**Smoking for the poor and vaping for the rich?**

**Distributional concerns for novel nicotine delivery systems**

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**Abstract**

We compare income-related inequalities in the use of traditional smoking and of novel nicotine delivery systems (NDS), such as e-cigarettes and other smokeless products, and we apply a regression-based decomposition method for rank-dependent inequality measures to estimate the source of inequalities in the use of NDS. Using data from the 2013 wave of the Health Survey for England, we find that pro-poor inequality is greater for traditional smoking than for smoking and the smokeless products combined. Significant pro-rich inequalities are found in e-cig and other NDS consumption due to higher take-up among richer, younger and better-educated smokers. These patterns might lead to a long-run equilibrium with both higher average health *and* higher socioeconomic health inequalities.

**Keywords**: smoking; income-related health inequalities; electronic-cigarettes.

**JEL codes:** I12;I14.

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1. **Introduction**

Electronic cigarettes (e-cigs) and other novel nicotine delivery systems (NDS) represent one of the most important innovations in the tobacco market. E-cigs are battery-operated devices that aim to simulate combustible cigarettes, while other NDS encompasses alternative methods to administer nicotine to the brain without the harms of combustion (i.e. chewing gum, nicotine patches). E-cigs are the newest and the most used nicotine delivery system. They don’t contain tobacco but operate by heating nicotine and other chemicals into a vapour that is inhaled.[[1]](#footnote-1) Since their introduction to the market in 2004, global usage of e-cigarettes has risen exponentially (Cobb *et al*., 2010; Rom *et al*., 2014)[[2]](#footnote-2).

The reasons for increasing prevalence are that these new methods are perceived as healthier, cheaper, and more socially acceptable than conventional cigarettes (Rom *et al*., 2014). However, the primary objective of users is essentially that of quitting smoking (Pepper and Brewer, 2013). Both the health benefits and the ability to help quitting smoking are the two most explored issues in the empirical literature. Despite some side effects and some debate on their effectiveness to aid quitting[[3]](#footnote-3), e-cigs are generally evaluated as much safer than smoking and a valid aid for quitting (Public Health England, 2015). As a consequence, in 2015, the UK's Royal College of Physicians recommended that e-cigs should be offered to smokers and that “with the right checks and measures, vaping could improve the lives of millions of people” (Public Health England, 2015).

The distributional consequences of these new smokeless products, and, in particular, whether their take-up varies systematically across socio-economic groups remains to be clarified. This is relevant in order to properly assess the desirability of any health promotion activity (as e-cigs and other NDS might be considered) and to identify welfare-improving interventions. Importantly, Contoyannis and Forster (1999a; 1999b) show that when responsiveness to health promotion policies varies across socio-economic groups, i.e. a higher take-up rate among the better off, a striking conflict between efficiency and equity may arise: average population health *and* inequalities in health may both increase.

This paper fills this gap using fresh data on e-cig and other NDS consumption from the latest wave of the Health Survey for England (2013). Our analysis follows three steps. First, we analyse whether e-cig and other NDS re-shape the income-related inequalities in smoking, comparing the level of inequalities in traditional smoking with the inequalities in smoking and NDS combined. Secondly, we estimate the level of income-related inequalities in NDS take-up. Finally, we investigate the sources of income-related inequalities in NDS take-up rate using a regression-based decomposition method for rank-dependent inequality measures, and assessing the contribution of income, education and demographics to inequality.

The paper is organized as follows: the next section presents the data and the methods; Section 3 presents the results; and the final section discusses the implication of our findings and concludes.

1. **Data and Empirical Methodology**

We use a sample of 10,980 individuals (including 1,697 current smokers) from the latest wave (2013) of the Health Survey for England (HSE), which contains information on traditional smoking, the use of e-cigs and other nicotine delivery systems (NDS) along with information on demographics and socio-economic variables.

The main variables we use ask individuals to report whether they currently or ever used e-cigs or other NDS, and to report their current smoking status (never/ex-regular smoker/ex-occasional smoker/current smoker). From these we define two dummy variables: the first to indicate current smokers the second to indicate current smokers combined with users of NDS.

With the aim of estimating and comparing income-related inequalities in traditional smoking *vs* both traditional smoking and use of the new smokeless products, we use the Erreygers (2009) index for both outcomes. The Erreygers index is a rank-dependent inequality measure for bounded dependent variables that can be conveniently calculated as follows[[4]](#footnote-4):

$EI\left(S\_{i}\right)=\frac{8}{b-a}cov\left(S\_{i},R\_{i}\right)$ (1)

Where $b $and $a$ are the upper and lower bounds of the dependent variable (1 and 0 in our case), $S\_{i}$ indicates the individual take-up of nicotine products (traditional smoking or both traditional smoking and NDS) while $R\_{i} $is a monotonically increasing function of income measuring the individual’s relative position in the income distribution, bounded between 0 (poorest) and 1 (richest). The Erreygers index varies from µ-1 to 1+µ, where µ is the mean of variable whose inequality is being investigated. Positive (negative) values of the index indicate that levels of $S$ are more concentrated among those with higher (lower) rank in the income distribution. This is generally termed pro-rich (pro-poor) inequality. As a measure income, we use equivalised household income including total income of a household from all sources, after tax and other deductions, divided by the number of household members converted into equivalised adults.

To measure income-related inequalities in the use of new smokeless products, we calculate the EI defined in (1) using e-cig and other NDS take-up as dependent variable. As e-cigs and other NDS are used as smoking cessation methods, we restrict the attention to the subsample of current smokers (1,697 observations). We consider current (instead of ex-) smokers, in order to evaluate potential consequences of these methods on the expected long-run smoking (and health) gradient across income. Lastly, for the purpose of investigating the main sources of inequality in the new smokeless products, take-up of e-cig and other NDS ($NDS\_{i}$) is modelled as follows:

$NDS\_{i}=α+β\_{inc}x\_{i}^{inc}+β\_{edu}x\_{i}^{edu}+β\_{dem}x\_{i}^{dem}+ε\_{i} $(2)

Where $x^{inc}$, $x^{edu}$, $x^{dem}$ represent income and the set of education and demographic variables, while $β\_{inc}, β\_{edu, }β\_{dem}$ the corresponding coefficients, and $ε\_{i}$ is the error term. The set of demographic variables include six age group variables (11-18, 18-34, 35-44, 45-64, 65-74, 75+), for each gender, while the set of education variables include one dummy for each of the following categories: degree or national vocational qualification (NVQ) 4 or 5; higher education below degree; NVQ 3 or General Certificate of Education (GCE) Advanced Level; NVQ 2 or GCE Ordinary Level; NVQ1 or Certificate of Secondary Education (CSE); Other qualifications from outside England; no qualification. Omitted categories in our analysis are males, aged 11-18 and with no qualification.

Assuming linearity of (2) and recalling that our dependent variable is bounded between 0 and 1, the Erreygers index can be decomposed as follows:

$EI\left(NDS\_{i}\right)=4\* \left[β\_{inc}\*GCI\left(x\right)\_{inc}+β\_{edu}\*GCI\left(x\right)\_{edu}+β\_{dem}\*GCI\left(x\right)\_{dem}+GCI\left(ε\_{i}\right)\right] $(3)

Equation (3) indicates that the contribution of income, education and demographics to overall income-related inequalities in $NDS\_{i}$ depends on: i) the effect of each set of variables ($β$) on $NDS\_{i}$ taken from OLS estimates of equation (2) and ii) the generalized concentration index ($GCI\left(x\right)$) of each set of variables with respect to income (given by the concentration index $CI\left(x\right)$ multiplied by the mean of the variable). The last term of equation (3) is the generalized concentration index for $ε\_{i}$ and reflects the unexplained part of inequalities in e-cig and other NDS take-up.

1. **Results**

Column 1 of Table 1 shows that traditional smoking take-up is more concentrated among poorer individuals. The estimated EI of -0.063 is significantly pro-poor and very close to the theoretical lower bound (0.1545-1= -0.846). Column 2 shows that pro-poor inequalities are reduced by around 15% when traditional smoking and NDS are combined (-0.063 *vs* -0.054). This suggests that a considerable share of users in the upper tails of the income distribution consume e-cig or other NDS. This pattern is confirmed in Column 3 of Table 1 where EI of the use of NDS for the sample of current smokers is reported. Column 3 shows significant take-up rates of e-cig and other NDS (around 54% of current smokers are current or past users of NDS) and high pro-rich inequalities in the use of these new smokeless products among current smokers[[5]](#footnote-5).

**Table 1. Estimates of income-related inequalities: Traditional vs New methods**

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| --- | --- | --- | --- |
|  | **Traditional smoking** | **All methods** | **E-cig and other NDS** |
| **Take-up rate** | 15.45% | 20.39% | 53.8% |
| **EI** | -0.063\*\*\* | -0.054\*\*\* | 0.074\*\* |
| ***Std. Error*** | *0.008* | *0.008* | *0.028* |
| **Observations** | 10,980 | 10,980 | 1,697 |

**\*\*\* ,\*\*** indicate significance at 1% and 5%, respectively.

Table 2 shows the main contributors to inequalities in e-cig and NDS take-up based on the decomposition shown in equation (3). Income itself contributes 30% of the total income-related inequalities. This is due to a positive relationship with e-cig and other NDS take-up (positive β) and the positive generalised concentration index for income. Education is the second leading contributor to inequality. More educated individuals (degree, higher education or NVQ3) have a higher take-up rate (positive β) and a larger share of income (positive GCI). The total contribution of these education variables is equal to around 17%. Demographics also display a positive contribution due to a lower take-up rate among older men and women (75+) (negative β) and a lower concentration of income among these groups (negative GCI). These variables account for around 5.5% of the total inequalities.

**Table 2. Decomposition of income-related inequalities in E-cig and other NDS**

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| --- | --- | --- | --- | --- |
| **Variables** | **Β** | **GCI** | **Contribution** | **% Contr.** |
| Income | 0.000 | 11960.05 | 0.022 | 29.27 |
| M (18-34) | -0.031 | 0.001 | 0.000 | -0.11 |
| M (35-44) | -0.095 | 0.005 | -0.002 | -2.34 |
| M (45-64) | -0.002 | 0.008 | 0.000 | -0.09 |
| M (65-74) | -0.019 | 0.001 | 0.000 | -0.06 |
| M (75+) | -0.197 | -0.003 | 0.002 | 3.364 |
| F (11-18) | -0.094 | 0.002 | -0.001 | -0.95 |
| F (18-34) | -0.017 | -0.009 | 0.001 | 0.84 |
| F (35-44) | 0.022 | 0.003 | 0.000 | 0.37 |
| F (45-64) | 0.094 | 0.003 | 0.001 | 1.27 |
| F (65-74) | 0.161 | -0.004 | -0.003 | -3.64 |
| F (75+) | -0.106 | -0.004 | 0.002 | 2.28 |
| Degree- NVQ 4,5 | 0.008 | 0.054 | 0.002 | 2.32 |
| Higher Education | 0.140 | 0.015 | 0.008 | 11.41 |
| NVQ 3- GCE A | 0.041 | 0.014 | 0.002 | 2.98 |
| NVQ 2 – GCE 0 | 0.021 | -0.012 | -0.001 | -1.32 |
| NVQ1 – CSE | 0.047 | -0.009 | -0.002 | -2.30 |
| Other Qualifications | 0.069 | 0.000 | 0.000 | -0.10 |
| **Total** |  |  | 0.032 | 43.17 |
| **Residuals** |  |  | 0.042 | 56.83 |
| **Erreygers Index** |  |  | 0.074 | 100% |
| **Observations** |  |  |  | 1,697 |

1. **Conclusions**

The twin objectives of health promotion activities are to increase average health and to reduce health inequalities. This paper analyses distributional issues related to the introduction of e-cigarettes and other smokeless products which are generally evaluated as much safer than traditional smoking.

Using data from the 2013 wave of the Health Survey for England, we find that pro-poor inequalities are greater for smoking than for smoking and NDS combined. Significant pro-rich inequalities are found in e-cig and other NDS consumption due to a higher take-up among richer, younger and better-educated smokers. Provided that these smoking cessation methods will effectively reduce the number of smokers, these results will lead to a long-run equilibrium with higher average health *and* higher health inequalities. As e-cig and other NDS are generally cheaper than traditional cigarettes, the equality of access in these smoking cessation methods needs to be improved through alternative methods, such as medical recommendations or advertising campaigns. Greater focus on less educated and older smokers could be beneficial for the purpose of narrowing the health gap between rich and poor.

**References**

ASH (Action on Smoking and Health), (2016), Electronic Cigarettes. London: ASH; January, available at: <http://ash.org.uk/files/documents/ASH_715.pdf>.

Bullen, C., Howe, C., Laugesen, M., *et al*., (2013), Electronic cigarettes for smoking cessation: a randomized controlled trial*, Lancet*, 382:1629-37.

Chittock, M., (2014), Focus on e-cigarettes: A touch of the vapours, *The Grocer*, February 15th: 51-52-54.

Clarke, J. (2014), E-cigarette market ‘booming’, *Press Association MediaPoint*, February 28.

Cobb, N.K., Byron, M.J., Abrams, D.B., Shields, P.G., (2010), Novel nicotine delivery systems and public health: the rise of “e-cigarette”, *American Journal of Public Health*, 100: 2340-2.

Contoyannis, P., Forster, M., (1999a), The distribution of health and income: a theoretical framework, *Journal of Health Economics*, 18: 605-622.

Contoyannis, P., Forster, M., (1999b), “Our healthier nation”?, *Health Economics*, 8: 289-296.

Dockrell M, Morison R, Bauld L, McNeill A. (2013), E-cigarettes: prevalence and attitudes in Great Britain. *Nicotine Tobacco Research*, 15:1737-44.

Erreygers, G., (2009), Correcting the concentration index, *Journal of Health Economics*, 28:504-515.

Etter, J.F., Bullen, C., (2011), Electronic cigarette: users profile, utilization, satisfaction and perceived efficacy. *Addiction*, 106:2017-28.

Goniewicz, M.L., Knysak, J., Gawron, M., *et al*., (2013), Levels of selected carcinogens and toxicants in vapour from electronic cigarettes, *Tobacco Control*, 0:1-7.

Pepper, J.K., Brewer, N.T., (2013), Electronic nicotine delivery system (electronic cigarette) awareness, use, reactions and beliefs: a systematic review, *Tobacco control*, 23: 375-84.

Public Health England, (2015), E-cigarettes: an evidence update. A report commissioned by Public Health England: London. Available at: <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/457102/Ecigarettes_an_evidence_update_A_report_commissioned_by_Public_Health_England_FINAL.pdf>

Rom, O., Pecorelli, A., Valacchi, G., Reznick, A.Z., (2014), Are E-cigarettes a safe and good alternative to cigarette smoking?, *Annals of the New York Academy of Sciences*, 1340: 65-74.

Schoenborn, C.A., Gindi, R.M., (2015), *Electronic cigarette use among adults: United States, 2014*. NCHS data brief, no. 217. Hyattsville, MD: National Center for Health Statistics.

Wagstaff, A., (2005), The bounds of the concentration index when the variable of interest is binary, with an application to immunization inequality*, Health Economics*, 14: 429–432.

Williams, M., Talbot, P., (2011), Variability among electronic cigarettes in the pressure drop, airflow rate, and aerosol production, *Nicotine Tobacco Research*, 13:1276-83.

1. Inhaling from e-cigarettes is commonly called *vaping*. [↑](#footnote-ref-1)
2. In the UK, there are an estimated 2.6 million e-cigs users (ASH, 2016), while, in 2014, 12.6% of adults had ever tried an e-cig at least one time in the USA (Schoenborn and Gindi 2015). The e-cigs market is estimated to be worth £ 91.3 million a year (Chittock, 2014). It increased by 340% in 2013 to reach £193 million, and is expected to be worth £340 million by 2015 (Clarke, 2014). [↑](#footnote-ref-2)
3. E-cigs have been found as effective, though not more, than nicotine patches for short-term cigarette cessation (Dockrell *et al*., 2013; Etter and Bullen, 2011; Bullen *et al*., 2013), and cartridge analyses find fewer toxins than are found in traditional cigarettes (Goniewicz et al., 2013). However, in a randomized trial 29% of e-cig users continued e-cigs at 6-months compared to only 8% of patch users (Bullen *et al*., 2013), suggesting e-cig use might persist after other cessation methods. In addition, cartridges have been found to contain hazards, such as cytotoxic heavy metal and silicate particles (Williams and Talbot, 2011). [↑](#footnote-ref-3)
4. We use the Erreygers index because it is the only rank-dependent inequality measure for bounded variables satisfying two desirable properties: the *mirror condition* - the invariance of the inequality index to the coding of the dependent variable as 0 or 1 - and the *quasi-absoluteness*. The mirror condition is also respected by the Wagstaff index (Wagstaff, 2005), but the Erreygers index is an absolute rather than a relative measure of inequality. An advantage of this property in our context is that our estimates of inequality are suitable for a comparison between countries characterized by a different average use of NDS. [↑](#footnote-ref-4)
5. Use of NDS among non-smokers is very rare: according to our data, only 0.6% of never smokers have used or use NDS. This is also very rare for ex-occasional smokers (4%) while it is much more common among ex-regular smokers (20%) and actual smokers (53%). This is not surprising as NDS were created and are used essentially as smoking cessation devices rather than as recreational devices. The EI for NDS estimated for the sample of ex-regular smokers is +0.039 (statistically significant at 5 % level). This means that we still find a concentration of NDS among richer ex-smokers, although lower in magnitude than the EI for current smokers (+0.074). The EI for NDS for the sample of ex-occasional smokers is -0.014 and for never smokers is -0.002 but neither are statistically significant at conventional levels. [↑](#footnote-ref-5)