The impact of public smoking bans on well-being externalities: Evidence from a policy experiment

Words (main text): 6846

Abstract

Recent studies on the effects of anti-smoking policies on subjective well-being present mixed results and do not account for potential externalities, especially among couples. We contribute to the literature by evaluating the impact of smoking bans on well-being externalities among smokers and non-smokers as well as couples of different types of smokers. We exploit the policy experiment provided by the timing of the UK public smoking bans and measure well-being via the GHQ. We employ matching techniques combined with flexible difference-in-differences fixed effects panel data models on data from the British Household Panel Survey. The joint use of matching methods with fixed effects specifications allows building more comparable treatment and control groups, producing less model-dependent results and accounting for individual-level unobserved heterogeneity. We find that public smoking bans appear to have a statistically significant short-term positive impact on the well-being of married individuals, especially among women with dependent children. These effects appear to be robust to alternative specifications and placebo tests and are discussed in the light of the economic theory and recent evidence.

JEL: C21; C23; I10; I18

Key words: subjective well-being; smoking bans; policy evaluation; BHPS

Acknowledgments: We would like to thank Bruce Hollingsworth, Andrew Jones, Giuseppe Migali, Luigi Sedda, Ian Walker, members of the Health Economics at Lancaster (HEAL) Research Group, Lancaster University (UK), and participants to seminars at the University of York (UK), for helpful discussions. We also wish to thank two anonymous referees for their useful feedbacks.

1. INTRODUCTION

Smoking is still the leading cause of avoidable mortality and morbidity in all developed countries and a growing public health concern among developing countries. According to the WHO Report on the Global Tobacco Epidemic (2013), smoking is directly linked to 6 million deaths every year worldwide. The 32rd Surgeon General's Report on Smoking and Health (US Department of Health and Human Services, 2014) finds that smoking increases the risk of cancer (e.g. lung, liver and colorectal cancers), respiratory infections (e.g. chronic obstructive pulmonary disease (COPD) and tuberculosis) and cardiovascular diseases. The same report also finds that women's risk of dying from smoking has tripled during the last 50 years and is now equal to men's risk; tobacco smoke causes 8 out of 10 cases of COPD; and that maternal smoking and exposure to second-hand smoke reduces fertility and is linked to pregnancy complications, low birth weight and sudden infant death syndrome (SIDS).

During the last two decades, tobacco-control policies such as smoking bans and increases in excise taxes have been implemented with the aim of reducing the effects of both second-hand smoke (SHS) and cigarette consumption. A large body of empirical research has analysed the impact of anti-tobacco policies. These studies mainly focus on the effects of tobacco-control interventions on passive smoking (Farrelly et al., 2005; Pearson et al., 2009); self-assessed health (Wildman and Hollingsworth, 2013, Kuehnle and Wunder, 2017); specific health conditions such as pulmonary disease (Menzies et al., 2006; Goodman et al., 2007) and myocardial infarction (Sargent et al., 2004; Seo and Torabi, 2007); as well as active smoking (cigarette consumption) (Anger et al., 2011; Jones et al., 2013) .[1] Overall, these suggest that smoking bans appear to reduce both exposure to SHS and the incidence of acute myocardial infarction, while also increasing general self-assessed health among non-smokers. However, their effects on tobacco consumption appear to be limited to specific population sub-groups

[1] For a comprehensive review of studies on the effects of partial and total smoking bans on second-hand smoke (in both public and private places such as cars and private homes), tobacco consumption and a number of health conditions, see Callinan et al. (2010).

such as individuals who often go to bars and restaurants or heavy smokers (Anger et al., 2011, Irvine and Nguyen, 2011, Jones et al., 2013). Whereas these papers focus on the direct consequences of anti-smoking policies on smoking behaviour and physical health, they do not appear to account explicitly for the presence of potential externalities on important measures of individual welfare such as subjective well-being (SWB).[2]

SWB and its measurement are now central to public policy as a number of governments worldwide are increasingly concerned with the use of well-being measures to inform and appraise policy interventions (Dolan and Metcalfe, 2012). Expected potential gains and losses of SWB could be employed as an additional tool to rank policy options across different domains or aid the allocation of resources towards policies with the largest expected improvements in SWB relative to their costs (Dolan and White, 2007; Dolan and Metcalfe, 2008) .

While an emerging stream of research has started examining the impact of smoking bans on SWB, results still appear to be mixed. Brodeur (2013) employs US data and finds that smokers who do not quit smoking after the introduction of smoking bans appear to present higher levels of life satisfaction. The author suggests that this may imply that current smokers are time-inconsistent and might benefit from anti-smoking policies. Odermatt and Stutzer (2013) use data from forty European countries and also suggest that smokers who would like to quit smoking report higher levels of life satisfaction after the implementation of smoking bans. However, they do not find significant effects of smoking bans on SWB. Hinks and Katsaros (2010) employ UK data and find that smokers who reduce their intake of cigarettes

---

[2] A related strand of research has focused on the potential unintended consequences of anti-smoking interventions. Adams and Cotti (2008) find that in the US local and state public smoking bans may increase the risk of fatal car accidents due to drunk driving by leading smokers to drive longer distances to reach bars in neighbouring jurisdictions allowing them to smoke. Using biomarkers (cotinine) for tobacco intake, Adda and Cornaglia (2010) show that by displacing smokers from public to private places, public smoking bans may increase the exposure to passive smoking of young children living with smokers. A subsequent study of Carpenter et al. (2011) employing self-reported data on smoking, however, find limited evidence of smoking bans causing displacement from public to private places.

after the ban report significantly lower levels of life satisfaction if compared to individuals who did not reduce their amount of tobacco intake (and smoked the same pre-ban amount of cigarettes). Leicester and Levell (2016) also exploit UK data and find that while tobacco excise taxes increase smokers' well-being, the impact of smoking bans appears to be weaker. Overall, these papers tend to overlook potential intra-household well-being externalities and appear to present conflicting results.[3] Furthermore, most of these studies do not appear to fully exploit the longitudinal nature of their data and do not explicitly account for the presence of individual-level unobserved heterogeneity.

The main objective of this paper is to evaluate the intra-couple well-being externalities of public smoking bans among couples of different types of smokers. We employ UK longitudinal data from the British Household Panel Survey (BHPS) and exploit the policy experiment provided by the differential timing of the introduction of public smoking bans in Scotland and England. We combine matching techniques with a series of flexible difference-in-differences fixed effects panel data models to estimate the impact of public smoking bans on the subjective well-being of smokers, non-smokers and couples of different types of smokers. We find that the UK public smoking bans appear to have a positive and statistically significant short-term effect on the well-being of married individuals, especially among women with dependent children. These effects appear to be robust to alternative specifications and placebo tests. Our results appear to suggest that public smoking bans may produce short-term positive externalities by increasing the subjective well-being of individuals in couples with dependent children, especially women. We discuss and interpret these results also in the light of the economic theory and recent evidence.

This paper provides several contributions to the literature. First, we build upon and extend previous analyses on the impact of smoking bans by focusing on well-being *externalities*. To

[3] It might be argued that some of the measures of overall life satisfaction used in these studies may indirectly account for potential intra-household externalities. However, previous studies do not seem to focus on well-being externalities, especially among couples.

the best of our knowledge, this is the first paper that focuses on bans driven well-being externalities among couples of smokers and non-smokers by employing a policy experiment. Secondly, we combine matching methods with difference-in-differences to build more comparable treatment and control groups, produce less model-dependent results and thus increase the reliability of our identification strategy. Finally, we employ panel data fixed effects models to account for individual-level time-invariant unobservables and exploit the longitudinal nature of the BHPS.

2. ECONOMIC THEORY AND SMOKING BANS

There are several potential mechanisms through which anti-smoking policies might have an impact on well-being. Standard economic models of tobacco consumption suggest that smoking decisions are the result of utility maximising behaviour. According to the seminal model of rational addiction (Becker and Murphy, 1988), smokers rationally maximise their utilities by trading off the long-run detrimental health effects with the immediate pleasure of smoking. Hence, this model appears to predict that smoking bans should decrease smokers' SWB by reducing the number of places in which they are allowed to smoke. The rational addiction model has also been extended to account for smokers' learning and regret (Leicester and Levell, 2016). For example, Jehiel and Lilico (2010) suggest that individuals may decide to smoke when young because of limited foresight and reduce or quit smoking once they have acquired a better foresight through learning as they age. However, this does not appear to fully explain why a number of adults may fail to give up smoking when they express a preference to do so or employ mechanisms to enhance self-control such as nicotine-replacement treatments (Amador and Nicolás, 2013).

More recent studies argue that smokers could make time-inconsistent decisions by placing more weight on short-run utility rather than long-run negative effects of smoking (Gruber and

Mullainathan, 2005). As a result, smokers might have decided to quit smoking and yet fail when they attempt to do so. In this case, smoking bans could act as a self-control device and potentially make smokers better off by helping them to quit smoking or reduce cigarette consumption (Gruber and Koszegi, 2000, Gruber and Koszegi, 2002). This may imply that individuals could benefit from mechanisms of self-control that might help them reconciling the divergence between planned for and actual decisions. According to this interpretation, smoking bans could therefore increase SWB among smokers attempting to quit.

Another stream of studies suggests that within-family altruism may play a role on the impact of smoking bans on well-being. According to Becker (1981), altruism is likely to dominate intra-family behaviours, and altruistic individuals derive utility from the well-being of other family members, including children.[4] Interestingly, smoking mothers are also found to be altruistic and to value their children's health more than their own (Agee and Crocker, 2007). Furthermore, some studies employ subjective well-being to measure altruism within family and find that children's health and well-being have a positive impact on their parents' life satisfaction (e.g. Schwarze, 2004; Bruhin and Winkelmann, 2009). Therefore, in the presence of anti-smoking policies and despite their smoking status, altruistic parents might also experience an increase in SWB because of the potentially reduced exposure to second-hand smoke in public places of their children.

Based on the above mechanisms and evidence, it may be argued that smoking bans might not only have a direct effect on the well-being of smokers, but could also impose indirect effects through well-being externalities on individuals living with smokers. Overall, given the potentially countervailing effects of smoking bans on SWB suggested by the economic theory, we argue that it is important to establish their net welfare effects empirically.

[4] Other studies analyse how parents allocate health-protective goods between themselves and their pre-teenage children living at home. Overall, they suggest that parents can be altruistic toward their young children, especially concerning health and exposure to environmental risks (e.g. Liu et al., 2000; Dickie and Ulery, 2001; Dickie and Messman, 2004; Dupont, 2004; Dickie and Gerking, 2007).

3. DATA

3.1 THE BRITISH HOUSEHOLD PANEL SURVEY

We draw individual-level information on smoking consumption and subjective well-being before and after the introduction of the UK public smoking bans from the British Household Panel Survey (BHPS). Two identical comprehensive public smoking bans were introduced on 26th March 2006 in Scotland and 1st July 2007 in England. These were the first binding laws (i.e. before these bans no fines could be levied for smoking in public places) in the UK to forbid smoking in *all enclosed public places* such as pubs and restaurants and were enforced immediately after their introduction. In our data, the ban in Scotland was introduced between waves 15 and 16 of the BHPS while the one in England between waves 16 and 17.[5]

More specifically, we exploit the variation provided by the differential timing of the introduction of these policies in the BHPS to identify the impact of Scottish ban on subjective well-being. Accordingly, we make use of data up to wave 16 (collected between 1st September 2006 and 3rd of April 2007, i.e. before the English ban) in order to employ Scotland and England as treatment and control groups respectively, and prevent contamination of the control group.[6]

[5] Seven respondents were interviewed in wave 15 after the imposition of the Scottish ban (26th March 2006) and were removed from our sample while in wave 16 all individuals were interviewed before the implementation of ban in England (1st July 2007). Therefore, in our analysis waves 15 and 16 represent the pre- and post-ban periods in Scotland respectively whereas waves 16 and 17 are pre- and post-ban periods in England. Note that although other tobacco control policies have been recently introduced in the UK, they are unlikely to have an impact on this study as they were implemented after the time period considered in this study. For example, since 1st October 2007 it is illegal to sell tobacco products to anyone under the age of 18 (previously 16) and picture warnings were introduced in October 2008 on cigarettes packs. Since our analysis only employs data until 3rd of April 2007 and our sample solely includes respondents who are 18 years old or above, these policies do not appear to be able to influence our identification strategy. Furthermore, this policy experiment has been exploited before in the empirical literature, e.g. Adda et al. (2007; 2012) and Wildman and Hollingsworth (2013).

[6] To be specific, we employ a sample of adult individuals from England and Scotland from wave 9 (1999) to wave 16 (2007). This is to exploit the additional sample of Scottish households included in wave 9. However, results based on the full set of waves are similar and available upon request.

[6] To be specific, we employ a sample of adult individuals from England and Scotland from wave 9 (1999) to wave 16 (2007). This is to exploit the additional sample of Scottish households included in wave 9. However, results based on the full set of waves are similar and available upon request.

The BHPS is a UK nationally representative panel survey that includes a wide range of variables on demographic and household characteristics, income, job status, health, subjective well-being and smoking behaviour. Wave 1 sample (1991) includes 5,500 households and 10,264 individuals from England, Wales and Scotland at the south of the Caledonian Canal. In wave 9, additional samples of 1,500 households from each of Scotland and Wales were added to the main sample while in wave 11 a sample of of 2000 households from Northern Ireland was also added (Buck et al., 2006).[7] Household members are followed through time and interviewed annually together with individuals that enter the sample as they move into the household after the start of survey. In this paper, we restrict the sample to adult members (aged 18 years or above) from England and Scotland.

3.2 Measures of subjective well-being

We employ the 12-item version of the General Health Questionnaire (GHQ) to define individual SWB (Goldberg and Williams, 1988). The GHQ is a psychometrically-validated and well-established measure of SWB that is often used in the economic literature (e.g. Clark and Oswald, 1994; Clark, 2003; Shields and Price, 2005; Gardner and Oswald, 2006; Gardner and Oswald, 2007; Dolan et al., 2008; Andersen, 2009; Binder and Coad, 2011) . More specifically, the GHQ is a summary measure of psychological distress based on 12 questions concerning both positive and negative recent emotional experiences (Gardner and Oswald, 2007).[8] In this study, we use the GHQ measured on the Likert scale with values ranging from 0 to 36 (computed by taking the sum of the responses to the 12 questions and assigning

[8] The 12-item version includes questions on: concentration; loss of sleep; playing a useful role; being capable of making decisions; being constantly under strain; having problems overcoming difficulties; enjoying day-to-day activities; ability to face problems, unhappiness/depression; losing confidence; believing in self-worth; and general happiness. For each item/question, respondents are asked to choose between four answers ranging from 1 to 4, with higher scores reflecting lower levels of well-being. Therefore, higher scores of the GHQ reflect lower levels of SWB. An example of the GHQ question is as follows: "Have you recently been able to concentrate on whatever you're doing?" followed by the answers "Better than usual (1)", "same as usual (2)", "less than usual (3)" and "much less than usual (4)".

values of 0 to the ones corresponding to the highest levels of well-being and 3 to the ones corresponding to lowest levels of well-being). The resulting measure is a summary index of well-being that is increasing in psychological distress: higher GHQ values correspond to lower levels of well-being.[9]

Since our main objective is to identify variations in well-being driven by smoking bans within a relatively short period of time, the use of the GHQ appears to be appropriate as it is often employed to define short-term fluctuations of emotional distress (for a discussion see Powdthavee and van den Berg, 2011). More general measures of "total" or "global" well-being such as life satisfaction might be less prone to detect temporary affective changes.[10] Furthermore, we exploit intra-couple information on well-being to define externalities. More specifically, we focus on changes in well-being among spouses of different types of smokers since we expect externalities to be more relevant for these sub-groups of individuals.

3.3 COVARIATES AND DESCRIPTIVE STATISTICS

The BHPS contains rich information on demographic and socioeconomic individual-level characteristics that we include in our panel data models. Our models control for age (age and age squared); gender (by estimating separate models for men and women); employment status (self-employed, unemployed; retired; family care; student; long-term sick/disability status; government training or in other jobs; all contrasted against being employed as an employee); marital status (by estimating separate models for individuals married or in a

[9] We have also estimated models using the 12 items from the GHQ separately. Results are available upon request.

[10] We have also considered the use of a measure of life satisfaction in an earlier version of the paper. However, this measure is only present in selected waves of the BHPS, leading to small sample sizes of treated individuals for most of the sub-samples employed in our analysis. This produced imprecise point estimates with large standard errors.

couple vs single/divorced/widowed); and household related variables including household size and the number of dependent children living within the household (if present).[11]

In the BHPS, information on smoking prevalence and intensity is based on the questions "Do you smoke cigarettes?" and "Approximately, how many cigarettes a day do you usually smoke?", respectively. For the purpose of our analysis, we define two types of individuals: potential smokers and never smokers. Potential smokers are individuals who report being a smoker at least once during the survey period (i.e. individuals who answered "yes" to the question on smoking prevalence at least once). Never smokers are defined as individuals who always reported being non-smokers throughout the entire period of the survey. Our definition of potential smokers allows us to go beyond current smoking status that might be affected by the introduction of the smoking bans while also including individuals with a propensity to smoke. Robustness checks provide key results for alternative definitions of smokers.

Table 1 presents summary statistics of the main variables in our analysis. These variables are presented for males and females separately. Since our analysis will focus on the effects of smoking bans on intra-couple well-being externalities, descriptive statistics are both presented for the overall unmatched sample (i.e. married and single individuals together) and are broken down by marital status (married/living with a partner vs unmarried/single).[12] Overall, there is a higher prevalence of smoking among men in all samples, especially among single men with an average of around 29%. Smoking intensity also appears to be larger among men with the highest mean value of daily number of cigarettes among married male individuals (16.5 cigarettes per day). Throughout all samples, women appear to present slightly lower levels of SWB (higher GHQ levels) if compared to men and the highest levels

[11] An earlier version of this paper included health status via self-assessed health and the presence of breathing and heart related problems. To avoid any potential issues around bad controls and post-treatment bias, we have removed these variables from our analysis.

[12] To avoid changes in the composition of treated and control groups over time, we include in our sub-samples of married vs single only those individuals who do not change marital status and are either married or single throughout waves 9-16.

of distress seem to be concentrated among single women. A higher proportion of men appears to be married or in a couple, yet women appear to show a generally higher average number of children.

[Table 1 about here]

4. ECONOMETRIC METHODS

We estimate the impact of smoking bans on subjective well-being by exploiting the different timing of the introduction of the Scottish and English smoking bans. Since an identical public smoking ban was implemented in England one year later than in Scotland, we can identify our treatment effect by computing differences in well-being between Scottish and English individuals before and after the implementation of the ban in Scotland via difference-in-differences (DD) models (Ashenfelter, 1978; Ashenfelter and Card, 1985; Heckman and Robb, 1985) . We first employ standard two-way fixed effects models (*2FE*) using Scotland and England as treated and control groups respectively, and then use a more flexible model with fixed effects and country-specific time trends that allows for different policy effects by region and time. We also combine our DD models with matching techniques to pre-process the data and enhance comparability between treatment and control groups while improving the overall credibility of our identification strategy (Ho et al., 2007).

4.1 MATCHING

We first use matching to pre-process the data before the estimation of our DD models in order to produce more accurate and less model-dependent estimates. The pre-processing approach matches the pre-treatment observable characteristics of individuals in treated and control groups to increase their comparability. The approach was proposed by Ho et al. (2007) and further discussed and applied in a number of recent studies (e.g. Blackwell et al., 2009; Hainmueller and Xu, 2011; Jones and Rice, 2011; Iacus et al., 2011; King et al., 2011).

In this case, the main goal of matching is to ensure that individuals in treatment (Scotland) and control (England) groups are as similar as possible in terms of covariate distribution. An advantage of this combined approach is that it is "doubly robust" in that under weak conditions (and excluding extreme cases where matching would lead to non-identification even when the subsequent parametric models are correctly specified) if either the matching or parametric models are correct, causal estimates should be consistent (Bickel and Kwon, 2001; Ho et al., 2007) .

In order to pre-process the data, we have applied a series of alternative matching methods such as nearest neighbour, kernel and Mahalanobis distance matching. The DD estimates presented in our result section are based on kernel matching.[13] In this case, kernel matching is preferred as it exploits a wider range of information on individuals in the control group to achieve a lower variance.

Table 2 shows the reduction in bias on observables obtained through kernel matching based on the pre-treatment (smoking ban) wave (i.e. wave 15). The matched sample used for the subsequent empirical analysis includes 2,220 individuals from Scotland and 6,227 individuals from England. The first four columns present statistics based on the unmatched sample while columns five to eight are based on the matched sample. The table displays mean values of each variable and provide standard t-test statistics to measure differences between mean values of the observables between treated and control groups. It appears that a number of variables are significantly different across treatment and control groups based on the unmatched sample (e.g. age, household size and income; employment status such as working

[13] Results based on nearest neighbor and Mahalanobis distance matching are similar and available upon request. Kernel matching builds the counterfactual outcome using weighted averages of all individuals in the control group, with higher weights being placed on the untreated individuals with scores closer to the treated. We impose common support condition and use a bandwidth of 0.01. We have also used alternative bandwidth values (e.g. 0.005, 0.0025 and 0.00125), however in our case lower bandwidths lead to a smaller sample size and do not appear to improve the overall quality of the matching. Hence, we present our results based on a 0.01 bandwidth. While the results presented here are based on observations included in the pre-treatment wave (wave 15), we have also tested kernel matching using observations throughout waves 9-15. Results are virtually identical and available upon request.

in family care and being a student) while none of these covariates appear to show significant differences after the matching. This underlines that in this case kernel matching appears to have reduced differences in the observables of individuals in treated and control groups.

[Table 2 about here]

4.2 Two-way fixed effects models

We estimate the impact of the smoking bans on the GHQ of smokers, non-smokers and couples using two-way fixed effects models (*2FE*). These models exploit differences in reported subjective well-being between England and Scotland between 1999-2007 (waves 9-16) while controlling for observed individual characteristics, time effects and time-invariant individual-level unobserved heterogeneity. Our basic *2FE* model is:

$$y_{it} = \alpha + \tau_s(S_i P_t) + X_{it}\emptyset + v_t + u_i + \varepsilon_{it} \qquad (1)$$

where y_{it} is subjective well-being measured by the GHQ of an individual *i* at time *t*. S_i is a dummy variable defining whether an individual resides in Scotland ($S_i = 1$) while P_t is an indicator for the post-ban period (i.e. $P_t = 1$ if the smoking ban is in force at survey time *t*, 0 otherwise). The *treatment effect* is identified by τ_s, an interaction between country of residence and the post-ban period. X_{it} is a vector of individual observed characteristics at time *t* (age and age squared, marital status, household characteristics, income, employment status) and u_i represents individual fixed effects. The inclusion of fixed effects allows capturing individual-level unobservable confounders and more specifically to ease concerns around the potential correlation between treatment status and error terms driven by unobserved characteristics (provided that this correlation is confined to the unobserved effects).[14] The time dummies v_t account for time trends common to both the treatment and control groups. ε_{it} is an idiosyncratic error term. This is a DD estimator with one of the differences corresponding to the within-individual difference of a standard fixed effects estimator (Jones and Rice, 2011).

4.3 COUNTRY-SPECIFIC TIME TRENDS MODELS

As an alternative to the basic *2FE* model, we also estimate a more flexible specification with fixed effects and country-specific time trends (*CSTT*). This is a more general specification which nests model (1) as a special case and identifies the impact of the UK smoking bans by disentangling the treatment effect by countries and different time periods:

$$y_{it} = \alpha + S_i \sum_{t=1}^{T} \tau_{St} v_t + E_i \sum_{t=2}^{T} \tau_{Et} v_t + X_{it} \emptyset + u_i + \varepsilon_{it} \qquad (2)$$

The impact of the bans on subjective well-being is captured by the parameters τ_{St} and τ_{Et} on the interactions between being resident in Scotland ($S_i = 1$) or England ($E_i = 1$), and the time dummies v_t. Here, changes in subjective well-being related to the introduction of the smoking bans are derived by comparing country-specific time trends with a baseline country-specific time trend.[15] These models are also estimated using linear fixed effects specifications.

5. RESULTS

---

14 Specifications without fixed effects appear to produce similar results. Estimates are available upon request.

15 In this case we use England in wave 9 as a baseline country-specific time trend as no public smoking ban was in place at that time. Treatment effects are computed using differences between estimated interaction terms, i.e. interactions between country of residence and time dummies, before and after the Scottish ban in England and Scotland. More specifically, the corresponding treatment effect reported in each table is the one obtained by the following double difference: (Scotland*wave 16 – England*wave 16) – (Scotland*wave 15 – England*wave 15) where waves 15 and 16 are the pre- and post-Scottish ban waves in the BHPS, respectively. Standard errors for these treatment effects are obtained using the *lincom* command in Stata.

5.1 DESCRIPTIVE STATISTICS

Identification of the average treatment effect on the treated through DD models relies on the parallel trend assumption so that values of our outcome of interest, well-being defined via the GHQ, should follow similar pre-treatment time trends in both Scotland and England. To examine whether this assumption holds, we display GHQ trends by country of residence, gender, marital status and the presence of dependent children in Figure 1. For the overall population (which includes both married and single individuals with and without children, upper part of Figure 1), GHQ trends appear to be broadly similar in Scotland and England before the introduction of the bans. More specifically, while for Scottish and English women GHQ trends appear to slightly converge between waves 14 and 15 (i.e. one year before the introduction of the ban in Scotland, although this change amounts to less than a half GHQ point), pre-Scottish ban trends appear very similar for male individuals.[16] Both graphs show that in the year where the Scottish ban was introduced (between waves 15 and 16), GHQ levels in Scotland appear to decrease (implying a small increase in SWB), especially among women. Still for the overall population sample of men, SWB also appears to somewhat increase in England after the smoking ban. Graphs for married individuals of both genders (second row of Figure 1) appear to display GHQ trends comparable to the ones of the overall population. Single women in Scotland and England (third row of Figure 1) show virtually identical self-reported GHQ trends, also during the introduction of the two bans with slight increases in SWB between wave 15 and 16 (Scottish ban) followed by decreases in SWB between waves 16 and 17 (English ban). However, SWB reported by single men seem to vary during the pre-Scottish ban period, although only between GHQ scores of 10 and 11. Men and women with children (fourth row of Figure 1) exhibit relatively stable differences in GHQ levels between England and Scotland before the Scottish ban with increases in SWB

[16] The presence of anticipation effects on well-being is explored using placebo tests in Table 7.

during the Scottish ban and simultaneous slight decreases in England. However, the very stable GHQ levels among men and women without children (last row) do not appear to be affected by the introduction of the smoking bans. Overall, we observe mostly stable pre-treatment trends and increases in SWB in the year of the implementation of the Scottish ban, especially among women. Yet, specific sub-groups display some, although limited, variation in pre-treatment GHQ trends (e.g. single men) while others present no apparent changes in GHQ levels in the presence of the bans (e.g. men with no children).

[Figure 1 about here]

5.2 ESTIMATES

In order to examine whether there are any intra-couple well-being externalities driven by the public smoking bans, we first present estimates separately by gender (men vs women), marital status (married/living with a partner vs single) and smoking status (overall population, potential smokers and never smokers), see Table 3. Furthermore, to identify potential well-being externalities within couples of different types of smokers, we present estimates also broken down by the smoking status of spouses (whether spouses are potential smokers versus spouses of never smokers), see Table 4, and whether these couples have cohabiting dependent children, see Table 5.

Estimates of both *2FE* and *CSTT* models are produced by combining kernel matching with DD linear fixed effects models. All treatments effects should be interpreted as point changes on the GHQ Likert scale. Table 3 displays estimates of the impact of the Scottish public smoking ban on well-being produced by *2FE* and *CSTT* models. The majority of treatment effects for married men and women appear to be negative and statistically significant in both models. Since lower GHQ scores correspond to higher levels of well-being, this suggests that the Scottish ban had a positive and statistically significant impact on the SWB of married individuals. For married male individuals (overall population, that is potential smokers and never smokers together), the ban led to a decrease in the GHQ (increase in well-being) of around between 0.4-5 points on the Likert scale (0.438, *2FE* model, and 0.506, *CSTT* model at 5% significance level) while for married females (overall population) the decrease in the GHQ appears to be well-over half a point (between 0.543-0.708). The ban does not appear to have had a statistically significant effect among single men or women. Married male and female never smokers also appear to experience statistically significant increases in well-being (around 0.5 points and 0.46-0.80 points, respectively). Therefore, the ban appears to have led to an increase in well-being among married men and women, and larger impacts have been found among married individuals who are never smokers compared to those who are potential smokers.

[Table 3 about here]

Table 4 reports treatment effects from *2FE* and *CSTT* models broken down by gender, type of smokers and "smoking type" of each spouse. We observe negative and statistically significant effects for both genders among the overall population and never smokers. Although presenting similar size and signs, treatments effects among potential smokers do not appear to be statistically significant. However, this may be partly due to the increased standard errors potentially driven by the relative small amount of observations available to estimate these models (especially the ones for women who are potential smokers and married/living with a never smoker). The largest statistically significant improvements in well-being following the ban are observed among males who are never smokers and married/living with potential smokers (with a decrease of around 0.97 GHQ points and statistically significant at 5% level in the *2FE* model) while, although sizeable (0.76-1.8 GHQ points), the effects for the corresponding female sub-samples are only weakly significant. There appears to be statistically significant improvements in well-being also among never smokers married/living with a never smoker, among both males and females (around 0.5-0.6 GHQ points for males, around 0.7 for females, though only for the CSTT model). This implies that the ban appeared to have had a positive impact especially among never smokers, regardless of the smoking status of their partners.

[Table 4 about here]

To further investigate the presence of well-being externalities induced by the public smoking bans, we look at the impact of the Scottish ban among couples with and without the presence of dependent children in the household (Table 5). Although still mostly negative, all treatments effects for both married men and women without children do not appear to be statistically significant. For specific sub-samples this could also be the result of relatively small sample sizes and thus imprecisely estimated effects. However, the magnitude of several of the treatments effects for individuals without children appear to be smaller if compared to the effects of their counterparts with children, especially among women. Conversely, we observe statistically significant improvements in well-being mostly among married women with children (lower right-hand side part of Table 5). Larger effects are observed among female individuals with dependent children who are potential smokers and whose partners are also potential smokers (2.3 GHQ points).

In order to further appreciate the extent of the variation induced by the ban on the GHQ scale, it might be useful to consider our estimates in the light of the ones of previous studies. For example, Gardner and Oswald (2006) use data from the BHPS and the GHQ on the Likert scale and find that unemployment is associated with an increase of nearly 1.9 GHQ points while marriage is correlated with a decrease of 1.3 points. Further, Clark and Oswald (2002) and Gardner and Oswald (2007) find that widowhood, the life event thought to have the largest negative effect on well-being observable in standard datasets, is associated with a decrease in well-being of around 5 GHQ points. While this may suggest that our effects are sizable, we should avoid comparing these estimates directly because of differences in the empirical approaches and the temporary nature of the treatment effects in our analysis.

[Table 5 about here]

Robustness checks and placebo tests

We also explore the effects of the public smoking bans using alternative definitions of smokers. Table 6 presents estimates on the impact of the Scottish ban on individuals who smoke throughout the survey (always smokers); respondents who report smoking at the time of the ban regardless of their previous smoking status (current smokers); as well as individuals who were smoking before the ban and quit smoking after the ban (quitters). These are broken down by gender and marital status and were produced using *2FE* models. The ban appears to have increased SWB for women who are married and either always or current smokers, although the latter treatment effect is only weakly statistically significant. We find a larger and statistically significant increase in SWB (around 3.6 GHQ points) among married males who are quitters. As quitters are a sub-group of our potential smokers, this may imply that changes in SWB for male potential smokers who are married might be partly driven by the effects of quitters. However, it should be kept in mind that the sub-samples presented in this table are relatively limited if compared to the ones based on similar models which employ previous definitions of smokers (Table 3, which overall does not appear to present significant effects for men potential smokers). For this reason, we were not able to further disentangle treatment effects by spouses' smoking type.

[Table 6 about here]

Table 7 shows results from placebo tests assuming that the Scottish ban was implemented in 2004 and 2005 (i.e. two and one year before its actual implementation, respectively). These should further explore the robustness of our results as well as the presence of potential anticipation effects. Results are broken down by gender, type of smokers and marital status. Apart from weakly statistically significant coefficients for married men who are potential smokers and among married women who are never smokers, all remaining estimated treatment effects do not appear to be statistically different from zero. Furthermore, the direction of these effects appears to be undetermined with a mixture of positive and negative signs. This also seems to provide some further support to our main results.

[Table 7 about here]

6. CONCLUSION AND DISCUSSION

We exploit the natural experiment provided by the timing of the introduction of the UK smoking bans to identify the impact of public smoking bans on subjective well-being. We extend the literature by focusing on well-being externalities among smokers and non-smokers as well as couples of different types of smokers. We employ kernel matching combined with fixed effects panel data difference-in-differences models and placebo tests. We find statistically significant effects of public smoking bans on well-being, especially among married female individuals with dependent children.

Our estimates might be interpreted via a number of potential mechanisms. For example, the positive well-being externalities among individuals with dependent children may indicate the presence of parental altruism. Individuals with altruistic preferences towards their children would benefit more from the introduction of public smoking bans than non-altruistic parents, mainly for the expected reduction of their children's exposure to second hand smoke, at least in public places. However, our findings appear to show statistically significant increases in SWB only for married women with children while the same estimates for men do not appear to show notable improvements. Since our models and data do not allow testing directly this hypothesis, we cannot exclude that these results may partly reflect broader gender based differences in reporting well-being.

Furthermore, our robustness checks also find an increase in SWB among married males who are quitters, i.e. individuals who quit smoking after the introduction of the ban. This might suggest that the effects for this sub-sample of married men could be to some extent driven by the ban leading individuals to quit or reduce smoking also at home. This would be in line with the recent empirical literature indicating that public smoking bans may also increase the likelihood of voluntary smoking restrictions at home (e.g. Cheng et al., 2013) and the use of anti-smoking policies as self-control devices (e.g. Leicester and Levell, 2016). Overall, further research and larger datasets might be needed to more precisely establish the causal pathways leading to the observed increase in well-being following public smoking bans. Yet, our placebo tests, showing mainly insignificant changes whose direction is undetermined in the two years prior the introduction of the ban, appear to suggest that our findings should be mainly the result of the Scottish ban.

It should be noted that through our data and methods, we are only capable of identifying the short-term effects of public smoking bans on intra-couple well-being externalities. In the medium and long-run, individuals could adapt to the presence of public smoking bans and as a result their reported well-being could also change over time. Although our estimated treatment effects on well-being appear to be non-negligible in size, we should be cautious in comparing them with the ones identified by previous studies (for instance those of important life events such as marriage and divorce on well-being, see Clark and Oswald, 2000; and Gardner and Oswald, 2007), also because of their transitory nature.

Overall, our findings appear to suggest that the welfare impact of public smoking bans should not be limited solely to smokers but could also be extended to partners and family members of smokers. From a policy perspective, while public smoking bans may have a limited effect on active smoking and some potential adverse effects on passive smoking (e.g. Adda and Cornaglia, 2010; Carpenter et al., 2011), they may also produce positive short-term well-being externalities, especially among couples living with young children. This additional information could be exploited by governments concerned with the overall impact evaluation of their anti-smoking policies alongside standard findings on smoking prevalence and intensity.

REFERENCES

ADAMS, S. & COTTI, C. 2008. Drunk driving after the passage of smoking bans in bars. *Journal of Public Economics,* 92**,** 1288-1305.

ADDA, J., BERLINSKI, S. & MACHIN, S. 2007. Short-run economic effects of the Scottish smoking ban. *International Journal of Epidemiology,* 36**,** 149-154.

ADDA, J., BERLINSKI, S. & MACHIN, S. 2012. Market Regulation and Firm Performance: The Case of Smoking Bans in the United Kingdom. *The Journal of Law and Economics,* 55**,** 365-391.

ADDA, J. & CORNAGLIA, F. 2010. The effect of bans and taxes on passive smoking. *American Economic Journal: Applied Economics,* 2**,** 1-32.

AGEE, M. D. & CROCKER, T. D. 2007. Children's health benefits of reducing environmental tobacco smoke exposure: evidence from parents who smoke. *Empirical Economics,* 32**,** 217-237.

AMADOR, L. B. & NICOLÁS, Á. L. 2013. Self-control and support for anti-smoking policies among smokers, ex smokers, and never smokers. *The European Journal of Health Economics,* 14**,** 161-170.

ANDERSEN, S. H. 2009. Unemployment and Subjective Well-Being A Question of Class? *Work and Occupations,* 36**,** 3-25.

ANGER, S., KVASNICKA, M. & SIEDLER, T. 2011. One last puff? Public smoking bans and smoking behavior. *Journal of Health Economics,* 30**,** 591-601.

ASHENFELTER, O. 1978. Estimating the effect of training programs on earnings. *The Review of Economics and Statistics,* 60**,** 47-57.

ASHENFELTER, O. & CARD, D. 1985. Using the Longitudinal Structure of Earnings to Estimate the Effect of Training Programs. *The Review of Economics and Statistics,* 67**,** 648-660.

BECKER, G. S. 1981. *A Treatise on the Family,* Cambridge, Harvard University Press.

BICKEL, P. J. & KWON, J. 2001. Inference for semiparametric models: some questions and an answer. *Statistica Sinica,* 11**,** 863-885.

BINDER, M. & COAD, A. 2011. From Average Joe's happiness to Miserable Jane and Cheerful John: using quantile regressions to analyze the full subjective well-being distribution. *Journal of Economic Behavior & Organization,* 79**,** 275-290.

BLACKWELL, M., IACUS, S. M., KING, G. & PORRO, G. 2009. cem: Coarsened exact matching in Stata. *Stata Journal,* 9**,** 524-546.

BRODEUR, A. 2013. Smoking, income and subjective well-being: Evidence from smoking bans. IZA Discussion Paper.

BRUHIN, A. & WINKELMANN, R. 2009. Happiness functions with preference interdependence and heterogeneity: The case of altruism within the family. *Journal of Population Economics,* 22**,** 1063-1080.

BUCK, N., BURTON, J., LAURIE, H., LYNN, P. & UHRIG, S. 2006. Quality profile: British household panel survey-version 2.0: Waves 1 to 13: 1991-2003. *ISER report, Essex*.

CARPENTER, C., POSTOLEK, S. & WARMAN, C. 2011. Public-Place Smoking Laws and Exposure to Environmental Tobacco Smoke (ETS). *American Economic Journal: Economic Policy,* 3**,** 35-61.

CLARK, A. E. 2003. Unemployment as a social norm: Psychological evidence from panel data. *Journal of Labor Economics,* 21**,** 323-351.

CLARK, A. E. & OSWALD, A. J. 1994. Unhappiness and unemployment. *Economic journal,* 104**,** 648-59.

CLARK, A. E. & OSWALD, A. J. 2002. A simple statistical method for measuring how life events affect happiness. *International Journal of Epidemiology,* 31**,** 1139-1144.

DICKIE, M. & GERKING, S. 2007. Altruism and environmental risks to health of parents and their children. *Journal of Environmental Economics and Management,* 53**,** 323-341.

DICKIE, M. & MESSMAN, V. L. 2004. Parental altruism and the value of avoiding acute illness: are kids worth more than parents? *Journal of Environmental Economics and Management,* 48**,** 1146-1174.

DICKIE, M. & ULERY, V. L. Valuing Health in the Household: Are Kids Worth More Than Parents? Association of Environmental and Resource Economists 2001 Workshop:"Assessing and Managing Environmental and Public Health Risks, 2001. 13-15.

DOLAN, P. & METCALF, R. 2008. Comparing willingness-to-pay and subjective well-being in the context of non-market goods. *CEP Discussion Papers.* Centre for Economic Performance, London School of Economics and Political Science.

DOLAN, P. & METCALFE, R. 2010. 'Oops… I did it again': Repeated focusing effects in reports of happiness. *Journal of economic psychology,* 31**,** 732-737.

DOLAN, P. & METCALFE, R. 2012. Measuring subjective wellbeing: Recommendations on measures for use by national governments. *Journal of Social Policy,* 41**,** 409-427.

DOLAN, P., PEASGOOD, T. & WHITE, M. 2008. Do we really know what makes us happy? A review of the economic literature on the factors associated with subjective well-being. *Journal of Economic Psychology,* 29**,** 94-122.

DOLAN, P. & WHITE, M. P. 2007. How can measures of subjective well-being be used to inform public policy? *Perspectives on Psychological Science,* 2**,** 71-85.

DUPONT, D. P. 2004. Do children matter? An examination of gender differences in environmental valuation. *Ecological Economics,* 49**,** 273-286.

FARRELLY, M. C., NONNEMAKER, J. M., CHOU, R., HYLAND, A., PETERSON, K. & BAUER, U. E. 2005. Changes in hospitality workers' exposure to secondhand smoke following the implementation of New York's smoke-free law. *Tobacco Control,* 14**,** 236.

GARDNER, J. & OSWALD, A. J. 2006. Do divorcing couples become happier by breaking up? *Journal of the Royal Statistical Society: Series A (Statistics in Society),* 169**,** 319-336.

GARDNER, J. & OSWALD, A. J. 2007. Money and mental wellbeing: A longitudinal study of medium-sized lottery wins. *Journal of health economics,* 26**,** 49-60.

GOLDBERG, D. & WILLIAMS, P. 1988. A user's guide to the General Health Questionnaire. *NFER-Nelson, Windsor*.

GOODMAN, P., AGNEW, M., MCCAFFREY, M., PAUL, G. & CLANCY, L. 2007. Effects of the Irish smoking ban on respiratory health of bar workers and air quality in Dublin pubs. *American journal of respiratory and critical care medicine,* 175**,** 840-845.

GRUBER, J. & KOSZEGI, B. 2000. Is addiction" rational"? Theory and evidence. National Bureau of Economic Research.

GRUBER, J. & KOSZEGI, B. 2002. A theory of government regulation of addictive bads: Optimal tax levels and tax incidence for cigarette excise taxation. National Bureau of Economic Research.

GRUBER, J. H. & MULLAINATHAN, S. 2005. Do cigarette taxes make smokers happier. *Advances in Economic Analysis & Policy,* 5.

HAINMUELLER, J. & XU, Y. 2011. Ebalance: A Stata package for entropy balancing. *Journal of Statistical Software,* 54**,** 18.

HECKMAN, J. J. & ROBB, R. 1985. Alternative methods for evaluating the impact of interventions: An overview. *Journal of econometrics,* 30**,** 239-267.

HINKS, T. & KATSAROS, A. 2010. Smoking Behaviour and Life Satisfaction: Evidence from the UK Smoking Ban. *Discussion Papers.* Bristol: Department of Accounting, Economics and Finance, Bristol Business School, University of the West of England,.

HO, D. E., IMAI, K., KING, G. & STUART, E. A. 2007. Matching as nonparametric preprocessing for reducing model dependence in parametric causal inference. *Political Analysis,* 15**,** 199-236.

IACUS, S. M., KING, G. & PORRO, G. 2011. Causal inference without balance checking: Coarsened exact matching. *Political analysis,* 20**,** 24.

IRVINE, I. J. & NGUYEN, H. V. Toxic choices: the theory and impact of smoking bans. Forum for Health Economics & Policy, 2011.

JEHIEL, P. & LILICO, A. 2010. Smoking Today and Stopping Tomorrow: A Limited Foresight Perspective. *CESifo Economic Studies,* 56**,** 141-164.

JONES, A. M., LAPORTE, A., RICE, N. & ZUCCHELLI, E. 2013. DO PUBLIC SMOKING BANS HAVE AN IMPACT ON ACTIVE SMOKING? EVIDENCE FROM THE UK. *Health Economics,* 24**,** 175-192.

JONES, A. M. & RICE, N. 2009. Econometric evaluation of health policies. *Health Economics and Data Group (HEDG), University of York Working Paper*.

KING, G., NIELSEN, R., COBERLEY, C., POPE, J. & WELLS, A. 2011. Comparative effectiveness of matching methods for causal inference.

KUEHNLE, D. & WUNDER, C. 2017. The Effects of Smoking Bans on Self‐Assessed Health: Evidence from Germany. *Health economics,* 26**,** 321-337.

LEICESTER, A. & LEVELL, P. 2016. Anti-Smoking Policies and Smoker Well-Being: Evidence from Britain. *Fiscal Studies,* 37**,** 224-257.

LIU, J.-T., HAMMITT, J. K., WANG, J.-D. & LIU, J.-L. 2000. Mother's willingness to pay for her own and her child's health: a contingent valuation study in Taiwan. *Health Economics,* 9**,** 319-326.

MENZIES, D., NAIR, A., WILLIAMSON, P. A., SCHEMBRI, S., AL-KHAIRALLA, M. Z., BARNES, M., FARDON, T. C., MCFARLANE, L., MAGEE, G. J. & LIPWORTH, B. J. 2006. Respiratory symptoms, pulmonary function, and markers of inflammation among bar workers before and after a legislative ban on smoking in public places. *Jama,* 296**,** 1742-1748.

ODERMATT, R. & STUTZER, A. 2013. Smoking bans, cigarette prices and life satisfaction. *IZA Discussion Paper.* Germany: IZA.

PEARSON, J., WINDSOR, R., EL-MOHANDES, A. & PERRY, D. C. 2009. Evaluation of the immediate impact of the Washington, DC, smoke-free indoor air policy on bar employee environmental tobacco smoke exposure. *Public Health Reports,* 124**,** 135–142.
POWDTHAVEE, N. & VAN DEN BERG, B. 2011. Putting different price tags on the same health condition: Re-evaluating the well-being valuation approach. *Journal of Health Economics,* 30**,** 1032-1043.
SARGENT, R., SHEPARD, R. & GLANTZ, S. 2004. Reduced incidence of admissions for myocardial infarcion associated with public smoking ban: before and after study. *BMJ,* 328**,** 977-980.
SCHWARZE, J. 2004. Living conditions of children and parental well-being: evidence from German data on life satisfaction. *IZA Discussion paper series.* Germany: IZA.
SEO, D. & TORABI, M. 2007. Reduced admissions for acute myocardial infarction associated with a public smoking ban: matched controlled study. *Journal of drug education***,** 217-26.
SHIELDS, M. A. & PRICE, S. W. 2005. Exploring the economic and social determinants of psychological well‐being and perceived social support in England. *Journal of the Royal Statistical Society: Series A (Statistics in Society),* 168**,** 513-537.
US DEPARTMENT OF HEALTH AND HUMAN SERVICES 2014. The health consequences of smoking—50 years of progress: a report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.
WILDMAN, J. & HOLLINGSWORTH, B. 2013. Public smoking bans and self-assessed health: Evidence from Great Britain. *Economics Letters,* 118**,** 209-212.
WORLD HEALTH ORGANIZATION 2013. *WHO report on the global tobacco epidemic, 2013: enforcing bans on tobacco advertising, promotion and sponsorship*, World Health Organization.

Table 1: Descriptive statistics

	Overall		Married		Single	
	Men	**Women**	**Men**	**Women**	**Men**	**Women**
GHQ 12 Likert scale	10.434	11.768	10.408	11.540	10.405	11.905
Smoker	0.262	0.253	0.228	0.222	0.291	0.261
Number of cigarettes	15.836	14.307	16.486	14.492	14.832	13.938
Age	45.717	46.886	49.108	46.728	40.700	52.252
Married/couple	0.704	0.642	---	---	---	---
Household size	2.811	2.744	3.052	3.073	2.343	2.105
Number of children	0.491	0.542	0.693	0.694	0.017	0.171
Unemployed	0.040	0.024	0.026	0.014	0.072	0.034
Self-employed	0.109	0.037	0.126	0.046	0.062	0.022
Retired	0.189	0.226	0.202	0.171	0.196	0.396
Family care	0.042	0.047	0.039	0.043	0.060	0.050
Student	0.004	0.119	0.003	0.151	0.004	0.056
Long-term sickness	0.033	0.035	0.004	0.008	0.113	0.084
Government training	0.001	0.001	0.000	0.000	0.003	0.002
Other jobs	0.005	0.006	0.004	0.005	0.008	0.008
Household income	2.039	1.874	2.059	2.052	1.888	1.552
Number of observations	39633	46066	24713	25409	8803	12571

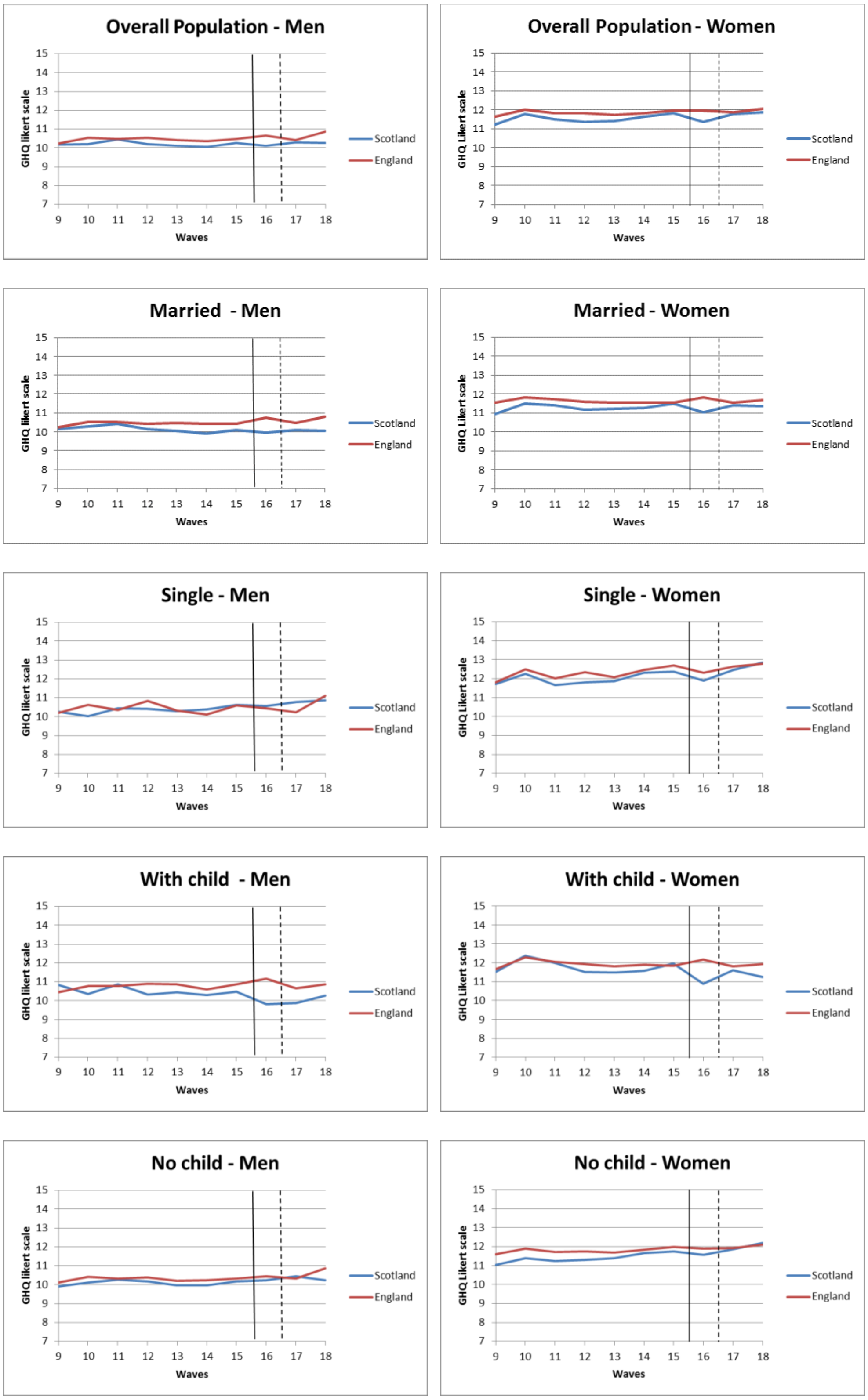
The table contains mean values for all the main variables computed for waves 9-16 for pooled samples and for males and females separately, broken down by marital status (i.e. married and unmarried/single).

Table 2: Reduction in bias on observables after kernel matching

	Pre-matching				Post-matching				
	Treated	**Untreated**	**t statistics**	**p>|t|**	**Treated**	**Untreated**	**t statistics**	**p>|t|**	**% reduction of bias**
Age	47.645	46.606	2.39	0.017	47.645	47.607	0.07	0.941	96.3
Age squared	25.71	24.836	1.98	0.047	25.711	25.68	0.06	0.954	96.5
Male	0.446	0.458	-0.96	0.339	0.446	0.448	-0.13	0.900	84.0
Household size	2.693	2.792	-3.00	0.003	2.694	2.696	-0.05	0.957	97.9
Number of children	0.535	0.512	1.04	0.297	0.536	0.538	-0.07	0.943	91.5
Unemployed	0.032	0.029	0.61	0.541	0.032	0.031	0.11	0.911	77.1
Self-employed	0.065	0.075	-1.54	0.124	0.065	0.066	-0.10	0.921	92.5
Retired	0.213	0.201	1.20	0.232	0.213	0.212	0.12	0.908	88.1
Family care	0.054	0.038	3.26	0.001	0.055	0.057	-0.42	0.377	82.3
Student	0.051	0.066	-2.51	0.012	0.051	0.050	0.22	0.829	90.5
Long term sick	0.031	0.029	0.49	0.625	0.030	0.031	-0.02	0.985	95.1
Government training	0.001	0.001	1.00	0.319	0.001	0.001	0.02	0.987	97.9
Other jobs	0.005	0.005	-0.28	0.782	0.005	0.005	-0.04	0.965	81.5
Household income	1.934	2.094	-4.68	0.000	1.934	1.946	-0.31	0.755	92.8
Number of observations	2221	6227			2220	6227			

The last column reports the reduction in bias after the kernel matching. This is the reduction (in %) in mean differences between the treated and untreated groups.

Figure 1: GHQ trends in Scotland and England (after kernel matching)



The continuous vertical lines indicate the Scottish smoking ban while the dashed lines represent the English bans. All graphs are based on matched samples of individuals obtained using kernel matching. GHQ trends based on unmatched samples are similar and available upon request.

Table 3: The impact of the Scottish ban on well-being (from wave 13 to 16)

ATET Scotland	2FE	CSTT
	Overall Population	
	Men	**Men**
Married	-0.438** (0.184)	-0.506** (0.205)
N	17385	17385
Single	0.236 (0.372)	-0.101 (0.453)
N	4833	4833
	Women	**Women**
Married	-0.543*** (0.194)	-0.708*** (0.227)
N	19003	19003
Single	-0.039 (0.313)	0.094 (0.369)
N	7366	7366
	Potential Smokers	
	Men	**Men**
Married	-0.283 (0.346)	-0.552 (0.385)
N	6022	6022
Single	0.259 (0.671)	-0.442 (0.819)
N	1749	1749
	Women	**Women**
Married	-0.708* (0.390)	-0.484 (0.434)
N	5976	5976
Single	0.225 (0.552)	0.426 (0.634)
N	2746	2746
	Never Smokers	
	Men	**Men**
Married	-0.522** (0.214)	-0.482** (0.238)
N	11363	11363
Single	0.389 (0.393)	0.272 (0.478)
N	3084	3084
	Women	**Women**
Married	-0.459** (0.222)	-0.795*** (0.264)
N	13027	13072
Single	-0.190 (0.372)	-0.079 (0.449)
N	4620	4620

Standard errors in parentheses. Statistical significance: *** 1% level; ** 5% level; * 10% level. This table reports average treatment effects on the treated (ATET) obtained from panel data difference-in-differences models (2-way fixed effects model, *2FE*, and country-specific time-trends models, CSTT). Subjective well-being is defined using the GHQ12. Models were estimated using linear fixed effects specifications on matched samples obtained using kernel matching. All models include individual fixed effects, the full battery of controls and dummies for the time trend.

Table 4: The impact of the Scottish ban on well-being externalities among couples

	2FE	CSTT
	Overall Population	
	Men	**Men**
Spouse: potential smoker	-0.662*	-0.551
	(0.357)	(0.399)
N	5033	5033
Spouse: never smoker	-0.350	-0.492*
	(0.224)	(0.252)
N	11122	11122
	Women	**Women**
Spouse: potential smokers	-0.732*	-0.852*
	(0.384)	(0.445)
N	5588	5588
Spouse: never smoker	-0.384	-0.623**
	(0.251)	(0.295)
N	10697	10697
	Potential Smokers	
	Men	**Men**
Spouse: potential smoker	-0.605	-0.809
	(0.505)	(0.564)
N	3213	3213
Spouse: never smoker	0.244	-0.120
	(0.523)	(0.570)
N	2321	2321
	Women	**Women**
Spouse: potential smoker	-0.666	-0.577
	(0.587)	(0.606)
N	3217	3217
Spouse: never smoker	-0.428	-0.306
	(0.659)	(0.785)
N	1739	1739
	Never Smokers	
	Men	**Men**
Spouse: potential smoker	-0.970**	0.271
	(0.476)	(0.542)
N	1820	1820
Spouse: never smoker	-0.520**	-0.615**
	(0.247)	(0.281)
N	8801	8801
	Women	**Women**
Spouse: potential smoker	-0.759*	-1.179*
	(0.458)	(0.651)
N	2371	2371
Spouse: never smoker	-0.380	-0.694**
	(0.271)	(0.317)
N	8958	8958

Standard errors in parentheses. Statistical significance:*** 1% level; ** 5% level; * 10% level. This table reports average treatment effects on the treated (ATET) obtained from panel data difference-in-differences models (2-way fixed effects model, *2FE*, and country-specific time-trends models, CSTT). Subjective well-being is defined using the GHQ12. Models were estimated using linear fixed effects specifications on matched samples obtained using Kernel matching. All models include individual fixed effects, the full battery of controls and dummies for the time trend.

Table 5: The impact of the Scottish ban among couples with and without dependent children

	Without children					
	Men			Women		
	Overall population	Potential smokers	Never smokers	Overall population	Potential smokers	Never smokers
Spouse: overall population	-0.263 (0.245)	-0.558 (0.470)	-0.184 (0.279)	0.059 (0.280)	-0.504 (0.587)	0.248 (0.302)
N	8545	2690	5855	9145	2687	6458
Spouse: potential smoker	-0.499 (0.446)	-0.809 (0.682)	-0.570 (0.503)	-0.087 (0.553)	0.152 (0.848)	-0.392 (0.563)
N	2550	1526	1024	2672	1495	1177
Spouse: never smoker	-0.090 (0.295)	-0.185 (0.635)	-0.079 (0.330)	0.146 (0.333)	-0.705 (0.830)	0.267 (0.350)
N	5918	1134	4784	5878	971	4907
	With children					
	Men			**Women**		
	Overall population	**Potential smokers**	**Never smokers**	**Overall population**	**Potential smokers**	**Never smokers**
Spouse: overall population	-0.568 (0.387)	-0.074 (0.732)	-0.835* (0.432)	-1.162*** (0.401)	-1.711** (0.743)	-0.882* (0.478)
N	4397	1703	2691	4762	1530	3232
Spouse: potential smoker	-0.711 (0.744)	-0.001 (0.975)	-1.853 (1.261)	-1.556** (0.692)	-2.344** (0.986)	-0.606 (0.969)
N	1379	935	444	1717	957	760
Spouse: never smoker	-0.605 (0.433)	-0.373 (1.132)	-0.705 (0.456)	-0.677 (0.536)	0.183 (1.351)	-0.850 (0.597)
N	2978	739	2239	2701	441	2260

Standard errors in parentheses. Statistical significance: *** 1% level; ** 5% level; * 10% level. This table reports average treatment effects on the treated (ATET) obtained from panel data difference-in-differences models (2-way fixed effects model, *2FE*). Subjective well-being is defined using the GHQ12. Models were estimated using linear fixed effects specifications on matched samples obtained using kernel matching. All models include individual fixed effects, the full battery of controls and dummies for the time trend.

Table 6: Robustness checks: alternative definitions of smokers

ATET Scotland	Men	Women
	Always Smokers	
Married	-0.248	-1.240**
	(0.585)	(0.601)
N	1600	1831
Single	1.138	-0.754
	(1.034)	(0.880)
N	574	888
	Current Smokers	
Married	0.0996	-0.782*
	(0.454)	(0.474)
N	3014	3168
Single	0.085	-0.024
	(0.805)	(0.702)
N	1191	1675
	Quitters	
Married	-3.578**	-0.182
	(1.420)	(2.091)
N	427	361
Single	1.690	3.435
	(3.090)	(5.719)
N	106	170

Standard errors in parentheses. Statistical significance: *** 1% level; ** 5% level; * 10% level. This table reports average treatment effects on the treated (ATET) obtained from panel data difference-in-differences models (2-way fixed effects model, *2FE*). Subjective well-being is defined using the GHQ12. Models were estimated using linear fixed effects specifications on matched samples obtained using kernel matching. All models include individual fixed effects, the full battery of controls and dummies for the time trend.

Table 7: Placebo tests: the impact of the Scottish ban on well-being in 2004 and 2005

ATET Scotland	2004	2005
	Overall Population	
	Men	**Men**
Married	-0.251	0.035
	(0.170)	(0.171)
N	12656	15053
Single	0.345	0.253
	(0.417)	(0.394)
N	3279	4078
	Women	**Women**
Married	0.120	0.203
	(0.203)	(0.197)
N	13872	16471
Single	0.156	-0.046
	(0.340)	(0.301)
N	5183	6301
	Potential Smokers	
	Men	**Men**
Married	-0.569*	0.271
	(0.296)	(0.300)
N	4365	5204
Single	-0.544	0.647
	(0.749)	(0.743)
N	1186	1477
	Women	**Women**
Married	0.256	-0.296
	(0.371)	(0.382)
N	4362	5181
Single	0.649	-0.082
	(0.621)	(0.492)
N	1926	2343
	Never Smokers	
	Men	**Men**
Married	-0.075	-0.103
	(0.205)	(0.209)
N	8291	9849
Single	0.773	0.043
	(0.498)	(0.433)
N	2093	2601
	Women	**Women**
Married	0.071	0.427*
	(0.243)	(0.231)
N	9510	11290
Single	-0.161	-0.055
	(0.385)	(0.382)
N	3257	3958

Standard errors in parentheses. Statistical significance: *** 1% level; ** 5% level; * 10% level. This table reports average treatment effects on the treated (ATET) obtained from panel data difference-in-differences models (2-way fixed effects model, *2FE*). Subjective well-being is defined using the GHQ12. Models were estimated using linear fixed effects specifications on matched samples obtained using kernel matching. All models include individual fixed effects, the full battery of controls and dummies for the time trend.