Blowing smoke: Yearly variation exists in lessons to be drawn from the adoption of national smoking bans*

Maximilian Pany† & Raha Imanirad‡

Abstract

National smoking bans have become a popular public policy tool to limit exposure to secondhand smoke in countries around the globe, yet levels of compliance widely differ. In this paper, we show that lessons to be drawn from a globally representative sample of countries vary with year of analysis. Specifically, we find that compliance with public smoking bans, but not their adoption, is consistently positively associated with per capita GDP. We further find that health to total government expenditure significantly predicts compliance only in one out of three years, and does not predict adoption at all. These findings contrast with, and improve upon, the previously most comprehensive study on the topic. Perhaps most importantly, our findings lead us to question the widespread belief that higher health to total government expenditure proxies stronger public health interests, and thus higher compliance with anti-smoke legislation.

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†Maximilian Pany is a research assistant at Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115. Email: mpany@partners.org.

‡Raha Imanirad is a graduate student at Harvard Business School, Soldiers Field, Boston, MA 02163.

1 Introduction

National smoking bans have become a popular public policy tool to mitigate the harmful effects of secondhand smoke. As such, they have been widely adopted by low-, middle-, and high-income countries alike, yet compliance varies widely (WHO, 2013). At the same time, the extent to which smoking bans may lead to improvements in public health outcomes depends to a large part on the degree of compliance (Lazuras *et al.*, 2012).

Most previous research on anti-smoking legislation has focused solely on adoption of smoke-free laws, and often considered only a small part of the world, predominantly high-income Europe (e.g., Muttarak *et al.*, 2015; Toshkov, 2012; Gallet and Catline, 2009). To our knowledge, only two previous studies have used globally representative samples of countries to investigate factors associated with the adoption of, or compliance with, smoking bans. Gallet (2009), relying mainly on 2003 data from the American Cancer Society, finds that less developed countries have a greater likelihood of adopting smoking bans than do their more developed counterparts. Using 2010 data from the World Health Organization, Perkins and Neumayer (2014) come to a different conclusion: in their analyses, per capita gross domestic product (GDP p.c.) is positively associated with both the propensity to adopt and the extent of compliance. Both studies share the limitation of using only a single year of data, leaving us to wonder about their generalizability across time.

In this article, we follow the analytical framework of Perkins and Neumayer (2014) to investigate political economy factors associated with the adoption of national smoking bans, as well as with the compliance with such bans in low-, middle-, and high-income countries. We successfully replicated the authors' results in a 2010 cross section of WHO data (WHO, 2011), and extend the same analyses to two more years for which we could obtain reliable data: 2008 and 2012 (WHO, 2009 and 2013).[1]

We do not evaluate the general justification of the assumptions, models, or statistical

[1] A 2007 cross section of much of the same data is also available, but omits some key predictors and suffers from a higher degree of missing values as well as more imprecisely measured indicators. We thus chose not to include it in our analyses.

estimation techniques used in Perkins and Neumayer (2014), but instead focus on testing their models out-of-sample in the two additional years of data we collected from the same sources the 'original' came from. We demonstrate that compliance with public smoking bans, but not their adoption, is reliable in its positive association with GDP p.c. across the years. We further find that health to total government expenditure significantly predicts compliance only in one out of three years (and does not predict adoption at all). This leads us to question the popular interpretation that higher health to total government expenditure proxies stronger public health interests, which in turn ensure higher compliance.

2 While the number of smoking bans in restaurants or bars has increased over time, compliance has fluctuated

Table 1 presents descriptive statistics for the key variables included in our analyses, by year. The number of smoking bans in restaurants or bars, a proxy thought to gauge public resolve to adopt strict smoking bans (where would it 'hurt' more?) and one of our dependent variables, has steadily increased from 23 (2008) to 59 (2012). However, compliance with smoke-free legislation, as assessed by WHO-hired experts (WHO, 2013), has fluctuated from a median of 5 (2008) over 3 (2010) to 6 (2012). The remaining variables in Table 1 are the predictors common to both our model specifications (see below), although we focus subsequent discussion solely on GDP p.c. and health to total government expenditure. [2]

Table 1: Descriptive statistics, by year

	2008	2010	2012
Smoking ban in rest. or bars, total number	23.00	44.00	59.00
Smoking ban compliance, median	5.00	3.00	6.00
GDP p.c., current $	3169.37	5225.10	3947.72
Smoking prevalence, %	24.00	27.00	23.00
Health care to total gov. expend., %	11.60	8.80	11.66
Tobacco production, thousand metric tons	0.03	0.00	0.04

[2]Please note that the median GDP p.c. in 2010 reported in Table 1 seems unusually high compared to the other figures. This is an artifact due to the way Perkins and Neumayer (2010) have assembled their data. It should not make results less comparable, as it is consistent within its year.

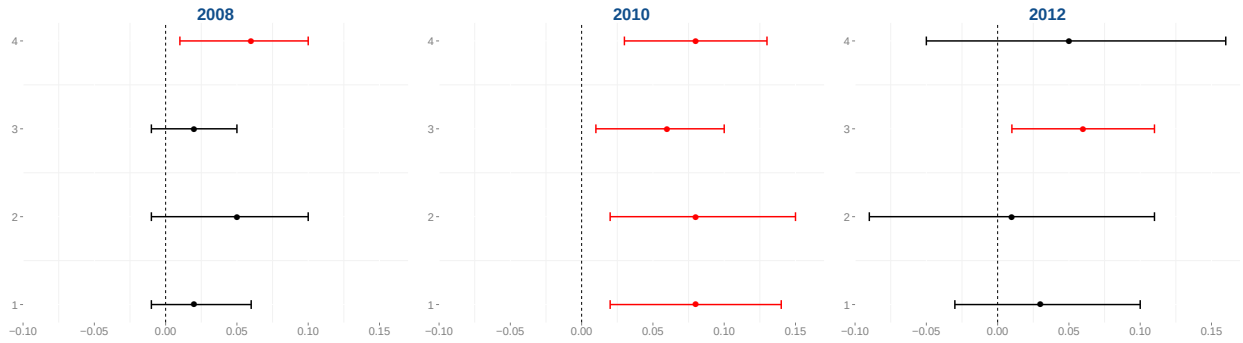

Figure 1: The average marginal effect of per capita GDP on the propensity to adopt smoking bans in restaurants or bars as a function of year. Circles indicate point estimates and horizontal lines indicate 95% confidence intervals. Red lines denote estimates whose confidence intervals do not include zero. Although we plot the effect of just one predictor, these estimates were obtained using multivariate probit models (see text for details). Missing values were listwise deleted (specifications 1, 2) or multiply imputed (3, 4).

3 Per capita GDP is reliably associated with smoking ban compliance, but not adoption

We focus on the adoption of smoking bans in restaurants or bars, as public opposition to bans tends to be strongest in these locations (Toshkov, 2012), and as this was the only public setting in which Perkins and Neumayer (2014) found a positive association between GDP p.c. and propensity to adopt smoking bans.[3]

Figure 1 shows the average marginal effect of GDP p.c. on the propensity to adopt smoking bans in restaurants or bars as a function of year and of the four model specifications favored by Perkins and Neumayer (2014). Circles indicate point estimates and horizontal lines indicate 95% confidence intervals. Red lines denote estimates whose confidence intervals do not include zero. Although we plot the effect of just one predictor, these estimates were obtained using multivariate models. Specifications (1) and (2) were estimated using listwise deletion of missing values, while (3) and (4) used the multivariate normal multiple imputation (MI) model specified in Perkins and Neumayer (2014).[4] All specifications were estimated by

[3]Neither they nor we found such an association in health care facilities, education facilities, government facilities, indoor offices, or public transportation.

[4]We redid the multiple imputation step pooling data from all three years and using a multiple imputation model built for time-series cross-section data (Honaker and King, 2010). This increased our sample size by

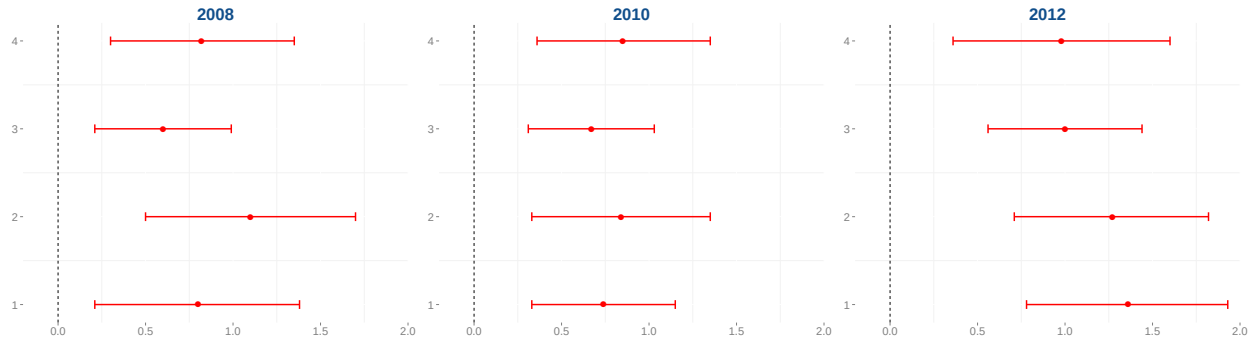

Figure 2: The association of per capita GDP with the WHO 0–10 smoking ban compliance score. Circles indicate point estimates and horizontal lines indicate 95% confidence intervals. Red lines denote estimates whose confidence intervals do not include zero. We plot the effect of just one predictor, but these estimates were obtained using multivariate ordinal logit (specifications 1, 3) and two-stage least squares (2, 4). Missing values were listwise deleted (1, 2) or multiply imputed (3, 4).

probit regression, but (2) and (4) instrumented for smoking prevalence using the share of the population between 15 and 64 years of age and that above 65 years of age.

Note that in 2010, all estimates of the effect of GDP p.c. on smoking ban adoption have associated 95% confidence intervals that do not overlap zero, while this is true for only one specification in each of 2008 and 2012 (Figure 1). Since Perkins and Neumayer (2014) relied only on the 2010 data, they concluded, albeit as far as one can tell reluctantly, that "[r]icher countries–as measured by GDP p.c.–are [...] more likely to have smoke-free policies in restaurants and bars [...]" (pp. 862). With the benefit of having more years of data analyzed, we observe that this happens to be true in 2010, but does not appear to be consistently the case across time. The effect of GDP p.c. on smoking ban adoption in restaurants or bars is thus ambiguous. Predictive accuracy, as evaluated by the area under the ROC curve, is on average about 2–3% higher in 2010 compared to 2008 and 2012 (and is always in the lackluster 0.6–0.7 range). Figure 2 follows the same design as Figure 1, but depicts the association of GDP p.c. with a 0–10 smoking ban compliance score calculated by the WHO from expert assessment (WHO, 2013).[5] As above, specifications (1) and (2) were

up to 30%, but did not qualitatively change the results presented here.

[5]Briefly, in each country, five experts from different professional fields (tobacco prevention, health professional, etc.) independently reviewed and rated the country's policies, which WHO officials translated into a

estimated after listwise deletion, while (3) and (4) relied on the same MI model referenced earlier. Specifications (1) and (3) show ordered logistic regression estimations, and (2) and (4) two-stage least squares estimations, using the same instrument as described above.

Figure 2 clearly suggests, on average, a positive effect of GDP p.c. on compliance, as no specification in any of the three years yields a single 95% confidence interval that overlaps with zero. This effect appears to be strongest in 2012. Since we observe estimates of similar magnitude and precision across all years analyzed, we can feel more confident that wealthier countries, on average, truly have higher rates of compliance than poorer ones compared to the scenario in which we would have analyzed just any one year of data.

4 Health care to total government expenditure is an unreliable predictor of compliance with smoking bans

Health care to overall government expenditure has been hypothesized to be directly related to the strength of a given country's public health interests. With more money coming into the public health profession, the profession is thought to have more resources and a stronger vested interest to lobby for its causes (Studlar *et al.*, 2011). In addition, the share governments choose to spend on health care, instead of on other goods, may proxy support for public health interventions (Perkins and Neumayer, 2014). While intuitively plausible and in fact supported by both Gallet (2009) as well as Perkins and Neumayer (2014), we find that this association holds only in the year 2010, but neither in 2008 nor in 2012.

Figure 3 depicts this association between health care to overall government expenditure and extent of smoking ban compliance, using the exact same specifications as mentioned in our discussion of Figure 2. While the coefficients in 2008 are imprecisely estimated as evidenced by their large confidence intervals, those in 2010 and 2012 are estimated with about the same level of precision. It is thus striking that one set (2010) is clearly non-zero, while another two years later (2012) is centered squarely around zero. Although specifications (2) and (4) include an instrument for smoking prevalence, it is conceivable that these models are

0–2 scale per expert.

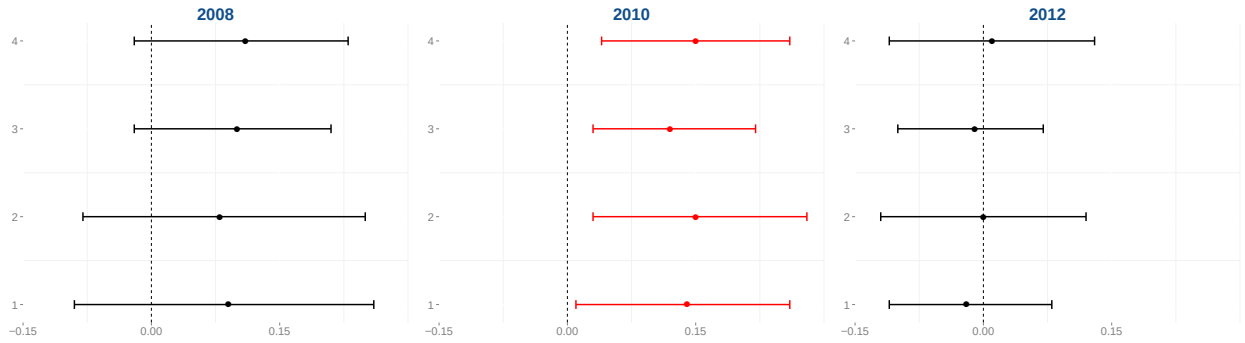

Figure 3: The association between health care to overall government expenditure and extent of smoking ban compliance (on a scale from 0 to 10). Circles indicate point estimates and horizontal lines indicate 95% confidence intervals. Red lines denote estimates whose confidence intervals do not include zero. These estimates were obtained using ordinal logit (specifications 1, 3) and two-stage least squares (2, 4). Missing values were listwise deleted (1, 2) or multiply imputed (3, 4).

threatened by an omitted variable associated both with compliance and health care to total government spending. In fact, it is not difficult to cook up such a story: perhaps a surge in popular demand for a healthier lifestyle caused both compliance with smoking bans and the health care expenditure share of government spending to go up. Since we don't include a proxy for such a surge, the mechanism described in this story, if true, would bias our results. One potential way future research could address this is by exploiting the time-series cross-section structure of the data using a country fixed effects model. A major takeaway is that with three years of data, we can start recognizing and thinking about these problems, which was not possible with a single cross section. This opens up new avenues for empirical estimation that future research should pursue.

5 Conclusions

In this paper, we investigated factors associated with the adoption and compliance of smoking bans in low-, middle-, and high-income countries. Ours is the most credible analysis on this subject to date, since we incorporate data from a globally representative sample of countries over three years. We extended findings first presented in Perkins and Neumayer (2014) by testing their models with two additional years of data we collected from the same sources

the 'original' came from. We demonstrated that compliance with public smoking bans, but not their adoption, is reliable in its positive association with GDP p.c. across the years. We further showed that health to total government expenditure significantly predicts compliance only in one out of three years (and does not predict adoption at all). This leads us to question an often-repeated interpretation that higher health to total government expenditure proxies a stronger public health lobby, which in turn ensures higher compliance. Our results suggest that the story is likely more complicated and that its elucidation will require empirical strategies that can account for trends over time. Future research might exploit the time-series cross-section nature of the pooled data to control for lurking variables.

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