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Public-Place Smoking Laws and Exposure to Environmental Tobacco Smoke (ETS)

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ABSTRACT

Public-place smoking restrictions are the most important non-price tobacco control measures worldwide, yet surprisingly little is known about their effects on exposure to environmental tobacco smoke (ETS). We study these laws in Canada using data with questions about respondents' ETS exposure in public and private places. In fixed-effects models we find these laws had no effects on smoking but induced large and statistically significant reductions in public-place ETS exposure, especially in bars and restaurants. We do not find evidence of substantial ETS displacement to private places. Our results indicate wide latitude for health improvements from banning smoking in public places.

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I. INTRODUCTION

Environmental tobacco smoke (ETS) is estimated to kill 600,000 people worldwide each year through increased heart disease, respiratory ailments, asthma, and lung cancer (Oberg et al. 2010 forthcoming).[1] Reducing population exposure to ETS is a key public health priority of many governments, and increasingly cites and countries have been adopting clean indoor air policies that restrict or completely prohibit smoking in a variety of public places such as restaurants and bars (EPHA 2010). Indeed, research based on a recent World Bank report informed by a panel of tobacco control experts in World Health Organization member countries ranks public-place smoking restrictions as the most important non-price policy to reduce death and disease caused by tobacco use, ahead of advertising bans, information campaigns, warning labels, and quit-assistance for current smokers (Joossens and Raw 2006).

Several peer-reviewed public health and medical studies link public-place smoking bans to reductions in acute myocardial infarctions (AMI) (i.e., heart attacks), and a 2009 report by the Institute of Medicine (IOM) finds the evidence is sufficient to conclude that smoking bans—including those that apply to public places such as bars and restaurants—have causal effects at reducing AMI.[2] According to the IOM report, even brief exposure to environmental tobacco smoke (ETS) can physiologically trigger AMI, thus making it plausible that public-place smoking bans could reduce AMI through reducing exposure to ETS. If true, the conclusions of

[1] As a point of comparison, active tobacco use is estimated to be responsible for 5.1 million deaths per year worldwide (Oberg et al. 2010 forthcoming). Throughout, we refer to environmental tobacco smoke or ETS. Depending on the setting and context, this is also sometimes referred to as second-hand smoke or SHS.

[2] Not all research has reached the same conclusion, however. Shetty et al. (2010, forthcoming), for example, find that evidence for a relationship between smoking bans and AMI in the US is sensitive to choice of cities and specification.

the IOM report suggest wide latitude for public health improvements for many jurisdictions in the US and elsewhere that have not yet banned smoking in public places.[3]

Notably, however, we know very little about whether, how, and to what extent public-place smoking laws actually affect exposure to ETS, and we know even less about whether these effects differ by smoking status. The IOM explicitly notes this fact as a key limitation to research in this area, writing in their report that a key gap in our understanding of the health effects of these policies is a "lack of information on changes in secondhand-smoke exposure" (IOM 2009). Most previous studies bans focus on own-smoking behavior (Bitler et al. 2010a, Tauras 2006), with a few notable exceptions. Carpenter (2009) examines the effects of laws restricting smoking in private workplaces on exposure to ETS at work, but he does not study exposure in other places. Adda and Cornaglia (2010) study the effects of public-place smoking laws on population exposure to ETS using saliva cotinine levels (a biological marker for nicotine metabolite), but their data do not permit them to observe *where* individuals were exposed. Several other public health studies use ambient nicotine measurements or other biological markers to study ETS exposure before and after smoking bans (usually in bars and restaurants). These studies generally find large reductions in exposure but are limited to a very small number of sites and suffer from the usual concerns about other unobserved characteristics about those sites that caused them to implement a smoking ban and that may be independently correlated with smoking-related outcomes.[4] Consistent with the IOM report, we are aware of no large-scale

[3] The Americans for Non-Smokers' Rights Foundation (ANRF), a group that tracks clean indoor air coverage across the United States, notes that only 22 states have laws that completely prohibit smoking in all workplaces, bars, and restaurants (the three main venues they track) without provisions for designated smoking rooms or firm size exemptions (ANRF 2010).

[4] See, for example, IOM (2009), Akbar-Khanzadeh et al. (2004), Ellingsen et al. (2006), Giorino et al. (2008), Mulcahy et al. (2005), Al-Delaimy et al. (2001), Menzies et al. (2006), Valente et al. (2007), Pell et al. (2008), and others. Evans et al. (1999) discuss these issues in detail.

quasi-experimental evaluations of the effects of public-place smoking laws that use direct information on the location of ETS exposure.

We fill this gap in the literature by studying the rapid diffusion of public-place smoking laws across Canada on smoking outcomes and exposure to ETS. Our main contribution is that we leverage unique confidential data from the 2002-2008 Canadian Tobacco Use Monitoring Surveys which contain detailed questions on the precise location of exposure to ETS, such as bars, restaurants, and homes.[5] This affords us the literature's first direct tests of how public place smoking laws affect exposure to ETS in the venues explicitly covered by the laws (public places). We also test the possibility that these laws may have induced displacement of smoking from public places to private places such as cars and homes (as suggested by Adda and Cornaglia 2010). We also draw on an independent source of confidential data from the Canadian Community Health Surveys (CCHS) from 2000 to 2008 which contains alternate measures of ETS exposure. We use both repeated cross-section datasets to estimate models with city and year fixed effects (i.e., a difference-in-differences framework), thus identifying the effects of the public-place smoking laws on outcomes using within-city changes over time in outcomes for individuals residing in places that adopted a law, controlling for the associated within-city changes in outcomes for individuals residing in places that did not adopt a law at that same time.

To preview, we find that public-place smoking laws in Canada had no economically or statistically significant effects at reducing population smoking participation or intensity.[6] This suggests that public-place smoking laws are unlikely to improve cardiovascular health by inducing existing smokers to quit or reduce the number of cigarettes smoked. We do, however,

[5] The validity of self-reports of ETS exposure is supported by previous research which demonstrates that these outcomes are strongly correlated with other biological markers of ETS such as ambient nicotine measurements (Coghlin et al. 1989, Okoli et al. 2007). Self-reports also have the advantage that we can make consistent comparisons of ETS exposure outcomes across space and time using very large samples of outcome data.
[6] Throughout, we use smoking 'intensity' to refer to the number of cigarettes smoked among smokers.

find that public-place smoking laws significantly reduced ETS exposure in a variety of public places, especially inside bars/taverns, inside restaurants, and on outdoor patios of bars and restaurants. These estimated reductions in public-place ETS exposure are: 1) observed for both non-smokers and smokers; 2) very large in magnitude (on the order of 65 percent for bars and 75 percent for restaurants); 3) highly robust to a variety of specification checks (e.g., trends, leads, etc.); and 4) confirmed in independent analyses of the CCHS. The ETS exposure reductions also exhibit a plausible monotonicity associated with the strength of the law in place (i.e., stronger laws induced larger reductions in ETS exposure). We also find that the timing of the estimated reductions in public-place ETS exposure is consistent with our causal interpretation, and we find similar effects of public-place smoking laws use using either variation from individuals living in cities that adopted restrictions prior to provincial laws or variation from individuals living in cities that did not adopt such laws prior to a provincial law (i.e., the 'reverse' experiment), which further validates our identification strategy. Finally, we do not find evidence of substantial displacement to private homes or vehicles in either the CTUMS or the CCHS data. We do, however, find that public-place smoking laws significantly increased the probability non-smokers report being exposed to ETS at building entrances, presumably reflecting a different type of displacement.

Over our sample period, total exposure to ETS in public places was cut by more than half, and exposure to ETS in bars and restaurants in Canada was essentially eliminated. We estimate that public-place smoking laws are responsible for most of these improvements. Our results are the first to show that public-place smoking laws significantly reduce ETS exposure in a range of public places for both smokers and non-smokers. Thus, our results highlight multiple plausible mechanisms through which such laws may improve cardiovascular health. Given that a large fraction of the US and other countries still do not ban smoking in public places, our results suggest the potential for significant public health improvements if smoking were universally banned in public places.

The paper proceeds as follows. We provide a literature review in Section II and present the data, institutional background, and methods in Section III. Section IV presents the main results on smoking and exposure to ETS, Section V offers evidence on displacement of smoking from public places to private homes, and Section VI offers a discussion and concludes.

II. PREVIOUS RESEARCH

Several recent studies in economics have used quasi-experimental methods to study the effects of clean indoor air policies, with most focusing on smoking behavior. Yurekli and Zhang (2000) used aggregate data on cigarette consumption in the US from 1970-1995 and found that smoke-free legislation significantly reduced cigarette consumption in models with state and year fixed effects. Taurus (2006) used data from the 1992-1999 Tobacco Use Supplements to the Current Population Survey and estimated models with state and year fixed effects. He found that a summary index of clean indoor air laws was estimated to reduce smoking intensity but not smoking participation. Bitler et al. (2010a, 2010b forthcoming) used data from 1992-2007 and examined the effects of venue-specific state clean indoor air laws on smoking outcomes. Their quasi-experimental results returned no evidence that clean indoor air laws reduced smoking either in the full population or for workers who should have been directly affected because they worked in the venues targeted by the clean indoor air laws, with the exception that laws restricting smoking in bars were estimated to significantly reduce the share of bartenders who smoked. Anger et al. (2010) study the effects of public-place smoking laws on smoking behavior in Germany from 2002-2008 using difference-in-differences models and find no effects of the policies on smoking overall but some evidence of smoking reductions for young, unmarried, urban dwellers and for stricter bans.

Although most studies of the effects of these types of laws focus on smoking outcomes, two quasi-experimental studies have tested for effects on ETS exposure. Carpenter (2009) studied local smoking laws in Ontario, Canada from 1997-2004 (before implementation of the province's strong provincial law) using data from the Centre for Addiction and Mental Health (CAMH) Monitor. He estimated models with year and county fixed effects and found that local workplace smoking laws significantly reduced ETS exposure at work among blue collar workers. Carpenter (2009) did not examine ETS exposure in other public or private places due to data constraints.

Adda and Cornaglia (2010) also studied the effects of workplace and bar/restaurant smoking laws on smoking behavior, time spent in various venues, and exposure to ETS using novel data on cotinine—a metabolite of nicotine—from saliva measurements in the National Health and Nutrition Examination Survey (NHANES III).[7] Their quasi-experimental models with state and year fixed effects showed: 1) no effects of the laws on smoking cessation; 2) significant effects of the laws on reducing the amount of time that smokers spent in bars and restaurants; and 3) significant increases in ETS exposure for children living with smokers. They suggest that these patterns can best be explained by displacement of ETS from public places to private places such as homes. They do not, however, directly observe where individuals were exposed to ETS.

[7] Adda and Cornaglia's smoking behavior data came from the 1984-2006 Behavioral Risk Factor Surveillance System. For information on time spent in various venues they pooled data from the 2003-2006 American Time Use Survey and the 1992-1994 National Human Activity Pattern Survey.

We build on the work of Carpenter (2009) and Adda and Cornaglia (2010) in several important ways. First and most importantly, we observe direct measures of exposure to ETS in a variety of public and private places. Carpenter (2009) only observes ETS exposure at work, and Adda and Cornaglia (2010) infer changes in ETS exposure indirectly from relationships between public-place smoking laws and cotinine measures. Second, we provide several useful robustness tests of the effects of public-place smoking laws, for example by directly testing for endogenous policy adoption (by controlling for leads of the public-place laws and by comparing the effects of public-place smoking laws for individuals living in cities that did or did not adopt a local smoking restriction prior to a stronger province-wide law). We are also able to explicitly test for differential effects of laws based on the strength of the law adopted. Adda and Cornaglia's policy data from the Americans for Non-smokers' Rights Foundation (ANRF) only includes variation from strong 100% smoke-free laws, and Carpenter (2009) similarly restricts attention to strong 100% smoke-free laws in Ontario. Since many strong laws were preceded by weaker laws (which may have had incremental effects at reducing ETS exposure), our empirical specifications are more comprehensive than have been estimated in previous work. Third, our outcome data from the CTUMS and CCHS includes detailed information on the respondent's full six-digit postal code of residence. This allows us to very precisely match the policies in place to each individual observation. In contrast, Adda and Cornaglia (2010) use as their dependent variable of interest the fraction of a state's residents covered by 100% smoke-free policies but do not directly match the local or state policy in effect to each respondent. In these ways our research complements and extends the previous quasi-experimental studies of ETS exposure in Adda and Cornaglia (2010) and Carpenter (2009).

III. DATA DESCRIPTION, INSTITUTIONAL BACKGROUND, AND EMPIRICAL APPROACH

a. Data Description

In order to analyze the effects of public-place smoking laws on smoking and ETS outcomes in Canada, we use confidential data from the Canadian Tobacco Use Monitoring Survey (CTUMS) from 2002-2008 and the Canadian Community Health Surveys (CCHS) from 2000-2008.[8] The CTUMS and the CCHS are both large repeated cross-sectional surveys used to gather health-related information on Canadians living in private households, excluding people on Indian reserves and on Canadian Forces bases. The main difference between the two datasets is that the CTUMS focuses entirely on smoking-related outcomes while the CCHS covers a broad range of health topics. As a result, the CTUMS contains a larger number of more detailed questions about smoking behavior and ETS exposure, while the CCHS contains only a handful of ETS exposure questions. The ETS exposure questions in the CCHS, however, cover a longer time period, and the CCHS has four times the sample size as compared to the CTUMS. Our main specifications restrict attention to respondents between the ages of 18 and 64 who have no missing data on the outcome variables or individual demographic covariates.

We construct several outcomes on own-smoking behavior using information that is available over the entire sample period in both datasets. First, we study the probability the respondent is a current smoker. All respondents are asked "At the present time, do you smoke cigarettes daily, occasionally, or not at all?" We create an outcome variable called "current smoker" that is equal to one if the individual reports smoking cigarettes daily or occasionally.

[8] For the CTUMS we use the annual file that combines Cycles 1 and 2 within each year. The CTUMS was also carried out in 1999, 2000, and 2001, but in these years there is no geographic information below province. Since a key contribution of our work is to test for the effects of numerous city-level laws prior to adoption of provincial laws, we focus on data from 2002-2008. For the CCHS, we use data from Cycle 1.1 (conducted in 2000/2001), Cycle 2.1 (conducted in 2003), Cycle 3.1 (conducted in 2005) and 4.1 (conducted in 2007/2008).

Individuals who report being daily or occasional smokers are then asked about their smoking intensity. We create an outcome equal to the number of cigarettes smoked in the previous month.[9]

Our primary information on ETS exposure comes from the CTUMS, which from 2005-2008 asked about each respondent's exposure to ETS in a variety of venues. Individual self-reports have been shown to be highly correlated with other biological markers of ETS exposure, such as saliva cotinine levels (Coghlin et al. 1999).[10] Specifically, individuals in the CTUMS are asked: "The next questions are about exposure to second-hand smoke in places other than your own home. Second-hand smoke is what smokers exhale and the smoke from a burning cigarette. In the past month, (excluding your own smoking), were you exposed to second-hand smoke: … inside a car or other vehicle?" Subsequent questions ask about exposure to ETS: 1) "inside someone else's home"; 2) "on an outdoor patio of a restaurant or bar"; 3) "inside a restaurant"; 4) "inside a bar or tavern"; 5) "at a bus-stop or shelter"; 6) "at an entrance to a building"; 7) "at your workplace"; 8) "at your school"; 9) "at any other public place such as a shopping mall, arena, bingo hall, concert, or sporting event"; and 10) "outdoors such as on a sidewalk or in a park". We code an indicator variable equal to one if the respondent reports she was exposed in each specific location.

[9] In the CTUMS, individuals are administered the 'smoking wheel' which asks them about the number of cigarettes smoked on each of the previous seven days, beginning with the day just before the interview and working backwards. We define smoking intensity as the number of cigarettes a smoker reports smoking in the past week multiplied by four. In the CTUMS, the smoking information is available from 2002 to 2008. In the CCHS (which does not administer the smoking wheel) we define this as the usual number of cigarettes smoked each day by daily smokers multiplied by thirty. For occasional smokers we compute past month consumption by multiplying the respondent's reported usual number of cigarettes smoked on the days she smoked multiplied by the number of days in the previous month she reported smoking at least one cigarette. This two-part model of smoking behavior is standard in the literature. See, for example, Cragg (1971), Manning *et al*. (1981), Duan *et al*. (1983), Mullahy (1998), and others. In the CCHS, the smoking information is available from 2000 to 2008.

[10] We are not aware of any data in Canada that cover the period in which the smoking laws were adopted and that include biological markers of ETS exposure (e.g., saliva cotinine) such as those used by Adda and Cornaglia (2010). Future work might employ the Canadian Health Measures Survey which did collect cotinine but which began only in 2007 and cover just 15 locations with very small sample sizes.

Several features of the core CTUMS ETS exposure outcomes are worth noting. First, the question is concrete. It explicitly defines ETS and asks respondents to think about locations *other than their own home*. Importantly, it also directs individuals to respond about *other people's smoke*; thus, the question is informative for both smokers and non-smokers. Finally, note that these questions are unlikely to suffer from desirability bias or related false reporting since there is no penalty to the respondent from reporting ETS exposure in these venues (unlike, say, surveys of bar or restaurant owners following adoption of smoking laws covering those venues). We rely on these CTUMS outcomes as our main sources of information on ETS exposure.

The information on public-place ETS exposure in the CCHS is more limited, so we use those data mainly to corroborate the findings in the CTUMS. For example, the CCHS only asks questions about ETS exposure to non-smokers. More importantly, these data do not ask about ETS exposure in each location/venue separately, so we instead create an outcome variable equal to one if the respondent reports being exposed to ETS in public places (defined in the CCHS as bars, restaurants, shopping malls, arenas, bingo halls, and bowling alleys) on all or most days in the previous month.[11]

b. Institutional Background

[11] The wording of the ETS exposure questions in the CCHS changed slightly over the sample period. Specifically, Cycle 1.1 of the CCHS asked all current respondents who did not report being a current smoker whether they were exposed to second-hand smoke (i.e., ETS) on most days in the previous month. Respondents who reported that they were exposed on most days then were asked a series of questions about where they were exposed, including "in a car or other private vehicle" and "in public places (bars, restaurants, shopping malls, arenas, bingo halls, bowling alleys)". Beginning with Cycle 2.1 and onward, the screener question about any exposure was eliminated, and non-smokers were explicitly asked about exposure "every day or almost every day" for the two venues (i.e., "in a car or other private vehicle" and "in public places" (with the identical venues listed in the question as in Cycle 1.1)). Our main CCHS results are unchanged if we restrict attention to data from Cycle 2.1 onward only. Also, note that all of our models include cycle-specific dummy variables.

We study the effects of public-place smoking laws using variation in the timing of policy adoption across cities and provinces in Canada over the past decade. The policies we study generally prohibit smoking in a variety of public places, including restaurants, bars, bingo halls, bowling alleys, shopping malls, and sporting arenas. Enforcement of these laws varies across cities and provinces, but generally the penalty for violating a public-place smoking ordinance is a modest to severe fine (e.g., $200 in Toronto, $2000 in Nova Scotia, and up to $10,000 in Saskatchewan) (CBC News 2009). The laws we study typically do not restrict smoking in private places such as cars, homes, or apartment buildings. Some of the laws we study do include language that prohibits smoking in private workplaces, though previous research has shown that these provisions were not binding for the vast majority of workers because most industries in North America voluntarily went smoke-free without the push of government intervention many years before the first public-place smoking restrictions were adopted (Carpenter 2010, Bitler et al. 2010a).

The public-place smoking restrictions we study were tracked by Health Canada,[12] which reports the specific public places covered by each city or province law, any relevant exemptions or provisions for Designated Smoking Areas (DSAs), and the date the law took effect.[13] In addition, Health Canada assigns to each policy a 'strength' rating, and below we describe how we use this additional variation to test whether stronger, more restrictive policies induced larger changes in outcomes than weaker, less restrictive policies. Gold laws are 100% smoke-free policies with no venue-specific exemptions. Silver laws allow for one venue-specific exemption

[12] Health Canada is the federal department responsible for maintaining and improving the health of Canadians.
[13] In the US, smoking laws vary substantially with respect to the venues covered (e.g., private workplaces, bars, restaurants, schools, government buildings, child care centers, transit facilities, shopping malls, and others) (Bitler et al. 2010a). In practice, most US-based research focuses on laws covering private workplaces, bars, and restaurants.

(most commonly this exemption pertained to bars).[14] Bronze laws allow for two or more venue-specific exemptions. Designated Smoking Areas are allowed under both Silver and Bronze laws but are prohibited under Gold laws.[15]

Figure 1 illustrates the cross-national variation in the presence of public-place smoking restrictions and provides information on the timing of policy adoption. Since some cities and provinces adopted multiple laws over the sample period (generally a weaker and then a stronger policy), we only show the first year in which individuals living in the area were subject to any type of public-place smoking restriction. In Figure 1 we outline the cities that adopted public-place smoking restrictions prior to the provincial law. As noted, some cites also adopted stronger laws after the initial provincial law, however for ease of presentation we do not identify these laws in Figure 1. A handful of cities adopted public-place smoking restrictions at the very beginning of our sample period, including Victoria and Vancouver, BC, in 1999 and 2000, respectively, as well as the capital city of Ottawa and the most populated city, Toronto, both in 2001.[16] By July 2005, seven of the top ten most populous cities had adopted a law, including: Toronto, Vancouver, Edmonton, Ottawa, Hamilton, Winnipeg, and London.[17] Figure 1 also shows that the province of Ontario had the largest number of city-wide public-place smoking restrictions, particularly in towns and cities around Toronto, London, and Windsor. Finally, Figure 1 shows that every province adopted a public-place smoking law at some point from 2000

[14] According to Health Canada, Gold, Silver, and Bronze laws all prohibit smoking in restaurants. We understand the exempted venues in Silver and Bronze laws to include venues such as bars, casinos, bowling alleys, billiard halls, and bingo halls.

[15] Clean indoor air laws in the United States also vary with respect to the strength of the laws adopted, and some previous research has used this variation (Tauras 2006, Bitler et al. 2010a, and others). One of the more commonly used policy tracking systems in the US, Robert Wood Johnson's ImpacTeen Database, for example, gives each covered venue in each state a rating from, say, 0 to 3, where 0 indicates no restrictions in smoking and 3 indicates a complete ban on smoking. We allow the gold/silver/bronze ratings to have independent relationships with our outcomes of interest, thus using the variation in the strength of the restrictions in a more flexible way.

[16] The strength of these laws varied: Toronto initially adopted a bronze law, Vancouver's initial law was classified as silver, while Victoria and Ottawa adopted gold laws.

[17] Montreal, Calgary and Quebec City did not adopt a city law prior to their respective provincial laws.

to 2008. British Columbia was the first province to do so in 2002, and Ontario and Quebec (the two other most highly populated provinces) followed suit in 2006.

Figures 2 and 3 show trends in the proportion of the CTUMS and CCHS samples, respectively, that we identify as living in an area covered by a public-place smoking law, as well as the proportion of people living in areas covered by the strongest 100% smoke-free gold laws. Both figures confirm that our samples cover the period of widespread adoption of public-place smoking restrictions. Figure 2 using the CTUMS data, for example, shows that only 35% (10%) of the country's population was covered by any (a gold) public-place smoking law in 2002 compared with 100% of Canadians currently covered by such a law. Figure 3 (which uses an independently drawn sample from the CCHS) confirms these trends and extends the time series back to 2000 when just over 10% of Canadians lived in an area covered by any public-place smoking law. Notably, both figures show that while the increase in the probability of being covered by any law was gradual over this period, there was a sharp break in the probability individuals were covered by stronger 100% smoke-free gold public-place smoking laws beginning in 2006 when many of the large provincial laws began taking effect.[18] Coincident with this sharp upturn in gold law coverage in Figure 2, we also observe corresponding reductions in ETS exposure inside bars and restaurants. Over this same period Figure 3 shows a very large proportional reduction in the fraction of non-smoking Canadians who reported being exposed to ETS in public places on all or most days of the previous month (from 23 to 11 percent) between 2000 and 2008. Both figures show declines in smoking participation over this period.

[18] The fact that the "any law" trend does not increase sharply at the same time illustrates that these strong province-wide laws were in many cases replacing weaker city-specific silver or bronze-level restrictions.

This general pattern of adoption whereby cities and towns adopted public-place smoking laws prior to more expansive province-wide laws in Canada generally mirrors the pattern of policy adoption in the United States as well, though the speed of adoption across Canada has occurred much faster. European countries began adopting public-place smoking restrictions around the same time as Canada, with Ireland going completely smoke-free (including in bars and restaurants) in 2004. Norway soon followed suit with its own bar and restaurant smoking ban later that year, and Italy adopted a similar law in 2005. Since then, laws completely restricting smoking in public places (including bars and restaurants) have been adopted in a variety of European countries, including: Scotland (in 2006), England (in 2007), Finland (in 2007), and France (in 2008) (EPHA 2010).[19] A proposal to ban smoking in all public places throughout the European Union is to be put forth by the European Commission in 2011. Many factors are thought to influence policy adoption, including an increase in worldwide anti-smoking sentiment and associated reductions in smoking prevalence (IOM 2010). We are not aware of good evidence on the prevalence of or trends in antismoking sentiment across countries, though smoking rates in Canada (about 20-25% over our sample period) are similar to those the US and are similar to or slightly lower than those in much of western Europe.[20]

c. Approach

To assess the impact of the public-place smoking laws, we use a difference-in-differences (DD) approach that controls for unobserved time invariant area-specific heterogeneity through

[19] Several European countries have exceptions for ventilated smoking rooms and/or bar/restaurant exemptions, while other countries have minimal enforcement of public-place smoking restrictions.
[20] A 2008 report by the Centers for Disease Control indicates the adult smoking rate in the United States is about 20%. The 2002 *Tobacco Atlas* by the World Health Organization reports the following adult smoking rates: Canada 25%; USA 23.6%; Ireland 31.5%; Norway 31.5%; Italy 24.9%; United Kingdom 26.5%; Finland 23.5%; and France 34.5% (Mackay and Eriksen 2002).

the inclusion of city (i.e., Canada's statistical area classification[21]) fixed effects and for area-invariant time-specific effects with the inclusion of time fixed effects. Specifically, we estimate the following:

$$(1)\ Y_{iat} = \alpha + \beta_1 X_{iat} + \beta_2 Z_{at} + \beta_3 (\text{Public-Place Smoking Law})_{at} + \text{Area}_a + \text{Year}_t + \varepsilon_{iat}$$

where Y_{iat} refers to the various smoking and ETS exposure outcomes for individual *i* in statistical area *a* in survey year *t*.[22] X_{iat} is a vector of individual demographic controls for age and its square, a male dummy, two marital status dummies (single never married and widowed/divorced/separated, with married/common-law as the reference group), and seven dummies for educational attainment (secondary school, some postsecondary school, some college, bachelors degree, graduate degree, and education missing, with less than high school as the reference group). Z_{at} is a vector of time-varying province-specific characteristics and policies that may be correlated with adoption of public-place smoking by-laws, including: the provincial unemployment rate and the real tax-inclusive provincial cigarette price. Area_a is a vector of statistical area dummies, and Year_t is a vector of survey year dummies. We also include unrestricted month-of-interview dummies in all specifications to account for seasonality.[23]

Public-Place Smoking Law_{at} is an indicator variable which equals one if the respondent lives in an area which is covered by a law restricting or prohibiting smoking in public places and

[21] Statistical area classifications are the combination of census metropolitan areas (population greater than 100,000 people) and census agglomerations (population between 10,000 and 100,000 people).
[22] We use linear probability models for ease of interpretation, but probit models returned very similar results. We use OLS for the smoking intensity models where the dependent variable of the natural log of the number of cigarettes smoked in the previous month.
[23] In some models we also allow for city-specific linear time trends which are created by interacting each city indicator with a variable that equals 1 in 2000, 2 in 2001, and so forth.

zero otherwise.[24] We construct the law variables by matching the local smoking policy in effect at the time of the CTUMS and CCHS interviews in the respondent's postal code of residence, similar to Carpenter's (2009) study of Ontario.[25] The coefficient of interest in equation (1) is β_3, which identifies the effect of public-place smoking laws as measured by the change in outcomes for individuals living in an affected area relative to the associated change in outcomes for individuals living in a non-affected area coincident with policy adoption. The key identifying assumption of the model is that that there are no shocks other than the public-place smoking laws that affected relative outcomes of individuals in adopting places versus non-adopting places. Throughout, ε_{iat} is assumed to be a well-behaved error term. All models use sampling weights provided by the CTUMS and CCHS, and standard errors are clustered at the statistical area level (Bertrand et al. 2004).[26]

IV. RESULTS

We provide basic weighted descriptive statistics for adult respondents age 18-64 in Tables 1 and 2 for the CTUMS and CCHS, respectively. Table 1 shows that about 43.7% of the CTUMS

[24] In robustness analyses we replace the single Public-Place Smoking Law dummy with a series of three indicator variables representing by-laws of varying restrictiveness as described above (i.e., Gold Public-Place Smoking Law, Silver Public-Place Smoking Law, and Bronze Public-Place Smoking law).

[25] Information on these local smoking restrictions comes from Health Canada. For most individuals we match on Statistical Areas (SAs) or province, but if the bylaw is below the SA level of geography (e.g., the subdivision level) we code according to the lower level of geography since we observe the respondent's full six-digit postal code. We drop a very small number of individuals whose postal code spans multiple SAs irrespective of the presence of a policy. We use the current policy in effect at the time of interview for all outcomes except the questions about exposure to ETS which ask about exposure over the past month. For these outcomes, we drop the small number of individuals who were interviewed within 30 days immediately following adoption of a public-place smoking policy.

[26] Note that all provinces adopted laws over our sample period. We code the strongest relevant policy in effect for each respondent. For example, many localities adopted a silver law prior to adoption of a province-wide gold law. Individuals in these cities are first coded as being subject to a silver law and subsequently as being subject to a gold law when the provincial law takes effect. In contrast, if a city first adopted a gold law and then the province later adopted a silver law, an individual residing in that city is coded as being subject to a gold law for the entire period beginning when the local law takes effect.

sample is covered by a 100% smoke-free gold public-place smoking law, compared with almost 20 percent covered by a silver law and 8 percent covered by a bronze law. Over the full sample period over ten percent of respondents report being exposed to ETS inside a bar/tavern or inside a restaurant, though as shown in Figure 2 these proportions fell dramatically from 2005-2008, coincident with adoption of public-place smoking laws. Over a third of respondents report being exposed to ETS on the patio of a bar or restaurant, while almost 58 percent of CTUMS respondents report being exposed to ETS at the entrance to a building. Over 20 percent of the CTUMS sample reports being a current smoker. Over 30 percent of respondents have at least a university degree, and the vast majority of the sample is married.

These same patterns are broadly confirmed in the CCHS descriptive statistics in Table 2. Almost a third of respondents in the CCHS are covered by a gold public-place smoking law, with lower proportions covered by silver or bronze laws (17.7 percent and 8.1 percent, respectively). Recall that our ETS exposure measure in the CCHS is slightly different than in the CTUMS; Table 2 shows that about 17.4 percent of non-smokers in the CCHS over the full sample period reports being exposed to ETS in public places on all or most days in the previous month. We also find slightly higher smoking rates in the CCHS than in the CTUMS, though this is partly a function of the fact that smoking rates were falling throughout the period, and the CTUMS data (2002-2008) are more recent than the CCHS data (2000-2008). Again, the patterns of demographic characteristics in the CCHS shown in Table 2 are largely similar to those reported in Table 1 for the CTUMS, confirming that the datasets are quite comparable. The large provinces (Ontario, Quebec, British Columbia, and Alberta) constitute over 85 percent of the population.

Table 3 presents the basic results for smoking participation (top panel) and smoking intensity (bottom panel) for both the CTUMS (columns 1-3) and CCHS (columns 4-6). Each column represents a separate model, and in each case we present the coefficient on the "public-place smoking law" indicator. We present results first without the city and year fixed effects; we then add the city and year fixed effects as in equation (1), and we subsequently add controls for linear city-specific time trends. All models include the individual level demographic controls, provincial level real cigarette prices, and provincial unemployment rates.

The results in Table 3 provide no evidence that public-place smoking laws significantly reduced smoking participation or intensity. Although models without city and year fixed effects in columns 1 (CTUMS) and 4 (CCHS) indicate that individuals in areas with public-place smoking laws are significantly less likely to smoke (top panel) and smoke significantly fewer cigarettes (bottom panel) than individuals in areas without public place smoking laws, these relationships are not robust to including unrestricted controls for statistical area and year fixed effects in columns 2 and 5 or to including city-specific linear time trends in columns 3 and 6. Our preferred estimate using the larger samples of the CCHS data, for example, indicates that there was virtually no relationship between adoption of public-place smoking laws and the probability an individual reports being a smoker (top panel of column 6), and the estimate is sufficiently precise that the 95% confidence interval rules out smoking reductions larger than 0.7 percentage points.[27] These null findings on smoking participation are consistent with recent

[27] Relative to a mean smoking rate of 30.7 percent in the CCHS (using the average from individuals in 2000 living in places without a law), this estimate rules out effect sizes of larger than about 2.3 percent [0.7/30.7=0.023] for public-place smoking laws on smoking participation. These null findings on smoking behavior are also inconsistent with endogenous policy adoption imparting serious bias to our estimates. It is also possible that it may take some time before the public-place smoking laws reduce smoking participation or intensity. Examining this issue by including a dummy for time greater than one year after the initial law, we still do not find much evidence of any effects of the law on either smoking participation or intensity.

research on similar policies in the US (Bitler et al. 2010a, Adda and Cornaglia 2010).[28] We find qualitatively identical patterns in the bottom panel for smoking intensity. Overall, we conclude that public-place smoking laws in Canada had no meaningful effects on population smoking prevalence.[29] These null findings on smoking prevalence suggest that any improvements in cardiovascular health associated with smoking bans are unlikely to be attributed to reductions in smoking by existing smokers.

We turn to our main ETS exposure outcomes from the CTUMS in Table 4. Each entry is the coefficient on the "public-place smoking law" indicator, and we only report results from our quasi-experimental models with city and year fixed effects (i.e., equation (1)). We present the relevant coefficient of interest for the first six outcomes (using the order in which they are asked in the survey) in the top panel and for the last six outcomes in the bottom panel. The results in Table 4 return strong evidence that public-place smoking laws significantly reduced exposure to ETS on outdoor patios of restaurants or bars (column 3), inside restaurants (column 4), and inside bars or taverns (column 5). Each of the estimated effects is statistically significant at the one percent level, and the estimated reductions are also very large in magnitude. The estimate in column 4, for example, indicates that adoption of a public-place smoking law reduced the probability a respondent reports being exposed to ETS inside a restaurant in the previous month by almost 40 percentage points, or by about 75 percent relative to a mean ETS exposure rate of 54 percent for individuals not covered by a public-place smoking law in 2005. Similarly, the

[28] These null findings on smoking also suggest that our CCHS models of ETS exposure that restrict attention to non-smokers are not seriously contaminated by composition bias (since smoking status is not correlated with adoption of public-place smoking laws). Recall that the ETS questions in the CCHS were only asked of non-smokers.

[29] In results not reported but available upon request, we did not find evidence that real tax-inclusive provincial cigarette prices had significant effects on smoking participation or intensity once we accounted for statistical area and year fixed effects. We similarly found no economically or statistically significant relationship between provincial unemployment rates and smoking prevalence. With respect to demographic characteristics, we found the usual patterns: men are more likely to smoke than women, smoking increases with age, married individuals are less likely to smoke than unmarried individuals, and highly educated individuals are less likely to smoke than individuals with less education. The full set of coefficient estimates is available upon request.

estimate in column 5 of Table 4 indicates that a public-place smoking law reduced exposure to ETS inside a bar or tavern by 23.9 percentage points, or by about 64 percent relative to the associated 2005 exposure rate for individuals not covered by a public-place smoking law (23.9/37.6=0.64). For the other venues in the top panel of Table 4 we find much smaller and statistically insignificant effects of public-place smoking laws, including inside a car or vehicle, inside someone else's home, and at a bus stop or shelter.

We examine the remaining venues in the bottom panel of Table 4, and again we only report the coefficient on the public-place smoking law in the preferred DD models with city and year fixed effects. Interestingly, in column 7 we estimate that public-place smoking laws *increased* the probability an individual reports she was exposed to someone else's smoke at the entrance to a building, and this estimate is statistically significant at the ten percent level. This may suggest that smoking is displaced from inside public places to just outside the entrance of those places; we return to this possibility below. Interestingly, we find no substantive or statistically significant relationship between exposure at one's workplace (column 8) or school (column 9) and the presence of a public-place smoking law. This is not surprising, given that the laws we study pertain to public places and not workplaces per se (though clearly bars, restaurants, and other public places are workplaces for some small share of workers)[30] and given other research that has documented that the vast majority of private workplaces went smoke-free without the push of government intervention far before the start of our sample period (Carpenter 2009, Bitler et al. 2010a, and others). We do, however, find that public-place smoking laws

[30] We do not have sufficient occupation data in the CTUMS to test whether these ETS exposure effects differ by occupation. We also considered estimating models that dropped individuals for whom the relevant venues are irrelevant (e.g., drop non-students for the question about exposure at school; drop non-workers for the question about exposure at the workplace) and making use of responses other than "Yes" or "No" in the CTUMS (e.g., "don't know"). However, 98% of the responses to the exposure questions in the CTUMS are "Yes" or "No", leaving us little power to do anything meaningful in this respect.

significantly reduced ETS exposure in a summary measure of other public venues that includes shopping malls, arenas, bingo halls, concerts, or sporting events (column 10). For these venues, we estimate that the laws reduce exposure by 5.1 percentage points, or about 15 percent relative to the proportion of individuals living in places without these laws who reported such exposure in 2005 (5.1/33.8=0.15). In column 11 we find that the laws had no meaningful effect on the probability an individual was exposed outdoors, such as on a sidewalk or in a park, suggesting that smokers were not displaced to these locations. Finally, in column 12 we find that the laws significantly reduced ETS exposure in other places not explicitly asked about in the CTUMS. Specifically, we estimate that a public-place smoking law reduced exposure to someone else's ETS "anywhere else" (i.e., other than in the locations explicitly asked previously) by 3 percentage points.[31]

In Table 5 we examine whether the reductions in ETS exposure observed in the various venues in Table 4 are driven by exposure reductions experienced by non-smokers, smokers, or both. Reduced smoking in public places could convey important cardiovascular health benefits to both non-smokers and smokers, but previous research has not addressed this question. We present results using the same specification as in Table 4 (i.e., with city and year fixed effects) but separately for the samples of current smokers and non-smokers in the CTUMS. Recall that current smoking status was unaffected by adoption of public-place smoking laws, so this exercise is not likely to be contaminated by systematic composition biases.

We present results for ETS exposure inside a restaurant (columns 1 and 2 for smokers and non-smokers, respectively), inside a bar or tavern (columns 3 and 4), and at the entrance to a building (columns 5 and 6). These results reveal strong evidence that the improvements in

[31] The results in Table 4 are very similar when we add controls for linear city-specific time trends (available upon request).

cardiovascular health from lower ETS exposure associated with public-place smoking laws accrue to both smokers and non-smokers. For example, we estimate reductions in ETS exposure inside a restaurant in columns 1 and 2 that are very similar in magnitude (and both statistically significant at the one percent level) for smokers and non-smokers, respectively. We find larger estimated absolute reductions in reported ETS exposure inside a bar or tavern for smokers compared with the associated reductions at those same types of venues reported by non-smokers, though the implied proportional reductions relative to the 2005 mean for individuals living in places without a law are very similar in magnitude (65% reduction for smokers and 63% reduction for non-smokers) and both are statistically significant.[32] Finally, in columns 5 and 6 of Table 5 we further probe the finding from Table 4 that public-place smoking laws were estimated to increase exposure to ETS at building entrances. When we separately examine smokers and non-smokers in Table 5, there is clearer evidence for displacement: while public-place smoking laws are not significantly related to the probability smokers report being exposed to ETS at building entrances in the past month (column 5), the laws significantly increase the probability non-smokers report being exposed to ETS at building entrances by 4.7 percentage points. We interpret this finding as suggesting that public-place smoking laws displace some smokers from inside public venues to just outside those venues.[33]

In Table 6 we examine the robustness of the main findings that public-place smoking laws significantly reduced exposure to other people's ETS in public places, particularly inside restaurants (top panel) and inside bars or taverns (bottom panel). In each column we present the

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[32] Results for other venues are available upon request. We do not present them here to conserve space. The patterns were qualitatively identical (i.e., significant reductions for both smokers and non-smokers) for ETS exposure: on outdoor patios of bars and restaurants; at public places such as malls, arenas, etc.; and 'anywhere else'.

[33] We do not find a similarly positive and statistically significant effect of public-place smoking laws on exposure to ETS at building entrances for smokers. One possibility is that smokers are being displaced to building entrances by themselves but not with others (recall the ETS exposure question explicitly asks about *other people's* smoke).

results from an alternative specification check. First, we reprint the basic difference-in-differences estimates (corresponding to those printed in Table 4) for each venue in column 1. In column 2 we add controls for linear city-specific time trends. In these models, we identify the effects of public-place smoking laws from sharp deviations off of smooth trends in outcomes coincident with adoption of the public-place smoking law. In column 3 we directly address concerns about possible policy endogeneity by controlling for a one-year lead of the public-place smoking law variable. If large shocks to outcomes systematically precede rather than follow public-place smoking laws, this could suggest that the laws were endogenously adopted or that there is some other specification error. Finally, in column 4 we report coefficient estimates from an alternative specification in which we replace the single public-place smoking law variable with separate indicators for laws of varying strength or restrictiveness (i.e., gold, silver, and bronze-level laws). In the presence of a true causal effect of the laws at reducing ETS in these venues, we might expect a plausible monotonicity in the strength of the law adopted.

The results in Table 6 confirm that the reductions in ETS exposure estimated in the previous tables are highly robust. For example, examining the top panel for exposure to ETS inside restaurants, we find that the coefficient estimate on the public-place smoking law variable remains large, negative, and highly significant once we include city-specific trends (column 2) or control for the one-year lead of the policy variable (column 3). Notably, the coefficient on the policy lead for the restaurant exposure variable is negative and statistically significant, but it is much smaller than the associated public-place smoking law coefficient estimate.[34] Finally, we

[34] A small negative and significant lead effect could arise, for example, if restaurant owners anticipated the law coming into effect and decided to comply in advance of the actual implementation date. Announcement effects would also produce the observed small lead coefficient for restaurant ETS exposure, particularly if there were uncertainty by smokers about when such laws took effect.

observe a plausible monotonicity in the strength of the law specification in column 5 (though the estimates for the gold and silver laws are very similar in magnitude).

For exposure to ETS inside bars and taverns in the bottom panel, we find that the effects of public-place smoking laws are also robust. The inclusion of city-specific time trends does little to the relevant coefficient estimate in the bottom panel (as for restaurant exposure), and we do not find evidence of a statistically significant lead effect in the bottom panel of column 3. Moreover, even with the control for the one-year lead, we continue to estimate that public-place smoking laws significantly reduced ETS exposure inside bars and taverns. In column 4 we observe stronger evidence of monotonicity in the effects according to the strength of the law adopted.[35] Overall, these results confirm that the estimated reductions in ETS exposure are highly robust, especially for exposure inside bars and taverns.

In Table 7 we examine the robustness of the ETS exposure reductions in a different way. Specifically, we turn to the independently drawn CCHS data that contains an alternative measure of such exposure: the probability an individual reports being exposed to ETS in public places (not separately by venue) on all or most days of the previous month. The format of Table 7 follows Table 6: we present the baseline difference-in-differences results in column 1, and in the remaining columns we assess robustness by: adding city-specific trends (column 2), controlling for a one-year policy lead (column 3), and controlling for the strength of the law adopted (column 4). The results in Table 7 confirm that the estimated reductions in public-place ETS exposure associated with adoption of a public-place smoking law are also found in the CCHS

[35] As noted above, Health Canada's coding indicates that smoking in restaurants is prohibited in Gold, Silver, and Bronze Laws; the venue-specific exemptions for Silver (one exemption) and Bronze (two or more exemptions) can include bars, casinos, bowling alleys, billiard halls, and bingo halls. This suggests we should observe a weaker Gold/Silver/Bronze gradient in the effects of public-place smoking laws on ETS exposure in restaurants as compared to bars. Indeed, this is what the patterns in Table 6 indicate. In results not reported but available upon request we found qualitatively similar results of the robustness exercises for the other venues. Exposure to ETS on outdoor patios of bars and restaurants exhibited patterns that were qualitatively identical to those for exposure to ETS in bars in the bottom panel of Table 6, for example.

data. Specifically, we estimate that a public-place smoking law reduces exposure to ETS in public places by about 6 to 10 percentage points. These effect sizes are large as a proportion of the sample mean for individuals in 2000 living in places without a law (.246), and all of the estimates in Table 7 are statistically significant at the one percent level. Thus, while the CCHS lacks detailed information on the precise location of exposure, the main finding that public-place smoking laws significantly reduced exposure to ETS in public places is confirmed.[36]

Finally, we perform two additional sets of analyses in Table 8 that speak directly to the validity of our identification strategy. First, we address the validity of the research design using an event study framework that traces out the dynamic effects of the policies relative to the year prior to adoption. Doing so allows us to assess the extent to which the observed effects are simple continuation of pre-existing trends, as well as whether there were systematic shocks to ETS exposure outcomes prior to policy adoption that would call into question the exogeneity of the timing of policy adoption. Second, we test whether the effects of public-place smoking laws are different for individuals living in cities that adopted such policies prior to a more expansive provincial law as compared to individuals living in cities that did not adopt a law prior to the province-wide law. This latter 'reverse experiment' variation for cities that were compelled by the stronger province-wide laws to go smoke-free in public places provides useful information on whether and to what extent the 'early adopters' were positively selected: if this were the case, the effects of 'city-level policies' would be larger than the effects of 'province-induced policies' (see Ananat et al. 2009 and Gruber et al. 1999 for a related discussion in the abortion literature).

[36] In results not reported but available upon request, we performed several other robustness checks to the main findings on public-place ETS exposure. First, our main results on reductions in ETS exposure in public places are robust to using a probit model for the dichotomous nature of the outcome instead of OLS; estimated marginal effects were virtually identical. Second, our main ETS results are also robust to excluding each of the highly populated provinces individually (Ontario, Quebec, British Columbia, and Alberta). Third, our main ETS results are robust to excluding Toronto and Vancouver. Fourth, our main ETS results are robust to excluding the small proportion of individuals living in cities that straddle province boundaries (e.g., Ottawa).

A finding that the effects of public-place smoking laws are largely similar using these two different sources of variation would indicate that the variation driving our identification is not substantially tainted from these selection concerns.

For both of these robustness tests the CCHS provides far superior information compared to the CTUMS. This is because the CTUMS ETS exposure outcomes only begin in 2005 which does not provide us enough pre-treatment data to credibly estimate a meaningful series of lead coefficients or the separate effects of city-level policy adoptions from province-level policy adoptions. In contrast, we observe the CCHS public-place ETS exposure outcomes as far back as 2000. Since Table 7 shows that the CCHS effectively reproduces the main findings from the CTUMS (i.e., that public-place smoking bans reduced ETS exposure), we use the CCHS for these additional tests regarding the timing of policy adoption.[37]

We show the results from these exercises in Table 8, beginning with the coefficient estimates from the dynamic specification that replaces the "any policy" variable with separate variables for "3 or more years before policy adoption", "2-3 years before policy adoption", and so forth (excluding the year just prior to policy adoption). We report estimates for the basic DD model and the augmented DD model with linear city trends in columns 1 and 2, respectively. These results support our identification strategy: there is no evidence of systematic spikes in public-place ETS exposure just prior to policy adoption, and our estimated policy effects do not

[37] There are a couple of practical issues that complicate these additional robustness tests that pertain to individuals living in cities with multiple policy adoptions (e.g., people in places that first adopted a bronze and then a silver local law). One issue is that the timing effects for individuals in those cities are confounded by differences in the strengths of laws adopted since cities almost always went from weaker to stronger laws. For simplicity, we have excluded individuals in cities with multiple adoption dates for the additional tests in Table 8. When we re-estimated the CCHS results from Table 7 removing individuals who lived in cities with multiple adoption dates, the Public-place smoking law coefficient is slightly larger in magnitude relative to our baseline results (-0.094** versus -0.074**) due to the fact that a larger proportion of cities that adapted only one law adopted a gold law and only multiple adoption cities ever adopted a weaker bronze law. When we re-estimated column (4) of Table 7 on the sample of individuals living in cities with at most one adoption date, we find that the magnitude of the Gold law and Silver law coefficients are very similar for the restricted and full sample (-0.095** versus -0.096** and -0.069* versus -0.077**, respectively).

simply reflect continuation of long-run pre-existing trends. Instead, there is a discrete, sustained reduction in ETS exposure coincident with policy adoption (in both the models with and without city trends). Figure 4 presents these results visually (using point estimates and 95% confidence intervals from column 1) and further supports our interpretation that the laws are responsible for the dramatic improvements in public-place ETS exposure.

Finally, in columns 3 and 4 of Table 8 we present results from the test of city versus province-level adoptions for the basic difference-in-differences model and a model with linear city-specific time trends, respectively. We find that the estimated effects of public-place smoking laws on ETS exposure in public places is generally similar when we use variation from the city adoptions as compared to estimates using variation from the wider province laws. Each of the four relevant point estimates in columns 3 and 4 of Table 8 indicate large and statistically significant reductions in public-place ETS exposure, and in the model with city trends we cannot reject that the two estimates are equal to each other (p=.107). Thus, we conclude that the estimated effects of public-place smoking laws described above are not substantially biased from selection concerns associated with endogenous policy adoption.

V. EVIDENCE ON DISPLACEMENT

Thus far our results show that public-place smoking laws in Canada were responsible for very large reductions in ETS exposure in public places, particularly in bars and restaurants. An important issue for welfare analysis is: how did these restrictions affect exposure to smoke in other venues not directly targeted by the laws. In particular, is there evidence of systematic displacement of smoking from public places to private places, as suggested by Adda and Cornaglia (2010)?

Notably, the results on exposure to ETS presented in Table 4 provide evidence inconsistent with displacement to at least two private places: cars and other people's homes. A more direct possibility, however, is that these public-place smoking restrictions may have induced substitution of smoking from public places to respondent's own homes. Understanding the importance of such potential displacement is important for assessing the likely overall effects of these laws on population health.

Fortunately, the CTUMS data contain this information. Specifically, from 2002-2008 in the household screener portion of the survey, respondents living with others were asked "Does anyone in your household smoke cigarettes, cigars, or pipes?"[38] All respondents are then asked "Including both family members and regular visitors, how many people smoke INSIDE your home every day or almost every day? [emphasis in original questionnaire]" Finally, respondents reporting that someone smokes inside the home every day or almost every day are asked: "On a typical day, about how many cigarettes are smoked INSIDE your home?" Responses are recoded into categories, including: None, 1-10, 11-20, 21-30, 31-40, and 41 or more.

Using this information, we can create two meaningful outcomes: an indicator for whether any positive number of cigarettes is smoked inside the home, as well as the number of cigarettes smoked inside the home on a typical day.[39] We can also use information on whether there is a smoker in the respondent's household to examine whether the effects differ between individuals in households without any smokers and individuals in households with at least one smoker. If the public-place smoking laws induce displacement from public places to private homes, we

[38] Smoking information for individuals living alone is ascertained later in the individual portion of the survey.

[39] By construction the information on number of cigarettes smoked inside the home is restricted to people who report a positive number of people smoking inside the home on every or almost every day. We could also examine as an outcome the number of people the respondent reports who smoke inside the home on every or almost every day, though we choose to use information on the number of cigarettes smoked inside the home because it is the ultimate construct of interest. Note that if the laws induce displacement to home smoking on "some" or "a few" days (e.g., if the law induces displacement for 'weekend' smokers), the CTUMS question will not detect this. This is a limitation of the self-reported data relative to objective information on cotinine.

would expect to see increases in reported smoking inside homes after the laws are adopted, and these effects should be particularly pronounced for individuals in households with smokers (note this includes smokers living alone).

We estimated equation (1) on these home smoking outcomes and present the results in Tables 9 and 10 for the dichotomous "someone smokes inside the home every day or almost every day" and the continuous "number of cigarettes smoked inside the home on a typical day" outcomes, respectively. The format of these tables is identical: we show results for the full sample in the simple fixed-effects specification in Column 1, and we add linear city-specific time trends in Column 2. We then estimate these same two specifications for the sample of individuals living in households without any smokers (Columns 3 and 4) and individuals living in households with at least one smoker (Columns 5 and 6).[40] In the top panel we show the results from the "any law" specification, while in the bottom panel we show results from the "gold/silver/bronze" specification.

The CTUMS results in Tables 9 and 10 regarding potential ETS exposure in private homes are inconsistent with substantial displacement to private homes. Specifically, in Table 9 for the outcome reflecting the presence of an every-day-or-almost-every day smoker inside the

[40] In the 2002 survey, the CTUMS editing procedures coded everyone in a single-person household who reported being a smoker as having someone in the household who smokes. Starting in 2003, the question wording was changed slightly to read "Do you/does anyone in your household smoke cigarettes, cigars, or pipes?" From 2003 onward, the CTUMS did not recode the "presence of a household smoker" variable to be consistent with the respondent's own smoking status for single-person households. Thus, from 2003 onward (and in 2002 for people in households with multiple persons) a small number of people who report being current smokers also report that there is nobody in the household who smokes. This could either be due to desirability bias or to mis-interpretation of the household screener question. In any event, it is unlikely that such biases are correlated with adoption of public-place smoking restrictions. Note also that all of our specifications include year dummies to account for survey differences common to any single year. In robustness analyses in Tables 9 and 10, however, these internally-inconsistent respondents are eliminated from the sample when we restrict attention to respondents reporting that there are no smokers in the household (since for these individuals it is not at all clear if their reports about the number of cigarettes smoked inside the house are valid). This explains the small difference in sample size when we split the sample by the presence of a household smoker (e.g., in theory the sample size in Columns 3(4) and 5(6) of Tables 9 and 10 should add up to the sample size in Column 1 (2); they do not because we have eliminated a small number of smoking respondents from Column 3 (4) who report that there are no smokers in their household.

home, we find no evidence in either the baseline difference-in-differences specification or in the augmented model with linear trends that public-place smoking laws increase smoking inside homes. In fact, the sign of the point estimate on the "any law" variable is negative (and in the model without trends it is also statistically significant), suggesting a *protective* association. Not surprisingly, the "strength of laws" specification similarly returns no evidence that the public-place smoking laws displace smoking from public places to the respondent's private home. Similarly, when we cut the data by whether there is a smoker in the respondent's household (including, potentially, the respondent), we find no systematic evidence favoring displacement in the group where it should be especially salient: households with smokers. That is, none of the eight point estimates in columns 5 and 6 are positive in sign (and none are statistically significant), which is what we would expect if the laws induce displacement to private homes.

Of course, Table 9 only tests one margin of home smoking, and this may not be a powerful test given that smokers may have smoked cigarettes inside the home even prior to public-place smoking restrictions being adopted. Indeed, we report in the top row of Table 9 that 58.9% of people living in households with at least one smoker in cities without a law in 2002 reported that a positive number of cigarettes are smoked inside the home, while the associated figure for people living in household without smokers was just 1.3%. Table 10 therefore tests for displacement measured by the number of cigarettes that the respondent reports are smoked inside the home on a typical day among the sample of respondents reporting the presence of an every-or-almost-every-day smoker.[41] This table replicates these same basic patterns and on the whole is inconsistent with systematic, significant displacement of smoking from public places to private homes in response to public-place smoking laws. In the top panel, only one of the six estimates

[41] We estimate the models in Table 10 using OLS on the midpoints of the ranges in the question, using a value of 45.5 cigarettes for the small proportion of respondents reporting more 40 or more cigarettes smoked inside the home on a typical day. More sophisticated methods, including interval regression, returned qualitatively identical results.

is positive in sign (which would be consistent with displacement), and it is observed for the sample that should be least likely to be exhibit displacement: individuals in households without any smokers. In the model with linear city-specific time trends in the top panel of column 6 for respondents living in households with smokers (where displacement should plausibly be the strongest), we estimate that a public-place smoking law is associated with a *reduction* in the number of cigarettes smoked by 0.492 cigarettes. The 95% confidence interval around this estimate means that we can rule out displacement effects of larger than 0.41 cigarettes. Relative to the associated average for people living in places without a law in 2002 of 9.473, this means that we can rule out displacement effect sizes larger than about 0.41/9.473=0.043, or about 4.3 percent. The patterns of point estimates in the bottom panel of Table 10 for the gold/silver/bronze specification are similarly inconsistent with substantial displacement effects.[42] Overall, these patterns in the CTUMS data do not return strong evidence of systematic displacement of smoking from public places to private homes.[43]

VI. DISCUSSION AND CONCLUSION

We examined the effects of numerous local and provincial public-place smoking laws adopted across Canada over the past decade on a variety of smoking-related outcomes, including a direct

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[42] Table 10 also shows, not surprisingly, that individuals in households without smokers living in places without these laws in 2002 report far fewer cigarettes smoked inside their homes on a typical day relative to individuals in households with at least one smoker (0.17 vs. 9.47 cigarettes, respectively).

[43] We found qualitatively identical results in the CCHS (available upon request). In the CCHS, the question about smoking inside homes is only asked of individuals who live with others or of non-smokers who live by themselves. (In Cycle 1.1, the question is asked of all respondents. We restricted the Cycle 1.1 sample to match that of the other cycles.) Also, there is no way in the CCHS to determine whether the respondent's household contains a regular smoker (only the smoking status of the respondent is directly ascertained). Finally, the home smoking question in the CCHS (which refers to the presence of someone who "regularly" smokes inside the home) is less concrete than in the CTUMS (which refers to smoking inside the home "every day or almost every day"). Despite these challenges, fixed-effects estimates of the effect of public-place smoking restrictions on the probability of having a regular smoker inside the home were extremely small in magnitude, statistically indistinguishable from zero, and as likely to suggest protective associations as they were to suggest displacement effects.

measure of exposure to ETS in the venues explicitly targeted by the laws. We also directly test for displacement of smoking from public places to private places. Most previous work has focused mainly on smoking prevalence, despite that the explicit goal of public-place smoking laws was to reduce population ETS exposure in public places. Moreover, previous research on displacement effects of similar policies lacked direct information on *where* individuals were exposed to ETS.

Our results indicate that public-place smoking laws in Canada did not have meaningful effects on smoking participation or intensity. We do, however, find that the laws significantly reduced exposure to ETS in a variety of public places—especially bars, restaurants, and outdoor patios of bars and restaurants. These reductions in public-place ETS exposure are observed for both smokers and non-smokers, are highly robust to a variety of important specification checks, and are replicated in an independently drawn sample (CCHS). Interestingly, we also estimate that public-place smoking laws significantly *increased* non-smokers' exposure to ETS at building entrances, suggesting that the laws displace some smokers from inside public venues to just outside those places. We did not, however, find that the laws had significant effects on ETS exposure in several other venues, however, including in cars, in other people's homes, and in the respondent's own home.

How large are these effects? Recall that the summary measure of public-place ETS exposure among non-smokers in Canada in the CCHS fell about 12 percentage points from 2000 to 2008 in the CCHS (from 23 percent of the sample to 11 percent being exposed on all or most days in public places). Our fixed-effects estimate in Table 7 suggests that public-place smoking laws can account for 7.4 percentage points (i.e., the majority) of this improvement. Measured differently using the venue-specific exposure outcomes in the CTUMS, we estimate that public-place smoking laws can account for the vast majority of the near elimination of ETS in bars and restaurants observed from 2005-2008. Importantly, our results uncover multiple plausible mechanisms through which public-place smoking laws may be expected to improve cardiovascular health for both smokers and non-smokers, as reported in a recent IOM report on smoking bans and heart attacks. Finally, our null findings on smoking prevalence suggest that any improvements in cardiovascular health associated with adoption of smoking bans are not likely attributable to reductions in own-smoking.

Our study is subject to several limitations. First, our outcome data are self-reported exposure outcomes and are not biological markers of exposure to ETS. Given our direct knowledge about location of exposure and the increase in external validity and generalizability, this seems a reasonable trade-off, particularly since the epidemiological literature using biomarker data is now full of single-site evaluations of public-place ETS exposure that focus on select samples (e.g., bar workers). Our results demonstrate that the effects of public-place smoking laws are economically and statistically significant across the population. A second limitation is that although we can identify the venues from which smoking is being displaced (e.g., bars, restaurants, outdoor patios, other public-places), we are unable to identify all of the venues towards which smoking is being reallocated (and we think such a reallocation exists because of the null findings on smoking participation and intensity). One possibility is that there is displacement to venues that do not fit nicely into the list of places in the CTUMS question (e.g., walking from one's car to a building). Another possibility is that smoke could be displaced to front porches or backyards of homes instead of inside homes. Third, we do not observe information on where respondents spend their time. Since one rational response by smokers and non-smokers alike is to change the amount of time spent in various places in response to public-place smoking restrictions, we cannot rule out that these behavioral changes are important responses to the laws.[44]

Despite these limitations, our results offer the strongest evidence to date that public-place smoking laws are effective tools at reducing non-smokers' and smokers' exposure to ETS in a variety of public places on a broad, population-wide scale. In so doing, these findings—coupled with the lack of evidence of large displacement effects to private homes—suggest wide latitude for significant public health improvements if the United States and other countries were to universally ban smoking in public places.

[44] We can, however, provide descriptive evidence indicating that a substantial share of the population spends time in bars and restaurants and that individuals who patronize these establishments spend a meaningful amount of time there. Specifically, we examined confidential data from cycle 19 of the Canadian General Social Survey (GSS) on Time Use. These data provide information on individual time use over a 24-hour period. Interviews for cycle 19 of the GSS were conducted between January and December 2005, which corresponds to the beginning of our CTUMS sample with questions on ETS exposure. The GSS data indicate that approximately 20 and 5 percent of the sample whose reference day was either Friday or Saturday went to a restaurant for a meal or to a bar to socialize on the reference day, respectively. An even higher proportion of young adults age 19-35 whose reference day was a Friday or a Saturday attended a bar on that day: 8 percent of this group did so. These age-specific differences in time spent in a bar correspond with the mean exposure in bars from the CTUMS sample, were we found that in 2005 34 percent of the respondents age 19 to 35 said they were exposed to ETS in a bar, while only 16 percent of respondents age 36 to 64 said they were exposed to ETS in a bar (recall these CTUMS exposure outcomes are measured over the previous month). Moreover, the GSS data indicate that among individuals patronizing these establishments, large amounts of time are spent at bars and restaurants. Among respondents who reported going to a bar and whose reference day was Friday or Saturday, the average time spent socializing was approximately 165 minutes; the associated figure for eating a meal at a restaurant was approximately 93 minutes. Overall, then, the GSS data indicate that in 2005 (before the widespread adoption of strong provincial public-place smoking laws) a substantial share of individuals attended bars and restaurants—especially on the weekends—and spent multiple hours there on each occasion. A natural follow-up analysis would be to examine how time use patterns changed with the widespread adoption of public-place smoking laws after 2005, when the province-wide regulations were implemented, as well as to examine how patterns of time use in bars and restaurants differ by smoking status. Unfortunately, the next most recent GSS Time Use survey (Cycle 24) is not available to researchers until late 2011, and none of the time use surveys provide information on respondent smoking status. As such, we describe these GSS time use patterns to show that the reductions in ETS exposure attributable to public-place smoking laws are consistent with meaningful health improvements documented in other studies.

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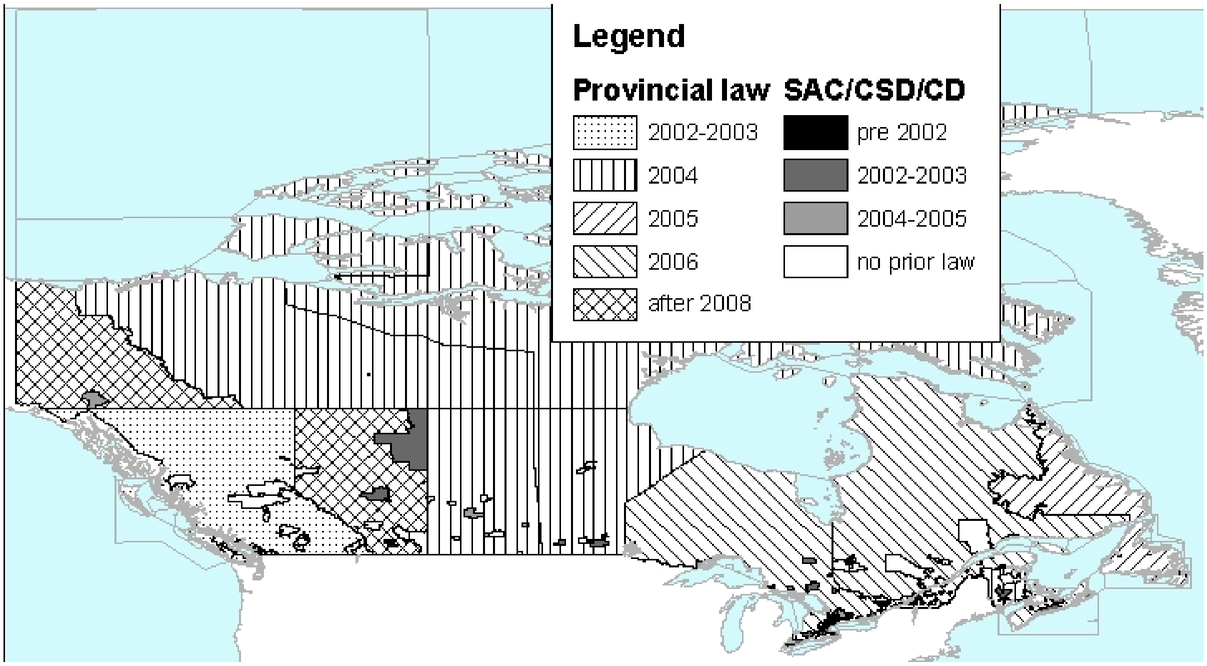
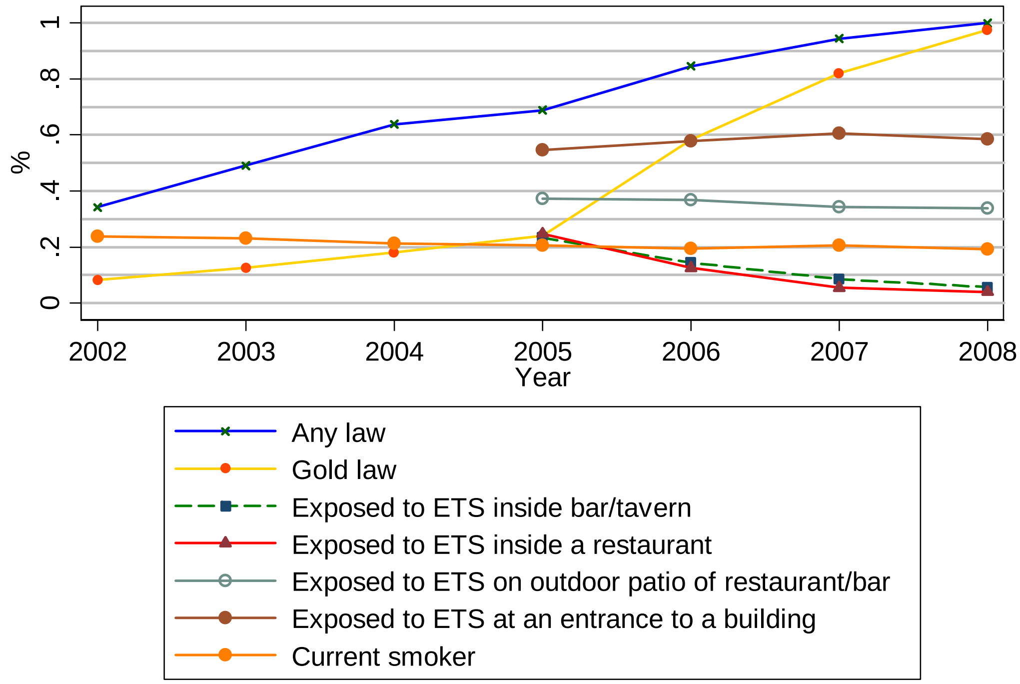
Figure 1: Timing of adoption of public-place smoking laws at the local and provincial level across Canada, 2000-2008



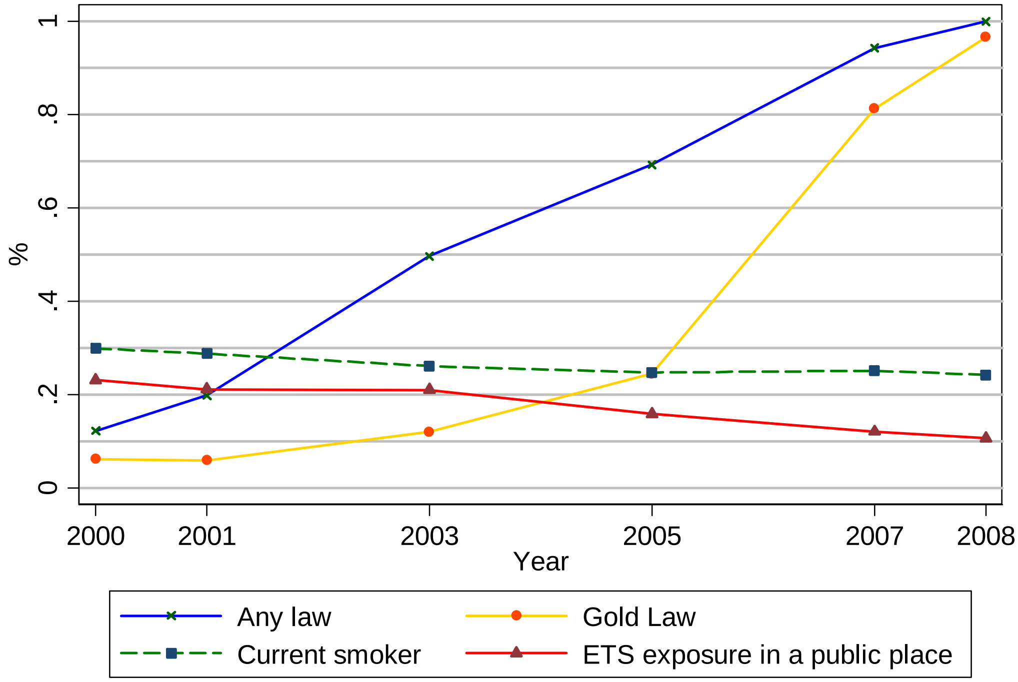
Notes: SAC, CSD, and CD are Canada's geographic designations for 'statistical area classification', 'census subdivision', and 'census division', respectively.

Figure 2: Trends in public-place smoking laws, ETS exposure inside bars/taverns, inside restaurants, on outdoor patios of restaurants/bars, and at building entrances, CTUMS 2002-2008



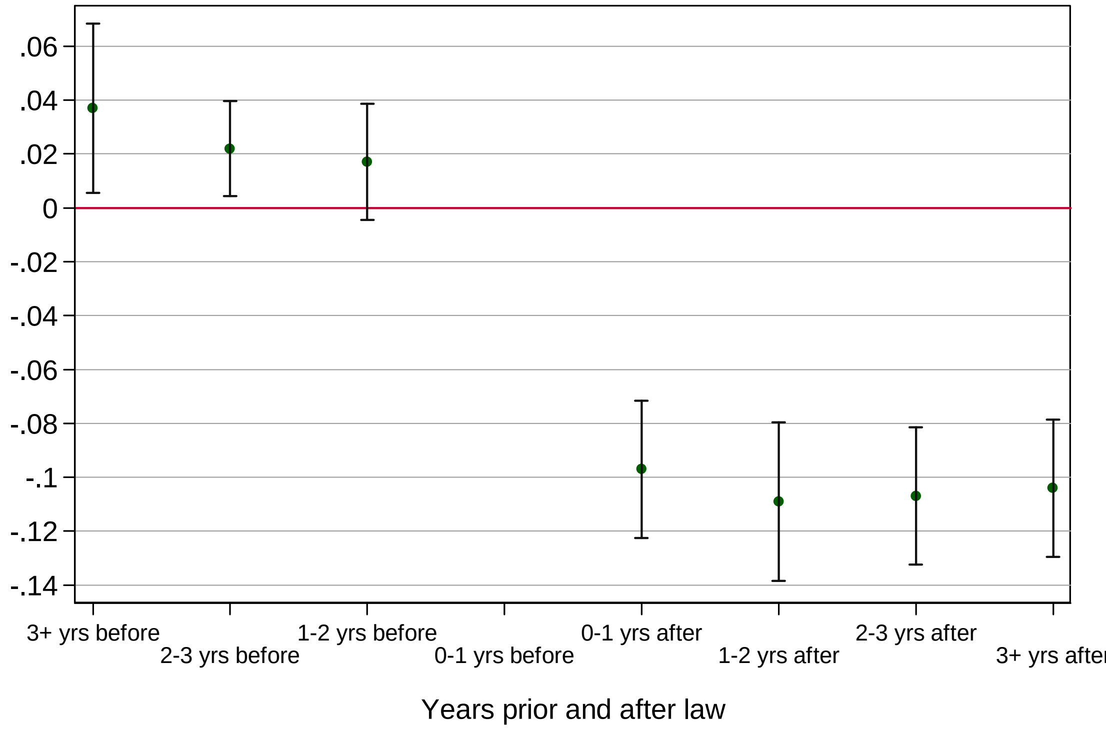
Source: CTUMS 2002-2008

Figure 3: Trends in public-place smoking laws, ETS exposure in a public place and smoking status, CCHS 2000-2008



Source: CCHS 1.1, 2.1, 3.1 and 4.1

Figure 4: Event study estimates of the effects of public-place smoking laws on ETS exposure in public places on all or most days of the previous month, CCHS 2000-2008



Notes: Coefficients and 95% confidence intervals. The reference category is year prior to the enactment of a law. The sample includes places that had at most one type of law and is restricted to non-smokers. Source: CCHS 1.1, 2.1, 3.1 and 4.1.

Table 1: Descriptive Statistics, CTUMS

	Full sample
Public-place smoking law	0.712
Gold public-place smoking law	0.437
Silver public-place smoking law	0.196
Bronze public-place smoking law	0.080
Exposed to second hand smoke*	
- inside a bar/tavern	0.130
- inside a restaurant	0.116
- on the patio of a bar or restaurant	0.355
- at the entrance to a building	0.579
- inside a car or vehicle	0.261
- inside someone else's home	0.293
- at a bus stop or shelter	0.186
- at your workplace	0.271
- at your school	0.070
- at any other public place such as a shopping mall, arena, etc	0.348
- outdoors such as on a sidewalk or in a park	0.568
- anywhere else	0.045
Current smoker	0.211
Number of cigarettes smoked last month (among smokers)	380.7
Age	39.70
Male	0.497
Education	
Less than high school	0.089
High school	0.231
Some post secondary	0.154
College	0.202
University	0.301
Other	0.011
Missing	0.012
Marital status	
Single never married	0.274
Not currently married (i.e., widowed, divorced, or separated)	0.081
Missing	0.013
Observations	67,142

Notes: Weighted means, CTUMS 2002-2008, adults age 18-64.
* Weighted means, CTUMS 2005-2008, adults age 18-64.

Table 2: Descriptive Statistics, CCHS

	Full sample
Public-place smoking law	0.584
Gold public-place smoking law	0.325
Silver public-place smoking law	0.177
Bronze public-place smoking law	0.081
Exposed to ETS in public places on most or all days in previous month (among non smokers)	0.174
Current smoker	0.261
Number of cigarettes smoked last month (among smokers)	377.6
Age	39.9
Male	0.498
Education	
Less than high school	0.047
High school	0.100
Some post secondary	0.063
College	0.379
Bachelor	0.224
Graduate school	0.125
Missing	0.062
Marital status	
Single never married	0.277
Not currently married (i.e., widowed, divorced, or separated)	0.093
Province	
Newfoundland	0.009
PEI	0.003
Nova Scotia	0.023
New Brunswick	0.018
Quebec	0.236
Ontario	0.409
Manitoba	0.030
Saskatchewan	0.023
Alberta	0.102
British Columbia	0.145
Yukon	0.001
North West Territories	0.001
Observations	238,503

Notes: Weighted means, CCHS Cycles 1.1-2008, adults age 18-64.

Table 3: Public-place smoking laws had no significant effects on smoking, sample is all adults in CTUMS and CCHS, 2000-2008

	CTUMS 2002-2008			CCHS 2000-2008		
	(1)	(2)	(3)	(4)	(5)	(6)
	Smoking participation (0/1)					
Mean of dep var in first year of sample, no law	0.261	0.261	0.261	0.307	0.307	0.307
Public-place smoking law	-0.037** [0.012] {-14.2%}	-0.016 [0.009] {-6.5%}	-0.011 [0.009] {-4.2%}	-0.024** [0.008] {-7.8%}	0.002 [0.004] {0.7%}	0.003 [0.005] {1.0%}
Observations	67,142	67,142	67,142	238,477	238,477	238,477
R-Squared	0.06	0.07	0.07	0.06	0.07	0.07
	Log # cigarettes smoked last month (among smokers)					
Mean of dep var in first year of sample, no law	6.04	6.04	6.04	5.62	5.62	5.62
Public-place smoking law	-0.073** [0.021] {-1.2%}	-0.007 [0.038] {-0.1%}	-0.009 [0.030] {-0.1%}	-0.124* [0.054] {-2.2%}	0.010 [0.017] {0.2%}	-0.001 [0.020] {0.0%}
Observations	11,647	11,647	11,647	66,640	66,640	66,640
R-squared	0.09	0.12	0.14	0.12	0.13	0.13
Individual and provincial controls?	Yes	Yes	Yes	Yes	Yes	Yes
City and year fixed effects?		Yes	Yes		Yes	Yes
City specific linear trends?			Yes			Yes

Notes: Sample in columns 1-3 includes adults age 18-64 in the CTUMS 2002-2008. Sample in columns 4-6 includes adults age 18-64 in the CCHS Cycles 1.1-4.1. The dependent variable in the top panel is an indicator variable equal to 1 if the person reports being a current smoker. The dependent variable in the bottom panel is the natural log of the number of cigarettes smoked last month. In the CTUMS we use information on number of cigarettes smoked over the last seven days to construct a monthly variable. Since a large number of occasional smokers in the CTUMS did not smoke in the last week, the sample in columns 5 and 6 is restricted to daily smokers. In the CCHS, the information on smoking was on the past month, and so we are able to use all current smokers. Individual demographic controls include: age and its square, a male dummy, two marital status dummies, and six education dummies (see text). All models also control for the provincial cigarette excise tax and the provincial unemployment rate. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 4: Public-place smoking laws significantly reduced exposure to ETS in public places--especially restaurants and bars, sample is all adults in CTUMS 2005-2008

	(1)	(2)	(3)	(4)	(5)	(6)
Exposed to ETS:	Inside a car or vehicle	Inside someone else's home	On an outdoor patio of a restaurant or bar	Inside a restaurant	Inside a bar or tavern	At a bus stop or shelter
Mean of dep var in 2005, no law:	0.309	0.420	0.394	0.539	0.376	0.138
Public-place smoking law	-0.020 [0.012] {-6.5%}	-0.017 [0.016] {-4.0%}	-0.113** [0.016] {-28.7%}	-0.396** [0.049] {-73.5%}	-0.239** [0.015] {-63.6%}	-0.024 [0.019] {-17.4%}
Observations	37,693	37,693	37,693	37,693	37,693	37,693
R-Squared	0.13	0.12	0.08	0.23	0.15	0.08

	(7)	(8)	(9)	(10)	(11)	(12)
Exposed to ETS:	At an entrance to a building	At your workplace	At your school	At any other public place…†	Outdoors such as on a sidewalk or in a park	Anywhere else
Mean of dep var in 2005, no law:	0.517	0.274	0.069	0.338	0.499	0.044
Public-place smoking law	0.026* [0.013] {5.0%}	-0.011 [0.015] {-4.0%}	0.001 [0.005] {1.4%}	-0.051** [0.012] {-15.1%}	-0.010 [0.014] {-2.0%}	-0.030** [0.008] {-68.2%}
Observations	37,693	37,693	37,693	37,693	37,693	37,693
R-Squared	0.04	0.05	0.19	0.04	0.05	0.02
Individual and provincial controls?	Yes	Yes	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Sample includes adults age 18-64 in the CTUMS 2002-2008. The dependent variable in each column is an indicator equal to one if the individual reports being exposed to someone else's smoke in each of the specific areas. See notes to Table 3 for control variables. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%. †The remainder of the question reads "…such as a shopping mall, arena, bingo hall, concert, or sporting event".

Table 5: Public-place smoking laws reduced exposure to ETS inside bars and restaurants for both non-smokers and smokers but increased non-smokers' ETS exposure at building entrances, sample is all adults in CTUMS 2005-2008

	(1)	(2)	(3)	(4)	(5)	(6)
Sample is:	Smokers	Non-smokers	Smokers	Non-smokers	Smokers	Non-smokers
Exposed to ETS:	Inside a restaurant	Inside a restaurant	Inside a bar or tavern	Inside a bar or tavern	At an entrance to a building	At an entrance to a building
Mean of dep var in 2005, no law:	0.582	0.525	0.572	0.311	0.572	0.499
Public-place smoking law	-0.399**	-0.391**	-0.374**	-0.197**	-0.017	0.047**
	[0.043]	[0.053]	[0.029]	[0.016]	[0.034]	[0.017]
	{-68.6%}	{-74.5%}	{-65.4%}	{-63.3%}	{-3.0%}	{9.4%}
Observations	8,681	29,012	8,681	29,012	8,681	29,012
R-Squared	0.32	0.21	0.27	0.12	0.07	0.05
Individual and provincial controls?	Yes	Yes	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Sample includes adults age 18-64 in the CTUMS 2002-2008. The dependent variable in each column is an indicator equal to one if the individual reports being exposed to someone else's smoke in each of the specific areas. See notes to Table 3 for control variables. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 6: The effects of public-place smoking laws on exposure to ETS are robust, sample is CTUMS 2005-2008

	(1)	(2)	(3)	(4)
Specification is:	Baseline DD	(1) + city trends	(1) + one year lead	(1), strength of laws
		Exposed to ETS inside a restaurant		
Mean of dep var in 2005, no law:	0.539	0.539	0.539	0.539
Year prior to adoption of law	--	--	-0.060** [0.022] {-11.1%}	--
Public-place smoking law	-0.396** [0.049] {-73.5%}	-0.339** [0.069] {-62.9%}	-0.438** [0.063] {-81.3%}	--
Gold law	--	--	--	-0.403** [0.048] {-74.8%}
Silver law	--	--	--	-0.398** [0.046] {-73.8%}
Bronze Law	--	--	--	-0.271** [0.058] {-50.3%}
Observations	37,694	37,694	37,694	37,694
R-squared	0.23	0.24	0.23	0.23
		Exposed to ETS inside a bar/tavern		
Mean of dep var in 2005, no law:	0.376	0.376	0.376	0.376
Year prior to adoption of law	--	--	-0.055 [0.042] { -14.6%}	--
Public-place smoking law	-0.239** [0.015] {-63.6%}	-0.213** [0.023] {-56.6%}	-0.278** [0.032] {-73.9%}	--
Gold law	--	--	--	-0.258** [0.015] {-68.6%}
Silver law	--	--	--	-0.218** [0.024] {-58.0%}
Bronze Law	--	--	--	-0.069 [0.054] {-18.4%}
Observations	37,694	37,694	37,694	37,694
R-Squared	0.15	0.16	0.15	0.22
Individual/provincial controls?	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes

Notes: Sample includes adults age 18-64 in the CTUMS 2005-2008. The dependent variable in each model is an indicator equal to one if the individual reports being exposed to someone else's smoke in each of the specific areas (inside a restaurant in the top panel; inside a bar/tavern in the bottom panel). See notes to Table 3 for control variables. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 7: The reductions in non-smokers' exposure to ETS in public places also obtains in the CCHS, sample is non-smokers in the CCHS Cycles 1.1-4.1 (2000-2008)

	(1)	(2)	(3)	(4)
	Baseline DD	(1) + city trends	(1) + one year lead	(1), strength of laws
Mean of dep var in 2000, no law:	0.246	0.246	0.246	0.246
Year prior to adoption of law	--	--	-0.039** [0.006] {-15.8%}	--
Public-place smoking law	-0.074** [0.017] {-30.1%}	-0.058** [0.018] {-23.6%}	-0.110** [0.018] {-44.7%}	--
Gold law	--	--	--	-0.096** [0.012] {-39.0%}
Silver law	--	--	--	-0.077** [0.009] {-31.3%}
Bronze Law	--	--	--	-0.046* [0.018] {-18.7%}
Observations	168,263	168,263	168,263	168,263
R-Squared	0.06	0.05	0.06	0.06
Individual/provincial controls?	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes

Notes: Sample includes adults age 18-64 who are non-smokers in the CCHS Cycles 1.1-4.1. The dependent variable is an indicator equal to 1 if the person reports being exposed to ETS in public places on most or all days of the previous month. Individual demographic controls include: age and its square, a male dummy, two marital status dummies, and six education dummies (see text). All models also control for the provincial cigarette excise tax and the provincial unemployment rate. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 8: Further evidence on the robustness of the reductions in non-smokers' exposure to ETS in public places, sample is non-smokers in the CCHS Cycles 1.1-4.1 in cities that adopted at most one law (2000-2008)

	(1)	(2)	(3)	(4)
	Dynamic specification	(1) + city trends	City vs. Province laws	(3) + city trends
Mean of dep var in 2000, no law:	0.194	0.194	0.194	0.194
3+ years prior to adoption	0.037*	0.000	--	--
	[0.016]	[0.014]		
	{19.1%}	{0.0%}		
2-3 years prior to adoption	0.022*	-0.001	--	--
	[0.009]	[0.008]		
	{11.3%}	{-0.5%}		
1-2 years prior to adoption	0.017	0.007	--	--
	[0.011]	[0.010]		
	{8.8%}	{3.6%}		
0-1 year prior to adoption	--	--	--	--
0-1 year after adoption	-0.097**	-0.085**	--	--
	[0.013]	[0.013]		
	{-50.0%}	{-43.8%}		
1-2 years after adoption	-0.109**	-0.083**	--	--
	[0.015]	[0.019]		
	{-56.2%}	{-42.8%}		
2-3 years after adoption	-0.107**	-0.071**	--	--
	[0.013]	[0.016]		
	{-55.2%}	{-36.6%}		
3+ years after adoption	-0.104**	-0.045*	--	--
	[0.013]	[0.018]		
	{-53.6%}	{-23.2%}		
City-level adoptions (experiment)			-0.076**	-0.069**
			[0.016]	[0.024]
			{-39.2%}	{-35.6%}
Province-level adoptions (reverse experiment)			-0.115**	-0.108**
			[0.010]	[0.012]
			{-56.7%}	{-55.7%}
Observations	93,332	93,332	93,332	93,332
R-Squared	0.07	0.07	0.07	0.07
Individual/provincial controls?	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes
City-specific linear trends?	No	Yes	No	Yes

Notes: Sample includes adults age 18-64 who are non-smokers in the CCHS Cycles 1.1-4.1. We also restrict attention to individuals living in cities that adopted at most one law over the sample period. The dependent variable is an indicator equal to 1 if the person reports being exposed to ETS in public places on most or all days of the previous month. Individual demographic controls include: age and its square, a male dummy, two marital status dummies, and six education dummies (see text). All models also control for the provincial cigarette excise tax and the provincial unemployment rate. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 9: Public-place smoking laws did not displace smoking to private homes, CTUMS 2002-2008, Outcome is any cigarettes smoked inside the home

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	Any cigarettes smoked inside the home (0/1)	Any cigarettes smoked inside the home (0/1)	Any cigarettes smoked inside the home (0/1)	Any cigarettes smoked inside the home (0/1)	Any cigarettes smoked inside the home (0/1)	Any cigarettes smoked inside the home (0/1)
Sample:	All respondents	All respondents	Individuals in households without any smokers		Individuals in households with at least one smoker	
Mean of dep var in 2002, no law:	0.235	0.235	0.013	0.013	0.589	0.589
Any Law Specification						
Any law	-0.017* [0.008] {-7.2%}	-0.006 [0.011] {-2.6%}	-0.001 [0.001] {-7.7%}	0.001 [0.003] {7.7%}	-0.012 [0.018] {-2.0%}	-0.030 [0.024] {-5.1%}
Observations	66815	66815	42,685	42,685	22,373	22,373
R-Squared	0.09	0.10	0.02	0.03	0.17	0.18
Strength of Laws Specification						
Gold law	-0.014 [0.009] {-6.0%}	-0.004 [0.011] {-1.7%}	0.001 [0.002] {7.7%}	0.002 [0.003] {15.4%}	-0.006 [0.020] {-1.0%}	-0.022 [0.025] {-3.7%}
Silver law	-0.017 [0.013] {-7.2%}	-0.009 [0.017] {-3.8%}	0.000 [0.001] {0.0%}	0.001 [0.002] {7.7%}	-0.032 [0.042] {-5.4%}	-0.056 [0.048] {-9.5%}
Bronze law	-0.021* [0.009] {-8.9%}	-0.006 [0.012] {-2.6%}	-0.002 [0.003] {-15.4%}	0.000 [0.004] {0.0%}	-0.009 [0.023] {-1.5%}	-0.024 [0.030] {-4.1%}
Observations	66815	66815	42,685	42,685	22,375	22,375
R-Squared	0.09	0.1	0.01	0.03	0.18	0.17
Individual and provincial controls?	Yes	Yes	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes
Linear city trends?		Yes		Yes		Yes

Notes: Sample includes adults age 18-64 in the CTUMS 2002-2008. The dependent variable in each column is an indicator equal to one if the individual reports that anyone smokes cigarettes, cigars, or pipes "INSIDE your home every day or almost every day". Models are estimated using OLS. See notes to Table 3 in the text for control variables. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.

Table 10: Public-place smoking laws did not displace smoking intensity to private homes, CTUMS 2002-2008, Outcome is the number of cigarettes smoked inside the home

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable:	# cigarettes smoked inside the home	# cigarettes smoked inside the home	# cigarettes smoked inside the home	# cigarettes smoked inside the home	# cigarettes smoked inside the home	# cigarettes smoked inside the home
Sample:	All respondents	All respondents	Individuals in households without any smokers	Individuals in households without any smokers	Individuals in households with at least one smoker	Individuals in households with at least one smoker
Mean of dep var in 2002, no law:	3.766	3.766	0.171	0.171	9.473	9.473
Any Law Specification						
Any law	-0.294 [0.172] {-7.8%}	-0.079 [0.201] {-2.1%}	-0.004 [0.015] {-2.3%}	0.042 [0.029] {24.6%}	-0.175 [0.396] {-1.8%}	-0.492 [0.451] {-5.2%}
Observations	66,816	66,816	42,685	42,685	22,375	22,375
R-Squared	0.08	0.08	0.01	0.02	0.12	0.14
Strength of Laws Specification						
Gold law	-0.124 [0.201] {-3.3%}	0.022 [0.204] {0.6%}	0.016 [0.018] {9.4%}	0.060* [0.029] {35.1%}	0.478 [0.500] {5.0%}	0.003 [0.503] {0.0%}
Silver law	-0.279 [0.239] {-7.4%}	-0.121 [0.276] {-3.2%}	0.008 [0.012] {4.7%}	0.046 [0.024] {26.9%}	-0.579 [0.721] {-6.1%}	-1.026 [0.783] {-10.8]}
Bronze law	-0.565** [0.163] {-15.0%}	-0.224 [0.214] {-5.9%}	-0.042 [0.030] {-24.6%}	0.007 [0.040] {4.1%}	-0.898* [0.393] {-9.5%}	-0.956 [0.598] {-10.1%}
Observations	66,816	66,816	42,685	42,685	22,375	22,375
R-Squared	0.08	0.08	0.01	0.02	0.12	0.14
Individual and provincial controls?	Yes	Yes	Yes	Yes	Yes	Yes
City and year fixed effects?	Yes	Yes	Yes	Yes	Yes	Yes
Linear city trends?		Yes		Yes		Yes

Notes: Sample includes adults age 18-64 in the CTUMS 2002-2008. The dependent variable in each column is the number of cigarettes smoked inside the home. Models are estimated using OLS on midpoints of ranges (see text). See notes to Table 3 in text for control variables. Robust standard errors in brackets are clustered on statistical areas (SAs). Implied percent impact as a proportion of base year average value of dependent variable for people living in places without a law in curly braces. * significant at 5%; ** significant at 1%.