# The effects of a hospitality smoking ban on smoking behaviour and health in The Netherlands

Master Thesis

ERASMUS UNIVERSITY ROTTERDAM
Erasmus School of Economics
Department of Economics

Supervisor: Dr Anne Gielen

Name: Katelyn Price
Student Number: 386516
Email address: katelyn.o.price@gmail.com

In this paper use is made of data of the LISS (Longitudinal Internet Studies for the Social sciences) panel administered by CentERdata (Tilburg University, The Netherlands).

# 1 Summary

This study investigates the effects of the Dutch hospitality smoking ban on individual smoking behaviour and self-reported health. In the Netherlands on 1 July 2008, national smoke-free legislation was extended to workplaces in the hospitality industry, placing an indoor smoking ban on all hospitality venues such as restaurants, bars and nightclubs. Using longitudinal data from the annually conducted LISS panel, fixed effect logit regression analysis could not determine any causal effect of the introduction of the hospitality ban on smoking or health outcomes. However, results for sub-groups of the population suggest that heterogeneous effects are masked by only considering population level effects. For individuals who go out more frequently to bars and restaurants, there is suggestive evidence that the hospitality smoking ban reduced smoking prevalence for those in the age category of 25-34 years and improved health for those in the age category of 15-24 years. Furthermore, results at the population level are consistent with existing research that shows that those of higher socio-economic status are reducing smoking prevalence and smoking intensity more so than those of low socio-economic status. Overall, the results of this study are in line with the more recent body of European evidence on hospitality smoking bans that finds no or limited effects of such bans on smoking behaviour.

# 2 Introduction

Smoking, both active and passive, is the leading preventable cause of mortality and morbidity worldwide, claiming around 6 million deaths each year globally (Eriksen et al.,2015; WHO, 2015). The sheer size of the global burden of disease and death associated with smoking, and the simple fact that this burden is entirely avoidable through changes in individual behaviour, provides a strong public health rationale to fight against what has been dubbed – "the global tobacco epidemic". Equally, economic theory provides compelling justification for government intervention in the market for tobacco products, both in pursuit of optimising social welfare[1] and on paternalistic grounds[2]. Underpinned by strong economic and public health rationale, the last three decades have been increasingly marked by the development and implementation of tobacco control policies (U.S. Department of Health and Human Services, 2014).

Smoke-free legislation is one tobacco control policy that has been implemented in an increasing number of countries over the last decade, especially since the entering into force in February 2005 of the World Health Organisation (WHO) Framework Convention on Tobacco Control (FCTC) and the launch in 2008 of the WHO′s best practice framework for tackling the global tobacco epidemic (MPOWER), both of which strongly advocate for smoke-free legislation. The main rationale for smoke-free legislation, as described in Article 8 of the WHO FCTC, is protecting people from exposure to tobacco smoke (WHO, 2003). In other words, smoke-free policies are directly targeted at reducing the negative externality associated with smoking based on the premise of optimising social welfare.

Implementation of comprehensive smoke-free legislation, as advocated by the WHO, is however lacking (WHO, 2015). The overwhelming majority of smoke-free

[1] Smoking is an example of what is known in economics as a classic negative externality problem. Due to the fact that the individual smoker does not bear the full costs associated with their smoking behaviour (the health damage borne by people other than the individual smoker through exposure to environmental tobacco smoke, as well as the collectively borne costs of publicly funded healthcare for treating smoking related diseases of both smokers and non-smokers), the smoker will consume more than what is socially optimal.

[2] Economic theories on smoking addiction , through employing various assumptions of imperfectly rational behaviour (myopic behaviour cognitive limitations, underestimates of addiction and overestimates of ability to quit), assert that individuals smoke unwillingly and hence government intervention is justified on the basis of protecting one's self from the harm of their own misguided decision to smoke. The Handbook of Health Economics includes a chapter, "The Economics of Smoking", which provides a summary of the economic theories on smoking addiction (Chaloupka and Warner, 2000).

legislation is partial[3], meaning that smoke-free legislation does not cover all indoor public places. Most commonly, hospitality venues are those public places given an exemption from smoke-free legislation with two-thirds of countries globally without a ban on smoking in restaurants, bars and nightclubs (WHO, 2015). It thus appears that in many countries the primary aim of smoke free legislation, protecting the health of non-smokers, is not providing enough impetus for comprehensive smoke-free legislation.

To potentially strengthen the case for smoke-free legislation, an important and interesting question that has arisen is whether smoke-free legislation has benefits not only for the health of non-smokers, but also effects on the behaviour of smokers in terms of reducing smoking prevalence and lowering cigarette consumption. With the dual objective of convincing those countries dragging their feet on smoke-free legislation to increase their efforts, as well as helping those countries leading developments in smoke-free policies to better target their efforts, credible evidence on the effects of hospitality smoke-free policies on smoking behavior is high on the world tobacco control agenda.

Credible evidence on the effects of hospitality smoking bans on smoking behavior is limited, however the recent wave of hospitality smoking bans introduced in various European countries provides fertile ground for new research. One such case is that of the Netherlands where a ban on smoking in hospitality venues came into effect on 1 July 2008[4]. Through examining if the Dutch hospitality smoking ban has had any effect on smoking behaviour, this study aims to add to the emerging body of European evidence on whether smoke-free legislation in hospitality venues has benefits beyond those of its primary aim - protecting non-smokers from passive smoking.

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3 As at 2014, 49 countries had comprehensive smoke-free laws in place and a further 146 countries had partial smoke-free legislation in place (WHO, 2015).

4 Tobacco Act (Decree enforcing smoke-free workplaces, hospitality establishments and other areas), 4 April 2008

## 2.1 Research question

The main question of this study is: what effect did the 2008 hospitality smoking ban in the Netherlands have on the smoking behaviour of the Dutch population? Given that previous research on the Dutch hospitality smoking ban found little effect on smoking behaviour at the population level, a finding mirrored by research on hospitality smoking bans implemented in other countries, this study investigates effects of the smoking ban for a specific sub-group of the population: those most exposed to the hospitality ban i.e. those most frequently visiting bars and cafes. Therefore the specific research question of this study is*:*

*What were the effects of the 2008 hospitality smoking ban in the Netherlands on the smoking behaviour of those Dutch citizens exposed to the smoking ban?*

The outcome measures used in this study to examine the effects of the smoking ban on smoking behaviour are the smoking prevalence rate and average daily cigarette consumption for Dutch adults (15 years and older). These outcome measures are examined according to the level of exposure to the ban, whereby exposure to the ban is classified according to self-reported frequency of visits to bars and cafes. While not the primary focus of this study, the health effects of the smoking ban are also investigated using self-reported health and diagnosed heart attacks as outcome measures.

Due to the worldwide trend of smoking prevalence increasingly being concentrated among people of low socio-economic status (SES), research has also focused on whether certain tobacco control policies have a greater or lesser impact on low socio-economic groups compared to high socio-economic groups. As such, this study also explores the sub-research question:

*Did the 2008 hospitality smoking ban in the Netherlands have different effects for low and high SES groups of the Dutch adult population?*

Both education level and income are used as proxies for SES.

## 2.2 Motivation and policy relevance

The motivation for this study is to provide evidence-based research that further informs smoke-free legislation applying to hospitality venues, both in the Netherlands and internationally. The effects of smoke-free legislation on smoking behaviour is of particular interest given that the health effects for non-smokers are already well studied and that the social welfare optimisation rationale currently appears insufficient to motivate a global commitment to smoke-free legislation in the hospitality setting.

Furthermore, results of a small number of recent studies suggest that existing research on behavioural effects of hospitality smoking bans has largely overlooked the possibility of heterogeneous effects by only measuring outcomes for the overall population. Population level empirical research that concludes that hospitality smoking bans do not affect smoking behaviour may therefore misinform future developments in smoke-free policies.

In addition, understanding the effects of smoke-free legislation in the hospitality industry on smoking behaviour for particular sub-groups of the population may prove highly valuable, especially if such policy reduces smoking prevalence or cigarette consumption among vulnerable sub-groups such as young people or those of low socio-economic status.

The policy relevance of this study is two fold. Firstly, the burden of morbidity and mortality associated with smoking is significant, compelling the need for effective, evidence-based tobacco control policies. Smoking is the leading preventable cause of mortality and morbidity in the Netherlands and 13% of the total disease burden in the Netherlands is attributed to smoking (Rijksinstituut voor Volksgezondheid en Milieu, 2014). Latest figures on smoking prevalence in the Netherlands show that the smoking rate[5] was 23% in 2014 with smoking rates highest for people of low socio-economic status and young people between 25 and 34 years of age (Verdurmen, Monshouwer and van Laar, 2015). Despite having one of the lowest rates of adult

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[5] For people 15 years and older

smoking in continental Europe[6], the smoking rate among school children in the Netherlands is above average compared to European peers (Van Laar and Van Ooyen-Houben, 2014). Thus, informed tobacco control policies have the potential to benefit the young and those of low socio-economic status the most, whilst further contributing to relieving the high burden of death and disease associated with smoking.

Secondly, the Netherlands is considered a poor achiever in relation to smoke-free legislation and with respect to tobacco control policies overall, having scored below average in comparison to European peers at a ranking of 13th in 2013 (Joossens and Raw, 2013; WHO, 2015). That said, following a period of stalled tobacco control policy in the Netherlands between 2010 and 2013, momentum on tobacco control appears to have been regained given the Dutch Government's actions in 2014 to increase the age limit for sale of tobacco to 18 years of age, re-establish comprehensive smoke-free legislation for the hospitality industry, renew public education campaigns and vote in support of the European Tobacco Products Directive (Heijndijk and Willemsen, 2015). In a domestic policy environment seemingly ripe for progressing tobacco control policies, it is important for the Dutch government to be well informed in the field of smoke-free legislation, especially considering there is a global push for extending smoke-free legislation to outdoor public places such as outdoor eating areas, festivals and beaches.

This study adds to the existing body of empirical evidence on hospitality smoking bans in the Netherlands and other countries by addressing limitations of earlier research. Limitations of previous research include the use of cross-sectional data, and the measuring of outcomes using population level data that does not allow for heterogeneous effects or account for different levels of exposure to hospitality smoking bans. This study addresses these limitations by using longitudinal data to examine the effects of the Dutch hospitality smoking ban for those most exposed to the ban and for different sub-groups of the population.

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6 Countries with smoking rates below that of the Netherlands include Sweden, Norway, Iceland, Denmark, USA, UK, Canada, Australia and New Zealand (Eriksen et al. 2015)

## 2.3 Literature review

There is a large body of literature on the many different types of smoke-free policies. Most research comes from the US, where smoke-free policies were first introduced[7]. Following the adoption in 2003 of the WHO Framework Convention on Tobacco Control, many European countries introduced smoke-free policies[8]. As a result, the empirical evaluation of smoke-free policies has expanded considerably and the most recent and robust research often contradicts, or at least tames, the conclusions of the earlier US research.

Results of early US research generally show that population exposure to tobacco smoke is reduced following implementation of a smoking ban, and that the negative short term health effects of exposure to tobacco smoke are lessened as a consequence (Hahn, 2010; Callinan et al., 2010). Evidence on the effect of smoking bans on smoking prevalence and cigarette consumption is inconsistent (Callinan et al., 2010). However, the credibility of results from many of these earlier US studies is questionable given that the methodology is typically based on simple pre and post comparison in one city or state without a control group, meaning that pre existing trends in smoking prevalence are not accounted for (Mazzonna and Salari, 2015). Furthermore, the robustness of the results of many of the early US studies are affected by problems with unobservable heterogeneity, contemporaneous policies or small sample sizes (for example the widely cited study by Sargent et al. (2004)) (Mazzonna and Salari, 2015; Adams et al., 2013).

Given that US research pre 2010 on smoking bans is already well summarised in the literature (see for example Hahn, 2010; Callinan et al., 2010; Meyers, Neuberger, & He, 2009), and due to concerns over credibility of the methodology employed in many of these studies, evidence discussed in this literature review is drawn predominately from methodologically strong and more recent research on European smoking bans.

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7 In 1975 the US state of Minnesota became the first to introduce a smoking ban in indoor public places, excluding bars, whilst in 1990 the US city of San Luis Obispo in California became the first city to implement smoke-free legislation in all public places, including bars (McNabola and Gill, 2009). Between 1990 and 2004, as many as 35 US states introduced various types of smoke-free legislation (McNabola and Gill, 2009), as did most Australian and Canadian states, as well as New Zealand.

8 For example Ireland (2004), Norway (2004), Netherlands (2004 & 2008), Italy (2005), Scotland (2006), Spain (2006), England (2007), France (2007 & 2008), German federal states (2007-2008) and Swiss cantons (2007-2012).

In the following sections, findings of empirical research related to the effects of comprehensive and workplace bans on tobacco smoke exposure, health and smoking behaviour are briefly presented. Evidence on the effects of hospitality smoking bans on health and smoking behaviour, the focus of this study, are then discussed.

### 2.3.1 Comprehensive and workplace smoking bans

*Tobacco Smoke Exposure*

Recent research from Europe concludes that exposure to tobacco smoke among non-smokers declined following introduction of smoking bans, except for non-smokers living with smokers. For example one study (Sims et al. 2012) on the effects of the comprehensive smoking ban in England on tobacco smoke exposure used national data from biological samples of cotinine (a metabolite of nicotine), and found a decrease in tobacco smoke exposure for non-smokers following the smoking ban that was well above the pre-existing declining trend. The study also found that these positive effects did not extend to those living with smokers or lower-social class households. Evidence from Scotland's introduction of a comprehensive smoking ban, again based on national data of cotinine levels, found similar results with large falls in cotinine levels among non-smokers but not statistically significant drops among non-smokers living with smokers (Haw and Gruer, 2007; Pell et al., 2008).

The study by Haw and Gruer (2007) also found that self-reported exposure to tobacco smoke reduced in public places but did not change in homes, indicating there was no displacement of smoking from public places into the home. This latter finding is in line with findings from a Canadian study by Carpenter el at. (2011). Carpenter el at. (2011) exploited differences in timing of public place smoking bans introduced in various Canadian states and found that smoking bans significantly lowered self-reported exposure to tobacco smoke, particularly in bars and restaurants. Higher reductions in exposure to tobacco smoke were found in those states with stronger smoking bans. However, the conclusions of these two studies rely on self-reported tobacco exposure, an arguably less reliable outcome measure than data on cotinine levels.

A study by Adda and Cornaglia (2010) used data on cotinine levels in national biological samples, and state and time variation in smoking bans introduced in the US, to evaluate the effect of smoke-free policies on tobacco smoke exposure among non-smokers. Estimates show non-significant effects of smoking bans on tobacco smoke exposure among non-smokers overall. However, the results show while smoking bans appear not to have effected non-smokers living with non-smokers, exposure to tobacco smoke was shown to increase for non-smokers sharing a household with smokers. The authors conclude that the smoking bans caused smoking to be displaced from public places to the home and therefore exposure of non-smokers to tobacco smoke actually increased for those living with smokers.

*Health*

Health effects of smoking bans are commonly assessed in the literature by incidence of acute coronary events such as acute myocardial infarction (AMI), also known as heart attack, and generally conclude that health improves following introduction of comprehensive or workplace bans (see meta-analysis by Mackay et al., 2010). Two recent US studies that evaluate the effect of workplace smoking bans on short term health as measured by AMI employ a more robust methodology than much of the earlier US research that is based on case studies with small sample sizes, by using national data on AMI and workplace smoking bans to estimate a fixed-effect model. One of the study's (Shetty et al., 2011) find a small reduction in AMI mortality, but the estimates are not statistically significant. The other (Adams et al., 2013), finds statistically significant health effects of workplace smoking bans, although these are smaller that those found by earlier US research. The key difference is that Shetty et al. (2011) uses county level data while Adams et al. (2013) uses a large data set of state-level data and finer graduations of effects by age.

Evidence from studies on European smoking bans also supports the conclusion that smoking bans improve short term health as measured by acute coronary events. A study of the Scottish smoking ban (Pell et al., 2008) evaluated changes in AMI before and after introduction of a national comprehensive smoking ban, compared to changes in AMI in England where no such ban was in place. The study found a decrease in admissions of acute coronary syndrome following the introduction of the comprehensive smoking ban that was far larger than the pre-existing annual trend, and no such out-of-trend decrease in England. One study on the Italian smoking ban (Barone-Adesi et al., 2006) also found out-of-trend decreases in AMI following introduction of Italy's comprehensive smoking ban, however the study design is less robust given the absence of a control group.

Another measure commonly used in estimating the health effects of smoking bans is self-assessed health, as reported in national panel studies. Wildman and Hollingsworth (2013) investigate effects on health by exploiting the difference in timing of introduction of comprehensive smoking bans in Scotland (March 2006) and England (July 2007). Using household panel data on self-reported health, the study finds no health effects for the overall population. However, when examining sub-groups of the population, health improvements are observed for non-smokers but not for smokers. The authors assert that this suggests that benefits for non-smokers are linked to reduced exposure to tobacco smoke, while the lack of health benefits for smokers indicate that the ban did not effect smoking behaviour. When considering sub-groups by gender, the health benefits for non-smokers is particularly large for females.

*Smoking behaviour*

The most recent economic, empirically strong research on the effects of comprehensive and workplace smoking bans on smoking behaviour finds no effects of smoking bans on smoking behaviour, conflicting results of the large body of earlier, predominantly US, research which generally concluded that smoking bans reduce smoking prevalence and cigarette consumption (see systematic reviews: Chapman et al., 1999; Fichtenberg and Glantz, 2002). Recent studies using robust difference-in-difference empirical methods to evaluate the comprehensive smoking ban in the United Kingdom (Jones et al., 2015) and in Canada (Carpenter et al., 2011), found no evidence of an effect of the respective smoking bans on population level smoking prevalence or cigarette consumption.

Jones et al., (2015) study the effects on smoking behaviour of comprehensive public place smoking bans introduced in the United Kingdom; Scotland in March 2006 and England in July 2007. The authors exploit the timing difference of the Scottish and English smoking bans and use a difference-in-difference approach to explore effects on smoking behaviour and whether these effects differ according to age, gender and previous cigarette consumption. The study found no effects of the smoking bans on population smoking prevalence or cigarette consumption.

Slightly less empirically strong, but nevertheless credible studies which use regression analysis to evaluate effects of nationally implemented smoking bans in Italy (del Bono et al., 2013) and England (Lee et al., 2011) that control for such factors as pre-existing trends, seasonality, and contemporaneous policies, also find no effect on overall population smoking behaviour. There are a number of recent studies on comprehensive smoking bans for example in Ireland (Mullally et al. 2009) and Italy (Buonanno and Ranzani 2013, Federico et al., 2012), as well as workplace bans in for example Japan (Morozumi & Ii, 2006) and the Netherlands (Verdonk-Kleinjan et al., 2011), which find that smoke-free legislation does reduce smoking prevalence and lower cigarette consumption for the overall population. However these studies have less credible empirical strategies, with for example problems of not accounting for pre-existing trends, seasonality effects, contemporaneous policies or the presence of self-selection bias.

For example, Buonanno and Ranzani (2013) and Federico et al. (2012) find that smoking prevalence declined following introduction of a comprehensive smoking ban in Italy, however the methodology used by both studies is simple pre and post comparison, with no control group and no accounting for pre-existing trends. Furthermore, del Bono et al (2013), argues that due to the timing of collection of the pre and past data used in these studies, seasonality effects may confound the results. Del Bono et al (2013) evaluates the effects of the comprehensive smoking ban implemented in Italy in 2005 on smoking behaviour using national survey data and taking into account both the pre-existing smoking trend and seasonal patterns in smoking as observed in Italy. Their estimates reveal that the smoking ban had no impact on population level smoking behaviour.

European studies on smoking behaviour, like the US studies, have tended to focus on average population effects. A limited but emerging area of research is effects for certain sub-groups of the population, for example heavy versus light smokers, men versus women, or young versus older smokers (Jones et al., 2015; del Bono et al., 2013). Studies from France and Canada that examine the effects of smoking bans for heavy smokers find positive effects of smoking bans (De Chaisemartin et al., 2011, Irvine & Nguyen, 2011). De Chaisemartin et al. (2011) evaluated the workplace smoking ban introduced in France in 2007 and found that the ban increased the number of successful quit attempts among heavy smokers seeking treatments to reduce or quite smoking. Similar results are found in research on workplace smoking bans in Canada (Irvine & Nguyen, 2011) where a stronger impact was found for heavy smokers. Jones et al., (2015), when investigating heterogeneous effects for various population sub-groups, found that significant differences in the level of cigarette consumption was observed but no pattern could be found in relation to the impact of the smoking bans as some groups decreased cigarette consumption while for others, consumption increased or remained stable following the ban.

### 2.3.2 Hospitality smoking ban

*Health*

Most recently, Mazzona and Salari (2015) investigated the short term health effects of smoking bans introduced in restaurants and bars in various states within Switzerland between 2007 and 2011, exploiting both time and geographical variation in implementation of bans. The study used AMI as the outcome measure for health and found that incidence of AMI decreased by 10-12% immediately after implementation of smoking bans. Results show large heterogeneity across sub-groups of the population according to age and gender. The decrease in AMI was most prominent for men over 50 years of age and in regions with lower levels of education and income. The authors explain the latter result as a consequence of the fact that incidence of smoking and (self-reported) exposure to tobacco smoke were higher pre-policy in the low income - low education regions. Larger effects are found in the winter, a time of year when people are more likely to sit in the indoor areas of restaurants and bars. Given its quasi-natural experimental design, this study provides evidence of a causal relationship between exposure to tobacco smoke and incidence of AMI.

Another recent study (Kuehnle and Wunder, 2014) exploited differences in timing and geographic location of the introduction of hospitality smoking bans in German federal states between 2007 and 2008 to assess impacts on health. Rather than using an objective health measure such as AMI, this study used self-assessed health as reported in the longitudinal German Socio-Economic Panel Study. The results of the difference-in-difference estimates for the overall population showed improvements in health following implementation of the hospitality smoking bans. When estimating the effects for population sub-groups, the analysis found that health benefits for non-smokers were twice that of smokers. There were no health improvements, or even adverse health effects, reported by smokers which is thought by the authors to be linked to mental stress and withdrawal symptoms due to reduced smoking opportunities subsequent to the ban. The health effects among non-smokers were found to be greatest for young people (below 30 years of age) and females. The authors attribute the finding in relation to age to the fact that young people more often frequent bars and restaurants and the finding in relation to gender as being in line with other research that has found women to have a high tobacco smoke sensitivity.

*Smoking behaviour*

Research which has evaluated the effects of hospitality smoking bans on smoking behaviour found no or limited effect on smoking prevalence and average cigarette consumption at the population level (Anger et al, 2011; Nagelhout et al., 2011; Buddelmeyer & Wilkins, 2011). However, evidence from Adda and Cornaglia, 2010 that points to smoking displacement from places were smoking is banned to the home, could indicate that limited effects on smoking behaviour found in other studies may be explained by people substituting from smoking in restaurants and bars to in the home.

There is emerging evidence that while smoking bans do not appear to effect smoking behaviour at the population level, they may impact smoking behaviour for certain sub-groups of the population. Only a very small number of studies have investigated heterogeneous effects of hospitality smoking bans on smoking behaviour. Those which have, have found heterogeneous effects according to age, gender, level of exposure to the ban and smoking status.

A study by Anger et al. (2011) takes advantage of timing differences in the implementation of hospitality smoking bans in a number of German states in 2007 and 2008. The study employs a difference-in-difference strategy to evaluate the change in smoking prevalence following introduction of hospitality smoking bans, using the states with no such introduction as a control group. The study finds no effect on population smoking prevalence or average cigarette consumption in the short term. However, when examining smoking behaviour for those who were more exposed to the ban, i.e. those who more frequently go out to bars and restaurants, Anger et al. (2011) find a decline in both smoking prevalence and cigarette consumption. Their results showed a 2 percentage point  lower propensity to smoke after introduction of the ban for those regularly visiting bars and restaurants, and for those most frequently going to bars and restaurants this was 4 percentage points.

Nagelhout et al., (2011) investigated the impact of the 2004 workplace smoking ban and 2008 hospitality smoking ban in The Netherlands on smoking behaviour. This study specifically tested whether exposure to the hospitality smoking ban (measured by frequency of bar visits), and socio-economic status (measured by education level), lead to different effects in smoking behaviour. The study found that both the workplace and hospitality smoking ban were followed by an increase in quit attempts and successful quit attempts, with this being more pronounced following the workplace ban. In addition, the workplace ban had a larger effect on successful quit attempts among higher educated than on lower educated participants and the hospitality smoking ban had a larger effect on quit attempts for those participants who visited bars more frequently compared to those who did not visit bars. The effects of the hospitality ban did not differ between higher and lower educated participants. Furthermore, the hospitality smoking ban did not effect smoking prevalence, rather it only had an impact on quit attempts.

### 2.3.3 Summary

Research on the effects of comprehensive and workplace smoking bans, as well as smoking bans in hospitality venues, provides evidence that levels of exposure to tobacco smoke are reduced and health of non-smokers is improved as a result of smoke-free policies. Evidence on the effects of comprehensive and workplace smoking bans on smoking behaviour is mixed, with the more recent and empirically strong evidence concluding that smoking bans do not effect smoking prevalence and cigarette consumption. The small body of literature that has examined the effects of hospitality bans on smoking behaviour has also generally concluded that such bans do not affect smoking behaviour at the population level. However, a small number of recent studies have tested for heterogeneous effects and found that a hospitality smoking ban does effect smoking behaviour for certain sub-groups of the population. These results suggest that important behavioural changes in response to hospitality smoking bans may be masked by only measuring effects according to average population smoking rates and average population cigarette consumption figures. Existing research highlights that important sub-groups to consider are those most exposed to the ban, as well as younger individuals, females and heavy smokers seeking to quit smoking.

# 3 Data

Information on smoking behaviour and health before and after introduction of the Dutch hospitality smoking ban (hereafter referred to as “the ban”) is drawn from seven waves of the Longitudinal Internet Studies for the Social Sciences (LISS) panel. The ban was enacted in the Netherlands on 1 July 2008, between waves 1 and 2 of the LISS panel. It should be noted that the ban was actually a removal of an exemption given to the hospitality industry under the workplace smoke-free legislation implemented on 1 January 2004[9]. This incremental approach allows for the effects of the ban to be evaluated separately to the effects of the earlier smoke-free legislation.

The LISS panel is a representative sample of the Dutch population that consists of households and individuals randomly selected from the population register. Participants complete online surveys each month on various topics. This study uses the Health Survey for information on health and smoking behaviour. Wave 1 of the LISS panel Health Survey consisted of 6,698 individuals and was completed in November 2007 with a follow up to non-respondents in February 2008. Further waves were completed annually in November and December, and remains ongoing. The questions in the LISS panel Health Survey[10] on smoking include; *Have you ever smoked?; Do you smoke now?; What do/did you smoke?;* and*, How many cigarettes (including rolling tobacco) do/did you smoke on average per day?.* The Health Survey includes questions on an individual’s general health status, such as; *How would you describe your health, generally speaking?* as well as questions on diagnosed health diseases/problems including; *Has a physician told you this last year that you suffer from a heart attack (including infarction or coronary thrombosis or another heart problem including heart failure)?.*

To establish the level of exposure to the ban for each individual, this study uses information from one question of the LISS panel Social Integration and Leisure survey; *How often do you visit a bar or café*?. Wave 1 of the Social Integration and

9 Tobacco Act, 18 April 2002

10 The questions are asked to respondents in Dutch. The questions are presented here in English, as per the translations provided by the LISS Panel organization in the survey codebook.

Leisure survey consisted of 7,369 individuals and was completed in February and March of 2008, and annually thereafter in the same months. Also included in the Social Integration and Leisure survey are questions relating to lifestyle behaviours such as frequency of alcohol consumption, use of (illicit) drugs, time spent on sporting and time spent on cooking.

This study makes use of the data from these two LISS panel surveys for individuals who completed both surveys and who were aged 15 years and older in Wave 1. Recruitment of refreshment samples for the LISS panel were undertaken several times, meaning that additional individuals were added to the main sample in Wave 3, Wave 5 and Wave 7. Over the seven waves, from 2007 to 2013, 10,090 individuals completed both surveys in one or more years and therefore appear in the data sample. Of these, 2,495 individuals aged 15 years and older are included in all waves (almost 25% of the sample). In addition to information on smoking behaviour, health status, lifestyle behaviours and level of exposure to the ban, the LISS panel surveys include a wide range of variables on individual and demographic characteristics. Relevant variables included in the data sample for this study are age, gender, education, income, domestic living situation and urban character of place of residence.

## 3.1 Outcome measures and sample of interest

To examine changes in smoking behaviour, two different outcome measures are used; smoking prevalence and the average number of cigarettes consumed per day (smoking intensity). Information on smoking prevalence is based on the questions; *Have you ever smoked?* and *Do you smoke now?* from which a binary variable is created that takes value 1 for those who answer ‘yes’ to being a smoker now, and value 0 for those who answer ‘no’ to having ever been a smoker or to being a smoker now. In this way, the panel model analysis examines the extensive margin, that is, the effect of the ban on smoking prevalence for the full sample population; smokers and non-smokers. Additionally, the panel models are performed conditioned on being a smoker in Wave 1. This construction allows for effect of the ban on successful quit attempts to be analysed, changes in smoking prevalence among those who were smokers in Wave 1 of the survey.

Average daily cigarette consumption is the second indicator used to measure changes in smoking behaviour. Cigarette consumption is used because more than 93.5% of the individuals in the sample who identified themselves as smokers, smoke cigarettes compared to only 3.4% and 10.3% who smoke pipes and cigars, respectively. Data on cigarette consumption is based on the question; *How many cigarettes (including rolling tobacco) do/did you smoke on average per day?*. Because this question asks for a value of daily cigarettes consumed both for individuals who currently smoke and for those who have smoked in the past, but who do not currently smoke, positive values of cigarettes consumed are recoded to 0 for those individuals who answered ‘no’ to the question *Do you smoke now?*. This prevents past cigarette consumption for individuals who were smokers, but who have quit, being mistakenly included within the data for current consumption. A small portion of the sample (0.04%) who identified themselves as a current smoker entered 0 for the number of cigarettes smoked per day. These represent individuals who smoke less than every day and are thus occasional or social smokers. It is important to note that the question on cigarette consumption is only asked to those who answered yes to the question; *Have you ever smoked?*, meaning that lifetime non-smokers have missing values for cigarette consumption. Therefore, the smoking intensity outcome measure examines smoking intensity at the intensive margin, that is, within the sample of smokers.

Furthermore, self-reported values of daily cigarettes consumed tend to be concentrated at intervals of 5, due to the fact that people generally report that they smoke, for example, 10 or 15 cigarettes, when in actuality they smoke 8 or 14 cigarettes. As a result, the cigarette consumption outcome measure is not a normally distributed continuous variable, but has spikes of observations at multiples of 5. A logical transformation of this variable would be to create categories according to multiples of five cigarettes, however, an ordered categorical dependent variable is problematic in fixed effect models. To resolve this issue the method proposed by Van Praag & Ferrer-i-Carbonell (2006), which allows the estimation of traditional ordered response logit models with panel data, is employed in this study. Using this method the original dependent variable, the number of cigarettes smoked on average per day, is replaced by a binary variable which takes values 1 if the number of cigarettes smoked per day, as reported in that survey year, is above the mean number of cigarettes smoked by the individual over the full survey period. The variables takes value 0 if the number of cigarettes smoked on average per day, as reported in that survey year, is equal to or below the mean number of cigarettes smoked by the individual over the full survey period. Hence, a value of 1 means an individual increased the number of cigarettes they consumed relative to their own mean, and a value of 0 means an individual retained the same or reduced cigarette consumption relative to their individual mean consumption.

To assess changes in individual health, self-reported health is used as an outcome measure. Information on self-reported health is based on the question; *How would you describe your health, generally speaking?* from which a binary variable is created that takes value 1 for good health (answers of good, very good or excellent) and value 0 for poor health (answers of poor or moderate). Self-reported health is an outcome measure that, while commonly used in quantitative research due to its simplicity and wide availability, must be used with caution as it is prone to misclassification error, differences in how individuals use rating scales, response bias and can be correlated with individual characteristics (Newell et al., 1999). Furthermore, self-reported health is likely to be particularly problematic for assessing the health effects of changes in smoking behaviour due to the fact that individuals who have recently quit smoking may themselves feel particularly poorly, due to withdrawal symptoms and other negative effects associated with quitting smoking, even though their actual health may have improved. Therefore, information on diagnosis of heart attack, based on the LISS panel Health Survey question; *Has a physician told you this last year that you suffered from a heart attack (including infarction or coronary thrombosis or another heart problem including heart failure)?* is used in this study as an additional health outcome measure in order to assess a more objective measure of health. This dependent variable of diagnosed heart attack takes value 1 if an individual answers ‘yes’ to being diagnosed with a heart attack (or other heart disease/problem), and takes value 0 if an individual answers ‘no’.

To separate the effect of the ban from the common trend in the Netherlands of decreasing smoking prevalence, and from other confounding factors such as contemporaneous tobacco control policies, an indicator of exposure to the ban is used to create a proxy control group and treatment group. The basic idea is that individuals who go out more frequently to bars and cafes are more exposed to the ban. Information on exposure to the ban is based on the question; *How often do you visit a bar or café?* from which a binary variable is created whereby answers of 'never', 'about once a year' and 'a few times a year' take value 0 and answers of 'about once a month', 'a few times per month', 'once or twice a week' and 'almost every day' take value 1. Only information on frequency of bar or café visits from the survey conducted before introduction of the ban (Wave 1) is used in determining the treatment and control groups. This is because individuals may have changed their frequency of bar and café visits due to the introduction of the ban; a behavioural response that would otherwise be captured in the ban exposure binary variable and affect results. The panel model analysis will also be performed with the ban exposure binary variable taking value 1 for answers of 'once or twice a week' and 'almost every day', and 0 for answers of 'never', 'about once a year', 'a few times a year', 'about once a month' and 'a few times per month', to see if effects are stronger for those individuals with the most frequent bar and café visits.

In addition to whether smoking behaviour changed as a result of the ban, an interesting further line of investigation is whether individuals have other behavioural (healthy) lifestyle responses associated with introduction of the ban. As such, alcohol consumption, drug use, time spent on sports activities and time spent on cooking are used as outcome measures to test whether the ban had an effect on healthy lifestyle choices more generally. Information on alcohol consumption is based on the question; *'How often did you have a drink containing alcohol over the last 12 months?'* which has answers on a scale of 1: almost every day to 8: not at all. Given the ordered, categorical nature of this variable, the method by Van Praag & Ferrer-i-Carbonell (2006) is again used in this case, whereby a binary variable is created that takes value 1 if an individual increased their alcohol consumption relative to their mean consumption over the survey period, and takes value 0 if the individual reduced or did not change their consumption relative to their own mean consumption over the survey period. The outcome measure for drug use is based on the question; *Did you use one or more of the following substances over the past month: sedatives, hallucinogens, soft drugs, XTC and hard drugs?* from which a binary value is created that that takes value 1 if an individual answered 'sometimes' or 'regularly' for any of the specified drugs and takes value 0 if an individual answered ‘never’. Information on sports activities is based on the question; *How many hours do you spend on sports per week, on average?* and information on cooking is based on a series of questions which results in a constructed variable of the average hours an individual spent on cooking per week, over that 12 month period. Again the method by Van Praag & Ferrer-i-Carbonell (2006) is employed to examine if an individual decreased or increased time spent on sport and cooking respectively, compared to their own mean over the survey period.

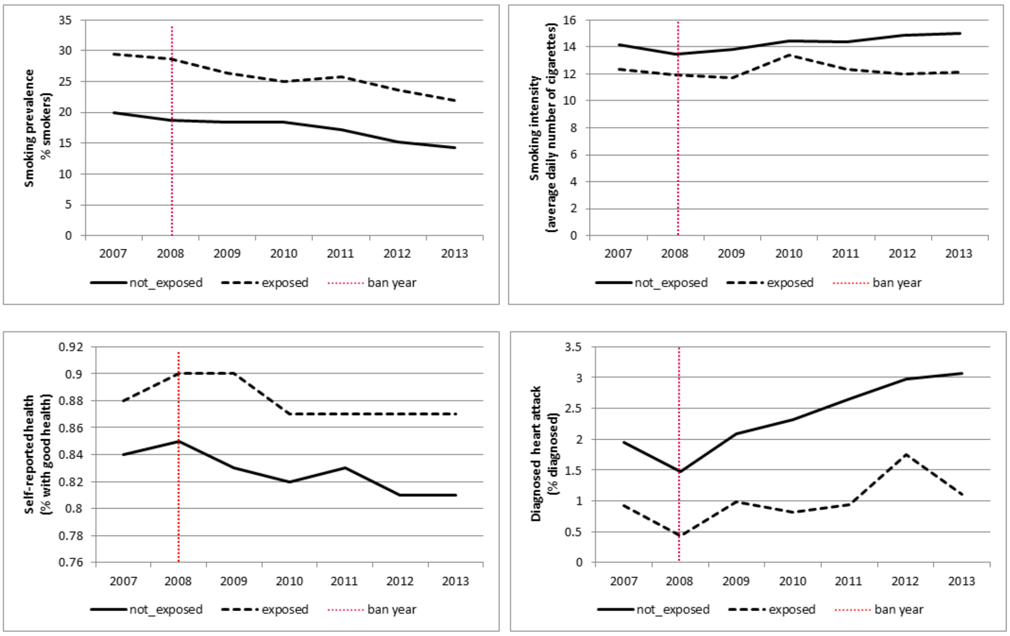
## 3.2 Descriptive statistics and graphical evidence.

Descriptive statistics for all outcome and explanatory variables, pre and post ban time periods, and both for the entire sample and by exposure to the ban, are provided in Table 3.1. Considering first the individual and demographic characteristics in the entire sample, 54% of respondents are female, the average age of individuals is 45 years, 53% have completed tertiary or higher education and 40% live in urban areas. Furthermore, 81% of the sample live together with a partner (either married or unmarried) and 51% co-reside with children.

The last row in Table 3.1 shows that slightly less than one third (29%) of the sample fall within the treatment group of being exposed to the ban (defined as those who were a frequent visitor to bars and cafes in Wave 1). Individuals in the two sub-samples of exposed and not exposed are similar in terms of mean education level and proportion of the sub-sample living with children. Larger mean differences between the exposed and not exposed groups are observable for age, gender, income and urban character of residence with the exposed group being on average younger, more often male, earning lower income, living in urban areas and more often living alone. Particularly gender (45% female in the exposed group compared to 57% female in the not exposed group) and age (37 years of age on average in the exposed group compared to 49 years of age on average in the not exposed group) are different between the two groups.

To examine the outcome variables visually and over the full sample period, Figure 3.1 plots the annual smoking prevalence, smoking intensity, self-reported health and diagnosed heart attack outcome measures for those exposed to the ban and those not exposed to the ban separately, for the full sample period.

**Figure 3.1 Smoking and health outcome measures, by exposure to the ban**




Note: The vertical line represents the year of introduction of the ban (year 2008).

**Table 3.1 Descriptive statistics**

| | Wave 1 (pre ban) | | | | | | Wave 2 (post ban) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Full sample** | | **Exposed to ban** | | **Not exposed** | | **Full sample** | | **Exposed to ban** | | **Not exposed** | |
| Variable | Mean | Obs | Mean | Obs | Mean | Obs | Mean | Obs | Mean | Obs | Mean | Obs |
| *Outcome variables* | | | | | | | | | | | | |
| Smoking prevalence | 0.23 | 6 648 | 0.29 | 1 820 | 0.20 | 4 401 | 0.22 | 5 944 | 0.29 | 1 391 | 0.19 | 3 559 |
| Smoking intensity (average daily # of cigarettes) | 13.51 | 1 479 | 12.31 | 518 | 14.17 | 833 | 12.60 | 1 164 | 11.90 | 347 | 13.43 | 578 |
| Self reported health (0=poor, 1=good) | 0.85 | 6 698 | 0.88 | 1 837 | 0.84 | 4 419 | 0.87 | 5 961 | 0.90 | 1 398 | 0.85 | 3 563 |
| Diagnosed heart attack | 0.017 | 6 649 | 0.009 | 1 820 | 0.020 | 4 401 | 0.012 | 4 919 | 0.004 | 1 137 | 0.015 | 2 905 |
| Alcohol use | | | | | | | | | | | | |
| almost never / never | 0.19 | 6 648 | 0.07 | 1 820 | 0.23 | 4 401 | 0.18 | 5 944 | 0.08 | 1 391 | 0.22 | 3 559 |
| sometimes | 0.22 | 6 648 | 0.21 | 1 820 | 0.21 | 4 401 | 0.22 | 5 944 | 0.21 | 1 391 | 0.22 | 3 559 |
| regularly | 0.59 | 6 648 | 0.71 | 1 820 | 0.55 | 4 401 | 0.60 | 5 944 | 0.71 | 1 391 | 0.56 | 3 559 |
| Drug Use | 0.07 | 6 698 | 0.11 | 1 837 | 0.07 | 4 419 | 0.07 | 5 691 | 0.09 | 1 398 | 0.06 | 3 563 |
| Sporting (average weekly hours) | 3.92 | 3 657 | 4.46 | 1 242 | 3.63 | 2 350 | 3.92 | 2 960 | 4.27 | 832 | 3.7 | 1 673 |
| Cooking (average weekly hours) | 1.17 | 4 670 | 1.18 | 1 334 | 1.16 | 3 246 | 1.18 | 3 948 | 1.16 | 943 | 1.16 | 2 374 |
| *Explanatory variables* | | | | | | | | | | | | |
| Female | 0.54 | 3 412 | 0.45 | 1 284 | 0.57 | 2 128 | 0.54 | 3412 | 0.46 | 1 284 | 0.57 | 2 128 |
| Age | 45.26 | 3 412 | 36.76 | 1 284 | 49.07 | 2 128 | 46.3 | 3412 | 37.7 | 1 284 | 50.5 | 2 128 |
| Education (0=low/medium, 1=high) | 0.53 | 3 412 | 0.54 | 1 284 | 0.54 | 2 128 | 0.52 | 3412 | 0.54 | 1 284 | 1,697 | 2 128 |
| Income | 1,774 | 3 412 | 1 422 | 1 284 | 1 877 | 2 128 | 1,631 | 3412 | 1,378 | 1 284 | 0.54 | 2 128 |
| Urban residence (0=not urban, 1=urban) | 0.40 | 3 412 | 0.47 | 1 284 | 0.37 | 2 128 | 0.40 | 3412 | 0.47 | 1 284 | 0.36 | 2 128 |
| Cohabitation (0=lives alone, 1=cohabitates) | 0.81 | 3 412 | 0.74 | 1 284 | 0.84 | 2 128 | 0.80 | 3412 | 0.74 | 1 284 | 0.84 | 2 128 |
| Living with children (0=without children, 1=with children) | 0.51 | 3 412 | 0.52 | 1 284 | 0.49 | 2 128 | 0.48 | 3412 | 0.52 | 1 284 | 0.46 | 2 128 |
| Ban exposure (based on frequency of bar visits, wave 1) | 0.29 | 3 412 | - | - | - | - | - | | - | - | - | - |

### 3.2.1 Outcome measures - full survey population

For the full sample population, smoking prevalence is 23.24% in Wave 1 of the survey (2007 – pre ban) and 22.16% in Wave 2 (2008 – post ban), decreasing to 17.02% in Wave 7 (2013). The average daily number of cigarettes consumed is 13.5 in Wave 1, decreasing to 12.6 in Wave 2 post the ban, but then rising for the remaining survey years to 13.4 in Wave 7. The data therefore suggests a general trend of decreasing smoking prevalence among the sample population over the survey period, alongside a fairly stable average daily cigarette consumption, except in the post ban year where there is a short-lived reduction in average daily cigarettes consumed.

Self-reported health over the full sample population is higher after introduction of the ban, however self-reported health then declines for the remaining years of the survey to lower than that reported in Wave 1. Similarly, diagnosed heart attacks among the sample are lower in Wave 2 than Wave 1, but then increase over the remaining years of the survey to higher than that reported in Wave 1. The health outcome measures thus seem to suggest an improvement in health after introduction of the ban, however this effect is not sustained over the longer term.

No clear differences in lifestyle behaviour are evident from the cursory descriptive statistics presented in Table 3.1.

### 3.2.2 Outcome measures - exposed and not exposed to the ban

When examining outcome measures for those exposed to the ban compared to those not exposed to the ban, Figure 3.1 provides strong visual evidence of a common time trend for the treatment and control groups across the two main smoking behaviour and two main health outcome measures. Table 3.1 and Figure 3.1 show that smoking prevalence is higher and average smoking consumption is lower among individuals exposed to the ban, compared to those not exposed to the smoking ban over the full survey period. Considering smoking prevalence, Table 3.1 shows that post introduction of the ban (Wave 2), smoking prevalence among those not exposed to the ban declines by slightly more than those exposed to the ban. Indeed from Figure 3.1 it can be seen that there is a declining trend in smoking prevalence over the full sample period that is common to both those exposed and those not exposed to the ban, with no apparent differences in smoking prevalence among the exposed and not exposed groups. Although merely descriptive, these findings suggest no effect of the ban on smoking prevalence.

In terms of smoking intensity, Table 3.1 shows that both exposed and not exposed groups experience a similar slight decline in cigarette consumption in Wave 2 of the survey. Figure 3.1 shows that from Wave 2 onwards, the average daily number of cigarettes consumed rises gradually, albeit initially more slowly for the exposed group. Thus the descriptive statistics suggest that both groups follow a common pattern in smoking intensity, but that there may be differences in smoking intensity among the exposed and not exposed groups in the years after introduction of the ban.

When examining self-reported health among the exposed and not exposed groups, the exposed group have a higher mean compared to the not exposed group, both pre and post ban (Table 3.1). Longer term, the post ban improvements in self-reported health seem more sustained initially for the exposed group compared to the not exposed group, but decrease overall for both groups (Figure 3.1). The rate of diagnosed heart attacks is the sample is lower for the exposed group in Wave 1, with both groups showing a decline in diagnosed heart attacks in the Wave 2 (Table 3.1). Figure 3.1 shows that both the exposed and not exposed groups have a similar overall pattern of a drop in diagnosed heart attack after the ban and then a gradual increase, however the increase is less constant for the exposed group. Therefore the descriptive statistics are suggestive of differences between the exposed and not exposed groups in health outcomes, but it is unclear if these difference are as a result of the ban.

Alcohol consumption and drug use are higher among those exposed to the ban compared to those not exposed to the ban, however neither group shows any significant change in alcohol consumption pre and post ban, while drug use declines slightly for both groups post ban. Time spent on sports activities and cooking is higher among those exposed, and remains fairly similar for both exposed and not exposed groups in the pre and post ban periods. As such, the descriptive statistics do not point to any effects of the ban on behavioural (healthy) lifestyle outcomes.

In the following section of this study, the indications from the descriptive statistics are formally tested using regression-adjusted analyses to determine if the ban had an effect on any of the outcome measures.

# 4 Empirical strategy and results

This chapter explains the choice of empirical model and presents the main results. In addition, a series of robustness checks are introduced and discussed to determine whether a causal interpretation of the results is credible.

## 4.1 Empirical strategy

The empirical strategy exploits differences among individuals in level of exposure to the ban to determine the effect of the ban on a range of smoking, health and other behavioural (healthy) lifestyle outcomes. Data on the frequency of visits to bars and cafes allows the impact of the ban to be evaluated for those individuals frequently visiting bars and cafes (the treatment group) and those not visiting bars and cafes (control group) separately. The underlying logic is that, all else being equal, those going out more frequently to bars and cafes are more exposed to the ban and hence, after introduction of the smoking ban, would be more responsive in smoking behaviour and more likely to experience improved health (due to less exposure to tobacco smoke) than those rarely going out to bars and cafes.

To estimate the effects of the ban in the Netherlands on the smoking behaviour, health and other behavioural (healthy) lifestyle outcome, a fixed-effect estimator is used, conditioned on whether individuals belong to the treatment (exposed to the ban) or control (not exposed to the ban) group. More specifically, the following equation is estimated:

$$y_{it} = \beta_1 BAN_{it} + \gamma' X_{it} + \beta_2 T + \alpha_i + \varepsilon_{it}$$

where $y_{it}$ represents alternatively, one of the two smoking outcomes, one of two health outcomes, or one of the four healthy lifestyle behaviour outcomes described above for individual i at survey time t. The variable $BAN_{it}$ is the primary variable of interest which equals 1 if the smoking ban is in place, and 0 otherwise. In Wave 1 of the survey, year 2007 which is prior to the introduction of the ban, $BAN_{it}$ takes the value 0 for all individuals. In Wave 2 of the survey, completed in November and December 2008, and for all survey years thereafter, $BAN_{it}$ takes value 1 given that the ban came into effect in July of 2008. The coefficient $\beta_1$ measures the effect of the policy. The specification also includes $X_{it}$, a vector containing individual observed characteristics in period t (education, income, domestic living status and urban character of place of residence), and a continuous year variable T to account for time trends common to both the treatment and control groups. The last two terms in the equation represent respectively, the unobserved individual characteristics that are fixed over time, $\alpha_i$, and an idiosyncratic error term, $\varepsilon_{it}$.

Ban exposure is not included as a variable within the fixed effect estimator because it is time-invariant for all individuals over the survey period (it is set based on frequency of bar and café visits in Wave 1 and remains fixed). As such, the model is estimated separately for the control group (ban exposure =0) and treatment group (ban exposure =1). In addition, estimates are separated by gender, age group and socio-economic status in order to examine if there are any differences in effect of the ban among population sub-groups.

## 4.2 Results

This section reports the main results of the analysis using the identification strategy presented above. In section 4.2.1 and 4.2.2 the results are presented from the estimation of the effect of the ban on smoking prevalence and smoking intensity. Section 4.2.3 shows the estimation of the effect of the ban on health outcomes, while the effect of the ban on other behavioural (healthy) lifestyle outcomes, specifically on alcohol consumption, drug use, time spent on sports activities and time spent on cooking, is examined in section 4.3.4. Finally, section 4.2.5 reports the results of effects of the ban for population sub-groups according to gender, age and socio-economic status.

### 4.2.1 Smoking prevalence

Estimates of the fixed effect models on the impact of the ban on smoking prevalence are presented in Table 4.1. These are provided for three alternative models; a baseline model without any conditioning on ban exposure, and models conditioned on being exposed or not exposed to the ban. In these logit fixed effect models, the estimates should be interpreted in terms of the sign of the coefficient (negative or positive) as this indicates whether there is a decrease (negative) or increase (positive) in the probability of smoking.

**Table 4.1 The effect of the ban on smoking prevalence**

| | Full sample<br>Smoking Prevalence | | | Smokers in Wave 1<br>Smoking Prevalence | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | 0.166 | 0.086 | 0.193 | -19.272 | -16.054 | -17.562 |
| pvalue | (0.176) | (0.654) | (0.232) | (0.988) | (0.967) | (0.975) |
| Observations | 3,412 | 1,284 | 2,128 | 2,225 | 1,454 | 771 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect binary logit estimator. Full sample represents the extensive margin. Smokers in Wave 1 represents successful quit attempts of smokers. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

In all models the estimated effect of the introduction of the ban on the probability of smoking is not statistically significant (at 10% significance level). These results suggest that the ban had no effect on smoking prevalence. These results are in line with findings by Nagelhout et al., (2011) who found that the Dutch hospitality smoking ban did not effect smoking prevalence for the full population or for smokers.

Even so, perhaps noteworthy is the sign of the estimated effects. The estimated effect of the ban on the probability of smoking is positive for the full sample, but negative for individuals who were smokers before introduction of the ban. This could suggest that the introduction of the ban had an (insignificant) effect on existing smokers in terms of increasing successful quit attempts, but not necessarily an effect on deterring potential smokers on taking up smoking, hence the positive (insignificant) effect on the probability of smoking for the full sample population. Findings in previous research that found smoking bans effective in decreasing smoking prevalence only for heavy smokers who were already seeking to quit smoking (De Chaisemartin et al., 2011). Given this group may be a rather small portion of the total smoking population, this may provide a reason for the negative but statistically insignificant effect of the introduction of the ban for smokers. Unfortunately data on whether an individual wishes to quit smoking is not available in the dataset used for this analysis.

### 4.2.2 Smoking intensity

Estimates of the fixed effect ordered logit models on the impact of the ban on smoking intensity are presented in Table 4.2. Again, estimates are displayed for three alternative models; a baseline model without any conditioning on ban exposure, as well the models conditioned on ban exposure. In these fixed effect ordered logit models, the estimates should be interpreted in terms of the sign of the coefficient as this indicates whether there is an increase (positive) or decrease (negative) in an individual's average daily number of cigarettes consumed.

**Table 4.2 The effect of the ban on smoking intensity**

| | Smokers | | |
|---|---|---|---|
| | Smoking Intensity | | |
| Outcome variable | Baseline | Exposed | Not exposed |
| BAN | -0.260*** | -0.066 | -0.372*** |
| pvalue | (0.008) | (0.686) | (0.002) |
| Observations | 3,816 | 1,328 | 2,488 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect ordered logit estimator. Smokers represents the intensive margin, smoking intensity given that a person is a smoker. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

In all models, the estimated effect of the introduction of the ban on the average daily cigarette consumption is negative, suggesting that the effect of the introduction of the ban was a reduction in smoking intensity, ceteris paribus. The estimated effect of the introduction of the ban when not conditioned on ban exposure is a statistically significant reduction in smoking intensity (significant at 1% level), ceteris paribus. However, for those exposed to the ban the effect is statistically insignificant (insignificant at 10% level), yet statistically significant (significant at 1% level) for those not exposed to the ban.

Overall, these results suggest that the introduction of the ban had an effect on smoking intensity, but the estimates do not suggest that those exposed to the ban experienced a stronger effect than those not exposed to the ban, quite the opposite. This suggests that the mechanism that is driving the reduction in smoking intensity, is not related to an individual's exposure to the ban. This finding will be further explored in the discussion section of this study.

### 4.2.3 Health outcomes

Results for the self-reported health and diagnosed heart attacks fixed effect logit models are presented in Table 4.3. Estimates are displayed for the baseline model and models conditioned on ban exposure.

**Table 4.3 The effect of the ban on self-reported health and diagnosed heart attacks**

| | Self-reported health | | | Diagnosed heart attack | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | 0.365*** | 0.416** | 0.346*** | -0.743*** | -0.833 | -0.724*** |
| pvalue | (0.000) | (0.020) | (0.001) | (0.001) | (0.148) | (0.004) |
| Observations | 6,774 | 1,551 | 5,223 | 1,178 | 194 | 984 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect binary logit estimator. Self-reported health is a binary dependent variable that takes 1 for good health and 0 for poor health. Diagnosed heart attack is provided as a more objective health outcome measure and is a binary dependent variable that takes 1 if the individual reports that a doctor has diagnosed them with a heart attack or another heart problem. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.
*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

In all models, the estimated effect s of the introduction of the ban indicate better heath. For self-reported health, the estimated effects of the introduction of the ban in the baseline model and for those not exposed to the ban are a statistically significant (significance at 1% level) increase in self reported health, ceteris paribus. The estimated effects of the introduction of the ban on self-reported health for those exposed to the ban are slightly less statistically significant (Significance at 5% level). As with smoking intensity, these results suggest that the introduction of the ban had a positive effect on self-reported health, but that the mechanism that is driving the improvements in health is not an individual's exposure to the ban.

Similarly, the estimated effects of the introduction of the ban on diagnosed heart attacks is a highly statistically significant (significance at 1% level) decrease in diagnosed heart attacks, ceteris paribus. However, the effects are only highly statistically significant in the model not conditioned on ban and for those not exposed to the ban, while statistically insignificant (insignificant at 10% level) for those exposed to the ban. In this case, the statistical insignificance of the effect for those exposed to the ban may be a result of lack of power, given that the number of observations in the exposed model for diagnosed heart attack is very low. In any case, the results again suggest that the introduction of the ban saw an improvement in health, but there is no evidence that the health improvements are linked to an individual's exposure to the ban.

### 4.2.4 Lifestyle outcomes

Results for the behavioural (healthy) lifestyle fixed effect logit models are presented in Table 4.4. Estimates are displayed for the baseline model and models conditioned on ban exposure for each of the outcome measures of alcohol consumption, drug use, sports activities and cooking.

**Table 4.4 The effect of the ban on behaviour (healthy) lifestyle outcomes**

| | Alcohol consumption | | | Drug use | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | -0.104** | -0.208** | -0.056 | 0.266** | 0.215 | 0.281* |
| pvalue | (0.030) | (0.021) | (0.319) | (0.036) | (0.318) | (0.074) |
| Observations | 18,784 | 5,188 | 13,596 | 2,828 | 942 | 1,886 |

| | Sports activities | | | Cooking | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | -0.109* | -0.152 | -0.068 | -0.008 | 0.063 | -0.032 |
| pvalue | (0.060) | (0.126) | (0.345) | (0.873) | (0.531) | (0.604) |
| Observations | 11,207 | 3,625 | 7,582 | 15,026 | 3,946 | 11,080 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect logit estimator. Alcohol consumption model is a fixed effect ordered logit model. Drug use is a fixed effect binary logit model. Sports activities and cooking models are fixed effect ordered logit models. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.
*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

In the fixed effect ordered logit model for alcohol consumption, the estimated effect of the introduction of the ban is a decrease in alcohol consumption, ceteris paribus. This effect is statistically significant (significant at 5% level) in the model not conditioned on ban exposure, and also for those exposed to the ban (significant at 5% level), while statistically insignificant for those not exposed to the ban (insignificant at 10% level). This result suggests that alcohol consumption decreased after introduction of the ban and that this effect may be related to an individual's exposure to the ban, with only those exposed to the ban showing a statistically significant decrease in alcohol consumption.

The estimated effect of the introduction of the ban on drug use is positive in all models and statistically significant (significant at 5% level) in the model not conditioned on ban exposure and marginally significant for those not exposed to the ban. The effect is statistically insignificant for those exposed to the ban (insignificant at 10% level). These results suggest that drug use increased after introduction of the ban, ceteris paribus, and that this effect may be related to an individuals exposure to the ban, with only those not exposed to the ban showing a (marginally) significant increase in drug use.

The estimated effects for the fixed effects ordered logit models for sports activities and cooking are not statistically significant (at 5% significance level). Only for the sports activities model not conditioned on ban exposure is there a marginally significant (significant at 10% level) decrease in time spent on sports activities. The results thus indicates that the introduction of the ban had very little or no effect on sports activities and cooking. Noteworthy however is the sign of the estimated effects. Time on sports activities decreased, ceteris paribus, in all model. In the model for time spent on cooking, the model not conditioned on ban and the model for those not exposed to the ban show a decrease in time spent on cooking, while those exposed to the ban have an increase in time spent on cooking. While the effects are not statistically significant, this perhaps indicates that those exposed to the ban had a different behavioural effect than those not exposed to the ban, after introduction of the ban. The estimates may be suggestive that those exposed to the ban spent more time on cooking, and those not exposed less time on cooking, after introduction of the ban.

*Frequency of visits to bars and cafes*

The fact the those exposed to the ban spent more time on cooking, and those not exposed less time on cooking, could be an indicator of an individual spending more time at home after introduction of the ban. This may suggest that those exposed to the ban decreased their frequency of bar and cafes visits after the introduction of the ban. Similarly, the fact that alcohol consumption decreased more strongly for those exposed to the ban could be linked to the frequency at which individuals visit bars and cafes after introduction of the ban, provided it is plausible to assume that individuals are more likely to drink alcohol when in bars and cafes than in their own homes. Indeed, loss of revenue for hospitality venues due to loss of patronage as a result of the introduction of the ban was a highly vocalised concern of lobby groups representing the hospitality industry, both leading up to and after introduction of the ban.

On the other hand, one might expect that frequency of visits to bars and cafes to increase after introduction of the ban, due to the reduced exposure to tobacco smoke for non-smokers. If one assumes that smokers are more likely to lessen their frequency of visits to bars and cafes, and non-smokers are more likely to increase their frequency of visits to bars and cafes  after introduction of the ban, the overall increase or decrease in frequency of visits to bar would depend on which effect is stronger.

To test if the frequency of visits to bars and cafes indeed reduced after introduction of the ban, a fixed effect ordered logit model is estimated. The dependent variable is frequency of visits to bars and cafes, a binary variable that takes value 1 if an individual increased the frequency of bar and café visits and value 0 if an individual decreased or kept bar and café visits the same (according to the method of Van Praag & Ferrer-i-Carbonell (2006)). Results for the frequency of visits to bars and cafes fixed effect logit models are presented in Table 4.5. Estimates are displayed for the baseline model and models conditioned on ban exposure. In addition, models are conditioned on being a smoker in Wave 1 or a non-smoker in Wave 1 in order to identify if there is any difference in effects for smokers and non-smokers.

**Table 4.5 Frequency of visits to bars and cafes**

| Outcome variable | Frequency of bar/café visits | | | Frequency of bar/café visits | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Baseline | Exposed | Not exposed | Baseline | | Exposed | | Not exposed | |
| | | | | Smokers | Non-smokers | Smokers | Non-smokers | Smokers | Non-smokers |
| BAN | 0.188*** | 0.972*** | -0.203*** | 0.370*** | 0.131** | 1.229*** | 0.870*** | -0.213 | -0.207*** |
| pvalue | (0.000) | (0.000) | (0.002) | (0.001) | (0.030) | (0.000) | (0.000) | (0.151) | (0.006) |
| Observations | 15,248 | 5,418 | 9,830 | 3,485 | 11,763 | 1,471 | 3,947 | 2,014 | 7,816 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect ordered logit estimator. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models are also conditioned on being a smoker in Wave 1 or a non-smoker in Wave 1. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

The estimated effects of the introduction of the ban on frequency of visits to bars and cafes is positive and highly statistically significant (significant at 1% level) in the model not conditioned on exposure, and for those exposed to the ban. The estimates effect is negative and highly statistically significant (significant at 1% level) for those not exposed to the ban. These results show that those who were exposed to the ban (those who had high frequency of visits to bars and cafes in Wave 1) increased their frequency of visits to bars and cafes after introduction of the ban, ceteris paribus, while those who had low frequency of visits to bars and café in Wave 1 decreased or kept the same the frequency of visits to bars and cafes after introduction of the ban, ceteris paribus. Given that those exposed to the ban increased their frequency of visits to bars and cafes, these results does not provide support for the hypothesis above that those exposed to the ban spent more time at home after introduction of the ban and hence time on cooking increased and alcohol consumption decreased.

Within each model of baseline, exposed and not exposed, there is no difference in the sign of the estimated effects for smokers and non-smokers. Therefore, there is no evidence that smokers decreased and non-smokers increased frequency of visits to bars and cafes.

In light of these result on frequency of visits to bars and cafes, it is not clear why alcohol consumption and time spent on cooking increased for those exposed to the ban, and not for those not exposed to the ban.

### 4.2.5 Population sub-groups

To examine whether the effects of the ban differ among population sub-groups, fixed effect models for the main outcome measures of smoking behaviour and self-reported health[11] are estimated, conditioned by gender, age and socio-economic status. The results (Table 4.6) provide evidence of heterogeneous effects of the introduction of the ban.

*Gender*

With respect to smoking prevalence (extensive margin), results of the baseline model show a marginally significant (significant at 10% level) effect of the introduction of the ban in increasing smoking prevalence among men, yet insignificant (insignificant at 10% level) effects for women. When conditioned on ban exposure, the model estimates show a statistically significant effect (significant at 5% level) of the introduction of the ban on increasing smoking prevalence for men not exposed to the ban, and insignificant

[11] It was not possible to estimate the models for diagnosed heart attack due to the very low numbers of observations which resulted in lack on variation in the control variables when models were conditioned on sub-groups.

(insignificant at 10% level) effects for men exposed to the ban and for women, both exposed or not exposed to the ban. These results suggest that the introduction of the ban lead to an increase in the smoking prevalence for men, especially for men not exposed to the ban, with no effects for women.

For smoking intensity (intensive margin), the estimated effects of the introduction of the ban in the baseline model are negative and highly significant for men (significant at 1% level), yet insignificant for women (insignificant at 10% level). When conditioned on ban exposure, the model estimates show a reduction in smoking intensity for men exposed to the ban but this is only marginally significant (significant at 10%), and a highly significant effect for men not exposed to the ban (significant at 1% level). These results suggest that the introduction of the ban may have reduced smoking intensity among men, especially men not exposed to the ban, with no effects for women.

Thus, for smoking behaviour overall, the evidence shows that smoking prevalence increased among men yet smoking intensity decreased among men. This seems to suggest that while more men have taken up smoking after introduction of the ban, men are smoking less cigarettes on average.

In terms of self-reported health, the estimated effects of the introduction of the ban in the baseline model show highly significant (significant at 1% level) improvements in health for women and significant (significant at 5% level) improvements in health for men. When conditioned on ban exposure, results show that health improvements are statistically significant (significant at 5% level) for men exposed to the ban and insignificant for men not exposed to the ban. In contrast, health effects for women are highly significant (significant at 1% level) for women exposed to the ban and insignificant for women not exposed to the ban. These results suggest that the introduction of the ban had a positive effect on health for both men and women. Furthermore, the results suggest that the effect of the introduction of the ban that are related to ban exposure are different for men and women. Alternatively, the results could simply be a reflection of the fact that there is a higher proportion of females in the not exposed group and a higher proportion of males in the exposed group.

In summary, when examining effects of the ban by gender, the results indicate that the introduction of the ban had an effect of increasing smoking prevalence (for men), reducing smoking intensity (for men) and improving health (both men and women), but that the mechanism driving the effects is not linked to ban exposure.

**Table 4.6 The effect of the ban on smoking behaviour and health, by gender, age and socio-economic status**

| | Smoking Prevalence | | | Smoking Intensity | | | Health | | |
|---|---|---|---|---|---|---|---|---|---|
| Outcome variable is BAN | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| **Gender** | | | | | | | | | |
| Male | 0.309* | 0.045 | 0.499** | -0.539*** | -0.480* | -0.584*** | 0.272** | 0.547** | 0.167 |
| | (0.077) | (0.863) | (0.039) | (0.001) | (0.056) | (0.008) | (0.037) | (0.030) | (0.275) |
| Female | 0.031 | 0.120 | -0.034 | -0.055 | 0.242 | -0.194 | 0.429*** | 0.306 | 0.465*** |
| | (0.859) | (0.677) | (0.877) | (0.717) | (0.378) | (0.289) | (0.000) | (0.234) | (0.001) |
| **Age categories** | | | | | | | | | |
| Aged 15-24 | 0.079 | 0.251 | -1.660 | 0.124 | 0.171 | -0.793 | 0.654* | 0.906** | -0.235 |
| | (0.828) | (0.521) | (0.173) | (0.751 | (0.683) | (0.539) | (0.052) | (0.027) | (0.725) |
| Aged 25-34 | -0.750** | -.945** | -0.628 | -0.243 | -0.247 | -0.007 | 0.221 | -0.584 | 0.565 |
| | (0.016) | (0.040) | (0.159) | (0.474) | (0.571) | (0.990) | (0.448) | (0.321) | (0.107) |
| Aged 35-44 | 0.527* | 0.790 | 0.433 | -0.412 | -0.286 | -0.442 | 0.286 | 0.242 | 0.339 |
| | (0.066) | (0.104) | (0.238) | (0.108) | (0.487) | (0.184) | (0.185) | (0.591) | (0.171) |
| Aged 45-54 | 0.635** | - | 0.519 | -0.299 | -0.608 | -0.149 | 0.215 | 0.279 | 0.185 |
| | (0.031) | - | (0.143) | (0.222) | (0.181) | (0.617) | (0.288) | (0.480) | (0.434) |
| Aged 55-64 | 0.439 | -0.032 | 0.515 | -0.029 | 0.897 | -0.159 | 0.640*** | 1.01** | 0.606*** |
| | (0.215) | (0.968) | (0.195) | (0.910) | (0.225) | (0.573) | (0.001) | (0.043) | (0.004) |
| Aged >64 | -0.006 | - | 0.274 | -2.07*** | - | -2.05*** | 0.135 | 0.843 | 0.074 |
| | (0.990) | - | (0.560) | (0.000) | - | (0.000) | (0.530) | (0.294) | (0.742) |
| **Socio-economic status** | | | | | | | | | |
| Low/ medium education | 0.518*** | 0.512* | 0.464** | -0.100 | 0.178 | -0.243 | 0.552*** | 0.843*** | 0.457*** |
| | (0.003) | (0.076) | (0.044) | (0.496) | (0.496) | (0.183) | (0.000) | (0.001) | (0.001) |
| High education | -0.166 | -0.216 | -0.141 | -0.544*** | -0.564** | -0.546** | 0.140 | -0.127 | 0.205 |
| | (0.342) | (0.426) | (0.542) | (0.001) | (0.036) | (0.015) | (0.276) | (0.639) | (0.163) |
| Low income | 0.508* | 0.383 | 0.439 | 0.084 | 0.529 | -0.275 | 0.449** | 0.473 | 0.421 |
| | (0.085) | (0.335) | (0.344) | (0.759) | (0.217) | (0.452) | (0.034) | (0.273) | (0.104) |
| Medium income | 0.095 | -0.106 | 0.189 | -0.362*** | -0.445** | -0.318** | 0.334*** | 0.377* | 0.319*** |
| | (0.501) | (0.655) | (0.290) | (0.004) | (0.037) | (0.041) | (0.001) | (0.084) | (0.005) |
| High income | 0.348 | - | - | - | - | - | - | - | - |
| | (0.679) | - | - | - | - | - | - | - | - |

Note: Waves 1 to 7 (2007 to 2013). Model for smoking prevalence is a fixed effect binary logit estimator, for the full sample population (extensive margin). Model for smoking intensity is a fixed effect ordered logit estimator, for the sample of smokers (intensive margin). Model for self-reported health is a fixed effect binary logit estimator where the dependent variable takes value 1 for good health and value 0 for poor health. Estimation of the model for diagnosed heart attack was not possible due to very low numbers of observations when this outcome measure was conditioned by sub-groups. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence. Estimates are missing where the number of observations was too small for the model to be able to estimated.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

*Age*

To determine effects by age, individuals were grouped into age categories according to the Dutch Central Bureau of Statistics classifications (as shown in Table 4.6).

For smoking prevalence in the baseline model, there is evidence of heterogeneity in effects according to age, with some age categories showing positive effects of the introduction of the ban and other age categories showing negative effects. This heterogeneity may explain why above in section 4.1.1 the baseline model that was not conditioned on age (see column 1 of Table 4.1) estimated no statistically significant effect on smoking prevalence. For age category 25-34 years, there is statistically significant (significant at 5% level) reduction in smoking prevalence, while for age category 45-55 years there is a statistically significant (at 5% level) increase in smoking prevalence. For all other age categories, effects are statistically insignificant (insignificant at 10% level). When conditioned by those exposed to the ban, there is a negative and statistically significant effect (significant at 5% level) for individuals of ages 25-34 years while for all other age categories, either exposed or not exposed, the effects are statistically insignificant (insignificant at 10% level). However, estimates for the exposed model for some age categories could not be estimated due to lack of observations/variation in variables. These results provide evidence that the introduction of the ban decreased smoking prevalence among 25-34 year olds, and this effect is related to ban exposure with only those exposed showing a significant effect.

With respect to smoking intensity, there is evidence of a negative and statistically significant (significant at 1%) effect on average daily cigarettes consumed only for individuals in the age group 65 years and older. When conditioned on ban exposure, this statistically significant (significant at 1%) reduction in smoking intensity remains for those not exposed to the ban, while the model could not be estimated for those exposed to the ban. These results suggests that the introduction of the ban had a significant effect in reducing smoking intensity only for individuals aged 65 and older, with a negative but not significant effect on smoking intensity among almost all other age categories (except 15-24 year olds).

In term of self-reported health, results show positive and highly statistically significant (significant at 1% level) effects of the introduction of the ban in the baseline model only for individuals aged 55-64. These effects remain significant for both exposed and not exposed groups in this age category, suggesting that the effects are not related to ban exposure. Also noteworthy is the health effects for the 15-25 age group. Health effects are positive and marginally significant (significant at 10% level) for these individual's, an effect which is stronger (significant at 5% level) for those exposed to the ban, and reverses to be negative but insignificant (insignificant at 10% level) for those not exposed to the ban. This result indicates that the introduction of the ban may have had positive health effects for 15-24 year olds that were related to being exposed to the ban.

*Socio-economic status*

To examine effects of the ban according to economic status, models were first conditioned on education and then conditioned on income separately. Together, the results of the estimated baseline models provide evidence that smoking prevalence increased for individuals of low socio-economic status given that those of low or medium education show a positive and highly statistically significant effect (significant at 1%) of the introduction of the ban, while the effect for those of high education is negative (albeit insignificant). There was no difference in effects between those exposed and not exposed to the ban, indicating that any significant effects of the introduction of the ban are not related to ban exposure. For smoking intensity, results provide evidence that individual of high socio-economic status reduced average daily cigarettes consumed by more than those of low socio-economic status as only individuals of high education and of medium income show negative and highly statistically significant (significant at 1% level) effects of the ban. These results for smoking behaviour are consistent with research on tobacco control policies which finds that reductions in smoking prevalence and smoking intensity over time are greater among those of higher socio-economic status.

In terms of effects on health, individuals of low education had a highly statistically significant (significant at 1% level) increase in health related to introduction of the ban, whereas the high education group had positive but insignificant effects. However, both the low and medium income groups had positive and significant improvements in health, more significant (significant at 1%) for the medium income group. Therefore it is not clear whether health effects differed among individual of low and high socio-economic status.

### 4.2.6 Summary of results

Overall, the results show no evidence of an effect of the ban on smoking prevalence but do provide strong evidence (effects significant at 1% level) that the introduction of the ban was associated with a reduction in smoking intensity and an improvement in health. However, the effects are not statistically significant for those exposed to the ban, indicating that the effect of the introduction of the ban on smoking intensity and health may not be linked to ban exposure. The results provide suggestive evidence (effects significant at 5% level) that the introduction of the ban had an effect of decreasing alcohol consumption, increasing drug consumption and increasing frequency of visits to bars and cafes, however again these effects were not related to exposure to the ban. There was no evidence of an effect of the introduction of the ban on sports activities and cooking.

Examining heterogeneous effects provides further insight. Smoking behaviour and lifestyle effects were only evident for men, while health effect were observable among men and women. Examining effects by age revealed that 25-34 years old decreased smoking prevalence and this was related to ban exposure with the effect only evident for those exposed to the ban. This provides evidence of the effects of the introduction of the ban working through the mechanism of ban exposure for this specific age sub-group. The observed reductions in smoking intensity at the population level appear to be significant only for individuals 65 years and older, while health improvements were significant only for 55-64 year olds. That said, there is suggestive evidence that the introduction of the ban improved health for individuals aged 15-24 who were exposed to the ban, indicating that the effect is related to ban exposure. Finally, results on socio-economic status provide evidence that reductions in smoking prevalence and smoking intensity were greater among high socio-economic status, and effects on health for were unclear.

Combining the results of the main analysis, and those by sub-groups, indicates that the effects of the introduction of the ban on smoking behaviour, health and lifestyle outcomes are limited. For example the reduction in smoking intensity was observable only for men and those above 65 years of age. Most importantly, the results demonstrate that the mechanism which is driving the effects of the introduction of the ban does not appear to be related to ban exposure, except for some very specific age groups. Explanations as to why this may be the case, and what the implications of this conclusion are, are presented in the discussion section of this study.

## 4.3 Robustness Checks

In this section, a set of robustness checks are described. The first set of robustness checks aimed to test the appropriateness of the fixed effect estimator. The second set of robustness checks aimed to test the way the dependent variables were defined in the models.

### 4.3.1 Model checks

*Varying the time period*

The models discussed in the above analysis section include individual observations for all available survey waves, 2007-2013. By having a multi-year time period, this allows the inclusion of a trend variable in order to capture changes that are common to both the treatment and control groups. Without allowing for a common trend, estimates of the effect of the introduction of the ban can be biased as they would include the general annual trend, and not only the effects of the introduction of the ban in the specific year. The longer the time period, the more years available for estimating the common trend. However, a drawback is that over longer periods of time, the likelihood that other policy changes occur or other factors change, increases. Thus there is a trade-off between having a time period long enough to account for a common trend, but short enough to keep all other factors fixed.

To check whether results were considerably different when examining shorter time periods, all models were re-estimated using only the pre ban and post ban survey waves (year 2007 and 2008/Waves 1 and 2), as well as for survey Waves 1-3, Waves 1-4, Waves 1-5 and Waves 1-6. In the pre and post model, the trend variable was removed due to perfect collinearity with the explanatory variable of interest, BAN, given that both variables increase by 1 from 2007 to 2008. In this case, age was added to the model as a proxy trend variable given that it increased by close to, but not exactly, 1 for all individuals due to the survey being completed in slightly different months in 2007 and 2008. In the models with successive survey waves, the trend variable was included instead of age. Re-estimating all models over various time periods did not considerably change the results.

In some estimations(see Table 4.7), the level of statistical significance increased of decreased slightly, but not enough to alter the previous conclusions. In addition, the effect of the ban on smoking intensity in the pre and post model is insignificant, while highly significant in all other models. Given that the pre and post model has only one year before and after, estimating the common trend precisely becomes very difficult and hence separating the effects of the time trend and the effect of the ban in such a model is problematic. Therefore, the fact that the pre and post model gives different conclusions than all other models for smoking intensity is not considered to be a concern.

**Table 4.7 Effects of the introduction of the ban using models over different lengths of time**

| | | Smoking Prevalence – Full Sample | | | Smoking Prevalence – Smokers in Wave 1 | | |
|---|---|---|---|---|---|---|---|
| Model | Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| All waves | BAN | 0.166 | 0.086 | 0.193 | -19.272 | -17.562 | -16.054 |
| | pvalue | (0.176) | (0.654) | (0.232) | (0.988) | (0.975) | (0.967) |
| Pre and post | BAN | 0.394 | -0.000 | 0.656 | - | - | - |
| | pvalue | (0.419) | (1.000) | (0.290) | - | - | - |
| Waves 1-3 | BAN | 0.249 | 0.621* | -0.062 | -30.900 | -45.424 | -27.634 |
| | pvalue | (0.275) | (0.078) | (0.838) | (0.989) | (0.992) | (0.992) |
| Waves 1-4 | BAN | 0.158 | 0.476* | -0.041 | -18.706 | -29.919 | -27.251 |
| | pvalue | (0.345) | (0.069) | (0.853) | (0.987) | (0.989) | (0.988) |
| Waves 1-5 | BAN | 0.136 | 0.169 | 0.117 | -17.387 | -31.277 | -18.009 |
| | pvalue | (0.344) | (0.448) | (0.541) | (0.975) | (0.989) | (0.987) |
| Waves 1-6 | BAN | 0.178 | 0.133 | 0.199 | -17.669 | -19.668 | -17.405 |
| | pvalue | (0.174) | (0.516) | (0.248) | (0.976) | (0.989) | (0.983) |

Note: Full sample represents the extensive margin. Smokers in Wave 1 represents successful quit attempts of smokers. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

| | | Smoking Intensity – Smokers | | |
|---|---|---|---|---|
| | Outcome variable | Baseline | Exposed | Not exposed |
| All waves | BAN | -0.260*** | -0.066 | -0.372*** |
| | pvalue | (0.008) | (0.686) | (0.002) |
| Pre and post | BAN | -0.300 | -0.039 | -0.415 |
| | pvalue | (0.366) | (0.937) | (0.369) |
| Waves 1-3 | BAN | -0.580*** | -0.439 | -0.669*** |
| | pvalue | (0.001) | (0.118) | (0.002) |
| Waves 1-4 | BAN | -0.659*** | -0.520* | -0.745*** |
| | pvalue | (0.000) | (0.072) | (0.001) |
| Waves 1-5 | BAN | -0.660*** | -0.436 | -0.792*** |
| | pvalue | (0.000) | (0.135) | (0.001) |
| Waves 1-6 | BAN | -0.721*** | -0.540* | -0.833*** |
| | pvalue | (0.000) | (0.068) | (0.000) |

Note: Fixed effect ordered logit estimator. Smokers represents the intensive margin, smoking intensity given that a person is a smoker. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

| | | Self-reported health | | | Diagnosed heart attack | | |
|---|---|---|---|---|---|---|---|
| Model | Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| All waves | BAN | 0.365*** | 0.416** | 0.346*** | -0.743*** | -0.833 | -0.724*** |
| | pvalue | (0.000) | (0.020) | (0.001) | (0.001) | (0.148) | (0.004) |
| Pre and post | BAN | 1.089*** | 0.981 | 1.127** | - | - | - |
| | pvalue | (0.005) | (0.147) | (0.018) | - | - | - |
| Waves 1-3 | BAN | 0.604*** | 0.524 | 0.625*** | -1.315*** | - | -1.236** |
| | pvalue | (0.000) | (0.134) | (0.001) | (0.003) | - | (0.012) |
| Waves 1-4 | BAN | 0.552*** | 0.748*** | 0.501*** | -0.952*** | -0.591 | -0.935*** |
| | pvalue | (0.000) | (0.003) | (0.000) | (0.003) | (0.468) | (0.007) |
| Waves 1-5 | BAN | 0.408*** | 0.576*** | 0.361*** | -0.854*** | -0.471 | -0.904*** |
| | pvalue | (0.000) | (0.007) | (0.002) | (0.002) | (0.495) | (0.002) |
| Waves 1-6 | BAN | 0.381*** | 0.521*** | 0.338*** | -0.842*** | -0.975 | -0.804*** |
| | pvalue | (0.000) | (0.007) | (0.002) | (0.001) | (0.119) | (0.003) |

Note: Fixed effect binary logit estimator. Self-reported health is a binary dependent variable that takes 1 for good health and 0 for poor health. Diagnosed heart attack is provided as a more objective health outcome measure and is a binary dependent variable that takes 1 if the individual reports that a doctor has diagnosed them with a heart attack or another heart problem. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level ($p<0.01$), ** Significant at 5% level ($p<0.05$), * Significant at 10% level ($p<0.1$)

*Conditioning by high ban exposure*

As outlined in section 3, ban exposure is defined based on an individual's frequency of bar and café visits, as reported in survey 1 whereby answers of 'never', 'about once a year' and 'a few times a year' take value 0 and answers of 'about once a month', 'a few times per month', 'once or twice a week' and 'almost every day' take value 1. To check if there are (stronger) effects for those individuals most frequently visiting bars and cafes, all models were re-estimated conditioned on high ban exposure whereby the variable *high ban exposure* is a binary variables taking value 1 for answers of 'once or twice a week' and 'almost every day', and 0 for answers of 'never', 'about once a year', 'a few times a year', 'about once a month' and 'a few times per month'. The estimated effect of the introduction of the ban when conditioned on those highly exposed to the ban was statistically insignificant (at the 10% level) in all models, for all outcome variables. This is likely due to the small number of individuals highly exposed to the ban which results in lack of power, and hence no conclusions from these results can be made (see Table 8.1in Appendix).

### 4.3.2 Variable checks

*Definition of logit dependent variables*

The dependent variables for smoking intensity uses the method proposed by Van Praag & Ferrer-i-Carbonell (2006). Using this method, a binary variable was defined that takes value 1 if the value in a given year is <u>higher than</u> the individual's mean value, and 0 if the value is <u>equal to or lower than</u> the individuals mean value for that variable. As a robustness check, the dependent variables was redefined to take value 1 if <u>equal or higher than</u> the individuals mean value, and 0 if <u>lower than</u> the individuals mean value. The model was re-estimated with the newly defined smoking intensity outcome measure and there were no differences in the estimated results (see Table 8.2 in Appendix).

*Definition of self-reported health*

The self-reported health outcome measure is a binary variable that takes value 1 for answers of 'good', 'very good' or 'excellent' health and value 0 for answers of 'poor' or 'moderate' health. Grouping answers in this way may have caused some of the variation in self-reported health to be lost. As such, an alternative self-reported health outcome measure was defined based on the method proposed by Van Praag & Ferrer-i-Carbonell

(2006). Based on the ordered- 5 scale range answers of health status, a binary variable was created that takes value 1 if an individual's health status is higher than their mean health status, and value 0 if an individual's health status is equal to or lower than mean health status. All models for self-reported health were re-estimated with the alternative definition of self-reported health and there were no changes in results (see Table 8.3 in Appendix).

*Definition of smoking intensity*

The dependent variable for smoking intensity is a binary variable, defined based on the method proposed by Van Praag & Ferrer-i-Carbonell (2006) that relates an individuals response in each year to their mean response over the full sample period to detect increases or decreases in individual behaviour. However, categorical variables require estimation of a logit model and therefore magnitude of effects cannot be estimated (only average marginal effects).

In order to estimate by how much (by how many cigarettes) individuals may have increased or decreased smoking intensity, a fixed effect linear model was estimated. The fixed effect linear model used the number of cigarettes smoked on average per day as the dependent variable, rather than the transformation of this into a binary variable as used in the fixed effect logit model. The estimates of the fixed effect linear model are presented in Table 4.8. As with the fixed effect ordered logit model (intensive margin), the estimates are negative, indicating a decrease in smoking intensity, and are statistically significant at the 1% significance level for the baseline model and the model conditioned on those <u>not</u> exposed to the ban. Therefore, the conclusions based on the fixed effect linear model are the same as those based on the fixed effect ordered logit model (Table 4.2).

With respect to magnitude, the effect of the introduction of the ban is estimated in the fixed effect linear model for the to reduce average daily cigarette consumption by 0.5 cigarettes in the baseline model and 0.8 cigarettes for those not exposed to the ban, ceteris paribus (significant at 1% level). The estimated effect of the introduction of the ban for those exposed to the ban is small (0.2 cigarettes) and is statistically insignificant (insignificant at 10% level).

**Table 4.8 Linear fixed effect model: smoking intensity**

| | Intensive Margin Smoking Intensity | | |
|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed |
| BAN | -0.592*** | -0.186 | -0.800*** |
| pvalue | (0.007) | (0.476) | (0.009) |
| Observations | 4,785 | 1,712 | 3,073 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect linear estimator. Model estimates the effect of the introduction of the ban on the average daily number of cigarettes consumed by smokers. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

Therefore, all robustness checks on dependent variables confirmed the results presented in the main analysis.

# 5 Discussion

The results of the empirical analysis provide evidence that the introduction of the Dutch hospitality ban had an effect on smoking intensity and health. However, the results do not show evidence that the effect on smoking behaviour and health outcomes was related to exposure to the ban. This could be for a number of reasons, including identification issues (section 5.1), confounding factors (section 5.2) or other considerations (section 5.3).

## 5.1 Identification issues

As discussed throughout this study, the identification of the effect of the smoking ban on the various outcome measures comes from distinguishing treatment and control groups according to ban exposure, determined by how often individuals visited bars and cafes in the pre ban year. As such, it is crucial that; 1) the effect of the ban translates to individual behaviour through the mechanism of ban exposure, 2) individuals in the exposed group were actually exposed to the smoking ban, and 3) individuals in the not exposed group were not exposed to the ban. However, each of these requirements may not be met.

Firstly, it could be that the mechanism through which the effects of the ban translate to individual behaviour is not related to ban exposure. For example, it is easy to imagine that the action by government to introduce a ban on smoking in the hospitality industry could send a strong public message of the dangers of smoking for smokers and for non-smokers. In response, individuals may reduce smoking in and outside of the home, and try to quit or cut down on the number of cigarettes smoked, either for their own health or the health of their own friends and family. Their decision to do so may have absolutely nothing to do with how frequently they go out to bars and restaurants. In this scenario, the ban effects both groups, those exposed and those not exposed to the ban.

Secondly, those in the exposed group may not have been exposed to the ban. Full compliance to the hospitality industry smoke-free legislation was never achieved. Particularly small bars had low compliance levels. Compliance was low even from first introduction of the ban on 1 July 2008 due to the existence of a three month grace period, within which venues in violation of the legislation were only warned (Nagelhout et al., 2011). Allowing for the three month grace period from July 2008, this means the ban may only have been effectively introduced for one or two months before individuals completed Wave 2 of the LISS panel Health Survey in November and December of the same year, 2008. In addition, the hospitality smoke-free legislation allowed for enclosed smoking rooms on the condition that no food or drinks were served in these rooms (Gonzalez and Glantz, 2011). The implication of these factors is that some smokers may have retained the ability to smoke indoors, and therefore may not have actually been exposed to the ban post its introduction.

Furthermore, between July 2009 and March 2010 the smoke-free legislation was temporarily suspended for small bars without employees as a result of court proceedings over whether the laws (which were aimed at protecting employees from environmental tobacco smoke) were discriminatory for small owner-run bars that did not have employees (Nagelhout et al, 2011b). Despite the court ruling in March 2010 that the law was not discriminatory, in November 2010 the Dutch government announced a plan to exempt small bars and no longer enforced the smoking ban for small bars without employees (Rijksoverheid, 2010). In July 2011 the exemption to the smoking ban officially came into effect for small bars (smaller than 70$m^2$) without employees[12]. Compliance lowered not only for the small bars, but for bars in general as a result. Following a Supreme Court decision in October 2014 that the exception for the small bars should not be considered binding, enforcement of the smoke-free legislation in small bars was reinstated and the exemption was officially removed as of 1 January 2015, in effect re-establishing comprehensive smoke-free legislation (Heijndijk & Willemsen, 2015). However, the reinstatement of the ban takes place outside the period of the survey data available and used in this study.

The low compliance with the ban, the combination of a grace period and lack of enforcement, the provision for enclosed smoking rooms and the later exemption for small bars, may mean that those individual whom frequently visited bars and cafes were not in reality ‘exposed’ to the smoking ban, or at least to a lesser degree, and hence may not differ substantially from those individuals in the sample that did not frequently

[12] Besluit van 14 juni 2011, houdende wijziging van het Besluit uitvoering rookvrije werkplek, horeca en andere ruimten.

visit bars and café. If this is the case, this provides an explanation for the lack of significant effects of the ban when conditioning by ban exposure.

Thirdly, it may be the case that those in the not exposed group were actually exposed to the ban. The question used to identify the exposed and not exposed groups; *How often do you go to a bar or café?* is quite specific with regards to the type of hospitality venues. The question refers only to bars and cafes, which to Dutch survey respondents, would not typically include restaurants, other dining places or clubs. As such, an individual who frequently visits restaurants, but who does not frequently go out to bars and cafes, would likely answer the question as ´never´ or ´a few times a year´. Hence such individuals would be classified in the not exposed group, despite being exposed in actuality as they frequently visit restaurants. Given that compliance to the smoking ban was highest in restaurants and other hospitality venues with dining, and lowest in bars, it could be the case that individuals in the not exposed group are in reality, more exposed than some individuals in the exposed group. On the other hand, it could be argued that those who go out frequently to bars and cafes, also go out frequently to restaurants. If this is a credible argument, the identification strategy would not be compromised. This however is not a highly reliable assumption. Thus, it must be acknowledged that some individuals in the not exposed group may have in fact been exposed to the ban.

Given the concerns over the identification strategy outlined above, it may be that the exposed and not exposed groups in the empirical analysis are not adequate treatment and control groups. Instead the two groups may simply be a collection of individuals with slightly different characteristics based on frequency of bars visits. Descriptive statistics showed that in this sample, those who go to bars more often are typically younger, and more often male, mirroring findings in other studies that use frequency of bar visits to identify treatment and control groups (Nagelhout et al., 2011; Anger et al. 2011, Mazzonna and Salari, 2015). Thus results for the exposed and not exposed groups may be reflective of gender and age differences rather than ban exposure.

## 5.2 Confounding factors

Estimations of the effects of the ban on smoking and health outcomes can only be interpreted as causal effects provided that all other factors remained fixed, i.e. the ceteris paribus assumption. If it is the case that other factors did not stay fixed over the sample period, a causal interpretation of the effect of the ban is not possible, but only an association can be drawn. One crucial factor that changed at the same moment of introduction of the ban, was other tobacco control policies. From 1 July 2008, The Netherlands government simultaneously introduced three population-level tobacco control interventions; a ban on smoking in hospitality venues, an increase in the tax on tobacco and funding up until 2011 for a quit smoking media campaign (Nagelhout et al., 2012). This study aimed to separate out the effects of the smoking ban from the other tobacco control policies in order to determine if the ban had an effect on smoking or health outcomes.

The empirical approach employed attempted to achieve this separation of effects by comparing individuals more and less exposed to the ban, an approach undertaken in other studies (Anger et al., 2011; Nagelhout et al., 2011; Verdonk-Kleinjan et al., 2009). It is important to realise that the primary explanatory variable BAN, that for which the models estimate, is a variable that simply represents the year of introduction of the smoking ban. In the baseline model, which is not conditioned on ban exposure, any other factors that changed in the same year in which the ban was introduced and had an effect on smoking behaviour or health, will inherently be included in the estimation of the effects of the BAN variable. In presentation of the results above, a statistically significant effect for this variable was interpreted as an effect of introduction of the ban. However, the finding of statistically significant effects in the baseline models for smoking intensity and health, but no evidence of effects when conditioned by exposure to the ban, may indicate that it is not the effects of the ban that are being estimated in the baseline models, but the effect of one or a combination of the other tobacco control policies. This it may be that the other factors occurring in the same year the ban was introduced are those which are primarily driving the statistically significant results.

Another factor that changed considerably during the sample period is the economic conditions. The financial crisis occurred in mid 2008 followed by the European banking crisis in subsequent years, resulting in a recession in European countries including the Netherlands. It is generally acknowledged that smoking behaviour is pro-cyclical (Ruhm, 2005 and 2007) and hence the estimated reductions in smoking intensity associated with the ban year, the same year in which the recession began, may not be related to tobacco policies at all but to economic conditions. However, the fact that health status showed positive improvements does not seem to support such a theory as one may expect people to also report worse health in hard economic times.

Another consideration for smoking behaviour and health outcomes is seasonal effects. In winter, people are likely to spend a greater amount of time indoors. People may thus smoke less during winter due to less smoking opportunities. Similarly, people may report poorer health in winter compared to summer due to the high occurrence of colds and flus and more depressive weather. Given that the survey is asked in November and December of each year, the early months of winter in the Netherlands, seasonal variation due to differences in timings of survey responses is mitigated. There could be some seasonal effects if one winter is particularly severe compared to other years, however the effects of such variations are considered to be quite small.

## 5.3 Other considerations

It is very important to acknowledge that part of the reason for different results for those exposed and not exposed to the ban may be due to unobserved differences across both groups. These unobserved difference may affect how each group responds to the ban. Given that there are clear observable differences between both groups (as discussed in descriptive statistics and shown in Table 3.1), it is not unlikely that unobservable characteristics also differ between the two groups. Where unobservable differences are time-invariant, these are adequately controlled for by using the fixed effect estimator. However, if the unobservable differences are time-variant, then this may influence the results. Therefore, it may be difficult to determine whether differences in results between exposed and not exposed groups are due purely to the difference in exposure to the ban, or due to differences in their unobservable, time-variant characteristics.

# 6 Conclusion

This study on the effects of the Dutch hospitality smoking ban on smoking behaviour and health found no evidence of a causal effect of the smoking ban on smoking prevalence, smoking intensity or self-reported health. However, the lack of statistically significant effects for those exposed to the ban does not necessarily provide a normative result, that is, it does per se establish that the smoking ban was ineffective in changing smoking behaviour and health. Instead, the absence of statistically significant effects for those exposed to the ban may be due to limitations in the empirical approach or due to low compliance and the less than comprehensive nature of the smoking ban. The results of the analysis do suggest that smoking intensity reduced and health status improved in the year that the ban was introduced for both those exposed and not exposed to the ban, possibly suggesting an effect from the tobacco policies that were introduced simultaneously to the hospitality smoking ban. Even so, the effects on smoking intensity and health were small and short term.

Furthermore, results support other research findings that there may be heterogeneous effects of a smoking ban that are masked when only examining population level effects. This study finds evidence of an effect of the hospitality smoking ban on reducing smoking prevalence for 25-34 year olds, and on improving health outcomes for 15-24 years olds. At the population level, reductions in smoking intensity were evident for men and not for women, while improvements in health were observed for men and women.

There are a number of limitations with this study. There are possibly problems in the identification strategy used to define the proxy treatment and control groups of individual exposed to the ban and individuals not exposed to the ban. One such issue is the low compliance of bars and cafes to the hospitality smoking ban. Another is that exposure to the ban (treatment and control) was determined based on a survey question about frequency of bar and cafe visits, a question that did not include reference to restaurants of other hospitality venues such as hotel and clubs. This could mean that the exposed and not exposed groups are not a true representation of actual exposure to the ban and hence could explain the reason for the lack of significant effects among those exposed to the ban. Alternatively, the lack of significant effects could be a result of low power due to small numbers of observations for the exposed group in some estimations.

A further limitation of this research is that the dataset contains data only one year prior to the ban coming into effect. This is problematic because it makes it difficult to estimate pre-existing trends in smoking behaviour or health outcome and thus the separation of effects of the ban from the time effects may be less precise. Finally, general limitations with survey data, particularly self-reported data, must be acknowledged. Similarly, due to the fact that some smokers only quit temporarily, the information about smoking status may be prone to measurement error resulting from on-and off smoking. However, information from multiple periods helps to distinguish more clearly between smokers and non-smokers.

Directions for future research within the Netherlands could be to obtain a dataset with multiple years before and after introduction of the ban, and to examine any differences in effects for smokers versus non-smokers, and smokers versus heavy smokers. To improve the reliability of the dependent variables for health and smoking prevalence, objective rather than self-reported measures could be used, if available. For example biological samples instead of self-reported smoking status, and incidence of AMI instead of self-reported diagnosed heart attack. However, the low compliance of hospitality venues to the ban and the fact the there were other tobacco control policies introduced simultaneously to the ban, are going to continue to be methodological stumbling blocks in evaluating the Dutch hospitality smoking ban. Given that the Dutch policy context does not provide a natural experiment for evaluation of the smoking ban, further research on the effects of smoke-free legislation may be better directed towards countries other than the Netherlands where a strong and credible empirical methodology can establish causal effects. Research that uses a robust difference-in-difference strategy and takes advantage of timing differences in implementation of bans across states or regions within one country remain the most credible avenue for further research.

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# 8 Appendix

**Table 8.1 Effects of the ban, conditioned by high ban exposure**

| Outcome variable | Full sample Smoking Prevalence | | | Smokers in Wave 1 Smoking Prevalence | | |
|---|---|---|---|---|---|---|
| | Baseline | Highly Exposed | Not highly exposed | Baseline | Highly Exposed | Not highly exposed |
| BAN | 0.166 | 0.040 | 0.186 | -19.272 | -34.777 | -18.168 |
| pvalue | (0.176) | (0.908) | (0.158) | (0.988) | (0.993) | (0.982) |
| Observations | 3,412 | 389 | 3,023 | 2,225 | 241 | 1,984 |

| Outcome variable | Smoking Intensity | | | Self-reported health | | |
|---|---|---|---|---|---|---|
| | Baseline | Highly Exposed | Not highly exposed | Baseline | Highly Exposed | Not highly exposed |
| BAN | -0.260*** | 0.487** | -0.370*** | 0.365*** | 1.050*** | 0.320*** |
| pvalue | (0.008) | (0.072) | (0.000) | (0.000) | (0.003) | (0.000) |
| Observations | 3,816 | 458 | 3,358 | 6,774 | 400 | 6,374 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect logit models. Smoking prevalence full sample represents the extensive margin. Smoking prevalence for smokers in Wave 1 represents successful quit attempts of smokers. Smoking intensity represents the intensive margin, smoking intensity given that a person is a smoker. Self-reported health is a binary dependent variable that takes 1 for good health and 0 for poor health. Baseline model is without any conditioning on ban exposure, highly exposed model is conditioned on individuals highly exposed to the ban and not highly exposed model is conditioned on individuals not highly exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

**Table 8.2 Effects of the ban, robustness checks on definition of logit dependent variables**

| | Smokers Smoking Intensity | | | Smokers Smoking Intensity - Check | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | -0.260*** | -0.066 | -0.372*** | -0.236** | -0.074 | -0.332*** |
| pvalue | (0.008) | (0.686) | (0.002) | (0.015) | (0.650) | (0.007) |
| Observations | 3,816 | 1,328 | 2,488 | 3,816 | 1,328 | 2,488 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect ordered logit estimator. Smokers represents the intensive margin, smoking intensity given that a person is a smoker. Dependent variable in column 1 represent if individuals increased their cigarette consumption, while column 2 represents if individuals increased or kept the same their cigarette consumption. Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level (p<0.01), ** Significant at 5% level (p<0.05), * Significant at 10% level (p<0.1)

**Table 8.3 Effects of the ban, alternative self-reported health dependent variable**

| | Self-reported health | | | Alternative Self-reported health | | |
|---|---|---|---|---|---|---|
| Outcome variable | Baseline | Exposed | Not exposed | Baseline | Exposed | Not exposed |
| BAN | 0.365*** | 0.416** | 0.346*** | 0.197*** | 0.212** | 0.186*** |
| pvalue | (0.000) | (0.020) | (0.001) | (0.000) | (0.029) | (0.003) |
| Observations | 6,774 | 1,551 | 5,223 | 16,629 | 4,676 | 11,953 |

Note: Waves 1 to 7 (2007 to 2013). Fixed effect binary logit estimator. Self-reported health is a binary dependent variable that takes 1 for good health and 0 for poor health. Alternative self-reported health is an ordered logic variable that uses a scale of health from 1 (poor) to 5 (excellent) and is then transformed according to the methods proposed by Van Praag and Ferrer-iCarbonell (2006). Baseline model is without any conditioning on ban exposure, exposed model is conditioned on individuals exposed to the ban and not exposed model is conditioned on individuals not exposed to the ban. Models include a time trend and control for education, income, domestic living situation and urban character of place of residence.

*** Significance at 1% level ($p<0.01$), ** Significant at 5% level ($p<0.05$), * Significant at 10% level ($p<0.1$)