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Estimating cigarette tax avoidance and evasion: evidence from a national sample of littered packs

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ABSTRACT

Introduction A number of recent studies document the proportion of all cigarette packs that are 'contraband' using discarded packs to measure tax avoidance and evasion, which we call tax non-compliance. To date, academic studies using discarded packs focused on relatively small geographical areas such as a city or a neighbourhood.

Methods We visited 160 communities across 38 US states in 2012 and collected data from littered cigarette packs as part of the State and Community Tobacco Control (SCTC) Research Initiative and the Bridging the Gap Community Obesity Measures Project (BTG-COMP). Data collectors were trained in a previously tested littered pack data collection protocol.

Results Field teams collected 2116 packs with cellophane across 132 communities. We estimate a national tax non-compliance rate of 18.5% with considerable variation across regions. Suburban areas had lower non-compliance than urban areas as well as areas with high and low median household income areas compared with middle income areas.

Discussion We present the first academic national study of tax non-compliance using littered cigarette packs. We demonstrate the feasibility of meaningful large-scale data collection using this methodology and document considerable variation in tax non-compliance across areas, suggesting that both policy differences and geography may be important in control of illicit tobacco use. Given the geography of open borders among countries with varying tax rates, this simple methodology may be appropriate to estimate tax non-compliance in countries that use tax stamps or other pack markings, such as health warnings.

INTRODUCTION

When cigarette taxes differ substantially across areas, some smokers, tobacco retailers and wholesalers engage in tax avoidance (legal) or evasion (illegal), which we collectively label as tax non-compliance. As higher taxes raise cigarette prices, reduce consumption and limit smoking uptake among youth, the public health community and government decision-makers are concerned about non-compliant cigarette sales.[1 2] Worldwide tax non-compliance has been estimated to cause 164 000 premature deaths a year.[3] Researchers have documented various methodologies to study cigarette tax non-compliance around the world.[4 5] A number of recent studies used discarded cigarette packs to measure tax non-compliance.[6–11] Researchers noted that, in many jurisdictions, cigarette packs contain markings indicating the taxes paid and the intended location of retail sale. For example, all 50 US states except North and South Carolina and North Dakota require a stamp indicating that appropriate state cigarette taxes have been paid. State cigarette taxes varied from $0.17 in Missouri to $4.35 in New York State as of February 2016.[12] Local taxes add further variation.

One can infer tax non-compliance by comparing the jurisdiction that issued packs' tax stamp with the location where packs are found. Some non-compliance may be 'incidental' in the sense that, in the ordinary course of their travels, smokers make a purchase in one tax jurisdiction but finish (and discard) their pack in another jurisdiction. Merriman[6] calculates an upper bound on incidental non-compliance in the Chicago metropolitan area and shows that it is likely to be very small. Evidence that incidental non-compliance also is very small also exists in our sample: the number of littered packs from a higher tax rate jurisdiction was very small (33 of 2116, <2%). If non-compliance were primarily incidental, we would expect a nearly equal probability of higher and lower tax rate out-of-jurisdiction stamps.

Use of evidence from littered packs to estimate population non-compliance requires that the littered packs are representative of all packs. A natural concern arises that smokers who litter and therefore violate a law and social norm are more likely also to actively circumvent taxes. Merriman[6] presents evidence to support the contention that his sample of Chicago littered packs is reasonably representative of the population of packs. Nonetheless, the results presented here should be interpreted cautiously as the representativeness of littered packs with respect to tax avoidance has not been definitively established.

To date, academic studies using discarded packs focused on relatively small densely populated geographical areas such as a city or a neighbourhood. By contrast, our collection of littered packs supplemented a previously planned national data collection. This is a significant expansion on previous efforts because we collected littered packs in a large variety of areas—some of which were not densely populated urban areas—and estimate tax non-compliance from a national sample of communities. We both demonstrate the feasibility of a simple method to collect national scale data and provide empirical evidence of US cigarette tax non-compliance.

METHODS

Overview

We leveraged resources from our State and Community Tobacco Control (SCTC) project by adding a littered cigarette packs collection to the

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2012 University of Illinois at Chicago (UIC) Bridging the Gap Community Obesity Measures Project (BTG-COMP), the community data collection component of the Robert Wood Johnson Foundation project *Bridging the Gap: Research Informing Practice and Policy for Healthy Youth Behavior.*[13] BTG-COMP collected data on measures associated with obesity behaviour, tobacco policy and environmental measures linked with youth tobacco behaviour and use in a national cross-sectional sample of communities from 2010 to 2012. The samples represented school enrolment areas for nationally representative samples of 8th, 10th and 12th grade public school students in the continental USA.[14] In 2012, 160 communities across 38 US states were sampled, of which 50.6% were suburban, 31.3% rural and 18.1% urban. Median household income at $60 464 was above the US average of $51 579, and the racial/ethnic composition of these communities was predominately white (73.1%). Confidentiality restrictions prevent us from revealing the exact sites in which data were collected.

Sample design

Data collectors were trained to collect littered packs during their week-long community observations of businesses (ie, retail food stores, fast food restaurants and physical activity facilities), parks and streets. For businesses, collection took place at business entrances and parking surfaces, as discussed in more detail in the section of 'Littered Cigarette Data Protocol' below. Businesses were drawn from commercial databases sold by InfoUSA and Dun and Bradstreet. Both companies classify the type of business using the US federal government's four-digit Standard Industrial Classification (SIC) coding system to identify the primary business of an establishment. We used these codes and specific word searches (eg, 'dollar') to identify relevant businesses. We merged the lists, deleted those appearing multiple times, screened businesses by telephone to confirm eligibility and then sampled by type of business to obtain a representative sample in each community. Data collectors also observed a random sample of community and county public parks identified through three source lists—TeleAtlas (Tom Tom), the US Geological Survey Names Information System (USGS/GNIS) and NAVTEQ.

To address limitations in commercial lists, samples were supplemented with field discovery.[15 16] Data collectors identified additional businesses and parks while in the field—using a half-open interval procedure to estimate the number of additional venues needed in each community.[17 18] Data collectors mapped their own data collection routes at each site. Data collection was restricted to daylight hours, resulting in daily and site variation in the timing of litter collection.

The street segment sampling frame was derived from NAVTEQ's Discover America NAVStreets centreline geography ArcGIS, and contained any street within, or on the border of, the community, unless it was inaccessible or within military installations or national forests or park. Streets without street names were excluded, as these were often inaccessible once in the field. GIS staff divided streets into segments or linear blocks extending from one intersection to another, or in cases where a rural road exceeded 2640 feet in length, into multiple one-quarter mile (1320 feet) segments with the exception of the final segment ending at an intersection. To account for variability between residential and arterial streets, and to ensure adequate representation of streets near the school, a stratified sampling scheme was applied, resulting in three strata (2 miles to school, arterial, beyond 2 miles to school residential) for each community. Street segments were then sampled proportionately to the population of 0–17 years old residing in the US Census block assigned to the given street segment. To increase the number of commercial-type streets, data collectors also observed any street segments abutting the entrance of any business that they observed.

Field staff training

All 32 data collectors participating in the 2012 BTG-COMP community data collection were college educated, and many had previously conducted community environmental observations for this project. Training for the littered pack collection consisted of a 90 min classroom PowerPoint presentation and discussion, followed by field practice on the streets of Chicago, as part of the 3-week BTG-COMP training. Following a written certification test, two-person teams of data collectors were sent into the field weekly to one of the communities from 1 May 2012 to 27 July 2012. Collectors visited each site for ~3 days to 1 week, depending on the number of businesses at the site. Teams rotated approximately every 3 weeks. Completed field instruments were sent and tracked via UPS weekly, and once delivered to the Chicago office, examined for completeness prior to data processing. The field manager checked in at least every few days with the teams, scheduled conference calls as needed, and, with the director of Community Data Collection, held an in-person debriefing approximately every 3 weeks.

Littered cigarette data collection protocol

Data collectors collected littered packs while visiting their BTG-COMP venues, applying a standardised observation protocol for each type of venue. Data collectors collected littered packs at sampled business entrances and any parking lot surface while walking from the business entrance to the street segment or the next business located on that street segment. At parks, data collectors walked the entire park and collected littered packs. For street segment collection, data collectors walked both sides of the segment to gather littered packs. On streets with no sidewalks, data collectors observed the space within two feet on either side of the street edge (total of four feet on each side of the street); on streets with a sidewalk, they observed the space beginning two feet into the street from the street edge and extending two feet beyond the outside sidewalk edge on each side of the street. Discarded packs where the print was unreadable due to weather degradation, located inside trash barrels, or without any container material besides the cellophane itself were not collected.

Data collectors placed littered packs in Ziploc bags for each street segment, and sorted these into two bags by whether or not cellophane was present. Data collectors were provided with protective gloves and masks, but the collectors found them too cumbersome to use. Littered packs without cellophane (and thus, without the tax stamps affixed to cellophane on a cigarette pack) were collected to simplify data collection and to obtain a sample of littered packs that can be used for research on compliance with tobacco product packaging regulations.

The field teams discarded any cigarettes remaining in the packs. Each Ziploc bag was labelled to identify the collection date, unique community and street segment identification numbers, and whether or not it contained cellophane-wrapped packs. Data collectors placed each Ziploc bag into either a white or black drawstring bag, depending on its cellophane wrapping, and recorded the number of Ziploc bags collected on each corresponding BTG-COMP instrument. At the end of the data collection week, the field team shipped the drawstring bags back to Chicago.

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Data processing

After all packs were collected and delivered to Chicago, coders processed the packs for data entry using three steps, working in pairs to ensure accuracy. In step 1, coders inputted the number of packs, observed location and presence of cellophane on each pack into a macro-embedded Microsoft Excel spreadsheet. In step 2, coders used the spreadsheet to generate labels that were affixed onto each pack. Labels included a serial number for each pack based on the community ID, the number of the packs collected from a community and whether there was cellophane on the pack. Coders worked as pairs to affix the labels onto each pack and to verify the community where the packs were collected before returning the packs to the appropriate drawstring bag. In step 3, coders entered data using a Microsoft Access database, with one coder reading the information on the pack and the other inputting the data.

Data analysis

We inferred tax non-compliance when there was a discrepancy between the jurisdiction that issued the tax stamp and the jurisdiction where the littered pack was found. Coders scrutinised stamps found on the packs (with a magnifying glass when necessary) to determine the jurisdiction that issued the stamp. We assembled a digital file of images with appropriate tax stamps for virtually all states and many local jurisdictions. When necessary, stamps on the littered packs were compared with the digital image file to establish the issuing jurisdiction. We coded a pack as being non-compliant if the pack had no tax stamp or had a stamp from a lower rate jurisdiction. Three US states (North Dakota, North Carolina and South Carolina) do not issue tax stamps. A limitation of research design is that we cannot differentiate packs with no tax paid from tax-compliant packs. However, we collected no packs in North Dakota, and we assumed low tax non-compliance within North and South Carolina due to their relatively low cigarette tax rates ($0.45 and $0.57, respectively, compared with the median US tax rate of $1.53). We treated packs with no tax stamp found outside of these three states as non-compliant. We coded 33 packs from higher rate jurisdictions as tax compliant because they do not indicate tax avoidance. For each community, we measured tax non-compliance by the proportion of packs that were non-compliant, and calculated the overall tax non-compliance rate and SE for the sample, as well as demographic characteristics of the communities—US Census region, median household income and urbanicity. Urbanicity is defined as urban (small, midsize and large cities), suburban (small, midsize and large suburbs plus distant and fringe towns) and rural (distant, fringe and remote rural areas plus remote towns).[19]

The probability a community is selected into the BTG-COMP sample is proportional to its weight in the relevant population (communities that house 8th, 10th and 12th grade public school students). As communities that are representative of larger shares of the relevant population are more likely to be included in the sample, mean non-compliance rates are calculated as the simple mean of community non-compliance rates with each community weighted equally (eg, in communities in which more packs were collected, each pack has a lower weight). Thus, our reported sample means are an unbiased estimate of relevant population means.[6 8]

We analysed data using one-way analysis of variance (ANOVA) using Stata V.14. Effects were considered statistically significant at $p<0.05$.

RESULTS

Field teams collected 2116 packs with cellophane across 132 communities. Teams also collected an additional 1724 packs without cellophane, but we did not use these packs in our analyses of tax non-compliance as tax stamps are affixed to the cellophane. We find an overall tax non-compliance rate (ie, the overall mean probability of a littered pack having no tax stamp or a tax stamp from a lower tax jurisdiction) of 0.185, with an SE of 0.03.

Table 1 reports means of non-compliance by region, as well as means by divisions within each region and the mean total number of packs found by region or division, that is, the total number of packs found in a region divided by the number of communities within the region, adjusted for population weights. The significance indicators denote whether each mean is statistically significantly different from zero. We see the highest non-compliance rate in Northeast (mean 0.35, SE 0.08), followed by the Midwest (mean 0.16, SE 0.04), the West (mean 0.16, SE 0.02) and the South (mean 0.14, SE 0.03). The result of

Table 1 Tax non-compliance by region and division

Region	Mean of tax avoidance rate	Mean of total number of packs found	Communities (N)
Northeast	**0.35*** **	**17.27*** **	**22**
	(0.08)	**(4.00)**	
New England	0.16***	15.29**	7
	(0.02)	(4.41)	
Mid-Atlantic	0.41***	18.20**	15
	(0.08)	(5.58)	
Midwest	**0.16*** **	**11.47*** **	**30**
	(0.04)	**(1.97)**	
East North Central	0.15***	11.36***	22
	(0.04)	(2.47)	
West North Central	0.19*	11.75**	8
	(0.08)	(3.16)	
South	**0.14*** **	**19.68*** **	**53**
	(0.03)	**(2.62)**	
South Atlantic	0.13***	23.39***	28
	(0.04)	(3.82)	
East South Central	0.03	12.14*	7
	(0.03)	(4.66)	
West South Central	0.19**	16.83***	18
	(0.06)	(4.41)	
West	**0.16*** **	**12.93*** **	**27**
	(0.02)	**(3.68)**	
Mountain	0.13	7.00*	8
	(0.07)	(2.85)	
Pacific	0.16***	15.42**	19
	(0.02)	(5.02)	

Bold typeface denotes tax compliance for a full region as opposed to a sub-region.
SEM in parentheses.
Significance indicators indicate whether the mean is statistically different from zero.
*p<0.05, **p<0.01, ***p<0.001.
By division, the states included in this study are listed as follows:
- New England: Connecticut, Massachusetts and New Hampshire;
- Mid-Atlantic: New Jersey, New York, and Pennsylvania;
- East North Central: Illinois, Indiana, Michigan, Ohio and Wisconsin;
- West North Central: Iowa, Kansas, Minnesota and Missouri;
- South Atlantic: Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia;
- East South Central: Alabama, Kentucky, Mississippi and Tennessee;
- West South Central: Arkansas, Louisiana, Oklahoma and Texas;
- Mountain: Colorado, Idaho and New Mexico;
- Pacific: California, Oregon and Washington.

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one-way ANOVA rejects the null hypothesis that all means are equal. The means of the four regions are statistically different from each other. We also find that non-compliance in the Northeastern region is statistically significantly higher than in the South ($p<0.05$).

We then used t-tests to analyse the equality of means of the division within the Northeast and South region, and found some variation within regions. For example, within the Northeast region, the Mid-Atlantic division had a higher non-compliance rate (mean 0.41, SE 0.08) than New England (mean 0.16, SE 0.02), and the difference is statistically significant ($p<0.01$). Within the South region, non-compliance in the South Atlantic division is statistically significantly higher than in the East South Central division. Non-compliance in the West South Central division also is statistically significantly higher than in the South Atlantic division. However, there is no statistical difference in the non-compliance rate between the South Atlantic and West South Central division.

We also examined how non-compliance varied with urbanisation and median household income. Table 2 reports the means of tax non-compliance by urbanisation, as well as the means of total number of packs found within each category of urbanisation with population weight adjusted. The t test of equality of means between the three categories show that, although communities located in suburban areas had a lower non-compliance rate (mean 0.13, SE 0.02) than those located in rural (mean 0.22, SE 0.09) and urban (mean 0.23, SE 0.05) areas, the difference is statistically significant only when compared with urban areas ($p<0.05$).

Table 3 shows lower non-compliance in areas with very low median incomes (bottom quintile) and very high median incomes (top quintile) but little pattern between very low and very high incomes. Although the difference across income quintile groups is not statistically significant, the means of non-compliance are higher in the second ($42 648–$52 008), third ($52 050–$59 801) and fourth ($59 948–$73 552) quintile.

Table 2 Tax non-compliance by urbanisation

Urbanisation	Mean of tax avoidance rate	Mean of total number of packs found	Communities (N)
Urban	0.23***	29.00***	28
	(0.05)	(4.21)	
Suburban	0.13***	14.05***	74
	(0.02)	(1.81)	
Rural	0.22*	8.80***	30
	(0.09)	(1.92)	

SEM in parentheses.
Significance indicators indicate whether the mean is statistically different from zero.
*p<0.05, **p<0.01, ***p<0.001.

Table 3 Tax non-compliance by income group

Median household income ($)	Mean of tax avoidance rate	Mean of total number of packs found	Communities (N)
25 000–42 642	0.12***	18.43***	28
	(0.03)	(3.08)	
42 648–52 008	0.19***	18.61***	23
	(0.06)	(4.04)	
52 050–59 801	0.26***	18.04***	24
	(0.08)	(4.65)	
59 948–73 552	0.23***	14.30***	27
	(0.06)	(3.40)	
74 726–157 690	0.11***	11.77***	30
	(0.03)	(2.21)	

SEM in parentheses.
Significance indicators indicate whether the mean is statistically different from zero.
*p<0.05, **p<0.01, ***p<0.001.

DISCUSSION

We present the first academic national study of tax non-compliance using littered cigarette packs. Our estimate of national tax non-compliance at 18.5% was similar to findings from some of the best designed studies relying on inspection of physical packs, including Fix and colleagues' mailed pack survey, which asked members of a nationally representative cohort to send in an unopened pack of their usual brand of cigarettes. Results showed that about 20% of packs were not taxed by recipients' state of residence.[20] Both this study and our study show lower rates of non-compliance than in littered pack studies of Chicago (75% in summer 2007) and New York City (51% in summer 2008).[6 8] The relatively high non-compliance rates in Chicago and New York City are to be expected. New York City ($4.25 tax rate) and Chicago ($3.66) had the highest cigarette tax rates in the nation at the time data was collected. Also, both cities had very high tax rates compared with nearby neighbouring sources of cigarettes. The national estimate found in this study results from the national variation in state and local cigarette tax rates as well as variation in the costs of tax non-compliance, such as distance to the nearest lower-rate jurisdiction.

Our finding of regional differences suggests that regional variation in cigarette tax rates may be associated with regional variation in tax non-compliance. Tax non-compliance was highest in the Northeast region, which had the highest average cigarette tax rate per pack of $3.14. Similarly, the lowest tax non-compliance region, the Southern region had the lowest average cigarette tax rate per pack of $0.98.

An important limitation of the study is that there is limited evidence about the extent to which littered packs are representative of the population of packs smoked. Owing to this, the data we report is probably most usefully viewed as indicative of the relative rather than absolute level of tax non-compliance.

A second important limitation of the study is that because the BTG-COMP sample was designed to provide information for a national childhood obesity prevention study, it is representative of communities in which middle and high school students live rather than a nationally representative sample of smokers. Hence, we cannot be assured that our sample littered packs from these communities would be a nationally representative sample of tax non-compliance even if littered packs are a representative sample of packs smoked in these communities. Despite this, we see no reason to believe that there is inherent bias with respect to the cigarette tax non-compliance rate in our sample. Another limitation is that we are unable to distinguish between cross-border shopping and other kinds of tax avoidance and illegal tax evasion. We are also unable to account for incidental littering that results from normal commuting behaviour or tourism.[6] We do not test to determine whether the observed tax stamps are legitimate or counterfeit.[21]

Another limitation is that, due to resource constraints, we were unable to examine potential seasonality associated with our estimates since we collected littered packs in each site at

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only one point in time. It is possible that levels of tax non-compliance vary seasonally and this may have affected our findings.

Our study extends a novel data collection method to investigate tax non-compliance using littered cigarette packs. We believe this method offers distinct advantages compared with measuring avoidance using surveys or administrative records. Both survey and administrative methods have a number of known limitations. For example, respondents who participate in a survey may provide answers that reflect favourably on themselves. Survey respondents consistently claim to smoke far less than the amount documented by administrative data about tobacco tax collections.[5] If respondents are obscuring this legal behaviour, survey responses about possibly illicit behaviour like tobacco tax avoidance and tax evasion also could be obscured. Administrative records of tax paid sales or regulatory compliance records avoid some of these problems since they are designed to track actual behaviour but also have known limitations. For example, one way to estimate the share of cigarette packs that are non-compliant is to compare survey-reported use with number of tax paid cigarettes from administrative records. This method, however, is vulnerable due to unknown levels of cigarette use under-reporting in surveys and the fact that in a jurisdiction that is both a receiver of illicit cigarettes and a smuggler, cigarette inflows and outflows would cancel out.

Concerns such as these led Webb *et al*[22] to introduce the concept of unobtrusive measures to gather data in the social science. The basic idea was to gather unbiased objective information about subjects' behaviour without disturbing the subject.[23] Unobtrusive (or non-reactive) measures are especially promising when studying behaviours explicitly undertaken to circumvent legal restrictions. Thus, it is natural to turn to such methods when studying tax non-compliance in general and cigarette tax non-compliance in particular. We emphasise, as do other writers in the unobtrusive measures tradition, that these methods are most useful when combined with, and cross-validated by, data analyses using other sources, including conventional survey methods and administrative records.

What this paper adds

What is already known

- Tobacco taxes discourage tobacco use.
- Estimates of tobacco tax non-compliance vary widely.
- Tobacco tax non-compliance is difficult to measure but methodologies using discarded cigarette packs have been tested in highly urbanised cities.

Important gaps in knowledge

- We do not know whether the discarded cigarette pack methodology can be used for large-scale data collection across a wide variety of geographies including suburban and rural areas.
- We do not know the extent to which there is geographic variation in tax non-compliance across regions and communities.

What this study adds

- Evidence that the discarded cigarette pack method can be used to study tobacco tax non-compliance across many geographic areas.
- Documentation of substantial but geographically varying tobacco tax non-compliance in the USA.

Our study demonstrates the feasibility of collecting littered packs nationally to get objective estimates of tax non-compliance. This approach could be implemented in other countries and could be used to counter the generally inflated estimates provided by the tobacco industry. Local contexts would need to be taken into context in other countries; for example, not all countries use tax stamps. In some cases, the protocol might be adapted to use health warnings or other identifying features on packs to indicate tax non-compliance and jurisdiction of origin. In addition, the littered pack method may not detect single-stick sales. However, the littered pack method has been used successfully by academic research teams in limited geographic areas of other countries[24] and has been used by the tobacco industry in other countries.[7] We believe this method holds promise for objective studies of tax non-compliance at the national level.

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Contributors DCB was the director of Community Data Collection for the Bridging the Gap Community Obesity Measures Project and in collaboration with her staff, developed the data collection protocol, supervised the training of the data collectors and oversaw data collection. SW supervised data coding, did the data cleaning and data analysis. DM helped to develop the data collection protocol and helped to design the data analyses and derive the statistical properties of the estimates. EAR was the Field Manager for the Bridging the Gap Community Obesity Measures Project and collaborated in developing the data collection protocol, trained data collectors and supervised data collection. AC assisted with design and supervision of data coding, cleaning and analysis and provided background on related literature and data coding portions of the project. FJC conceptualised the project, helped form the hypotheses and helped the research team situate the project in the literature. Most of the manuscript was drafted by DB, SW and DM, with other authors contributing to revisions.

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