]	1[c]	0[a]	E-cigarettes with nicotine were banned at the time
Estonia	0[c]	0[c]	0[c]	0[c]	0[c]	0[c]	0[a]	N/A
Finland	1[c]	1[c]	1[c]	1[c]	1[c]	1[c]	0[a]	E-cigarettes with nicotine were banned
France	0[h]	0[a]	0[a]	0[d]	0[a]	0[a]	0[a]	Source (h) indicates that a public places ban was not in place as of April 2014 but was intended.
Germany	0[c]	0[c]	0[c]	0[i]	0[c]	0[c]	0[a]	N/A
Greece	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	0[a]	The source says that e-cigarettes are prohibited unless specifically approved by Health Ministry. Medical Xpress reports that e-cigarettes are "widely sold"
Hungary	1[c]	1[c]	1[c]	1[c]	1[c]	1[c]	0[a]	E-cigarettes with nicotine were banned
Ireland	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[a]	No specific rules

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Italy	0[b]	0[b]	0[b]	1[g]	0[b]	0[b]	0[a]	No specific rules. Medical Xpress reports that the Health Ministry banned sales to minors as of April 2014 (dated 1 month after the Parliament Source).
Latvia	0[b]	0[b]	0[b]	0[d]	0[b]	0[b]	0[a]	No specific rules. Medical Xpress refers to a minor sales ban, but I rely on Tobacco Control Laws
Lithuania	1[b]	1[b]	1[b]	1[b]	1[b]	1[b]	0[a]	E-cigarettes were banned
Luxembourg	0[c]	0[c]	0[c]	0[c]	0[c]	0[c]	0[a]	N/A
Malta	1[k]	0[a]	0[a]	0[a]	1[j]	0[a]	0[a]	Source (b) says its regulated under tobacco act
Netherlands	0[c]	0[c]	0[c]	0[c]	0[c]	0[c]	0[a]	N/A
Poland	0[b]	0[b]	0[b]	0[b]	0[b]	1[b]	0[a]	Medical Xpress claims there is no e-cigarette regulation in place, but I rely on European Parliament source.
Portugal	0[g]	0[a]	0[a]	0[a]	0[a]	0[a]	0[a]	N/A
Romania	0[d]	0[d]	0[d]	0[d]	0[d]	0[d]	0[a]	Laws with restrictions came into force only in 2016
Slovakia	1[g]	0[g]	0[a]	1[g]	1[g]	1[g]	0[a]	Source states that there is no difference between cigarettes and e-cigarettes.
Slovenia	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[a]	No specific rules
Spain	0[b]	0[b]	0[b]	1[l]	0[b]	0[b]	0[a]	No specific rules
Sweden	1[c]	1[c]	1[c]	1[c]	1[c]	1[c]	0[a]	E-cigarettes with nicotine were banned
United Kingdom	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[a]	No specific rules

10.35 Sources:

(a) No information found regarding the existence of a restriction; therefore, it has been assumed to be 0

(b) https://epthinktank.eu/2013/04/03/electronic-cigarettes/electronic_cigarettes/

(c) https://tablites.com/blog/can-you-use-your-e-cigarette-abroad/

(d) https://www.tobaccocontrollaws.org/legislation

(e) https://finance.yahoo.com/news/e-cigarette-regulation-belgium-may-123000961.html

(f) https://globaltobaccocontrol.org/en/policy-scan/e-cigarettes/countries?country=3

(g) https://medicalxpress.com/news/2013-06-europe-electronic-cigarettes.html#:~:text=%2D%20GERMANY%3A%20The%20sale%20of%20electronic,need%20authorisation%20to%20be%20sold.&text=It%20is%20prohibited%20to%20use,as%20an%20anti%2Dsmoking%20tool.

(h) https://www.thelocal.fr/20140430/french-minister-reaffirms-plan-to-ban-e-cigs-in-public/

(i) https://www.jugendschutz-aktiv.de/rauchverbot-fuer-minderjaehrige-auch-e-zigaretten-und-e-shishas-erfasst.html

(j) https://tobaccolabels.ca/2011/04/

(k) https://epha.org/updated-european-smoking-bans-evolution-of-the-legislation/

(l) https://www.mariscal-abogados.com/the-use-of-the-electronic-cigarette-in-spain/

Table 10-12: Components of the e-cigarette hostility index for 2017

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Austria	0[a]	0[a]	1[b]	0[c]	1[d]	1[d]	0[a]	N/A
Belgium	1[e]	0[a]	1[b]	0[f]	1[g]	1[d]	0[a]	The source mentions that since 2016, they have been classed as tobacco – implying the same smoking bans as cigarettes. Unclear when the age ban for 16 was introduced.
Bulgaria	0[a]	0[a]	1[b]	1[h]	1[g]	1[g]	0[a]	N/A
Croatia	0[i]	0[a]	0[h]	0[h]	1[g]	1[d]	0[a]	Cross border sales reflect Tobacco Control Laws data – the only relevant regulation mentioning cross border sales, contains guidelines but no ban on cross border sales. Corroborated by Global Tobacco Control.
Cyprus	1[j]	0[a]	1[b]	0[c]	1[g]	1[g]	0[a]	Sales ban for minors came into force in 2017 - month is unclear but all the relevant laws listed in Tobacco Control Laws are dated only from March 2017 - so assumed to be 0 for this wave.
Czechia	0[a]	0[a]	0[b]	1[h]	1[d]	1[d]	0[a]	N/A
Denmark	0[a]	0[a]	0[b]	1[h]	1[d]	1[d]	0[a]	N/A
Estonia	0[a]	0[a]	1[b]	0[h]	1[g]	1[d]	0[a]	I rely on Tobacco Control Laws for the minimum age date
Finland	1[h]	1[h]	1[b]	1[h]	1[d]	1[d]	1[x]	N/A
France	0[a]	0[a]	0[b]	1[h]	1[g]	1[d]	0[a]	N/A
Germany	0[a]	0[a]	0[b]	1[k]	1[d]	1[d]	0[a]	N/A
Greece	1[i]	0[a]	1[b]	1[c]	1[g]	1[d]	1[x]	N/A
Hungary	1[i]	1[l]	1[b]	1[l]	1[g]	1[d]	1[x]	N/A
Ireland	0[a]	0[a]	0[b]	0[a]	1[d]	1[d]	0[a]	Most sources only discuss cabinet approval for a minimum sales age; none mention an enforcement

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Italy	0[a]	0[a]	1[b]	1[h]	1[d]	1[d]	1[x]	N/A
Latvia	1[i]	0[a]	1[b]	1[h]	1[d]	1[d]	1[x]	N/A
Lithuania	1[i]	0[a]	1[b]	1[m]	1[d]	1[d]	0[a]	N/A
Luxembourg	0[n]	0[a]	1[b]	0[h]	1[g]	1[g]	0[a]	N/A
Malta	0[m]	0[a]	0[b]	1[h]	1[d]	1[d]	0[a]	Exact date of sales ban to minors is unclear but probably 2016 (see source 'y')
Netherlands	0[a]	0[a]	0[b]	1[o]	1[d]	1[d]	0[a]	N/A
Poland	1[p]	0[a]	1[b]	1[p]	1[g]	1[g]	0[a]	N/A
Portugal	1[q]	0[a]	1[b]	1[r]	1[d]	1[d]	1[x]	N/A
Romania	0[a]	0[a]	1[b]	0[h]	1[g]	1[g]	1[x]	N/A
Slovakia	1[i]	0[a]	0[b]	1[d]	1[g]	1[d]	0[a]	Source (e) also mentions that in 2018 vaping is banned wherever smoking is banned
Slovenia	1[s]	0[a]	1[b]	1[h]	1[g]	1[g]	1[x]	N/A
Spain	0[a]	0[a]	0[t]	1[u]	1[g]	1[d]	0[a]	N/A
Sweden	0[a]	0[a]	0[b]	0[h]	1[g]	1[g]	0[a]	Source 'v' mentions the title of the relevant legislation for minor sales ban
United Kingdom	0[a]	0[a]	0[b]	1[w]	1[d]	1[d]	0[a]	N/A

10.36 Sources:

(a) No information found regarding the existence of a restriction; therefore, it has been assumed to be 0

(b) https://health.gov.mt/en/environmental/tobaccofree/Documents/Tobacco-Control/Member_States_that_permit_cross-border_distance_sales.pdf

(c) https://globaltobaccocontrol.org/en/policy-scan/e-cigarettes/countries?country=263

(d) https://tobaccocontrol.bmj.com/content/26/4/440

(e) https://www.redvape.com/blog/vaping-laws-around-the-world-in-2018

(f) https://www.brusselstimes.com/news/belgium-all-news/75689/belgium-bans-tobacco-sales-to-minors-under-age-18

(g) The last two waves have been updated to account for packaging/advertising restrictions in line with the Tobacco Products Directive revision (applicable in EU countries from May 2016)

(h) https://www.tobaccocontrollaws.org/legislation

(i) https://www.drugsandalcohol.ie/27261/

(j) https://cyprus-mail.com/2017/02/24/new-smoking-law-scrapes/

(k) https://www.jugendschutz-aktiv.de/rauchverbot-fuer-minderjaehrige-auch-e-zigaretten-und-e-shishas-erfasst.html

(l) https://dailynewshungary.com/smoking-and-vaping-rules-in-hungary/#:~:text=Advertising%20e%2Dcigarette%20is%20banned,border%20sale%20is%20also%20prohibited.

(m) https://gsthr.org/countries

(n) https://untobaccocontrol.org/impldb/luxembourg-new-anti-smoking-regulations-came-into-force-on-1-august-2017/

(o) https://www.reuters.com/article/us-dutch-ecigarettes-idUSKBN0TU1U420151211

(p) https://medicalxpress.com/news/2016-09-poland-sale-e-cigarettes-minors-vaping.html#:~:text=Adopted%20by%20parliament%20in%20July,anywhere%20that%20smoking%20is%20banned.

(q) https://www.theportugalnews.com/news/no-exceptions-for-e-cigs/39426

(r) https://ecigintelligence.com/portugal-adds-public-vaping-ban-to-new-tpd-law/

(s) http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6717

(t) https://www.boe.es/buscar/doc.php?id=BOE-A-2017-13277

(u) https://www.mariscal-abogados.com/the-use-of-the-electronic-cigarette-in-spain/

(v) https://www.loc.gov/item/global-legal-monitor/2019-09-25/sweden-new-rules-on-smoking-in-public-places-and-sale-of-tobacco-enter-into-force/

(w) https://www.gov.uk/government/publications/new-rules-about-tobacco-e-cigarettes-and-smoking-1-october-2015/new-rules-about-tobacco-e-cigarettes-and-smoking-1-october-2015

(x) https://vaporproductstax.com/taxation-database/

(y) https://www.vapingpost.com/2016/11/04/malta-vaping-banned-in-cars-with-minors/

Table 10-13: Components of the e-cigarette hostility index for 2020

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Austria	1[k]	0[a]	1[c]	1[b]	1[b]	1[b]	0[a]	N/A
Belgium	1[d]	0[a]	1[b]	1[e]	1[b]	1[b]	0[a]	N/A
Bulgaria	0[d]	0[a]	1[b]	1[f]	1[b]	1[b]	0[a]	N/A
Croatia	1[d]	0[a]	0[b]	1[f]	1[b]	1[b]	0[a]	N/A
Cyprus	1[g]	0[a]	1[b]	1[b]	1[b]	1[b]	1[x]	N/A
Czechia	0[d]	0[a]	0[b]	1[f]	1[b]	1[b]	0[a]	N/A
Denmark	0[a]	0[b]	0[b]	1[f]	1[b]	1[b]	0[a]	Flavor ban started from 2021. Tax from 2022.
Estonia	1[d]	1[h]	1[b]	1[f]	1[b]	1[b]	1[x]	N/A
Finland	1[f]	1[f]	1[b]	1[f]	1[b]	1[b]	1[x]	N/A
France	0[a]	0[a]	0[b]	1[f]	1[b]	1[b]	0[a]	N/A
Germany	0[b]	0[a]	0[b]	1[b]	1[b]	1[b]	0[a]	E-cigarettes were included in the smoking ban only in 2021. Tax from 2022
Greece	1[c]	0[a]	1[b]	1[b]	1[b]	1[b]	1[x]	Cross border sales to Greece are forbidden; but from Greece to other markets is allowed
Hungary	1[i]	1[i]	1[i]	1[i]	1[j]	1[j]	1[x]	N/A
Ireland	0[d]	0[a]	0[b]	0[a]	1[b]	1[b]	0[a]	Most sources only discuss cabinet approval for a minimum age; not an enforcement
Italy	0[a]	0[a]	1[b]	1[f]	1[j]	1[j]	1[x]	N/A
Latvia	1[c]	0[a]	1[b]	1[f]	1[b]	1[b]	1[x]	N/A
Lithuania	1[b]	0[a]	1[b]	1[k]	1[b]	1[b]	1[x]	N/A
Luxembourg	1[l]	0[a]	1[m]	1[f]	1[b]	1[b]	0[a]	N/A

Country	Indoor Vaping Ban	Flavor Bans	Cross border sales	Minor Sales Ban	Packaging	Advertising	Tax	Comments
Malta	0[k]	0[a]	0[b]	1[f]	1[b]	1[b]	0[a]	Source 'k' also mentions 18 as the minimum age
Netherlands	1[b]	0[a]	0[b]	1[n]	1[b]	1[b]	0[a]	Smoking ban extended to e-cigarettes in July 2020
Poland	1[d]	0[a]	1[b]	1[o]	1[b]	1[b]	0[a]	N/A
Portugal	1[p]	0[a]	1[b]	1[q]	1[b]	1[b]	1[x]	N/A
Romania	0[d]	0[a]	1[b]	0[f]	1[b]	1[b]	1[x]	N/A
Slovakia	1[d]	0[a]	0[b]	1[k]	1[b]	1[b]	0[a]	N/A
Slovenia	1[r]	0[a]	1[b]	1[f]	1[b]	1[b]	1[x]	N/A
Spain	0[a]	0[a]	1[s]	1[t]	1[b]	1[b]	0[a]	N/A
Sweden	1[b]	0[a]	0[b]	1[f]	1[b]	1[b]	1[y]	Title of legislation for minor sales ban given in source 'u'
United Kingdom	0[a]	0[a]	0[v]	1[w]	1[b]	1[b]	0[a]	N/A

10.37 Sources:

(a) No information found regarding the existence of a restriction; therefore, it has been assumed to be 0

(b) https://globaltobaccocontrol.org/en/policy-scan/e-cigarettes/countries?country=263

(c) https://www.drugsandalcohol.ie/27261/

(d) https://www.redvape.com/blog/vaping-laws-around-the-world-in-2018

(e) https://www.brusselstimes.com/news/belgium-all-news/75689/belgium-bans-tobacco-sales-to-minors-under-age-18

(f) https://www.tobaccocontrollaws.org/legislation

(g) https://cyprus-mail.com/2017/02/24/new-smoking-law-scrapes/

(h) https://ethra.co/news/34-estonia-takes-the-first-steps-towards-recognising-tobacco-harm-reduction

(i) https://dailynewshungary.com/smoking-and-vaping-rules-in-hungary/#:~:text=Advertising%20e%2Dcigarette%20is%20banned,border%20sale%20is%20also%20prohibited.

(j) The last two waves have been updated to account for packaging/advertising restrictions in line with the Tobacco Products Directive revision (applicable in EU countries from May 2016)

(k) https://gsthr.org/countries

(l) https://untobaccocontrol.org/impldb/luxembourg-new-anti-smoking-regulations-came-into-force-on-1-august-2017/

(m) https://health.gov.mt/en/environmental/tobaccofree/Documents/Tobacco-Control/Member_States_that_permit_cross-border_distance_sales.pdf

(n) https://www.reuters.com/article/us-dutch-ecigarettes-idUSKBN0TU1U420151211

(o) https://medicalxpress.com/news/2016-09-poland-sale-e-cigarettes-minors-vaping.html

(p) https://www.theportugalnews.com/news/no-exceptions-for-e-cigs/39426

(q) https://ecigintelligence.com/portugal-adds-public-vaping-ban-to-new-tpd-law/

(r) http://www.pisrs.si/Pis.web/pregledPredpisa?id=ZAKO6717

(s) https://www.boe.es/buscar/doc.php?id=BOE-A-2017-13277

(t) https://www.mariscal-abogados.com/the-use-of-the-electronic-cigarette-in-spain/

(u) https://www.loc.gov/item/global-legal-monitor/2019-09-25/sweden-new-rules-on-smoking-in-public-places-and-sale-of-tobacco-enter-into-force/

(v) https://www.gov.uk/government/publications/tobacco-products-and-e-cigarette-cross-border-sales-registration/guide-to-making-registrations

(w) https://www.gov.uk/government/publications/new-rules-about-tobacco-e-cigarettes-and-smoking-1-october-2015/new-rules-about-tobacco-e-cigarettes-and-smoking-1-october-2015

(x) https://vaporproductstax.com/taxation-database/

(y) https://www.loc.gov/item/global-legal-monitor/2018-07-26/sweden-new-tax-on-electronic-cigarettes-and-other-non-tobacco-nicotine-products-takes-effect/#:~:text=The%20tax%20will%20be%20a,nicotine%20in%20the%20finished%20product.

11. Appendix C: Dataset Construction

11.1 I construct the dataset used for my analysis in four stages:

11.1.1 First, I extract the relevant data from the five Eurobarometer waves, clean the data and combine them into a single dataset.

11.1.2 Second, I aggregate the individual-level dataset into a dataset arranged around groups of individuals defined by age category, gender and country of residence ("**reference groups**"). In doing so, I calculate current smoking prevalence rates and e-cigarette usage prevalence rates for each reference group in each year, as well as the proportion of unemployed, and the proportion with high school education.

11.1.3 Finally, I augment this dataset with data obtained outside of Eurobarometer (i.e. on e-cigarette and tobacco prices and restrictions).

11.2 The second stage is the most complex part of my dataset construction, so I expand on it in detail in the remainder of this Appendix.

Detail on Aggregating Individual-level Data into Reference Groups

11.3 Individual-level data from the combined Eurobarometer dataset is aggregated into reference groups. Each group is defined by unique combinations of each of the following characteristics:

11.3.1 Gender: male or female;

11.3.2 Age category: one of "15 – 24", "25 – 54", or "55+";

11.3.3 Country: one of 28, either EU member states or the UK.

And each group is observed once per wave (each wave is represented by the Year in which the survey was collected)

11.4 This dataset can be considered a "pseudo panel", where 168 groups of individuals (defined by the combinations of gender, age category, and country) are observed at 5 points in time.[167]

Weights Used in the Construction of My Dataset

11.5 Before reference groups are constructed, statistical weights are applied to the individual level data, to ensure that the data is representative of the population to which it applies.

11.6 I use the following weights, provided with the Eurobarometer data, when constructing my dataset:

11.6.1 Weight Result From Target (W1) - *"a pure post-stratification weight which reproduces the real number of cases for each country. British and Northern Irish as*

[167] 2 genders * 3 age categories * 28 countries = 168 groups, and 168 groups * 5 years = 840 observations. However, Croatia did not participate in the 2012 wave of the Eurobarometer, so observations are actually, 840 - 6 = 834.

well as East and West German samples are weighted separately."[168]

11.6.2 Weight (Special) Germany (W3) – *"adjusts the East and the West German samples to their respective proportions in the united Germany and includes the respective post-stratification factors. This weight has to be applied whenever the united Germany (East+ West) is analyzed as a whole."*[169]

11.6.3 Weight (Special) United Kingdom (W4) – *"adjusts the British and the Northern Irish samples to their respective proportions in the United Kingdom and includes the respective post-stratification factors. It has to be applied whenever the United Kingdom is analyzed as a whole."*[170]

11.7 W1 is applied in 2006 to 2017 to all countries except East & West Germany, and Great Britain & Northern Ireland. The weights W3 and W4 are applied to the German and British constituents respectively (population weights already include post-stratification weights within them).

11.8 In 2020, Northern Ireland and Great Britain are not presented separately, but as one United Kingdom. Thus, there is no W4 to apply, and W1 is applied to the United Kingdom. Germany is still presented separately as East & West. So, W3 is still applied to East and West Germany in 2020.

11.9 Prevalence rates for smoking and e-cig use and proportions for unemployed and people with only compulsory education are then calculated for each reference group in each year by adding up the weighted responses and dividing by the total weight for each reference group.

11.10 An illustrative example of a reference group calculation (with made up numbers) is given below.

168 See: gesis.org, "Weighting overview"

169 See: gesis.org, "Weighting overview"

170 See: gesis.org, "Weighting overview"

Figure 11-1: Illustrative example on aggregating Eurobarometer data into reference groups

Step 1: An extract of the combined and cleaned Eurobarometer individual-level data. 1=yes, 0=no.

country	wave	age_cat	gender	current smoker	e-cig user	unemplyed	high school only	weight
Austria	2017	15-24	Male	1	1	0	0	2.1
Austria	2017	15-24	Male	1	0	1	0	1
Austria	2017	15-24	Male	0	0	0	1	0.9
Austria	2017	15-24	Female	1	0	0	0	0.7
Austria	2017	15-24	Female	0	0	0	0	4
Total				3	1	1	1	8.7

Step 2: Apply weights to each individual row. The individuals constituting an example reference group in 2017 are highlighted.

country	wave	age_cat	gender	weighted current smoker	weighted e-cig user	weighted unemplyed	weighted high school only	weight
Austria	2017	15-24	Male	2.1	2.1	0	0	2.1
Austria	2017	15-24	Male	1	0	1	0	1
Austria	2017	15-24	Male	0	0	0	0.9	0.9
Austria	2017	15-24	Female	0.7	0	0	0	0.7
Austria	2017	15-24	Female	0	0	0	0	4
Total				3.8	2.1	1	0.9	8.7

Step 3: Calculate prevalences and proportions. For example, for the reference group of "Austrian males aged 15-24 surveyed in 2017", the smoking prevalence is 78%. This is calculating by summing "weighted current smoker" and dividing by the sum of "weight".

country	wave	age_cat	gender	current smoker	e-cig user	unemplyed	high school only
Austria	2017	15-24	Male	78%	53%	25%	23%

11.11 I use the following post-stratification weights when constructing the dataset:

11.11.1 Weight Result From Target (W1) - *"a pure post-stratification weight which reproduces the real number of cases for each country. British and Northern Irish as well as East and West German samples are weighted separately."*

11.12 I use the following population weights when constructing the dataset (note that these include post-stratification weights within them):

11.12.1 Weight (Special) Germany (W3) – *"adjusts the East and the West German samples to their respective proportions in the united Germany and includes the respective post-stratification factors. This weight has to be applied whenever the united Germany (East+ West) is analyzed as a whole."*

11.12.2 Weight (Special) United Kingdom (W4) – *"adjusts the British and the Northern Irish samples to their respective proportions in the United Kingdom and includes the respective post-stratification factors. It has to be applied whenever the United Kingdom is analyzed as a whole."*

11.13 W1 is applied in 2006 – 2017 to all countries except East & West Germany, and Great Britain & Northern Ireland. The weights W3 and W4, applied to the German and British constituents respectively, already include post-stratification weights within them (in addition to population weights), so applying W1 is not necessary here.

11.14 In 2020, Northern Ireland and Great Britain are not presented separately, but as one United Kingdom. Thus, there is no W4 to apply, and W1 is applied to the United Kingdom. Germany is still presented separately as East & West. So, W3 is still applied to East and West Germany in 2020.

12. Appendix D: Regression Analysis

12.1 This Appendix sets out the details of my econometric analysis, in particular:

12.1.1 The specification of my regression model;

12.1.2 My estimation results; and

12.1.3 The results of various robustness and sensitivity checks around this model.

Specification of Regression Model

12.2 To estimate the effect of e-cigarette availability on smoking prevalence, I estimate the following econometric model using Ordinary Least Squares regression:

$$
\begin{aligned}
&\boldsymbol{SmokingPrevalence_{cagt}} = \\
&\quad \boldsymbol{\beta} * \boldsymbol{EcigHostilityIndex_{cagt}} + \\
&\quad \boldsymbol{\theta} * \boldsymbol{Log}\left(\boldsymbol{RealTobaccoPriceIndex_{cagt}}\right) + \\
&\quad \boldsymbol{\xi} * \boldsymbol{NonPriceTobaccoControlIndex_{cagt}} + \\
&\quad \boldsymbol{\pi} * \boldsymbol{PercentUnemployed_{cagt}} + \boldsymbol{\rho} * \boldsymbol{PercentLeftEduc1618_{cagt}} + \\
&\quad \sum_{n=1}^{27} \boldsymbol{\lambda_n} * \boldsymbol{CountryDummy_n} + \sum_{k=1}^{2} \boldsymbol{\mu_k} * \boldsymbol{AgeCatDummy_k} + \boldsymbol{\delta} * \boldsymbol{MaleDummy} + \\
&\quad \boldsymbol{Constant} + \boldsymbol{ErrorTerm_{cagt}}
\end{aligned}
$$

12.3 Where:

12.3.1 The subscripts ***c, a, g, t*** refer to the country of residence of the respondent, age group, gender, and wave of the Eurobarometer survey.

(a) ***c*** can take values between 1 and 28 for each country in our dataset.

(b) ***a*** can take values between 1 and 3, one for each age category: 15–24, 25–54, 55+ years old.

(c) ***g*** can take values 1 or 2, for male or female.

(d) ***t*** can take values between 1 and 3, one for each of the 2014, 2017 and 2020 Eurobarometer wave. Due to lack of reliable data on e-cigarette restrictions before 2014, I estimate the model on the last three waves of the Eurobarometer survey.

Each combination of ***c, a, g*** scripts defines a reference group at a time ***t***, for a total of 28*3*2 =168 reference groups, each observed over 3 waves (a total of 504 observations).

12.3.2 ***SmokingPrevalence*** is the dependent variable. It measures the proportion of people in each reference group who stated they currently smoke cigarettes (including boxed and roll-your-own), cigars, cigarillos or pipes, as detailed in Table 10-1.

12.3.3 ***EcigHostilityIndex*** is the main treatment variable, an index taking values between

0 and 7 as explained in paragraph 10.29.

12.3.4 ***Log(RealTobaccoPriceIndex)*** is a control variable measuring the monthly real tobacco price, as explained in paragraph 10.21.

12.3.5 ***NonPriceTobaccoControlIndex*** is the non-price component of the TCS index, with a higher value representing stricter tobacco controls, as explained in paragraph 10.25.

12.3.6 ***PercentUnemployed*** is a control variable measuring the percentage of people who are unemployed in each reference group in each year, as detailed in Table 10-5.

12.3.7 ***PercentLeftEduc1618*** is a control variable measuring the percentage of people in each reference group in each year who reported leaving formal education between 16 and 18 years of age, as detailed in Appendix B: Data. This is roughly equivalent to people who only completed compulsory education.

12.3.8 ***CountryDummy$_n$*** are a group of dummy variables for 27 of the 28 countries. Dummy ***n*** takes the value 1 for country ***n*** and 0 otherwise. One country dummy is omitted to avoid the 'dummy variable trap'.[171]

12.3.9 ***AgeCatDummy$_k$*** are a group of dummy variables for 2 of the 3 age categories. One age category is omitted.

12.3.10 ***MaleDummy*** takes the value 1 if gender is male and 0 when female. The "male" dummy is omitted.

12.3.11 ***ErrorTerm*** represents the error term.

Estimation Results

12.4 I estimate the above model specification on my dataset, consisting of 504 observations spanning 28 countries and a period between 2014 and 2020. The model assumes the regression errors are independent and uncorrelated between time periods but allows for correlation within countries by use of cluster robust standard errors (clustered at the country level).

12.5 Table 12-1 presents the results of my regression estimation, corresponding to the models discussed in Section 5. In particular:

12.5.1 Model 0 represents the "base model", with all control variables included, before I introduce the treatment variable.

12.5.2 Model 1 also adds the treatment variable. It is the "preferred model" in my analysis.

[171] It is incorrect (and impossible) to estimate a model in which an exhaustive list of dummy variables is included, because of a statistical problem known as a 'dummy variable trap'. The standard solution is to omit one dummy variable (in this case, I choose Austria, 15–-24 age category and the male dummy), and to interpret the coefficients on the remaining dummy variables as the difference between average effect and the omitted base category. The choice of base dummies is arbitrary, and has no effect on the model's conclusions. For further details, see Kennedy, P. (2008), Chapter 15.

12.5.3 The columns list the estimated model coefficients, two-sided p-values, and 90% and 95% intervals on the coefficients for each model.

12.5.4 In this and subsequent tables, all p-values of the regression coefficients are the result of a two-sided test, unless otherwise stated. A two-sided test is a *"test where the alternative hypothesis is not directional, for example, that one population mean is either above or below the other."*[172] When testing whether a coefficient is different from zero, my alternative hypothesis allows the coefficient to be either larger or smaller than zero (rather than restricting it to only option). In the case of ***EcigHostilityIndex***, for example, this means I allow both for the possibility that e-cigarettes and cigarettes are complements (coefficient has negative sign), and the possibility they are substitutes (positive sign). The p-value of a two-sided test is twice as large as the p-value of one-sided tests, as both tails of the distribution of coefficient estimates are considered.

12.6 The table shows that for the full model (Model 1):

12.6.1 ***EcigHostilityIndex*** is positively related to smoking prevalence with (two-sided) p-value of 7.64%, which is statistically significant at the 10% level, but not at the 5% level. This means that for a given country, moving from a score of 0 on the hostility index (e.g. Bulgaria in 2014; no e-cigarette regulations) to the median score in the sample of 4 (e.g. Bulgaria 2020) is associated with smoking prevalence increasing by 0.39*4=1.56pp. This is consistent with e-cigarettes and traditional burning tobacco being economic substitutes.

(a) The conventional description of statistical significance is a p-value for the two-sided test of the null hypothesis of zero effect, which is 7.64% for this point estimate of 0.39 percentage points.

(b) However, even this result from the RRP-price test understates the strength of the substitutes hypothesis because the conventional "zero effect" null hypothesis – that e-cigarettes and conventional cigarettes are *neither* substitutes nor complements – is not of particular interest in this matter.[173] We want to know whether, and to what degree, the data support the substitutes hypothesis (a positive effect) over the complements hypothesis (a negative effect). This calls for the one-sided test, which for the 0.39-percentage-point estimate says that the complements hypothesis is only 3.8 percent likely. In Bayesian terms, this is "strong" evidence to support the substitutes hypothesis over the complements hypothesis.[174]

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172 Everitt and Skrondal (2010)

173 Marsman and Wagenmakers (2017)

174 The Bayesian factor is 25, which means that the 0.39 finding by itself increases the likelihood of the substitutes hypothesis relative to the complements hypothesis by a factor of 25 (Lavine and Schervish, 1999). Bayesian statistics interprets statistical results for the purpose of informing decisions, such as the decision of how to regulate or tax a new product with potential health effects. It does not necessarily recommend alternative statistical calculations but rather proper interpretation of the results of conventional calculations.

(c) Moreover, the economics of consumer demand says that inference about the competing hypotheses should, when possible, account for both the results of the RRP-price test (one-sided p-value of 3.8 percent) and the cigarette-price test (one-sided p-value of 0.09 percent). In Bayesian terms, the two together are "decisive" or "extreme evidence" supporting the substitutes hypothesis over the complements hypothesis.[175]

12.6.2 ***NonPriceTobaccoControlIndex*** has a high p-value, meaning the coefficient is not statistically significant at the 10% level. The high p-value means that I do not find evidence that there is a relationship between smoking and non-price tobacco controls in my dataset.[176]

12.6.3 The ***Log(RealTobaccoPriceIndex)*** has a negative and statistically significant (at the 5% level) coefficient. It suggests that a 10% change in real tobacco prices is associated with a 12.89*ln(110/100)=1.23pp reduction in smoking prevalence. This is consistent with economic theory and a downward sloping demand curve for burning tobacco.

12.6.4 ***PercentUnemployed*** has a negative and statistically significant (at the 5% level) coefficient. A 10pp increase in unemployment in a given reference group is associated with 0.23*10pp=2.3pp increase in smoking prevalence.

12.6.5 ***PercentHighSchoolOnly*** has a negative and statistically significant (at the 5% level) coefficient. A 10pp increase in the proportion of people in a given reference group who left school between the ages of 16 and 18 is associated with an increase in smoking prevalence of 0.17*10pp=1.7pp.

12.6.6 The remaining coefficients in the table show the fixed effects of gender, age category and country of residence. These coefficients show that, for example, that males have a 7.84pp higher smoking prevalence than females on average, and that people aged 25–54 have a higher smoking prevalence (on average) than any other age category.

12.6.7 The R-squared and adjusted R-squared are 66.3% and 63.8% respectively, implying that over 60% of the variation in current smoking prevalence is explained by the explanatory variables included in my model.

[175] Jeffreys (1961) and Lee and Wagenmakers (2013), respectively, based on a Bayes factor that exceeds 100.

[176] For information, moving from the minimum index value of 18 to the median of 34 is associated with increased smoking prevalence of 1.12pp.

Table 12-1: Stata regression output for the main model, without and with treatment variable added

	(0)				(1)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
EcigHostilityIndex					0.39+	(0.076)	[0.03, 0.75]	[-0.04, 0.82]
NonPriceTobacco ControlIndex	0.14	(0.181)	[-0.03, 0.32]	[-0.07, 0.36]	0.07	(0.574)	[-0.13, 0.26]	[-0.17, 0.30]
Log(RealTobaccoPrice Index)	-12.21*	(0.019)	[-20.57, -3.85]	[-22.28, -2.14]	-12.89*	(0.011)	[-20.94, -4.83]	[-22.59, -3.18]
PercentUnemployed	0.21**	(0.005)	[0.09, 0.33]	[0.07, 0.35]	0.23**	(0.004)	[0.10, 0.35]	[0.08, 0.37]
PercentLeftEduc1618	0.17**	(0.002)	[0.08, 0.25]	[0.07, 0.27]	0.17**	(0.002)	[0.09, 0.26]	[0.07, 0.27]
25–54	2.99*	(0.022)	[0.89, 5.10]	[0.46, 5.53]	2.94*	(0.024)	[0.85, 5.04]	[0.42, 5.47]
55+	-9.00***	(0.000)	[-11.36, -6.65]	[-11.84, -6.17]	-8.96***	(0.000)	[-11.31, -6.61]	[-11.79, -6.13]
Male	7.84***	(0.000)	[5.53, 10.15]	[5.06, 10.62]	7.83***	(0.000)	[5.52, 10.14]	[5.05, 10.62]
BE	-4.40***	(0.000)	[-6.01, -2.78]	[-6.34, -2.45]	-4.61***	(0.000)	[-6.25, -2.98]	[-6.58, -2.64]
BG	8.83***	(0.000)	[8.26, 9.40]	[8.14, 9.52]	8.99***	(0.000)	[8.40, 9.58]	[8.28, 9.70]
CY	-0.69	(0.155)	[-1.50, 0.11]	[-1.66, 0.28]	-1.19+	(0.066)	[-2.24, -0.13]	[-2.46, 0.09]
CZ	1.48**	(0.001)	[0.79, 2.17]	[0.65, 2.31]	1.77***	(0.000)	[1.04, 2.51]	[0.89, 2.66]
DE	-0.57	(0.533)	[-2.09, 0.96]	[-2.41, 1.27]	-0.68	(0.442)	[-2.16, 0.80]	[-2.46, 1.10]
DK	-3.73*	(0.012)	[-6.07, -1.38]	[-6.55, -0.90]	-3.79*	(0.011)	[-6.16, -1.42]	[-6.65, -0.94]
EE	-5.03***	(0.000)	[-5.88, -4.18]	[-6.05, -4.01]	-4.82***	(0.000)	[-5.75, -3.89]	[-5.94, -3.70]
EL	9.48***	(0.000)	[8.69, 10.27]	[8.53, 10.43]	8.02***	(0.000)	[6.25, 9.78]	[5.89, 10.14]
ES	-2.73	(0.125)	[-5.68, 0.21]	[-6.28, 0.81]	-1.76	(0.332)	[-4.80, 1.28]	[-5.42, 1.90]
FI	-6.74***	(0.000)	[-9.30, -4.18]	[-9.82, -3.66]	-7.06***	(0.000)	[-9.65, -4.46]	[-10.19, -3.93]
FR	2.91*	(0.045)	[0.55, 5.27]	[0.06, 5.76]	4.50*	(0.015)	[1.56, 7.44]	[0.95, 8.04]
HR	4.33***	(0.000)	[2.87, 5.80]	[2.57, 6.10]	4.38***	(0.000)	[2.91, 5.85]	[2.61, 6.15]
HU	-0.71	(0.489)	[-2.43, 1.01]	[-2.78, 1.36]	-1.46	(0.167)	[-3.21, 0.29]	[-3.57, 0.65]
IE	-9.23***	(0.000)	[-12.59, -5.86]	[-13.28, -5.17]	-6.95**	(0.008)	[-11.11, -2.79]	[-11.96, -1.94]
IT	-2.01+	(0.051)	[-3.70, -0.33]	[-4.04, 0.01]	-1.87+	(0.069)	[-3.56, -0.19]	[-3.90, 0.15]
LT	2.49***	(0.000)	[1.72, 3.25]	[1.56, 3.41]	1.45+	(0.075)	[0.11, 2.78]	[-0.16, 3.06]
LU	-1.31	(0.228)	[-3.12, 0.50]	[-3.49, 0.87]	-0.75	(0.507)	[-2.65, 1.15]	[-3.04, 1.54]

	(0)				(1)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
LV	4.89***	(0.000)	[4.36, 5.42]	[4.25, 5.53]	4.58***	(0.000)	[3.93, 5.22]	[3.80, 5.35]
MT	-7.52***	(0.000)	[-8.79, -6.26]	[-9.05, -6.00]	-6.87***	(0.000)	[-8.38, -5.36]	[-8.69, -5.05]
NL	-6.68***	(0.000)	[-8.28, -5.07]	[-8.61, -4.74]	-5.82***	(0.000)	[-7.68, -3.96]	[-8.06, -3.58]
PL	1.43*	(0.022)	[0.43, 2.42]	[0.23, 2.63]	1.48*	(0.018)	[0.48, 2.49]	[0.28, 2.69]
PT	-1.39*	(0.020)	[-2.35, -0.44]	[-2.55, -0.24]	-1.72**	(0.009)	[-2.77, -0.68]	[-2.98, -0.47]
RO	0.49	(0.389)	[-0.47, 1.45]	[-0.66, 1.65]	1.08	(0.143)	[-0.14, 2.29]	[-0.39, 2.54]
SE	-14.24***	(0.000)	[-16.78, -11.71]	[-17.30, -11.19]	-14.21***	(0.000)	[-16.72, -11.69]	[-17.24, -11.18]
SI	1.54	(0.144)	[-0.20, 3.28]	[-0.56, 3.64]	1.62	(0.120)	[-0.10, 3.34]	[-0.45, 3.69]
SK	-3.02***	(0.000)	[-3.56, -2.48]	[-3.68, -2.37]	-3.42***	(0.000)	[-4.09, -2.75]	[-4.22, -2.62]
UK	-14.14***	(0.000)	[-17.95, -10.32]	[-18.73, -9.54]	-12.01***	(0.000)	[-16.49, -7.53]	[-17.40, -6.62]
constant	70.36**	(0.002)	[35.67, 105.05]	[28.58, 112.15]	74.45***	(0.001)	[40.67, 108.22]	[33.76, 115.14]
Observations	504				504			
R-squared	0.6610				0.6632			
Adjusted R-squared	0.6365				0.6380			

*Notes: (1) p-values are in parentheses; (2) * p<0.05; (3) ** p<0.01; (4) *** p<0.001; (5) + p<0.10;*

Sensitivities and robustness checks of the main model

12.7 I run the following sensitivities and robustness checks on my main model:

12.7.1 Re-estimating the main model on the subsample of people aged 15–24 and those aged 25+;

12.7.2 Constraining the tobacco price coefficient with estimate from existing literature;

12.7.3 Testing the effects of including a linear time trend or using dummies for each Eurobarometer wave;

12.7.4 Using an alternative weighting for the components of the e-cigarette hostility index, placing more weight on the presence of e-cigarette tax and indoor vaping bans;

12.7.5 Measuring the effect of e-cigarette taxes separately to non-price hostility to e-cigarettes;

12.7.6 Testing a definition of the education variable which includes people who left full time education between the ages of 16 and 19; and

12.7.7 Conducting a regression for the cigarette-price test described in paragraph 3.4.1.

Re-Estimating the Main Model on the Subsamples of People Aged 15–24 and Those Aged 25+

12.8 Table 12-2 below shows regression outputs from the main model (Model 1), a model estimated separately on those aged 15–24 only (Model 2), and a model estimated on the remainder (those aged 25 and older, in Model 3).

12.9 The results for Model 2 (those aged 15–24 only) shows that:

12.9.1 The estimated effect of e-cigarette hostility is more than twice as large in Model 2 compared to Model 1 (0.99 vs 0.39). These two coefficients are statistically significantly different from one another: a 1 point increase in the index leads to 0.99pp increase in smoking prevalence in younger people (Model 2) vs 0.39pp for the all-age sample (Model 1), with the difference between the two coefficients being statistically significant at the 5% level (p-value 0.037). [177]

12.9.2 This difference is consistent with either of the below:

(a) Young people are the primary users of e-cigarettes (perhaps as early adopters), so I am able to more precisely measure the effect of e-cigarette restrictions on this group.

(b) E-cigarettes affect traditional smoking through preventing or delaying smoking initiation. As people usually start smoking when they are young, e-cigarette use affects smoking prevalence in this subgroup of

[177] The test of whether given coefficient from Model 1 is statistically significantly different from its counterpart in Model 2 is conducted following the steps in Stata.com, "How do you test the equality of regression coefficients that are generated from two different regressions, estimated on two different samples?".

young respondents, more than in the whole sample.

12.9.3 The coefficient on the tobacco price index is still negative and larger in magnitude than in Model 2, consistent with the view that young people are more sensitive to price changes than the general population. The coefficients are statistically significantly different from one another at the 5% level (with the p-value of the difference of 0.046).

12.9.4 The coefficients on unemployment are of similar magnitude but with higher p-values (on the t-test) in Model 2. These controls are arguably less applicable to the 15–24 group, where a larger proportion of people are economically inactive or still studying.

12.10 The results for Model 3 (those aged 25+) shows that:

12.10.1 The coefficient on the e-cigarette hostility is not statistically significantly different from 0 (p-value on the t-test is 0.549).

12.10.2 The coefficient on tobacco price has a high p-value (0.334 on the t-test) and is not statically significantly different from 0. This suggests that older people are less sensitive to the price of tobacco (perhaps because of a stronger habit or more accumulated wealth on average, compared to younger people).

12.10.3 The coefficients on the unemployment and education variables both have small p-values (0.023 and 0.000, respectively) and similar magnitudes to the corresponding coefficients in Model 1. This is arguably in line with the fact that unemployment and education are more salient controls in the subsample which contains a higher proportion of economically active people and people who have already left school.

Table 12-2: Results from estimating the main model on (1) whole sample, (2) subsample of those aged 15–24 and (3) subsample of those aged 25+

	(1)				(2)				(3)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
EcigHostility Index	0.39+	(0.076)	[0.03, 0.75]	[-0.04, 0.82]	0.99*	(0.037)	[0.22, 1.77]	[0.06, 1.92]	0.11	(0.549)	[-0.20, 0.43]	[-0.27, 0.49]
NonPrice TobaccoControlIndex	0.07	(0.574)	[-0.13, 0.26]	[-0.17, 0.30]	-0.04	(0.863)	[-0.45, 0.36]	[-0.53, 0.45]	0.10	(0.307)	[-0.06, 0.27]	[-0.10, 0.30]
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	[-20.94, -4.83]	[-22.59, -3.18]	-25.88*	(0.010)	[-41.79, -9.96]	[-45.05, -6.70]	-4.78	(0.334)	[-13.06, 3.50]	[-14.75, 5.19]
PercentUnemployed	0.23**	(0.004)	[0.10, 0.35]	[0.08, 0.37]	0.23+	(0.093)	[0.01, 0.45]	[-0.04, 0.49]	0.20*	(0.023)	[0.06, 0.34]	[0.03, 0.37]
PercentLeftEduc1618	0.17**	(0.002)	[0.09, 0.26]	[0.07, 0.27]	0.15	(0.248)	[-0.07, 0.37]	[-0.11, 0.42]	0.26***	(0.000)	[0.17, 0.35]	[0.15, 0.37]
25–54	2.94*	(0.024)	[0.85, 5.04]	[0.42, 5.47]								
55+	-8.96***	(0.000)	[-11.31, -6.61]	[-11.79, -6.13]					-12.27***	(0.000)	[-14.63, -9.90]	[-15.12, -9.42]
Male	7.83***	(0.000)	[5.52, 10.14]	[5.05, 10.62]	4.95*	(0.012)	[1.83, 8.07]	[1.19, 8.71]	9.11***	(0.000)	[6.82, 11.39]	[6.36, 11.86]
BE	-4.61***	(0.000)	[-6.25, -2.98]	[-6.58, -2.64]	-4.80+	(0.054)	[-8.86, -0.74]	[-9.69, 0.09]	-3.95***	(0.000)	[-5.48, -2.43]	[-5.79, -2.12]
BG	8.99***	(0.000)	[8.40, 9.58]	[8.28, 9.70]	10.52***	(0.000)	[8.82, 12.21]	[8.47, 12.56]	7.92***	(0.000)	[7.11, 8.73]	[6.94, 8.90]
CY	-1.19+	(0.066)	[-2.24, -0.13]	[-2.46, 0.09]	-6.06***	(0.000)	[-7.79, -4.32]	[-8.15, -3.97]	1.36*	(0.048)	[0.24, 2.48]	[0.01, 2.71]
CZ	1.77***	(0.000)	[1.04, 2.51]	[0.89, 2.66]	6.54***	(0.000)	[5.46, 7.63]	[5.23, 7.85]	-1.60*	(0.024)	[-2.74, -0.46]	[-2.98, -0.22]

	(1)				(2)				(3)			
	Coefficient	p-Value	90% CI	95% CI	Coefficient	p-Value	90% CI	95% CI	Coefficient	p-Value	90% CI	95% CI
DE	-0.68	(0.442)	[-2.16, 0.80]	[-2.46, 1.10]	-0.93	(0.586)	[-3.79, 1.93]	[-4.37, 2.52]	-1.12	(0.162)	[-2.45, 0.21]	[-2.72, 0.48]
DK	-3.79*	(0.011)	[-6.16, -1.42]	[-6.65, -0.94]	-10.54***	(0.000)	[-14.62, -6.47]	[-15.45, -5.64]	1.99	(0.236)	[-0.81, 4.79]	[-1.38, 5.36]
EE	-4.82***	(0.000)	[-5.75, -3.89]	[-5.94, -3.70]	-8.95***	(0.000)	[-11.66, -6.24]	[-12.21, -5.68]	-2.51***	(0.000)	[-3.32, -1.70]	[-3.49, -1.54]
EL	8.02***	(0.000)	[6.25, 9.78]	[5.89, 10.14]	-1.08	(0.612)	[-4.67, 2.51]	[-5.41, 3.25]	12.64***	(0.000)	[11.29, 13.98]	[11.02, 14.26]
ES	-1.76	(0.332)	[-4.80, 1.28]	[-5.42, 1.90]	-3.06	(0.375)	[-8.82, 2.71]	[-10.00, 3.89]	0.16	(0.926)	[-2.78, 3.11]	[-3.39, 3.71]
FI	-7.06***	(0.000)	[-9.65, -4.46]	[-10.19, -3.93]	-8.90**	(0.003)	[-13.53, -4.27]	[-14.48, -3.33]	-4.61**	(0.007)	[-7.27, -1.95]	[-7.81, -1.40]
FR	4.50*	(0.015)	[1.56, 7.44]	[0.95, 8.04]	5.74	(0.135)	[-0.61, 12.08]	[-1.91, 13.38]	4.00*	(0.014)	[1.40, 6.60]	[0.87, 7.13]
HR	4.38***	(0.000)	[2.91, 5.85]	[2.61, 6.15]	3.43	(0.117)	[-0.17, 7.03]	[-0.91, 7.76]	3.72***	(0.001)	[2.03, 5.42]	[1.68, 5.77]
HU	-1.46	(0.167)	[-3.21, 0.29]	[-3.57, 0.65]	1.30	(0.550)	[-2.35, 4.95]	[-3.10, 5.70]	-4.37**	(0.004)	[-6.73, -2.00]	[-7.22, -1.51]
IE	-6.95**	(0.008)	[-11.11, -2.79]	[-11.96, -1.94]	-2.54	(0.626)	[-11.30, 6.22]	[-13.09, 8.02]	-8.71***	(0.000)	[-12.19, -5.22]	[-12.91, -4.51]
IT	-1.87+	(0.069)	[-3.56, -0.19]	[-3.90, 0.15]	-3.38	(0.108)	[-6.85, 0.09]	[-7.56, 0.80]	0.06	(0.952)	[-1.50, 1.62]	[-1.82, 1.94]
LT	1.45+	(0.075)	[0.11, 2.78]	[-0.16, 3.06]	1.98	(0.141)	[-0.24, 4.21]	[-0.70, 4.66]	1.05	(0.138)	[-0.12, 2.22]	[-0.36, 2.46]
LU	-0.75	(0.507)	[-2.65, 1.15]	[-3.04, 1.54]	4.21	(0.144)	[-0.55, 8.97]	[-1.53, 9.94]	-1.94+	(0.050)	[-3.56, -0.33]	[-3.89, 0.00]
LV	4.58***	(0.000)	[3.93, 5.22]	[3.80, 5.35]	4.42***	(0.000)	[3.37, 5.48]	[3.15, 5.70]	4.34***	(0.000)	[3.38, 5.30]	[3.18, 5.50]

	(1)				(2)				(3)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
MT	-6.87***	(0.000)	[-8.38, -5.36]	[-8.69, -5.05]	-7.95***	(0.001)	[-11.53, -4.38]	[-12.26, -3.65]	-7.22***	(0.000)	[-8.88, -5.55]	[-9.23, -5.21]
NL	-5.82***	(0.000)	[-7.68, -3.96]	[-8.06, -3.58]	-4.77	(0.120)	[-9.84, 0.29]	[-10.87, 1.33]	-5.52***	(0.000)	[-6.94, -4.10]	[-7.24, -3.81]
PL	1.48*	(0.018)	[0.48, 2.49]	[0.28, 2.69]	-1.45	(0.404)	[-4.37, 1.47]	[-4.96, 2.06]	3.26***	(0.000)	[2.39, 4.14]	[2.21, 4.32]
PT	-1.72**	(0.009)	[-2.77, -0.68]	[-2.98, -0.47]	-2.40***	(0.000)	[-3.38, -1.42]	[-3.58, -1.22]	-0.36	(0.643)	[-1.69, 0.96]	[-1.96, 1.23]
RO	1.08	(0.143)	[-0.14, 2.29]	[-0.39, 2.54]	3.89*	(0.012)	[1.45, 6.34]	[0.95, 6.84]	-0.96	(0.227)	[-2.29, 0.36]	[-2.56, 0.64]
SE	-14.21***	(0.000)	[-16.72, -11.69]	[-17.24, -11.18]	-15.71***	(0.000)	[-20.71, -10.71]	[-21.74, -9.69]	-11.40***	(0.000)	[-13.94, -8.86]	[-14.46, -8.34]
SI	1.62	(0.120)	[-0.10, 3.34]	[-0.45, 3.69]	4.17	(0.121)	[-0.27, 8.62]	[-1.18, 9.53]	0.88	(0.382)	[-0.81, 2.58]	[-1.16, 2.92]
SK	-3.42***	(0.000)	[-4.09, -2.75]	[-4.22, -2.62]	-0.51	(0.466)	[-1.67, 0.66]	[-1.91, 0.90]	-5.76***	(0.000)	[-6.84, -4.68]	[-7.06, -4.45]
UK	-12.01***	(0.000)	[-16.49, -7.53]	[-17.40, -6.62]	-9.32+	(0.075)	[-17.90, -0.74]	[-19.66, 1.01]	-13.59***	(0.000)	[-17.66, -9.51]	[-18.49, -8.68]
constant	74.45***	(0.001)	[40.67, 108.22]	[33.76, 115.14]	138.47**	(0.002)	[70.15, 206.78]	[56.18, 220.76]	35.87	(0.100)	[-0.01, 71.76]	[-7.35, 79.10]
Sample	Full sample				Age 15–24 only				Age 25+ only			
Observations	504				168				336			
R-squared	0.6632				0.5264				0.7827			
Adjusted R-squared	0.6380				0.4098				0.7581			

*Notes: (1) p-values are in parentheses (2) + p<0.10; (2) * p<0.05; (3) ** p<0.01; (4) *** p<0.001*

Constraining the Tobacco Price Coefficients with Estimates Taken from the Literature

12.11 The main purpose of my model is to estimate the impact of e-cigarette hostility on smoking prevalence. The remaining variables are controls to ensure that the interpretation of the e-cigarette hostility variable is causal. However, estimating some of the variation in my dataset is 'used up' in order to estimate the coefficients of all control variables, which may possibly lead to imprecise estimation of the e-cigarette hostility coefficient.

12.12 To test this, I run a constrained regression, fixing the coefficient on tobacco price to values already estimated in the academic literature. The most recent relevant paper I find is Flor et al (2021). The authors use the Global Burden of Disease dataset from 2017 to study the determinants of smoking prevalence globally. They regress the logarithm of smoking prevalence on a "cost of cigarettes" price index.[178] They find that a 10pp increase in the price index leads to a 7% decline in smoking prevalence (for all sexes and all ages in dataset), with a 95% confidence interval from -11% to -4%.[179]

12.13 The average value of the cigarette price index in the authors' dataset is 12.7.[180] I use this to calculate a price elasticity of smoking prevalence to be between -1.4 and -0.5.[181] I then convert this elasticity into constraints consistent with my level-log specification of the relationship between prevalence and tobacco price using the formula:

constraint=elasticity average smoking prevalence in my sample*[182]

12.14 I obtain the following lower and upper bound for the values of the tobacco price coefficient consistent with Flor et al (2021): -35 and -13. At -12.89, my estimate of the tobacco price coefficient falls near the upper bound of this range.

12.15 Table 12-3 below shows the results of using the above constraints in my model specification. Model 1 is the unconstrained estimation, Model 2 constrains tobacco price coefficient to -13 and Model 3 constrains it to -35.

12.16 Both the size and p-value of the e-cigarette variable are similar in Model 8 compared to Model 1. Model 9 has an e-cigarette coefficient similar in magnitude to Model 1, but with a p-value that is almost half the p-value in Model 1. I take these results as indicating the following:

12.16.1 My estimate of the tobacco price coefficient is in line with the latest literature;

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178 The index, they call RIP, measures the % of GDP per capita required in order to purchase half a box of cigarettes every day for a year across different countries.

179 See Table 2 here in Flor et al. (2021) . See also the following quote for authors' interpretation of the numbers in the table: "Furthermore, a 10 percentage point increase in RIP was associated with a 9% (95% UI, −12.6 to −5.0, P < 0.0001) decrease in overall smoking prevalence."

180 See the lagged_rip variable in the "Processed input data [CSV]" file here: ghdx.healthdata.org, "Global Tobacco Control and Smoking Prevalence Scenarios 2017"

181 Calculated by dividing the absolute increase in the price index by the average price index value to get % changes and then dividing the % changes in smoking prevalence by the result: elasticity = 11% / (10pp / 12.7).

182 I use the simple average of the smoking prevalence in each observation in my dataset. This equals 24.9%.%

and

12.16.2 The unconstrained model (Model 1) is reasonably precise when estimating e-cigarette hostility – not much is gained by adding constraints.

Table 12-3: Results of unconstrained estimation of my mode (1), constraining the tobacco price coefficient to -0.13 in model (8), and -0.35 in model (9).

	(1)		(8)		(9)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
EcigHostilityIndex	0.39+	(0.076)	0.39+	(0.065)	0.46*	(0.038)
NonPriceTobaccoControlIndex	0.07	(0.574)	0.07	(0.476)	0.32*	(0.013)
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	-13.00	(.)	-35.00	(.)
PercentUnemployed	0.23**	(0.004)	0.23**	(0.003)	0.19*	(0.017)
PercentLeftEduc1618	0.17**	(0.002)	0.17***	(0.001)	0.16**	(0.001)
25–54	2.94*	(0.024)	2.95*	(0.016)	3.23**	(0.010)
55+	-8.96***	(0.000)	-8.96***	(0.000)	-8.88***	(0.000)
Male	7.83***	(0.000)	7.83***	(0.000)	7.86***	(0.000)
BE	-4.61***	(0.000)	-4.62***	(0.000)	-5.37***	(0.000)
BG	8.99***	(0.000)	8.99***	(0.000)	9.34***	(0.000)
CY	-1.19+	(0.066)	-1.18+	(0.069)	-0.47	(0.463)
CZ	1.77***	(0.000)	1.78***	(0.000)	2.93***	(0.000)
DE	-0.68	(0.442)	-0.66	(0.188)	2.10**	(0.002)
DK	-3.79*	(0.011)	-3.79**	(0.007)	-3.81**	(0.007)
EE	-4.82***	(0.000)	-4.81***	(0.000)	-3.77***	(0.000)
EL	8.02***	(0.000)	8.02***	(0.000)	9.41***	(0.000)
ES	-1.76	(0.332)	-1.78	(0.217)	-5.00*	(0.011)
FI	-7.06***	(0.000)	-7.06***	(0.000)	-8.06***	(0.000)
FR	4.50*	(0.015)	4.49**	(0.006)	3.12	(0.163)
HR	4.38***	(0.000)	4.39***	(0.000)	5.59***	(0.000)
HU	-1.46	(0.167)	-1.46	(0.152)	-1.80	(0.184)
IE	-6.95**	(0.008)	-6.96**	(0.002)	-9.41**	(0.002)
IT	-1.87+	(0.069)	-1.88*	(0.034)	-3.11**	(0.004)
LT	1.45+	(0.075)	1.46+	(0.061)	3.33***	(0.000)

	(1)		(8)		(9)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
LU	-0.75	(0.507)	-0.76	(0.460)	-2.22+	(0.055)
LV	4.58***	(0.000)	4.58***	(0.000)	5.80***	(0.000)
MT	-6.87***	(0.000)	-6.88***	(0.000)	-8.49***	(0.000)
NL	-5.82***	(0.000)	-5.82***	(0.000)	-6.48***	(0.000)
PL	1.48*	(0.018)	1.48**	(0.005)	0.69	(0.314)
PT	-1.72**	(0.009)	-1.72**	(0.005)	-1.78**	(0.007)
RO	1.08	(0.143)	1.08	(0.132)	1.11	(0.225)
SE	-14.21***	(0.000)	-14.22***	(0.000)	-16.67***	(0.000)
SI	1.62	(0.120)	1.61*	(0.047)	-0.28	(0.794)
SK	-3.42***	(0.000)	-3.42***	(0.000)	-3.09***	(0.000)
UK	-12.01***	(0.000)	-12.03***	(0.000)	-16.06***	(0.000)
constant	74.45***	(0.001)	74.94***	(0.000)	169.54***	(0.000)
Observations	504		504		504	
R-squared	0.6632					
Adjusted R-squared	0.6380					

*Notes: (1) p-values in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) ***p<0.001*

Testing the Effects of Including a Linear Time Trend or Using Dummies for Each Eurobarometer Wave

12.17 My main model does not include time trends, as it is estimated using observations from three waves of the survey, and I do not consider this is sufficient to estimate a reliable time trend. I also use the time-variation of smoking prevalence for identifying the effect of the time varying explanatory variables in my model, such as e-cigarette hostility and the real of tobacco.

12.18 To test this assumption, Table 12-4 below presents the results of adding to my main model a dummy for each wave of the Eurobarometer (2014, 2017, 2020) in Model 5, and a linear time trend (linear in the year) in Model 6. The coefficients on the time variables in both Models 5 and 6 are not statistically significant at the 10% level. However, the coefficient on the real tobacco price becomes smaller in magnitude and with a larger p-value in Models 5 and 6. This is possibly because much of the variation the price of tobacco (tobacco prices tend to increase over time) is now picked up by time variables. I take the results of Models 5 and 6 as indicative that it is not possible or necessary to measure a time trend as part of my main model.

Table 12-4: The main model (1), adding a dummy for each Eurobarometer wave (5) and adding a linear time trend (6)

	(1)		(5)		(6)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
EcigHostilityIndex	0.39+	(0.076)	0.38	(0.257)	0.51+	(0.059)
Year of Eurobarometer wave=2017			0.38	(0.779)		
Year of Eurobarometer wave=2020			-2.25	(0.244)		
Year of Eurobarometer wave					-0.38	(0.231)
NonPriceTobaccoControlIndex	0.07	(0.574)	0.14	(0.147)	0.14	(0.192)
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	-5.70	(0.410)	-7.82	(0.301)
PercentUnemployed	0.23**	(0.004)	0.21**	(0.004)	0.21**	(0.005)
PercentLeftEduc1618	0.17**	(0.002)	0.17**	(0.002)	0.17**	(0.002)
25–54	2.94*	(0.024)	2.93*	(0.022)	2.94*	(0.023)
55+	-8.96***	(0.000)	-9.07***	(0.000)	-9.07***	(0.000)
Male	7.83***	(0.000)	7.83***	(0.000)	7.83***	(0.000)
BE	-4.61***	(0.000)	-5.70***	(0.000)	-5.86***	(0.000)
BG	8.99***	(0.000)	8.58***	(0.000)	8.67***	(0.000)
CY	-1.19+	(0.066)	-0.98	(0.125)	-1.04+	(0.078)
CZ	1.77***	(0.000)	1.39**	(0.008)	1.59**	(0.003)
DE	-0.68	(0.442)	-0.74	(0.340)	-0.52	(0.548)
DK	-3.79*	(0.011)	-4.59**	(0.003)	-4.63**	(0.002)
EE	-4.82***	(0.000)	-5.96***	(0.000)	-5.82***	(0.000)
EL	8.02***	(0.000)	7.90***	(0.000)	7.57***	(0.000)
ES	-1.76	(0.332)	-2.69+	(0.086)	-2.68	(0.121)
FI	-7.06***	(0.000)	-9.08***	(0.000)	-9.33***	(0.000)
FR	4.50*	(0.015)	2.42	(0.145)	2.76	(0.125)
HR	4.38***	(0.000)	3.92***	(0.000)	4.06***	(0.000)
HU	-1.46	(0.167)	-2.92	(0.149)	-3.23+	(0.098)
IE	-6.95**	(0.008)	-9.52***	(0.000)	-9.07***	(0.001)

	(1)		(5)		(6)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
IT	-1.87+	(0.069)	-2.51*	(0.013)	-2.59*	(0.011)
LT	1.45+	(0.075)	0.66	(0.656)	0.50	(0.708)
LU	-0.75	(0.507)	-1.35	(0.192)	-1.33	(0.193)
LV	4.58***	(0.000)	3.84***	(0.000)	3.85***	(0.000)
MT	-6.87***	(0.000)	-7.64***	(0.000)	-7.61***	(0.000)
NL	-5.82***	(0.000)	-6.95***	(0.000)	-6.77***	(0.000)
PL	1.48*	(0.018)	0.88	(0.176)	0.80	(0.213)
PT	-1.72**	(0.009)	-2.07**	(0.009)	-2.18**	(0.004)
RO	1.08	(0.143)	-0.02	(0.986)	0.15	(0.875)
SE	-14.21***	(0.000)	-14.78***	(0.000)	-15.02***	(0.000)
SI	1.62	(0.120)	1.02	(0.291)	0.86	(0.392)
SK	-3.42***	(0.000)	-3.76***	(0.000)	-3.86***	(0.000)
UK	-12.01***	(0.000)	-14.37***	(0.000)	-14.12***	(0.000)
constant	74.45***	(0.001)	40.03	(0.201)	820.37	(0.184)
Observations	504		504		504	
R-squared	0.6632		0.6679		0.6643	
Adjusted R-squared	0.6380		0.6415		0.6384	

*Notes: (1) p-values in parentheses (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

Using a Different Weighting for the E-cigarette Hostility Index Components

12.19 As mentioned in paragraph 12.3.3, the main model treats all components of the e-cigarette hostility index as having equal impact on smoking prevalence. I also test an alternative specification where I reweight the index. The alternative weighting rebases the index to between 0 and 1 and:

12.19.1 Assigns a weight of 0.5 to the sum of the categories "indoor vaping ban" and "tax". This is in line with the TCS index from the 2019 report which assigns 52 out of the 100 points to "price cigarettes" (30 points) and "smoke free work and other public places" (22 points).

12.19.2 Assigns a weight 0.5 to the sum of the remaining components.

12.20 Table 12-5 below compares the results of the main model to the model using a re-weighted e-cigarette hostility index. The table shows that all p-values and the adjusted R-squared are the same between Model 1 and Model 11. The e-cigarette hostility coefficient is larger in magnitude in Model 11, but no other coefficients change. I take this to mean that my results are robust to this alternative weighting of the e-cigarette hostility index.

Table 12-5: Results of main model and a model where the e-cigarette hostility index is reweighted in line with the TCS index components

	(1)		(11)	
	Coefficient	**p-Values**	**Coefficient**	**p-Values**
EcigHostilityIndex	0.39+	(0.076)		
WeightedEcigHostility			0.78+	(0.076)
NonPriceTobaccoControlIndex	0.07	(0.574)	0.07	(0.574)
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	-12.89*	(0.011)
PercentUnemployed	0.23**	(0.004)	0.23**	(0.004)
PercentLeftEduc1618	0.17**	(0.002)	0.17**	(0.002)
25–54	2.94*	(0.024)	2.94*	(0.024)
55+	-8.96***	(0.000)	-8.96***	(0.000)
Male	7.83***	(0.000)	7.83***	(0.000)
BE	-4.61***	(0.000)	-4.61***	(0.000)
BG	8.99***	(0.000)	8.99***	(0.000)
CY	-1.19+	(0.066)	-1.19+	(0.066)
CZ	1.77***	(0.000)	1.77***	(0.000)
DE	-0.68	(0.442)	-0.68	(0.442)
DK	-3.79*	(0.011)	-3.79*	(0.011)
EE	-4.82***	(0.000)	-4.82***	(0.000)
EL	8.02***	(0.000)	8.02***	(0.000)
ES	-1.76	(0.332)	-1.76	(0.332)
FI	-7.06***	(0.000)	-7.06***	(0.000)
FR	4.50*	(0.015)	4.50*	(0.015)
HR	4.38***	(0.000)	4.38***	(0.000)
HU	-1.46	(0.167)	-1.46	(0.167)

	(1)		(11)	
	Coefficient	**p-Values**	**Coefficient**	**p-Values**
IE	-6.95**	(0.008)	-6.95**	(0.008)
IT	-1.87+	(0.069)	-1.87+	(0.069)
LT	1.45+	(0.075)	1.45+	(0.075)
LU	-0.75	(0.507)	-0.75	(0.507)
LV	4.58***	(0.000)	4.58***	(0.000)
MT	-6.87***	(0.000)	-6.87***	(0.000)
NL	-5.82***	(0.000)	-5.82***	(0.000)
PL	1.48*	(0.018)	1.48*	(0.018)
PT	-1.72**	(0.009)	-1.72**	(0.009)
RO	1.08	(0.143)	1.08	(0.143)
SE	-14.21***	(0.000)	-14.21***	(0.000)
SI	1.62	(0.120)	1.62	(0.120)
SK	-3.42***	(0.000)	-3.42***	(0.000)
UK	-12.01***	(0.000)	-12.01***	(0.000)
constant	74.45***	(0.001)	74.45***	(0.001)
Observations	504		504	
R-squared	0.6632		0.6632	
Adjusted R-squared	0.6380		0.6380	

*Notes: (1) p-values are in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

Measuring the Effect of E-cigarette Taxes Separately to Non-price Hostility to E-cigarettes

12.21 I test the following different configurations of my treatment variable:

12.21.1 Model 12 only includes e-cigarette tax, expressed in EUR per ml of liquid as treatment;

12.21.2 Model 13 only includes a hostility index without a tax category; and

12.21.3 Model 14 includes two separate treatment variables – a tax variable measured in EUR per ml of liquid, and a hostility index without a tax category.

12.22 These alternative specifications are directionally consistent with my preferred model (i.e. they continue to suggest that hostility towards e-cigarettes, albeit measured differently is consistent with higher rates of smoking) but are inferior to my preferred specification on account of omitting aspects of hostility, and / or "working the data too hard".

12.23 Table 12-6 summarizes the results. The figure shows that:

12.23.1 When e-cigarette tax is measured in EUR per ml and used as the only treatment variable (Model 12), the tax coefficient is still positive (which is consistent with smoking and e-cigarettes being substitutes), but with a large p-value (0.208).

12.23.2 When e-cigarette hostility without a tax category is used as the only treatment variable (Model 13), the coefficient is almost the same in magnitude (and sign) as the coefficient of my preferred treatment variable (Model 1), but with a slightly larger p-value. This suggests that non-tax e-cigarette restrictions account for the

majority of the effect of e-cigarette hostility on smoking, which is perhaps a result of taxes being relatively low compared to the price of e-cigarettes. For example, a pack of 4 JUUL pods, each containing 0.7ml of liquid,[183] is sold for EUR 13.90 online.[184] In 2020, the e-cigarette tax in Italy was roughly EUR 0.4 per ml, for a total tax of EUR 1.12, or just over 8% of the retail price. In comparison, the minimum excise duty on box cigarettes in Italy was almost 60% of the WAP in July 2020.[185]

12.23.3 When the e-cigarette tax in EUR and the non-tax hostility index are both entered into the model (Model 14), they both have large p-values (0.554 and 0.216, respectively). They are also not jointly significant (joint significance test p-value is 0.1364). This may be because there is not enough variation in my dataset to estimate two separate treatment coefficients (expressed in different scales, EUR vs index). Also, as noted in paragraph 10.29.7, once e-cigarette tax is introduced, it does not meaningfully vary in magnitude. What little variation there is may actually be causing the EUR tax variable to be measured less precisely than the 0/1 tax dummy.

183 See: meanings.com, "How much liquid is in a Juul pod"

184 Prices taken from JUUL Italian online shop.

185 See the "Overall minimum excise duty" on cigarettes in the European Commission excise duty tables for July 2020, accessed through circabc.europa.eu, "Archived Excise Duty Tables".

Table 12-6: Testing adding EUR measured e-cig tax as treatment variable (12), non-tax e-cig hostility index (13), and both EUR e-cig tax and non-tax hostility index (13)

	(1)		(12)		(13)		(14)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
EcigHostilityIndex	0.39+	(0.076)						
EcigTaxEur			5.45	(0.208)			3.26	(0.554)
NoTaxEcigHostility					0.40	(0.114)	0.35	(0.216)
NonPriceTobaccoControlIndex	0.07	(0.574)	0.13	(0.215)	0.07	(0.543)	0.07	(0.544)
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	-13.38*	(0.015)	-12.52*	(0.015)	-13.19*	(0.016)
PercentUnemployed	0.23**	(0.004)	0.22**	(0.004)	0.22**	(0.004)	0.23**	(0.004)
PercentLeftEduc1618	0.17**	(0.002)	0.17**	(0.002)	0.17**	(0.002)	0.17**	(0.002)
25–54	2.94*	(0.024)	2.98*	(0.022)	2.94*	(0.024)	2.94*	(0.024)
55+	-8.96***	(0.000)	-8.97***	(0.000)	-8.97***	(0.000)	-8.96***	(0.000)
Male	7.83***	(0.000)	7.84***	(0.000)	7.83***	(0.000)	7.83***	(0.000)
BE	-4.61***	(0.000)	-4.22***	(0.000)	-4.71***	(0.000)	-4.57***	(0.000)
BG	8.99***	(0.000)	8.88***	(0.000)	8.97***	(0.000)	8.98***	(0.000)
CY	-1.19+	(0.066)	-0.98+	(0.062)	-1.03+	(0.085)	-1.17+	(0.050)
CZ	1.77***	(0.000)	1.53***	(0.001)	1.76***	(0.000)	1.76***	(0.000)
DE	-0.68	(0.442)	-0.56	(0.532)	-0.66	(0.458)	-0.65	(0.468)
DK	-3.79*	(0.011)	-3.57*	(0.015)	-3.85*	(0.010)	-3.75*	(0.013)
EE	-4.82***	(0.000)	-5.20***	(0.000)	-4.76***	(0.000)	-4.89***	(0.000)
EL	8.02***	(0.000)	9.11***	(0.000)	8.26***	(0.000)	8.17***	(0.000)
ES	-1.76	(0.332)	-2.59	(0.141)	-1.84	(0.320)	-1.85	(0.317)
FI	-7.06***	(0.000)	-7.47***	(0.000)	-6.97***	(0.000)	-7.39***	(0.000)
FR	4.50*	(0.015)	3.25*	(0.027)	4.35*	(0.020)	4.40*	(0.018)
HR	4.38***	(0.000)	4.37***	(0.000)	4.36***	(0.000)	4.38***	(0.000)
HU	-1.46	(0.167)	-0.90	(0.378)	-1.33	(0.208)	-1.38	(0.186)
IE	-6.95**	(0.008)	-8.81***	(0.000)	-7.13**	(0.008)	-7.11**	(0.008)

	(1)		(12)		(13)		(14)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**	**Coefficient**	**p-Value**
IT	-1.87+	(0.069)	-3.32*	(0.036)	-1.67	(0.112)	-2.49	(0.189)
LT	1.45+	(0.075)	2.38***	(0.000)	1.52+	(0.074)	1.56+	(0.080)
LU	-0.75	(0.507)	-1.19	(0.271)	-0.80	(0.481)	-0.78	(0.489)
LV	4.58***	(0.000)	4.63***	(0.000)	4.79***	(0.000)	4.65***	(0.000)
MT	-6.87***	(0.000)	-7.38***	(0.000)	-6.94***	(0.000)	-6.92***	(0.000)
NL	-5.82***	(0.000)	-6.47***	(0.000)	-5.90***	(0.000)	-5.86***	(0.000)
PL	1.48*	(0.018)	1.54*	(0.014)	1.43*	(0.022)	1.49*	(0.017)
PT	-1.72**	(0.009)	-2.47*	(0.022)	-1.49*	(0.016)	-2.12+	(0.085)
RO	1.08	(0.143)	0.28	(0.632)	1.26	(0.140)	1.05	(0.290)
SE	-14.21***	(0.000)	-14.46***	(0.000)	-14.14***	(0.000)	-14.28***	(0.000)
SI	1.62	(0.120)	0.99	(0.413)	1.82+	(0.089)	1.46	(0.273)
SK	-3.42***	(0.000)	-2.98***	(0.000)	-3.45***	(0.000)	-3.38***	(0.000)
UK	-12.01***	(0.000)	-13.75***	(0.000)	-12.20***	(0.000)	-12.17***	(0.000)
constant	74.45***	(0.001)	76.05**	(0.002)	72.58**	(0.001)	75.75**	(0.002)
Observations	504		504		504		504	
R-squared	0.6632		0.6618		0.6630		0.6633	
Adjusted R-squared	0.6380		0.6365		0.6378		0.6373	

*Notes: (1) p-values are in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

Testing a Definition of the Education Variable which Includes People who Left Full Time Education Between the Ages of 16 and 19

12.24 My preferred model includes an education control which measures the proportion of people in each reference group who left full time education between the ages of 16 and 18. This roughly corresponds to people who have only received compulsory education.[186]

12.25 I also test a model (Model 15) with an education variable defined as people who left school between the ages of 16 and 19. This is in line with the education categories presented in the European Commission's report on the tobacco Eurobarometer. Table 12-7 below presents the results of the model and shows that:

12.25.1 The coefficient for the 16-19 education category in Model 15 (PercentLeftEduc1619) is of similar magnitude (but lower p-value) to the education coefficient (PercentLeftEduc1618) in the Model 1.

12.25.2 Furthermore, redefining the education variable does not materially impact the magnitudes and p-values of the coefficients for the treatment (EcigHostilityIndex) and tobacco control (NonPriceTobaccoControlIndex and "Log(RealTobaccoPriceIndex)") variables.

12.25.3 I conclude from the above that the definition of the education control variable in Model 1 is reasonable.

Table 12-7: Testing a different definition of the education control variable

	(1)		(15)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**
EcigHostilityIndex	0.39+	(0.076)	0.37+	(0.095)
NonPriceTobaccoControlIndex	0.07	(0.574)	0.06	(0.591)
Log(RealTobaccoPriceIndex)	-12.89*	(0.011)	-13.01*	(0.011)
PercentUnemployed	0.23**	(0.004)	0.24**	(0.002)
PercentLeftEduc1618	0.17**	(0.002)		
PercentLeftEduc1619			0.15***	(0.001)
25–54	2.94*	(0.024)	2.63*	(0.037)
55+	-8.96***	(0.000)	-8.62***	(0.000)
Male	7.83***	(0.000)	7.87***	(0.000)
BE	-4.61***	(0.000)	-4.13***	(0.000)
BG	8.99***	(0.000)	8.07***	(0.000)
CY	-1.19+	(0.066)	0.31	(0.653)
CZ	1.77***	(0.000)	0.74	(0.258)
DE	-0.68	(0.442)	-0.11	(0.891)
DK	-3.79*	(0.011)	-3.12*	(0.038)
EE	-4.82***	(0.000)	-4.58***	(0.000)
EL	8.02***	(0.000)	9.62***	(0.000)
ES	-1.76	(0.332)	-0.58	(0.746)

[186] See for example European Commission (2019/20)

	(1)		(15)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**
FI	-7.06***	(0.000)	-6.50***	(0.000)
FR	4.50*	(0.015)	5.49**	(0.004)
HR	4.38***	(0.000)	4.64***	(0.000)
HU	-1.46	(0.167)	-0.13	(0.890)
IE	-6.95**	(0.008)	-6.03*	(0.020)
IT	-1.87+	(0.069)	-2.56**	(0.002)
LT	1.45+	(0.075)	2.00*	(0.018)
LU	-0.75	(0.507)	0.01	(0.994)
LV	4.58***	(0.000)	4.59***	(0.000)
MT	-6.87***	(0.000)	-5.42***	(0.000)
NL	-5.82***	(0.000)	-4.97***	(0.000)
PL	1.48*	(0.018)	0.78	(0.109)
PT	-1.72**	(0.009)	-0.59	(0.439)
RO	1.08	(0.143)	1.79*	(0.013)
SE	-14.21***	(0.000)	-14.20***	(0.000)
SI	1.62	(0.120)	0.87	(0.325)
SK	-3.42***	(0.000)	-4.60***	(0.000)
UK	-12.01***	(0.000)	-10.62***	(0.000)
constant	74.45***	(0.001)	73.90***	(0.001)
Observations	504		504	
R-squared	0.6632		0.6632	
Adjusted R-squared	0.6380		0.6381	

*Notes: (1) p-values are in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

Conducting a Regression for the Cigarette-price Test

12.26 The cigarette-price and RRP-price tests each have their advantages and disadvantages. Cigarette prices are among the best-measured variables in the industry. Due to Hicksian symmetry, their effect – either in the substitutes or complements direction – is expected to loom large in the comparatively small RRP segment. On the other hand, the cigarette-price test is largely limited to the cross-country dimension because the price differences across countries are quite large in comparison to the changes that occur over short time intervals.

12.27 The RRP-price test, implemented with the e-cigarette hostility index, permits within-country comparisons due to the fact that the e-cigarette hostility index varies significantly over time during our sample period. Moreover, the quantity side of the RRP-test, smoking prevalence, is better measured than the quantity side of the cigarette-price test. Table 12-1 shows my various specifications of, and estimates from, the RRP price test.

12.28 The cigarette-price test was conducted with OLS to estimate Model 16 and Model 17, which have the following:

$$EcigaretteUsePrevalence_{cagt} = \phi * TaxInclusiveCigaretteWap_{cagt} + \kappa * NonPriceTobaccoControlIndex_{cagt} + \varsigma * PercentUnemployed_{cagt} + \rho * PercentLeftEduc1618_{cagt} + \sum_{n=1}^{2} \kappa_n * YearDummy_n + \sum_{k=1}^{2} \zeta_k * AgeCatDummy_k + \omega * MaleDummy + Constant + ErrorTerm_{cagt}$$

12.29 Where:

12.29.1 The subscripts ***c, g, a, t*** describe the same reference groups as in my main Model 1, described in 12.2.

12.29.2 ***EcigaretteUsePrevalence*** is the dependent variable which measures the proportion of people currently using e-cigarettes on regular basis (see Table 10-2).

12.29.3 ***TaxInclusiveCigaretteWap*** measures the tax-inclusive weighted average price in EUR per 1000 cigarettes (see Table 10-7). In this mode, I wish to take advantage of cigarette price variation across countries, rather than over time. This provides me with more data points, counterbalancing the fact that detecting effects on e-cigarette use is more difficult due to the low e-cigarette prevalence rates. Comparing cigarette prices across countries necessitates the use of the cigarette WAP, as the real tobacco price index only allows comparisons over time (see paragraph 10.21).

12.29.4 Model 16 uses ***2012TaxInclusiveCigaretteWap*** as the treatment variable**.** This is the cigarette WAP in 2012, copied over in each of the three waves 2014, 2017 and 2020 (this variable does not change with ***t***).

12.29.5 ***NonPriceTobaccoControlIndex***, ***PrecentageUnemployed*****,** a ***PrecentageLeftEduct1618*** and ***MaleDummy***, are the same controls used in Model 1 and described in paragraph 12.3. Note that I do not have country dummies, as I am using the cross-country variation in the dataset.[187]

12.29.6 ***YearDummy$_n$*** is a dummy variable for each Eurobarometer wave in the regression. As with Model 1, I use the Eurobarometer waves 2014, 2017, and 2020. As Model 16 exploits variation across countries, I control for year fixed effects.

12.30 The key takeaway from Model 16 is the coefficient on the ***TaxInclusiveCigaretteWap*** variable. It is positive and significant at the 1% level (two-sided test). It shows that an increase in the cigarette WAP by EUR 23.8 (10% of the average WAP between 2014–2020 in my dataset, at EUR 238 per 1000 cigarettes) is associated with an increase in e-cigarette use prevalence by 0.0079*23.8=0.2pp. This is a substantial effect, given the average e-cigarette prevalence in my dataset (including the period 2014–2020) is 2.3%. The effect is, evaluated at the mean, a cross-price elasticity of around 0.8 for e-cigarette use with respect to (conventional) cigarette prices.

187 I still used standard errors clustered on the country level.

12.31 Model 17 uses a fixed cigarette WAP as of 2012 (the earliest date for which WAP is available for all countries). It addresses the concern that cigarette prices are endogenous, and that cigarette manufacturers might be lowering their prices to respond to competition from e-cigarettes as the latter become more popular over 2014–2020. There are no material differences between Models 16 and 17. This suggests the conclusions from the previous paragraph are not importantly affected by endogenous price changes over time.[188]

Table 12-8: Model regressing e-cigarette use on traditional cigarette WAP (16)

	(16)		(17)	
	Coefficient	**p-Value**	**Coefficient**	**p-Value**
2012TaxInclusiveCigaretteWap			0.0079**	(0.0018)
TaxInclusiveCigaretteWap	0.0079***	(0.0003)		
NonPriceTobaccoControlIndex	-0.0218	(0.3708)	-0.0046	(0.8511)
PercentUnemployed	0.0144	(0.5663)	0.0114	(0.6564)
PercentLeftEduc1618	0.0103	(0.3931)	0.0111	(0.3550)
25–54	-0.5454	(0.1942)	-0.5568	(0.1842)
55+	-1.5684**	(0.0015)	-1.5998**	(0.0012)
Male	0.8549***	(0.0001)	0.8545***	(0.0001)
Year of Eurobarometer wave=2017	0.5072*	(0.0485)	0.5474*	(0.0498)
Year of Eurobarometer wave=2020	1.0342**	(0.0080)	1.2350**	(0.0021)
constant	0.0926	(0.9085)	-0.2312	(0.7860)
Observations	486		486	
R-squared	0.2229		0.2116	
Adjusted R-squared	0.2082		0.1967	

*Notes: (1) p-values are in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

12.32 The cigarette-price test presented in regression form here and discussed graphically in Section 4 agrees with the RRP-price test discussed in section 5. Both tests provide evidence that e-cigarettes and traditional cigarettes are economic substitutes.

12.33 Note that the (two-sided) p-value on the ***TaxInclusiveCigaretteWap*** coefficient is 0.0003. The (two-sided) p-value on the ***EcigHostilityIndex*** from Model 1 is 0.0764. To the extent that the estimates from the two separate models are independent of one another, the probability of obtaining both these coefficient values by chance (ie, if e-cigarettes and cigarettes are not substitutes) is 0.0003*0.0764 = 0.002%. This is a level of significance well below the 1% level. In Bayesian terms, the two together are "decisive" or "extreme evidence" supporting the substitutes hypothesis over the complements hypothesis.

[188] The 2012 average WAP in my dataset is EUR 194, for a cross-price elasticity for Model 17 of 0.7.

13. Appendix E: Associations Between Flavored E-Cigarette Use and Smoking, and Motivations for Starting to Vape

13.1 In this appendix I set out my analysis of subjective survey data provided within the Eurobarometer surveys, which sheds light on the associations between flavor e-cigarette use and smoking, and on people's motivations for starting to vape – as described from paragraph 13.2 below. In particular:

13.1.1 First, I summarize the kinds of research questions that I intend to address with the subjective Eurobarometer data;

13.1.2 Second, I describe the Eurobarometer data I use in this analysis;

13.1.3 Third, I explain my methodology; and

13.1.4 Finally, I present my results.

Questions I Address

13.2 The 2017 and 2020 waves of the Eurobarometer survey include several questions covering the motivations and flavor-preferences of flavor e-cigarette users. I use these questions to shed light on the associations between e-cigarette flavor use and smoking behavior, as well as to explore the reasons stated by respondents for why they started to vape. In particular, I focus on four areas of smoking behavior: general e-cigarette use, smoking cessation, vaping initiation and smoking initiation. The table below summarizes the questions I focus on in each area.

Table 13-1: Summary of research questions I address

Smoking behavior	Questions my analysis addresses
General e-cigarette use	How do flavor vapers compare to tobacco flavor only vapers and non-vapers? e.g., what is their age distribution and gender distribution? What is the smoking status of flavor vapers? If they do smoke, do they smoke more or less than others?
Smoking cessation	Among current smokers, how do quit attempts vary with flavor e-cigarette use? Among people who state they successfully quit or reduced smoking with the aid of e-cigarette products, what proportion are current flavor vapers?
Vaping initiation	What reasons do vapers give for starting to vape? How often do people cite flavors vs tobacco harm-reduction as reasons for vaping?
Smoking initiation / gateway effects	For current smokers who tried vaping first, what reasons they gave for starting to vape? [I explain later that the Eurobarometer information relating to this question is not reliable]

Data

13.3 I examine the characteristics (such as demographics and smoking status) of flavored, unflavored e-cigarette users and non-vapers. I use the two flavor-related questions from the 2017 and 2020 Eurobarometer waves to classify e-cigarette users according to Table 13-2 below.

Table 13-2: How I categorize e-cigarette users based on their survey responses

Question	"Flavor vaper"	"Tobacco flavor vaper"	"Non vaper"	"Failed to answer"
Thinking about [e-cigarettes], which of the following applies to you?[189]	Answered "You currently use it"	Answered "You currently use it"	Did not answer "You currently use it"	Answered "You currently use it"

189 QC3 in 2020, QB11 in 2017.

Question	"Flavor vaper"	"Tobacco flavor vaper"	"Non vaper"	"Failed to answer"
Which of the following e-cigarette liquid variants do you use on at least monthly basis?[190]	"Menthol or mint", "Fruit, like cherry or strawberry", "Candy, like chocolate or vanilla", "Alcohol flavor, like whisky or champagne", "Nicotine salts based liquid" [only available as an answer in 2020], "Other flavors" As respondents are allowed to select more than one flavor, "flavor vapers" might also have selected "tobacco flavor" in addition to any of the above answers.	Answered only "Tobacco flavor" and nothing else		Did not give an answer, or answered "Don't know"

13.4 Additionally, I examine respondents' stated reasons for starting to vape by looking at the following questions from the 2017 and 2020 Eurobarometer.

Table 13-3: Questions used to examine respondents' stated reasons for starting to vape

Question	Possible answers
Have you ever tried to quit smoking?[191]	1. Yes, in the last 12 months 2. Yes, more than a year ago 3. Never 4. Don't know
You said that you smoke or used to smoke tobacco but also use, used or tried electronic cigarettes or a similar device. Did the use of electronic cigarettes or any similar device help you to stop or reduce your tobacco	1. Yes, stopped smoking tobacco completely 2. Yes, stopped smoking tobacco for a while but then you started again 3. Yes, you reduced your tobacco consumption but you did not stop 4. No, you did not reduce your tobacco consumption at all

190 QC10a in 2020, QB13a in 2017.

191 QC15a in 2020, QB18 in 2017.

Question	Possible answers
consumption?[192]	5. No, and you actually increased your tobacco consumption 6. Don't know
Which of the following products did you use or try first?[193]	1. Boxed cigarettes 2. Hand-rolled cigarettes 3. Cigars 4. Cigarillos 5. Pipe 6. Water pipe tobacco (shisha, hookah) 7. Oral tobacco (snus) 8. Chewing tobacco 9. Nasal tobacco (snuff) 10. E-cigarettes or similar electronic devices 11. Heated tobacco products (2020 only) 12. Other 13. Don't know
Which of the following factors, if any, were important in your decision to start using e-cigarettes?[194]	1. To stop or reduce your tobacco consumption 2. They were cool or attractive 3. You could vape in places where tobacco smoking was not allowed 4. They were cheaper than tobacco 5. Your friends used e-cigarettes 6. You liked the flavours of e-cigarettes 7. You believed that vaping was less harmful using tobacco 8. Other 9. None 10. Don't know

13.5 Note that each of the above questions is asked of a slightly different base of respondents, depending on their answers to prior questions. The details are laid out in the relevant Eurobarometer questionnaires for 2017 and 2020.[195] In my analysis, I account for these differing bases when calculating percentages.

Methods

13.6 I examine the characteristics of flavor vapers, tobacco vapers and non-vapers by looking at

[192] QC12a in 2020, QB15 in 2017

[193] QC3 in 2020, QB16 in 2017.

[194] QC11a in 2020, QB14 in 2017.

[195] See: Gesis.org, "Eurobarometer 93.2" and Gesis.org, "Eurobarometer 87.1", "*Questionnaire*"

four broad categories of smoking behavior:

13.6.1 General flavor e-cigarette use;

13.6.2 Smoking cessation;

13.6.3 Vaping initiation; and

13.6.4 Smoking initiation

13.7 I shed light on each of these behaviors by cross-tabulating vaping status / stated reason for staring to vape against demographic and socio-economic characteristics. All the numbers presented in the remainder of this Appendix are population-weighted, unless explicitly otherwise stated, as is recommended by the Eurobarometer website.[196]

Results

13.8 The table below summarizes my results. More detail and the raw data underlying my calculations are presented in subsections.

Table 13-4: Summary of findings

Smoking behavior	Questions we explore with cross-tabulation analysis
General e-cigarette use	On average, flavor e-cigarette users are much more likely to be current or ex-smokers (92%), more likely to be male (64%), aged 25–54 (64%) and employed (64%). Overall, flavor e-cigarette use is rare, with only 1.5% of respondents across 2017 and 2020 Eurobarometer waves being flavor vapers. Only 0.2% of never-smokers[197] use flavored vapes. Thus, any flavor ban would overwhelmingly impact current and ex-smokers, who are possibly trying to quit. Flavor vaping is similarly rare in the youth – only 1.6% of the respondents under-18 said they use flavors (but none said they are exclusive tobacco flavor vapers).
Smoking cessation	Current smokers who use flavor vapes are more likely to have tried to quit smoking recently than smokers who use tobacco flavor vapes. Among current smokers, 31% of those who are also flavor vapers and 17% of those who are exclusively tobacco flavor vapers reported trying to quit smoking in the past year. This compares to 14% of smokers who do not vape at all. Among smokers who tried to quit by using e-cigarettes and other similar devices (heat-not-burn), the proportions who were successful are almost the same for flavor and tobacco flavor vapers (47% and 45% respectively). By contrast, only 13% of smokers who do not currently

196 See: Gesis.org, "Weighting overview"

197 I define never-smokers as people who are neither current nor ex-smokers. It is possible these people tried cigarettes once or twice, but they never developed a smoking habit.

Smoking behavior	Questions we explore with cross-tabulation analysis
	use e-cigarettes and tried and/or use heat-not-burn were successful quitters. I emphasize that the above statements do not imply causation, as vapers could be more highly motivated to quit smoking than other smokers.
Vaping initiation	Flavor is only the fourth (out of 8 possibilities) most cited reasons why people started vaping, with 16% of respondents citing it. A similar proportion (13%) cited "friends use it" as a reason. Reducing tobacco consumption (59%), the lower harmfulness of vaping vs smoking (34%), and the fact that vaping is cheaper than tobacco (24%) were all cited more frequently than flavor. Among those who cited flavor a reason to start vaping, the vast majority were current or ex-smokers (89%).
Smoking initiation / gateway effects	I have considered current or ex-smokers who started vaping first, trying to examine their reasons for vaping initiation. I conclude the data for this subset of people is not reliable: more than 50% of the approximately 200 current or ex-smokers who started vaping first gave "reduce tobacco consumption" as a reason for vaping initiation; this is self-contradictory, unless they meant that they started vaping in order not to start smoking in the future.

13.9

General E-Cigarette Use

13.10 Table 13-5 below shows a cross tabulation of e-cigarette flavor use status and various demographic factors. The table shows that:

13.10.1 **Flavor e-cigarette use is rare overall, but, among vapers, flavor vapers are the vast majority.** Only 817 (pop-weighted) people, or 1.5% of all respondents, are flavor vapers. However, of the roughly 1,000 people who answered the flavor question, 75% use flavors (possibly in addition to tobacco flavor).

13.10.2 **Furthermore, the vast majority of flavor vapers are current or ex-smokers; there are almost no never-smokers[198] who vape.** 92% of flavor vapers[199] are current or ex-smokers. Only 63 population-weighted respondents (0.2% of all never-smoker respondents) said they are never-smokers *and* flavor vapers.

13.10.3 **Still, among never-smokers, flavors are much more popular, with only 0.02% (or**

198 See above footnote for never-smoker definition.

199 As noted in Table 13-2, "flavor vapers" may use tobacco flavor in addition to other flavors. "Tobacco flavor vapers" are those respondents who exclusively use tobacco flavor and nothing else.

5 population-weighted respondents) of never-smokers vaping tobacco flavor exclusively (this does not mean flavors *caused* never-smokers to start vaping or that a ban on flavors would cause them to stop vaping).

13.10.4 **Vaping is also rare in youth, but all 23 people under-18 in the data who said they vape (across all Eurobarometer countries), also said they use flavors.** 1.6% of under-18 are flavor vapers, similar to the overall population; however, there were no exclusive tobacco flavor youths in our sample

13.10.5 **Few people responded that they are flavor vapers in each year.** 373 in 2017 and 444 in 2020 said they are flavor vapers (a prevalence rate of 1.3% and 1.6%, respectively). In the under-18 category, 5 people said they use flavors in 2017 and 17 in 2020 (prevalence of 0.8% and 2.3%, respectively)

13.10.6 **The low numbers of flavor vapers make comparisons over time volatile and potentially misleading.** For example, at face value flavor vaping in youth increased by over 200% between 2017 and 2020. This comparison masks the fact that only 17 (population-weighted) respondents under 18 years old were flavor vapers in 2020.

Table 13-5: Cross tabulation of e-cigarette flavor use status and various demographics[200,201, 202]

	Both years					2017 only					2020 only				
	Flavor vaper	Tobacco flavor vaper	Non vaper	Failed to answer	Total respondents	Flavor vaper	Tobacco flavor vaper	Non vaper	Failed to answer	Total respondents	Flavor vaper	Tobacco flavor vaper	Non vaper	Failed to answer	Total respondents
Weighted group size	817	269	54,928	187	56,201	373	151	27,336	41	27,901	444	118	27,592	146	28,300
Sample size	579	233	55,228	161	56,201	236	121	27,513	31	27,901	343	112	27,715	130	28,300
Smoking status															
Current smoker	410	164	13,124	165	13,863	190	98	6,973	32	7,293	220	65	6,151	133	6,569
Ex-smoker	344	100	11,434	2	11,880	157	52	5,421	2	5,632	187	48	6,012	0	6,248
Never-smoker	63	5	30,214	20	30,302	26	1	14,823	8	14,858	37	4	15,391	12	15,444
Gender															
Male	524	154	26,467	102	27,247	266	88	13,078	25	13,456	258	66	13,390	77	13,791
Female	293	115	28,457	85	28,951	107	64	14,258	16	14,445	186	51	14,199	69	14,506
Education level					-					-					-
Education different to high school	438	108	32,169	106	32,821	193	50	16,137	16	16,395	245	59	16,032	91	16,426
High school education	379	161	22,759	81	23,380	179	102	11,199	26	11,506	199	59	11,560	55	11,874
Age															
Under 18	23	0	1,407	2	1,432	5	0	676	1	683	17	-	731	1	750
18-24	132	19	5,549	43	5,743	51	8	2,863	18	2,940	80	11	2,686	25	2,803
25-54	525	124	26,367	90	27,106	256	72	13,095	13	13,436	269	51	13,273	77	13,670
55+	137	126	21,600	52	21,915	59	71	10,702	9	10,842	77	55	10,898	42	11,073
Employment status															
Employed	523	140	28,503	109	29,275	237	71	13,257	18	13,583	286	69	15,246	91	15,692
Student	87	12	4,968	14	5,081	26	6	2,541	3	2,576	61	6	2,426	11	2,504
Unemployed	95	29	3,304	22	3,450	51	16	1,831	16	1,914	44	13	1,473	6	1,536
Retired	84	84	14,598	30	14,796	51	56	7,747	4	7,859	33	28	6,851	26	6,937
Stay at home	27	5	3,555	12	3,599	7	2	1,959	0	1,969	20	2	1,596	12	1,630
Smoking intensity															
Cigarette smokers	377	136	13,003	159	13,675	173	86	6,877	32	7,168	204	50	6,125	127	6,507
Average intensity (cigs per day)	*11*	*12*	*14*	*16*		*11*	*13*	*14*	*17*		*11*	*12*	*14*	*15*	
Less than one cigarette	19	3	383	0	405	7	2	149	-	158	12	1	234	0	247
1-10 cigarettes	207	63	5,544	60	5,874	86	40	3,060	10	3,195	122	23	2,485	50	2,680
11-20 cigarettes	135	60	5,864	68	6,127	75	39	3,040	14	3,169	60	21	2,823	54	2,959
21+ cigarettes	14	4	1,072	20	1,110	5	4	588	7	604	9	0	484	12	505

200 The "Sample size" row presents unweighted respondent numbers; "average intensity" row presents cigarettes smoked per day. All other rows present population-weighted respondent numbers.

201 When calculating proportions of flavor/tobacco vapers and non-vapers, the respondents who failed to answer flavor question are excluded from both numerator and denominator, as these people are e-cigarette users but I do not have information on their flavor usage.

202 I define never-smokers as people who are neither current nor ex-smokers.

Smoking Cessation

13.11 Table 13-6 below shows a cross tabulation of e-cigarette flavor use status and attempts to quit tobacco. The table shows that:

13.11.1 **E-cigarette users are, in general, more likely to attempt to quit smoking than smokers who do not use e-cigarettes, and flavor e-cigarette vapers are more likely than tobacco flavor vapers to try to quit both in the last 12 months and ever.** 31% of flavor e-cig vapers attempted to quit recently, vs 17% tobacco flavor vapers and 14% of current smokers who are non-e-cig users. 25% of flavor e-cig vapers never attempted quitting, vs 37% tobacco flavor vapers and 49% of non-e-cig users).

13.11.2 **This correlation between flavored e-cigarette use and quit attempts is consistent with flavored e-cigarettes encouraging quitting attempts (which if true, would suggest that e-cigarette flavor bans would discourage smoking cessation).** However, this is not a causal relationship: it could well reflect a difference in motivation and preferences (e.g. e-cigarette users who prefer tobacco flavored e-cigarettes are anyway less likely to attempt to quit smoking, because they like the flavor of tobacco).

Table 13-6: Cross tabulation of e-cigarette flavor use status and attempts to quit tobacco

Both years (weighted respondents)				
	Flavor vaper	**Tobacco flavor vaper**	**Non vaper**	**Failed to answer**
Weighted group size	410	164	13,124	165
Sample size	314	134	12,983	134
Quit attempt in last 12m	126	28	1,897	34
Quit attempt ever	308	103	6,657	87
Never attempted quit	102	60	6,408	75

13.12 Table 13-7 below shows a cross tabulation of e-cigarette flavor use status and the success of tobacco quit attempts. The table shows that:

13.12.1 **E-cigarettes are associated with a greater chance of stopping smoking completely** (over 40% of vapers stopped smoking completely, compared to only 13% of non-vapers). Overall, 87% of flavor vapers and 91% of tobacco flavor vapers said they stopped smoking at least temporarily or reduced their smoking due to e-cigarettes vs only 43% who are not current e- cigarette users

13.12.2 Again, this is not necessarily a causal relationship: it is possible that current e-cigarette users might have been more motivated to quit, or e- cigarettes were more effective for them, which is why they kept using them for quitting smoking.

13.12.3 **Flavored e-cigarettes are not associated with a material difference chance of stopping, compared to tobacco flavored** (47% of current flavor vapers and 45% of tobacco flavor e-cig vapers stopped smoking completely). However, flavor vapers were more likely to quit only temporarily (9%) vs tobacco flavor vapers (3%).

Table 13-7: Cross tabulation of e-cigarette flavor use status and success of tobacco quit attempts

	All years (weighted respondents)			
	Flavor vaper	Tobacco flavor vaper	Non vaper	Failed to answer
Weighted group size	752	264	4,081	77
Sample size	548	228	3,655	64
Yes, stopped completely	353	120	513	1
Yes, stopped then started again	69	8	545	8
Yes, reduced smoking	230	111	689	27
No reduction	93	23	2,099	37
No, increased smoking	7	1	234	5

Vaping Initiation and Smoking Initiation

13.13 Table 13-8 below shows a cross tabulation of the reasons people give for starting to vape, including a breakdown for current or ex-smokers who reported vaping first. The table shows that:

13.13.1 **Flavor is only the third most cited factor for why people started vaping, with 16% of respondents citing it; reducing tobacco consumption (54%) or the lower harmfulness of vaping vs smoking (34%) were cited much more frequently.**

13.13.2 Friends vaping was about as important a factor (13% cited it) as flavors (16%).

13.13.3 **The majority of people who cited flavor as a reason to start vaping are current smokers (70%).** A further 34% are ex-smokers (and could have used vaping to help them to quit smoking). Only 10% are never smokers.

13.13.4 Of the 56 never smokers who cite flavor as a reason for vaping, 21 also cited "friends used" as a factor and 17 "less harmful". It possible some of these people would have been smokers had e-cigarettes been unavailable, but more data is needed to establish any such causative relationships.

13.14 I also attempt to examine the relationship between vaping and smoking initiation by looking at the current or ex-smokers who said they tried vaping first, before "graduating" to smoking. However, I conclude that the data relevant to this question is unreliable and cannot be used to draw conclusions. For example, most current smokers who said they started vaping first said they did so to reduce tobacco consumption, which does not make sense. Presumably, if respondents started vaping first, they had no tobacco consumption to begin with. I conclude answers to the "Which did you try first?" question are unreliable, and I do not comment on this relationship.

Table 13-8: Cross tabulation of reasons for vaping and various demographic factors

	Tobacco related reasons				Reasons not related to tobacco ("pure" vaping initiation)				
	Reduce tobacco	**Less harmful**	**Cheaper than tobacco**	**Vape where no smoking**	**Liked flavors**	**Friends used**	**Cool or attractive**	**Other reasons**	**Weighted respondents**
Weighted group size	1,932	1,105	772	523	530	439	225	37	3,261
Sample size	1,430	925	547	469	394	395	189	32	
% of weighted respondents	59%	34%	24%	16%	16%	13%	7%	1%	
Smoking status									
Current smoker	1,262	684	492	370	329	292	152	24	2,049
Ex-smoker	651	377	251	127	145	113	41	5	1,037
Never smoker	19	44	29	26	56	34	32	8	175
Age									
Under 18	15	17	8	4	19	35	8		59
18 - 24	185	144	81	75	132	116	42	1	417
25 - 54	1,265	698	534	329	309	227	131	24	2,030
55+	466	246	149	115	70	61	44	12	754
Gender									
Female	831	459	341	203	207	195	96	21	1,347
Male	1,101	646	431	320	322	244	129	16	1,914
Current or ex-smoker who vaped first	136	77	54	31	35	26	6	2	213

14. Appendix F: Cigarette-Price Test for Flavored E-Cigarettes

14.1 In this appendix, I set out the econometric version of the flavor-cigarette-price test described in Section 6. In particular:

14.1.1 I explain the necessary modifications I make to my dataset;

14.1.2 I describe my methodology; and

14.1.3 I present my results.

Data

14.2 I begin with the dataset described earlier. In order to replicate the methodology of the cigarette price test as closely as possible, I use grouped data rather than individual-level data. The 2017 and 2020 waves of the Eurobarometer have questions regarding flavored e-cigarette use, but the 2014 wave does not. I drop the 2014 wave from the data. To the remaining 2017 and 2020 data, I add a variable detailing flavored e-cigarette use prevalence, using question QB13a from the 2017 survey (*"Which of the following e-cigarette liquid flavors do you use on a monthly basis?"* and QC10a from the 2020- survey (*"Which of the following e-cigarette liquid variants do you use on at least a monthly basis?").* In both years respondents can select multiple answers in response to these questions. The question is asked of people who stated they currently use electronic cigarettes at least monthly. Table 14-1 below shows the possible responses and how I account for them in the data.

Table 14-1: Details of the flavor e-cigarette use question from 2017 and 2020 Eurobarometer

Answer	Treatment
Menthol or mint flavor	Respondents who gave at least one of these answers to the flavor questions are coded as flavor e-cigarette users. I assume users of nicotine salts (from the 2020 cohort) are flavor users because the vast majority of nicotine salts liquids commonly available are flavored (other than pure tobacco flavor).
Fruit, like cherry or strawberry flavor	
Candy, like chocolate or vanilla flavor	
Alcohol flavor, like whisky or champagne	
Nicotine salts based liquid [only available in the 2020 survey questionnaire]	
Other flavors	
Tobacco flavor	Respondents who exclusively answered with either of these categories OR were not asked the flavor questions are not coded as flavor e-cigarette users.
Don't know / Failed to answer	

14.4 Once I code all respondents to the 2017 and 2020 Eurobarometer surveys as either current

flavored e-cigarette users (=1) or other (=0), per the table above, I calculate the flavor use prevalence in each age-gender-country grouping for each of the two Eurobarometer survey waves, following the methodology outlined in Appendix C: Dataset Construction. I then augment my dataset with the new e-cigarette flavor use prevalence variable.

Methodology

14.5 I then estimate the following OLS model, which is identical to my cigarette price test regression described in paragraph 12.28, apart from the dependent variable:

$$FlavorEcigaretteUsePrevalence_{cagt} = \phi * TaxInclusiveCigaretteWap_{cagt} + \varkappa * NonPriceTobaccoControlIndex_{cagt} + \varsigma * PercentUnemployed_{cagt} + \rho * PercentLeftEduc1618_{cagt} + \kappa * 2020Dummy + \sum_{k=1}^{2} \zeta_k * AgeCatDummy_k + \omega * MaleDummy + Constant + ErrorTerm_{cagt}$$

14.6 Where:

14.6.1 The subscripts ***c, g, a, t*** describe the same reference groups as in my main Model (1), described in paragraph 12.3.

14.6.2 ***FlavorEcigaretteUsePrevalence*** is the dependent variable which measures the proportion of people stating the used at least one non-tobacco e-cigarette flavor in the last month.

14.6.3 ***2020Dummy*** is a dummy variable taking the value 1 when the survey wave is 2020 and 0 if the wave is 2017.

14.6.4 The remaining terms are as described in paragraph 12.29.

14.6.5 As with the general cigarette-price test, I use post-stratification weights (not population weights) and cluster the standard errors by country.

Results

14.7 Table 14-2 below shows the results cigarette-price test for flavor. Models (16-Flavor) and (17-flavor) are comparable to their equivalents in Table 12-8 (for the general cigarette-price test).

14.8 The table shows that:

14.8.1 The cigarette price coefficients are positive and have very low p-values, suggesting that countries with high cigarette prices saw more flavor e-cigarette use compared to countries with low cigarette prices. This is consistent with the hypothesis that flavored e-cigarette and traditional cigarettes are economic substitutes.

14.8.2 The cigarette price coefficients are comparable but smaller than the equivalent

coefficients in models (16) and (17). This is to be expected, as not all e-cigarette users are flavor users (though the majority of them are), so models (16-Flavor) and (17-Flavor) are measuring smaller effects to begin with.

Table 14-2: Stata regression output for modified cigarette-price test for flavor use

	(16-Flavor)		(17-Flavor)	
2012TaxInclusiveCigaretteWap			0.0065**	(0.0065)
TaxInclusiveCigaretteWap	0.0065***	(0.0004)		
NonPriceTobaccoControlIndex	-0.0164	(0.5132)	0.0024	(0.9178)
PercentUnemployed	0.0211	(0.4650)	0.0178	(0.5435)
PercentLeftEduc1618	0.0105	(0.3692)	0.0112	(0.3540)
25–54	-0.5855	(0.1212)	-0.5964	(0.1165)
55+	-1.6159***	(0.0006)	-1.6464***	(0.0005)
Male	0.7181**	(0.0011)	0.7168**	(0.0011)
Year of Eurobarometer wave=2017				
Year of Eurobarometer wave=2020	0.2900	(0.2450)	0.4013+	(0.0963)
constant	0.1495	(0.8626)	-0.2526	(0.7687)
Observations	324		324	
R-squared	0.2179		0.2067	
Adjusted R-squared	0.1981		0.1865	

*Notes: p-values are in parentheses; + p<0.10; * p<0.05; ** p<0.01; *** p<0.001.*

15. Appendix G: Feasibility of a RRP-Price Test for Flavored E-Cigarettes

15.1 In this appendix I:

15.1.1 Provide details on the Eurobarometer countries that have introduced, or plan to introduce, e-cigarette flavor bans;

15.1.2 Explain that Estonia and Finland were unable to fully enforce the e-cigarette flavor bans they introduced; and

15.1.3 Explain why the 2014–2020 Eurobarometer data are likely insufficient to detect statistically significant effects of e-cigarette flavor bans on smoking behavior.

Flavor Bans in Eurobarometer Countries

15.2 In the EU, four Member States (Estonia, Finland, Denmark, and Hungary) have imposed a flavor ban, but the majority of Member States, to date, have not. I summarize this information in Table 15-1 below.

Table 15-1: European countries with e-cigarette flavor bans

Location	Scope of flavor ban	Date effective	Comments
Denmark	Ban on flavors except tobacco and menthol flavors.	April 2022	Production ban from April 2021. Sale ban from April 2022.[203]
Estonia	Ban on flavors except tobacco flavor.[204]	July 2019; partially lifted in May 2020	Ban partially lifted in May 2020, allowing menthol flavor.[205]
Finland	Ban on flavors except tobacco flavor.	May 2016	Ban came into effect as part of the transposition of EU TPD in national law.[206,207]
Hungary	Ban on flavors *including* tobacco flavor.	May 2016 partial ban; May 2020 complete ban	Legally the ban has been in place since May 2016.[208] Some flavors (fruit, tobacco, and menthol) could be marketed until May 2020.[209] I consider that a partial ban was in effect as of May 2016,[210] and a stricter ban came in effect in May 2020.
Lithuania	Ban on flavors except tobacco flavor.	July 2022 [expected]	
Netherlands	Ban on flavors except tobacco flavor.	January 2023[211] [expected]	
Sweden	Ban on flavors except tobacco flavor.	January 2023[212] [expected]	

Note: Only Finland, Hungary and Estonia introduced flavor bans in the period 2014–2020, covered by my Eurobarometer dataset.

203 Vaping360.com, "Denmark will ban flavours and impose a huge e-liquid tax"

204 Nannystateindex.org, "Estonia 2021"

205 Vaping.trusticert.com, "Estonia softens the e-cig regulation"

206 See: Tobaccocontrolllaws.org, "Finland"

207 See: Ecigintelligence.com, "Finland takes a hard line banning all flavours except tobacco"

208 See: Dailynewshungary.com, "Smoking and vaping rules in Hungary"

209 See: Net.jogtar.hu, "jogszabaly",

210 This was also assumed in the Nanny State Index report for Hungary for 2017, see: Nannystateindex.org, "Hungary 2017"

211 See: Business.gov.nl, "Amendment – Ban flavoured e-cigarettes"

212 Vaping360.com, "Sweden will prohibit vape flavours"

Evidence Relating to Flavor Ban Enforcement in Europe

15.3 Table 15-2 presents on information on (i) the problems with enforcement faced by Finland and Estonia when introducing their flavor bans; (ii) comparison of the (population-weighted) number of respondents saying they use flavor e-cigarettes per country per survey wave.

15.4 The table shows that the flavor bans in both Finland and Estonia could be and were circumvented. In none of the three countries introducing bans did flavor e-cigarette use reduce to zero after the ban (as would be expected if it were well enforced and adhered to). In fact, according to the Eurobarometer data, flavor e-cigarette use increased in Estonia after the ban. However, overall, data on flavor e-cigarette use within the Eurobarometer dataset is based on a small number of respondents, and therefore year-on-year changes in flavor use may not be reliable.

Table 15-2: Summary of flavor ban enforcement issues and flavor cigarette use in treatment countries

Country	Issues with enforcement (mentioned by European Commission report)	Number of all respondents in 2017 (population-weighted)	Number of people saying they use flavors in 2017 (population-weighted)	Number of all respondents in 2020 (population-weighted)	Number of people saying they use flavors in 2020 (population-weighted)
Estonia	Small companies with large companies' support immediately mounted legal challenge leading to May 2020 partial relaxation.[213] E-cig flavors marketed as food to avoid ban. Public officials enforcing ban same as those working on COVID, so effectively no enforcement after ~March 2020. [214]	75	0.8	71	1.5
Finland	9 appeals to the ban by 2 law firms. Narrow judgement that e-cig flavors are not foodstuffs still being appealed.[215] Vendors selling through Facebook which is not covered	307	2.7	296	1.8

213 See: EC report, PDF page 344—345

214 See: EC report, PDF page 345

215 See: EC report, PDF page 343

Country	Issues with enforcement (mentioned by European Commission report)	Number of all respondents in 2017 (population-weighted)	Number of people saying they use flavors in 2017 (population-weighted)	Number of all respondents in 2020 (population-weighted)	Number of people saying they use flavors in 2020 (population-weighted)
	by local authority (as US hosted)[216]				
Hungary	No information	568	2.2	551	1.7

Statistical Power to Detect Effect of Flavor Ban on Smoking Using Eurobarometer Data

15.5 In this subsection I present a simplified statistical demonstration of the difficulty of detecting a statistically significant effect of flavor bans on smoking in the 2014–2020 Eurobarometer data, even if such effect exists.

15.6 Measuring the effect of e-cigarette flavor bans on smoking would involve comparing the trend in smoking prevalence in countries which have introduced an e-cigarette flavor ban (In my case, this would involve using waves of the Eurobarometer survey for Estonia, Finland or Hungary, which might be referred to as "treatment countries") to smoking prevalence in countries which have not introduced those bans, after controlling for other material determinants of smoking prevalence that vary between the countries or over time. One could then conduct statistical tests of whether the change in smoking prevalence is statistically significantly different from zero.

15.7 Table 15-3 below presents the countries and time-periods I can use from my dataset to measure the effects of e-cigarette flavor bans on smoking behavior.[217]

Table 15-3: Smoking prevalence and sample size of treatment countries

Country	Date of (partial) ban	Smoking prevalence, wave after ban	Sample size, wave after ban
Estonia	July 2019	18%	1,104
Finland	May 2016	20%	1,012
Hungary	May 2016 (assumed partial ban)	27%	1,053
Hungary	May 2020 (assumed complete ban)	28%	1,058

[216] See: EC report, PDF page 343

[217] In Hungary, the e-cigarette flavor ban was legally in place since May 2016. In my seven-point e-cigarette hostility index, Hungary scores 1 point on flavor bans in both the 2017 and 2020 Eurobarometer waves. However, marketing certain flavors like fruit tobacco and menthol were still allowed until May 2020, so I consider that the flavor ban was partial after May 2016 and full after May 2020. The effects of the partial and full bans can potentially be measured separately.

15.8 As the table shows, my average sample size (for a country exposed to a flavor ban) would be around 1,000 respondents. The average sample smoking prevalence is approximately 25% in the post-ban period, and I would be looking for changes to that number compared to the pre-ban period. This implies that in order for me to be able to detect a statistically significant effect (at 5% significance), flavor bans in one of my samples must increase or decrease traditional smoking by approximately 4 percentage points,[218] and likely more due to the additional data needed to estimate other parameters of the regression model.

15.9 If my samples contained real effects of flavor bans (in either direction) smaller than approximately 4 percentage points, I would not be able to detect them. Note that my general RRP-price test estimated that a one point increase in e-cigarette hostility (the equivalent of introducing an e-cigarette flavor ban) is associated with a 0.4-percentage-point increase in smoking prevalence. It is therefore implausible that the effect of flavor bans alone will be large enough for detection in the currently available Eurobarometer data.

15.10 If I had more data – more waves of the Eurobarometer, or more respondents from countries affected by bans – I would have a better chance of detecting an effect. However, there is currently insufficient data in Europe to study effects of flavor bans in isolation of other e-cigarette hostility measures.

[218] I calculate this in the following way. The standard formula for calculating the 95% confidence interval of the difference between two population proportions is $(p_1 - p_2) \pm 1.96 * \sqrt{\frac{p_1(1-p_1)}{n_1} + \frac{p_2(1-p_2)}{n_2}}$, where, in my case, p_1 and p_2 are the pre- and post-ban smoking prevalences, respectively, and n_1 and n_2 are sample sizes (equal to 1,000 in both my pre- and post-ban samples). My statistical tests will detect an effect on smoking prevalence if the effect is around 4 percentage points or more (but will not detect a 3.5-percentage-point effect, for example). This is because substituting p_1=0.25±0.04 and p_2=0.25 in the formula above produces a 95% confidence interval which excludes zero, while substituting p_1=0.25±0.035 does not. For details, see for example Statology.org, "Confidence Interval for the Difference in Proportions"

16. Appendix H: Sensitivities for the analysis of the impact of TPD2 non-price regulations on smoking

16.1 This appendix presents further detail underlying my analysis of the effect on smoking of non-price cigarette restrictions in Section 7. It contains:

16.1.1 a more detailed overview of non-price TPD2 smoking regulations, and my assessment of which regulations are suitable for inter-country analysis;

16.1.2 details on the how the Tobacco Control Scale encapsulates elements of the TPD2 and its suitability for assessing the impacts of TPD2;

16.1.3 details on when different countries implemented picture warning requirements and cross-border distance sales bans for cigarettes and RYO; and

16.1.4 relevant sensitivities that ensure the robustness and reliability of my analysis.

Overview of TPD2 regulations

16.2 The table below summarizes the non-price regulations on cigarettes and roll-your-own tobacco products introduced in TPD2, explains how and whether these are related to provisions from TPD1, and explains which regulations are suitable for my inter-country analysis (and why).

Table 16-1: Summary of policies included in TPD2, and their suitability for graphical analysis

TPD2 policy	Details of policy and any TPD1 precursor policies	Whether policy is suitable for my country-level analysis (and why)
Mandatory picture health warnings	TPD2 required combined health warnings with pictures, text, and cessation information to cover 65% of the front and back of cigarette and RYO packs.[219] TPD1 set out requirements for mandatory text warnings covering not less than 30% of the front side and 40% of the back side of cigarette and RYO packs, and standards for the optional use of picture warnings.[220]	The TPD2 requirement to add picture warnings to mandatory health warnings on packs is suitable for inter-country analysis because there is cross-country variation, with some countries having picture warnings in place prior to TPD2, while other countries introduced these only with TPD2.
Ban on cigarettes and RYOs with characterizing flavors	TPD2 banned cigarettes and RYO tobacco with a characterizing flavor. For products with more than 3% share of the EU-wide tobacco-market (e.g., menthol cigarettes), the ban applied as of May 2020. [221] No mention in TPD1.	This policy is not suitable for inter-country analysis, because there is no sufficient cross-country variation in the implementation dates of this policy. The main impact of this policy was the ban on menthol cigarettes and RYO which came into effect in May 2020 and no member states had an effective ban of menthol cigarettes and RYO before May 2020.

219 See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 10, Section 1

220 See: Eur-lex.europa.eu, "Directive 2001/37/EC", Article 5, Sections 2 and 3

221 See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 7, Sections 1, 6 and 14

TPD2 policy	Details of policy and any TPD1 precursor policies	Whether policy is suitable for my country-level analysis (and why)
Replacement of TNCO labelling	TPD2 replaced the tar, nicotine, and carbon monoxide (TNCO) labelling requirements on cigarettes and RYOs set out by the TPD1 with the information message, "Tobacco smoke contains over 70 substances known to cause cancer."[222] TPD1 introduced standardized TNCO indications on packets. Yields were required to be printed on the side of the pack, in the official language(s) of the member state, covering at least 10% of the corresponding surface. In addition, general warnings were made mandatory.[223]	This policy is not suitable for intercountry analysis. The TPD2 regulation repealed and replaced a mandatory regulation from TPD1. Thus, there is not sufficient variation across countries in the degree or timing of implementation of this measure.
Ban on certain types of packages	TPD2 required cigarette packs to be cuboid shaped, containing at least 20 cigarettes, with slim packs and 10-packs no longer allowed, and prohibited certain promotional and packaging elements.[224] TPD1 banned texts, names, trademarks and figurative or other signs suggesting that a particular tobacco product is less harmful than others. [225]	This policy is not suitable for intercountry analysis. With regards to the ban of non-standard (<20) cigarette packs, my research suggests that there is not sufficient variation in adoption date between countries, with only Ireland having a ban that pre-dates 2016, and the remaining countries all adopting the regulation in 2016 or 2017.[226] There is also not sufficient variation across countries in the timing of implementation of the additional restrictions on product presentation.

222 See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 9, Section 2

223 See: Eur-lex.europa.eu, "Directive 2001/37/EC", Article 3, Article 5, Sections 1 and 2

224 See : Health.ec.europa.eu, "Directive 2014/40/EU", Article 9, Section 3, Article 13, Section 1, Article 14

225 See: Eur-lex.europa.eu, "Directive 2001/37/EC", Article 7

226 Ireland banned 10-pack boxes in 2007, but seems to be the only country that has done so pre TPD2 implementation deadline of May 2016. For detail on Ireland, see Rte.ie, "Ban on ten-pack cigarettes in effect"

TPD2 policy	Details of policy and any TPD1 precursor policies	Whether policy is suitable for my country-level analysis (and why)
Mandatory electronic reporting on ingredients	TPD2 required manufacturers and importers of tobacco to report on ingredients in all products they place on the EU market through a standardized electronic format.[227] TPD1 required manufacturers and importers of tobacco to submit a list of all ingredients and their quantities used in the manufacture of tobacco products by brand name and type to member states on a yearly basis.[228]	This policy is not suitable for intercountry analysis, because there is not sufficient variation across countries in the level or timing of implementation of this measure.
Optional ban on cross-border distance sales	TPD2 allowed member states to decide whether to prohibit cross-border distance sales (CBDS) of tobacco products. [229] TPD1 did not allow member states to prohibit or restrict the import, sale or consumption of tobacco products which comply with the TPD1.[230]	This policy is suitable for country-level analysis. TPD2 gave member states the option (for the first time) to ban cross-border-sales of cigarettes and RYO. According to the EC report, nine member states continued to allow cross-border sales as of May 2021, while the rest implemented bans.[231] I obtained a list of the countries that allowed cross-border sales from the UK gov website, which allows me to examine differences in smoking prevalence between the two groups of countries.[232]

227 See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 5, Section 1

228 See: Eur-lex.europa.eu, "Directive 2001/37/EU", Article 6, Section 1

229 See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 18, Section 1

230 See: Eur-lex.europa.eu, "Directive 2001/37/EC", Article 13, Section 1

231 See: EC report

232 See: Gov.uk, "Cross-border distance sales of tobacco and e-cigarettes: registration guide"

TPD2 policy	Details of policy and any TPD1 precursor policies	Whether policy is suitable for my country-level analysis (and why)
Measures to combat illicit trade	TPD2 introduced measures intended to combat illegal trade of tobacco products, including an EU-wide tracking and tracing system for the legal supply chain and a security feature of visible and invisible elements. Introduced for cigarette and RYOs in 2019, and for all other tobacco products in 2024.[233] No mention in TPD1.	This policy is not suitable for inter-country analysis. My research suggests there is insufficient cross-country or time variation in the implementation of the policy, as the track and trace system took effect in 2019 for cigarette and RYO, and the last datapoint of Eurobarometer data is in 2020.

[233] See: Health.ec.europa.eu, "Directive 2014/40/EU", Article 15

Relationship Between TCS Non-Price Index and TPD2 Non-Price Regulations

16.3 In paragraph 10.25, I explain how I use a non-price TCS index to measure the effect of non-price tobacco regulations. The table below shows how that index relates to the specific non-price restrictions contained in TPD2.

16.4 The table shows that the TCS index captures the effect of picture warnings (assigning up to 3 points for the presence of picture warnings on cigarette and RYO packs) but does not clearly capture any other TDP2 provision. The index also covers several non-price restrictions that are unrelated to TPD2.

Table 16-2: How the TCS index relates to TPD2 non-price tobacco policies

Category of non-price restriction reflected in TCS	**Overlaps with TPD2**
Smoke free work and other public places. Up to 22 points assigned.	Not applicable. TPD2 does not contain regulations covering this category.
Spending on public information campaigns. Up to 15 points assigned prior to 2019 and up to 10 points in 2019 report.	Not applicable. TPD2 does not contain regulations covering this category.
Comprehensive bans on advertising and promotion. Up to 13 points assigned	Not applicable. TPD2 does not contain regulations covering this category.
Large and direct warning labels. Up to 10 points assigned: - Plain packaging – 4 points; - Coverage of health warnings – 1 point if warnings cover <50% of packet, 2 points if warnings cover 51-79% of packet, 3 points if warnings cover 80% of packet (max 3 points); and - Pictorial warnings – 2 points assigned for pectoral warnings on cigarette packs, and 1 point for pictorial warnings on hand rolling tobacco (max 3 points)	This TCS category includes the TPD2 picture warning regulations. Fully implementing TPD2 would result in 3 points being assigned for picture warnings. My "late adopters" group of countries would score 0 on this component before TPD2 implementation, and 3 after. "Early adopters" would score 2 or 3 points before TDP2 implementation and 3 points after. Additionally, while both TPD1 and TPD2 required text health warnings on packaging, TPD2 increased the size of the warnings to 65% of the pack. Before TPD2 was introduced, all countries in my dataset had health warnings covering a portion of cigarette packaging, and complying with the 65% requirement would earn them at most 1 additional point on the index, which is a comparatively small change whose effect (if

	any) would be difficult to detect. I therefore only consider the picture warnings element in my analysis.
Treatment of smokers to stop. Up to 10 points assigned.	Not applicable. TPD2 does not contain regulations covering this category.
Illicit tobacco trade measures (new for 2019 report only). Up to 3 points: - 1 for ratification of the WHO Illicit Trade Protocol; - Up to 2 points for a track and trace system of tobacco products partially or fully compliant with the WHO Framework Convention on Tobacco Control.	TPD2 introduced new track and trace rules for tobacco products. However, because this TCS category was not available in the 2013 and 2016 Eurobarometer reports, my non-price index cannot measure how the 28 countries in my dataset changed in this respect over time.
Tobacco industry interference (new for 2019 report only). Up to 2 points assigned	Not applicable. TPD2 does not contain regulations covering this category.
1 point removed for not ratifying the WHO Framework Convention on Tobacco Control.	Not applicable. TPD2 does not contain regulations covering this category.

Source: TCS 2019 report, Table 2; TCS 2016 and 2013 reports; TPD2.

Country Detail on TPD2 Picture Warning and CBDS Ban Implementations

16.5 The table below presents more detail on when different countries implemented picture warnings and cross-border sales bans, which I use in grouping countries for the purpose of my intercountry analysis in paragraphs 7.17-7.23. Over the period 2016-2020, some countries went beyond the TPD2 warning label regulations, and additionally implemented plain packaging requirements; I note where this is the case in the table below. Information on the precise implementation of CBDS bans is not readily available for all countries in my dataset. I assume that all countries which banned CBDS did so during or shortly after the May 2016 TDP2 deadline.

Table 16-3: Cross-country variation in the implementation of pictorial warning and cross-border distance sales policies

Country name	Picture warnings	Cross-border distance sales[234]
Austria	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Belgium	Implemented pictorial health warnings in 2006, required to cover 63% of the back of the package. Plain packaging introduced in January 2020 at manufacturer level.[235]	CBDS ban.
Bulgaria	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Croatia	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Cyprus	No pre-TPD2 pictorial warning regulations. TPD2 implemented in March 2017.[236]	CBDS ban.
Czech Republic	No pre-TPD2 pictorial warning regulations.	CBDS allowed.
Denmark	Implemented pictorial health warnings in 2012, required to cover 35% of the package. Plain packaging introduced on 1 July 2021 for tobacco products.[237]	CBDS allowed.
Estonia	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Finland	No pre-TPD2 pictorial warning regulations.	CBDS ban.
France	Implemented pictorial health warnings in 2011, required to cover at least 40% of the back of the package. [238] Plain packaging introduced on 20 May 2016, with full implementation from 1 January 2017. [239]	CBDS ban.
Germany	No pre-TPD2 pictorial warning regulations.	CBDS allowed.

234 See: Gov.uk, "Cross-border distance sales of tobacco and e-cigarettes: registration guide"

235 See: Tobaccofreekids.org, "Belgium"

236 See: Ncbi.nlm.gov, "Tobacco control achievements and priority areas in the WHO Europe Region: A review"

237 See: Tobaccolabels.ca, "Denmark"

238 See: Tobaccolabels.ca, "France"

239 See: Tobaccoinduceddiseases.org, "Plain packaging on tobacco products in France: Effectiveness on smokers' attitudes one year after implementation"

Greece	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Hungary	Implemented pictorial health warnings in 2012, required to cover 30% of the front and 40% of the back package. [240] Plain packaging introduced in May 2021, with full implementation from January 2022.[241]	CBDS ban.
Ireland	Implemented pictorial health warnings in 2013, required to cover 45% of the back of the package. TPD2 pictorial warnings implemented in 2016, with one year transition period for retailers. Plain packaging introduced in September 2017, with full implementation from 30 September 2018.[242]	CBDS allowed.
Italy	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Latvia	Implemented pictorial health warnings in 2010, health warnings required to cover 48% of the package.[243]	CBDS ban.
Lithuania	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Luxemburg	No pre-TPD2 pictorial warning regulations. TPD2 pictorial warnings implemented in 2017.[244]	CBDS ban.
Malta	Implemented pictorial health warnings in 2011, health warnings required to cover 38.5% of the package.[245]	CBDS allowed.
Netherlands	No pre-TPD2 pictorial warning regulations. Plain packaging introduced for manufacturers on 1 October 2020, for retailers on 1 October 2021 for cigarettes and RYO.[246]	CBDS allowed.
Poland	No pre-TPD2 pictorial warning regulations.	CBDS ban.

240 See: Tobaccolabels.ca, "Hungary"

241 See: TCS report 2021, page 17.

242 See: Tobaccolabels.ca, "Ireland"

243 See: Tobaccolabels.ca, "Latvia"

244 See: Tobaccoinaustralia.org.au, "Health warnings used in other countries"

245 See: Tobaccolables.ca, "Malta"

246 See: Tobaccofreekids.org, "Lates News - 2020 through January 2022 – The Netherlands has implemented plain packaging laws for cigarettes, rolling tobacco, e-cigarettes, and cigars"

Portugal	No pre-TPD2 pictorial warning regulations.	CBDS ban.
Romania	Implemented pictorial health warnings in 2008, health warnings required to cover 48% of the package.[247]	CBDS ban.
Slovakia	No pre-TPD2 pictorial warning regulations.	CBDS allowed.
Slovenia	No pre-TPD2 pictorial warning regulations. Plain packaging introduced on 1 January 2020. [248]	CBDS ban.
Spain	Implemented pictorial health warnings in 2011, health warnings required to cover 43% of the front and 53% of the back of the package.[249]	CBDS ban.
Sweden	No pre-TPD2 pictorial warning regulations.	CBDS allowed.
United Kingdom	Implemented pictorial health warnings in 2008, health warnings required to cover 48% of the package. Plain packaging introduced on 20 May 2016 with full implementation from 20 May 2017.[250]	CBDS allowed.

247 See: Tobaccolabels.ca, "Romania"

248 See: Untobaccocontrol.org, "Slovenia passes law to require plain tobacco packaging from 2020"

249 See: Tobaccolabels.ca, "Spain to require picture warnings"

250 See: Tobaccolabels.ca, "United Kingdom"

Sensitivities

16.6 Below I present various sensitivity analyses to check the robustness of my conclusions.

Re-estimating my Preferred Model with the "Picture Warning" Element of the Non-Price TCS Index as a Separate Variable

16.7 I re-estimate my preferred model (described in paragraph 12.2) by splitting the ***NonPriceTobaccoControlIndex*** into two variables:

16.7.1 ***PictureComponentNPTCI,*** which only measures how many points (of a maximum of 3) each country was awarded in each for the 2013, 2016 and 2020 TCS reports for implementing "pictorial health warnings" on cigarettes and RYO packages (see Table 16-2 above).

16.7.2 ***NonPictureNPTCI,*** which includes the remaining non-price TCS index. It is calculated by subtracting the ***PictureComponentNPTCI*** score from the ***NonPriceTobaccoControlIndex*** score.

16.8 The results of my re-estimated regression are presented below. The table shows that:

16.8.1 The picture component of the non-price TCS index is statistically insignificant, and the sign of the point estimate is positive (suggesting that, if anything, picture warnings are associated with an increase in smoking, though this can be due to chance). This corroborates my conclusion that the Eurobarometer dataset does not provide any evidence that picture warnings reduce smoking.

16.8.2 The coefficient on ***EcigHostilityIndex*** is still positive and economically significant. For each additional regulatory restriction imposed on consumer access to e-cigarettes, there is a 0.28-percentage-point increase in smoking prevalence. This increase represents 1.2 million additional smokers in Europe who otherwise would not be smoking. However, the coefficient is not as precisely estimated as in the previous specification.

16.8.3 There are no other substantive changes between my preferred model and the re-estimation with splitting of the TCS non-price index.

Table 16-4: Results from re-estimating the main model (1) with "picture warning" element of the non-price TCS Index as a separate variable

	(1)				(18)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
EcigHostilityIndex	0.39+	(0.076)	[0.03, 0.75]	[-0.04, 0.82]	0.28	(0.324)	[-0.20,0.76]	[-0.29,0.86]
NonPriceTobacco ControlIndex	0.07	(0.574)	[-0.13, 0.26]	[-0.17, 0.30]				
PictureComponentNPTCI					0.57	(0.221)	[-0.20,1.33]	[-0.36,1.49]
NonPictureNPTCI					-0.01	(0.952)	[-0.19,0.18]	[-0.23,0.22]
Log(RealTobaccoPrice Index)	-12.89*	(0.011)	[-20.94, -4.83]	[-22.59, -3.18]	-13.05**	(0.007)	[-20.73,-5.36]	[-22.31,-3.79]
PercentUnemployed	0.23**	(0.004)	[0.10, 0.35]	[0.08, 0.37]	0.24**	(0.002)	[0.12,0.36]	[0.09,0.38]
PercentLeftEduc1618	0.17**	(0.002)	[0.09, 0.26]	[0.07, 0.27]	0.17**	(0.002)	[0.09,0.26]	[0.07,0.27]
25–54	2.94*	(0.024)	[0.85, 5.04]	[0.42, 5.47]	2.94*	(0.024)	[0.84,5.03]	[0.41,5.46]
55+	-8.96***	(0.000)	[-11.31, -6.61]	[-11.79, -6.13]	-8.89***	(0.000)	[-11.25,-6.53]	[-11.73,-6.04]
Male	7.83***	(0.000)	[5.52, 10.14]	[5.05, 10.62]	7.83***	(0.000)	[5.51,10.14]	[5.04,10.62]
BE	-4.61***	(0.000)	[-6.25, -2.98]	[-6.58, -2.64]	-4.15***	(0.000)	[-5.78,-2.52]	[-6.11,-2.18]
BG	8.99***	(0.000)	[8.40, 9.58]	[8.28, 9.70]	9.14***	(0.000)	[8.50,9.77]	[8.37,9.90]
CY	-1.19+	(0.066)	[-2.24, -0.13]	[-2.46, 0.09]	-0.75	(0.395)	[-2.23,0.73]	[-2.53,1.03]
CZ	1.77***	(0.000)	[1.04, 2.51]	[0.89, 2.66]	1.73***	(0.000)	[1.01,2.44]	[0.87,2.59]
DE	-0.68	(0.442)	[-2.16, 0.80]	[-2.46, 1.10]	-1.12	(0.191)	[-2.53,0.30]	[-2.82,0.59]
DK	-3.79*	(0.011)	[-6.16, -1.42]	[-6.65, -0.94]	-3.89*	(0.010)	[-6.30,-1.49]	[-6.79,-1.00]
EE	-4.82***	(0.000)	[-5.75, -3.89]	[-5.94, -3.70]	-4.37***	(0.000)	[-5.26,-3.49]	[-5.44,-3.31]
EL	8.02***	(0.000)	[6.25, 9.78]	[5.89, 10.14]	8.20***	(0.000)	[6.19,10.22]	[5.78,10.63]
ES	-1.76	(0.332)	[-4.80, 1.28]	[-5.42, 1.90]	-1.43	(0.422)	[-4.43,1.56]	[-5.04,2.17]
FI	-7.06***	(0.000)	[-9.65, -4.46]	[-10.19, -3.93]	-5.58**	(0.003)	[-8.45,-2.71]	[-9.03,-2.12]
FR	4.50*	(0.015)	[1.56, 7.44]	[0.95, 8.04]	5.04**	(0.005)	[2.21,7.86]	[1.63,8.44]
HR	4.38***	(0.000)	[2.91, 5.85]	[2.61, 6.15]	4.45***	(0.000)	[2.93,5.96]	[2.62,6.27]
HU	-1.46	(0.167)	[-3.21, 0.29]	[-3.57, 0.65]	-0.66	(0.638)	[-3.04,1.71]	[-3.53,2.20]
IE	-6.95**	(0.008)	[-11.11, -2.79]	[-11.96, -1.94]	-6.09*	(0.014)	[-10.06,-2.12]	[-10.87,-1.31]
IT	-1.87+	(0.069)	[-3.56, -0.19]	[-3.90, 0.15]	-1.31	(0.178)	[-2.92,0.30]	[-3.25,0.63]

	(1)				(18)			
	Coefficient	**p-Value**	**90% CI**	**95% CI**	**Coefficient**	**p-Value**	**90% CI**	**95% CI**
LT	1.45+	(0.075)	[0.11, 2.78]	[-0.16, 3.06]	1.85+	(0.079)	[0.13,3.57]	[-0.23,3.92]
LU	-0.75	(0.507)	[-2.65, 1.15]	[-3.04, 1.54]	-0.28	(0.787)	[-2.00,1.44]	[-2.35,1.80]
LV	4.58***	(0.000)	[3.93, 5.22]	[3.80, 5.35]	4.50***	(0.000)	[3.92,5.08]	[3.80,5.20]
MT	-6.87***	(0.000)	[-8.38, -5.36]	[-8.69, -5.05]	-6.83***	(0.000)	[-8.38,-5.29]	[-8.69,-4.97]
NL	-5.82***	(0.000)	[-7.68, -3.96]	[-8.06, -3.58]	-5.24***	(0.000)	[-6.89,-3.58]	[-7.23,-3.25]
PL	1.48*	(0.018)	[0.48, 2.49]	[0.28, 2.69]	1.98**	(0.002)	[0.99,2.97]	[0.78,3.18]
PT	-1.72**	(0.009)	[-2.77, -0.68]	[-2.98, -0.47]	-1.43*	(0.038)	[-2.54,-0.31]	[-2.77,-0.09]
RO	1.08	(0.143)	[-0.14, 2.29]	[-0.39, 2.54]	1.22+	(0.097)	[0.01,2.42]	[-0.24,2.67]
SE	-14.21***	(0.000)	[-16.72, -11.69]	[-17.24, -11.18]	-13.44***	(0.000)	[-15.78,-11.10]	[-16.26,-10.62]
SI	1.62	(0.120)	[-0.10, 3.34]	[-0.45, 3.69]	2.87*	(0.025)	[0.81,4.94]	[0.39,5.36]
SK	-3.42***	(0.000)	[-4.09, -2.75]	[-4.22, -2.62]	-3.16***	(0.000)	[-4.11,-2.22]	[-4.30,-2.03]
UK	-12.01***	(0.000)	[-16.49, -7.53]	[-17.40, -6.62]	-10.93***	(0.000)	[-15.24,-6.61]	[-16.12,-5.73]
constant	74.45***	(0.001)	[40.67, 108.22]	[33.76, 115.14]	76.26***	(0.000)	[44.14,108.38]	[37.57,114.95]
Observations	504				504			
R-squared	0.6632				0.6647			
Adjusted R-squared	0.6380				0.6389			

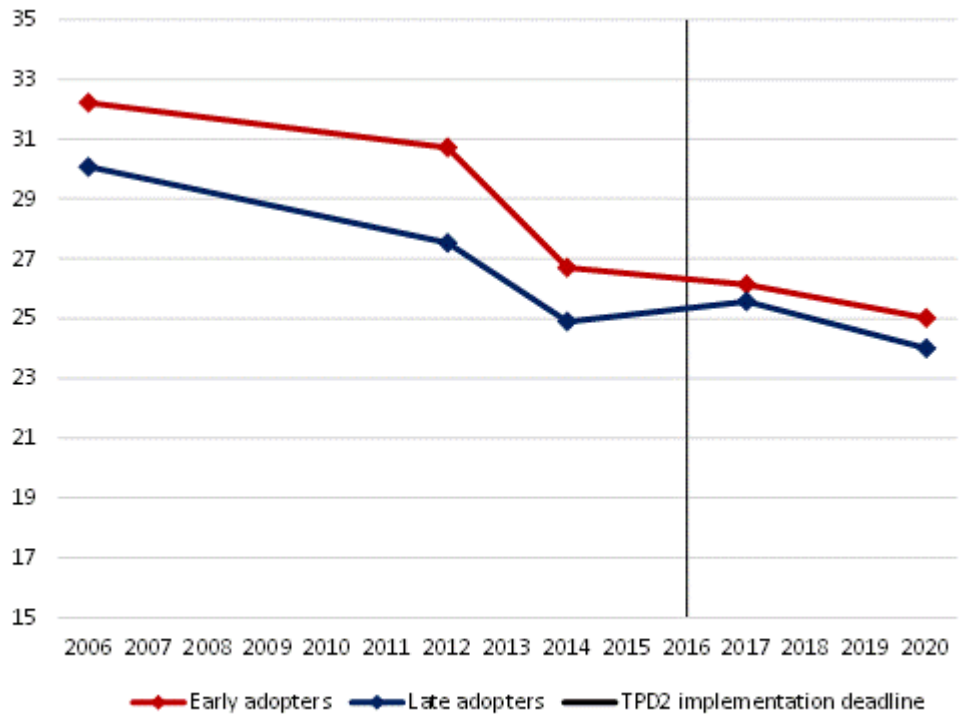
*Notes: (1) p-values are in parentheses; (2) + p<0.10; (3) * p<0.05; (4) ** p<0.01; (5) *** p<0.001*

Controlling for the Potentially Confounding Effects of Additional Plain Packaging Restrictions

16.9 Some countries went beyond the requirements of the TPD2 and introduced plain packaging regulations. I highlight this in Table 16-1. Eight countries have implemented plain packaging as of 2021. These are Belgium (January 2020), Denmark (July 2021), France (January 2017), Hungary (May 2021), Ireland (September 2017), Netherlands (October 2020), Slovenia (January 2020), and the UK (May 2016). Thus, some early adopters of picture warnings also implemented plain packaging, while others did not (and similarly, some late adopters did not implement plain packaging, while others did). It is possible that the inclusion of countries with plain packaging restrictions in Figure 7-1 confounds the true impact of TPD2 picture warning requirements. For example, the UK is an early adopter of picture warnings that introduced plain packaging in May 2016, so it may not be directly comparable to other early adopters who do not have plain packaging.

16.10 To address this possible confounding effect, I reproduce my comparison of early and late adopters of picture warnings while excluding all countries which introduced plain packaging prior to September 2020 (the end of my dataset), to produce a better 'like-for-like' comparison The result is presented in Figure 16- below. I find that excluding countries with plain packaging does not change any of my conclusion in paragraph 7.19.

Figure 16-1: Trend in smoking prevalence between early and late adopters, excluding countries that introduced plain packaging before September 2020



Notes: (1) Croatia is excluded from my analysis as it did not participate in the 2012 Eurobarometer survey. (2) Belgium, France, Ireland, Slovenia, and the UK introduced plain packaging legislation prior to September 2020, so they are excluded from the figure.

Controlling for the Possibility that CBDS and Picture Warning Policies May Have an Ambiguous Net Effect on Smoking Prevalence

16.11 The country groups I examine in Figure 7-1 and Figure 7-2 do not coincide perfectly across picture warning adoption and CBDS ban implementation. For example, some of the early adopters of picture warnings (who had picture warnings prior to 2016 implementation) banned cross-border distance sales with (or soon after) their implementation of TPD2. On the other hand, some of the late adopters of picture warnings continued to allow CBDS after 2016. The split between the two groupings is set forth in the table below.

Table 16-5: Implementation approaches to picture warnings and cross-border distance sales

	Early adopters of picture warnings	**Late adopters of picture warnings**
Cross-border distance sales ban	Belgium, France, Hungary, Latvia, Romania, Spain	Austria, Bulgaria, Cyprus, Estonia, Finland, Greece, Italy, Lithuania, Luxembourg, Poland, Portugal, Slovenia
Cross-border distance sales allowed	Denmark, Ireland, Malta, UK	Czech Republic, Germany, Netherlands, Slovakia, Sweden

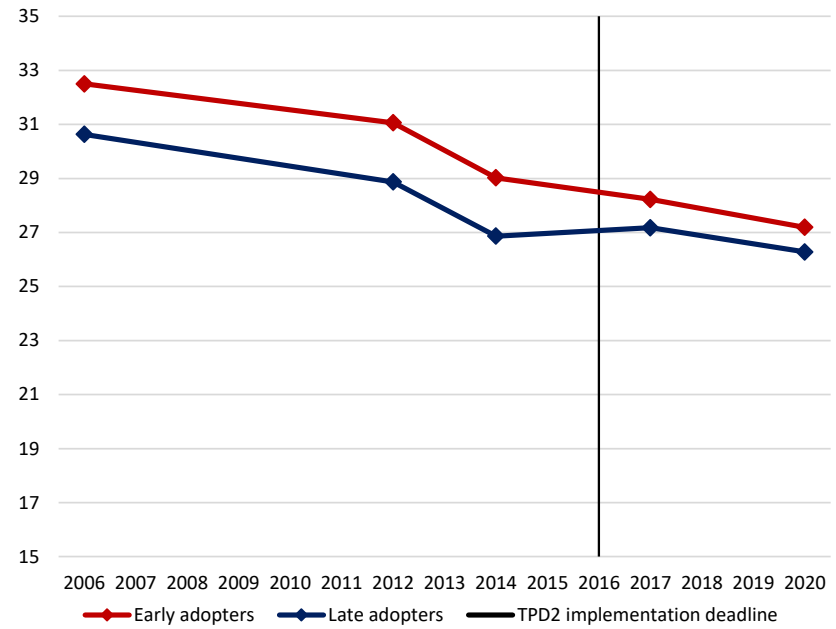
Source: Table 16-3. *Note: I exclude Croatia from my analysis as it did not participate in the 2012 Eurobarometer survey.*

16.12 It is possible that introducing picture warnings late while at the same time allowing CBDS at has an ambiguous net effect on smoking prevalence, if one makes smoking harder while the other makes it easier. This is also the case for countries banning CBDS without much change to their picture warning rules. Thus, one potential explanation for why Figure 7-1 and Figure 7-2 do not show clear effects of picture warnings or CBDS bans, is that the figures are not ”like-for-like” comparisons and possibly show the net effect of different policies working in opposite directions.

16.13 I graphically test for this possibility and find that there is no evidence to support it. My test is presented in Figure 16-2 and Figure 16-3 below. Figure 16-2 compares early versus late adopters of picture warnings but only among the countries who banned CBDS (these are the countries in the top row of Table 16-5). Holding CBDS bans constant across the two groups allows me to conduct a “like-for-like” comparison and better isolate any effect of the picture warnings policy. Similarly, Figure 16-3 compares countries who banned versus allowed CBDS, but only among the countries who were late adopters of picture warnings (the second column in Table 16-5). This allows me to isolate the effect CBDS bans from the effect of picture warnings.

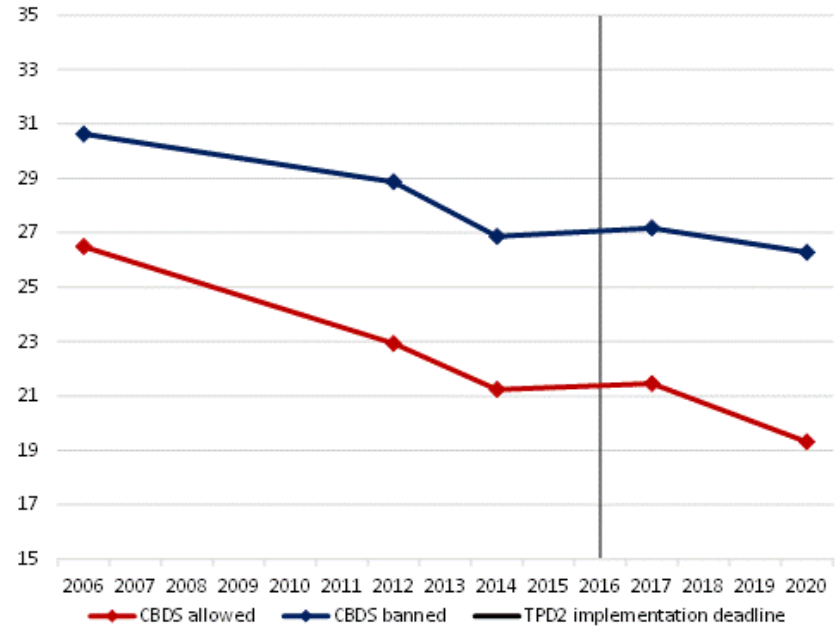
16.14 The figures show that isolating the effect of CBDS bans from the effect of picture warnings does not change any of the conclusions in 7.19 and 7.22, and does not provide any evidence that either policy had a measurable effect on smoking rates.

Figure 16-2: Trend in smoking prevalence between early and late adopters of picture warnings, keeping CBDS policy constant (ban)



Note: Country groupings as per the top row of Table 16-5.

Figure 16-3: Trend in smoking prevalence between countries where CBDS is allowed and where it is banned, keeping picture warning adoption constant (late)



Note: Country groupings as per the right column of Table 16-5

17. Signature Page

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May 15, 2023

Casey B. Mulligan

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