Statistical Detection of Tax Fraud using Auditing Announcements

Stephen KASTORYANO *

Abstract

In the Netherlands, the tax authorities announce at the beginning of the tax-filing period a specific component in tax reports which will receive special attention when auditing. Theoretical models predict that rational taxpayers will reduce misreporting on these components in response to stricter auditing. We use detailed administrative data from the Dutch tax authorities (Belastingdienst) to detect unusual patterns in tax reports due to two announcements. We find increased declarations of secondary income and freelance income not subject to third-party reporting. We also observe patterns in property and residual assets declarations which presuppose that increases are not always directly visible on the tax item targeted by the announcement but reveal themselves in other overlapping topics. The substitution patterns suggest that taxpayers try to reduce their declarations in the announcement related topic whenever possible and declare previously underreported income and wealth across other topics in an effort to minimize their tax burden. When shifting declarations to other sections is not possible, taxpayers increase their declarations in the topic targeted by the auditing announcement.

*University of Mannheim, IZA

Address: Department of Economics, University of Mannheim, Block L7, 3-5, D–68131 Mannheim, Germany. E-mail: s.kastoryano@uni-mannheim.de

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1 Introduction

The prevention of tax fraud is paramount to the in the well functioning of the modern welfare state. Reports of the shadow economy estimate that on average 17.1% of work is undeclared in high income OECD countries amounting to almost €1 trillion lost every year to tax evasion (Schneider, Buehn and Montenegro, 2010). Constrained by a limited budget, tax authorities must selectively choose which population to target for auditing. These auditing procedures come at a large cost both to the government and the individual being audited. But targeting the audits optimally is hindered by the fact that most tax evasion occurs on topics for which the government may have limited counterfactual information. Furthermore, fraudulent actors actively try to hide their trails. As a result, the government will not always apprehend tax evaders since the true tax liability of an individual is observed imprecisely.

The approach to uncover fraud departs from usual economic applications where the researcher considers a well defined outcome measure and tries to find the determinants of these outcomes (Jacob and Levitt, 2003). A range of ingenious statistical methods have been developed to uncover fraudulent behaviour.[1] Their common approach is to search for patterns in data that do not conform to expected behaviour. Applications of fraud detection in economics have been used for instance to uncover cheating on exams by teachers and students, collusion in financial trading, medical fraud, and skimping on construction projects (see Zitzewitz (2012) for a comprehensive overview).

This paper takes a new approach in the detection of tax evasion and unintentional tax misreporting by looking at the effect of publicly announced tax auditing campaigns in the Netherlands on tax declarations. In January of each year, the Dutch tax authorities announce to the public a specific topic in the tax reports of the previous fiscal year which will be subject to intense auditing. The spotlight topic is spread through radio, television, newspaper and internet announcements. Guided by the theoretical literature on tax compliance, we use this exogenous increase in the topic specific probability of audit to search for unusually large fluctuations in declarations.

The theoretical literature on tax compliance builds upon the Allingham-Sandmo (1972) tax evasion model. In their economics-of-crime type model, the taxpayer chooses the fraction of evaded earnings to maximize income net of taxes given the probability of being detected and the size of the fine if caught. In this model, the probability of audit and fine are exogenously determined so the amount of misreporting increases with income. The share of misreported income however depends on the risk aversion of the agent. It will be decreasing for risk averse agents and constant for risk neutral agents. In the context of our study, the model predicts that taxpayers will respond to the exogenous increase in the probability of audit in announcement years by decreasing the amount of misreported

[1] See Chandola, Banerjee and Kumar (2009) for an overview of methods and applications in statistics and computer science.

income.[2]

Extensions to this model try to explain the disparity between the high predicted levels of evasion and the low levels actually observed (Andreoni, Erard, and Feinstein, 1998). Alm (2012) provides an overview of behavioural models which underline the importance of psychology and culture in tax compliance. Others have built upon the Allingham-Sandmo model to include new dimensions of taxpayer choice, alternative penalty schemes and uncertainty about the relevant fiscal parameters. The model extension by Kleven et. al. (2011) is particularly relevant to our study since it formalizes a recurrent finding in empirical studies. It introduces a distinction between self-reported income and income subject to third-party reporting. The model predicts that misreporting will be low for third-party reported income but substantial for self-reported income.

Initial empirical research in economics drew estimates of tax evasion from direct observation of the returns for randomly sampled individuals.[3] As discussed in detail in Schneider and Enste (2000), one criticism of audit data is that they do not detect all underreported income and are uninformative about non-filers. Furthermore, random audits can say little about how taxpayers respond to changes in their probability of audit or in the size of the punishment for committing fraud. More recent empirical studies have employed innovative approaches to overcome selection problems and consider behavioural responses to changes in audit, enforcement and punishment factors.

In a randomized experiment on tax-filers in Minnesota, Slemrod, Blumenthal and Christian (2001) use threat of audit letters to directly manipulate the probability of audit. They find that sole proprietors whose income is not subject to third party reporting tend to report higher income after receiving a letter. These findings are consistent with another randomized letter experiment in Denmark by Kleven et. al. (2011). Other studies in tax fraud detection look for discrepancies between household expenditures or electricity usage and reported earnings to address the question of non-compliance by non-filers (Gorodnichenko et. al., 2009; Johnson et. al., 1997). Uncovering new forms of fraud can in turn allow policymakers to implement mechanisms capable of revealing and restricting illegal behavior at significantly lower costs. A creative example is presented in Marion and Muehlegger (2008) who evaluate a new policy adding red dye to untaxed off-road diesel fuel such as heating oil. This change gave controllers a direct way to distinguish the origin of the fuel thereby generating a sharp increase in sales of taxed on-road diesel. Changes in enforcement strategies can also have amplifying effects. Rincke and Traxler (2011) find that controls of TV subscriptions on one household created positive spillovers on neighbours.

Grounded on the Kleven et. al. (2011) model emphasizing the importance of whether the tax returns are self-reported, we choose to focus on the announcement for the 2005

[2]See Yitzhaki (1987) for comparative statics of the model.

[3]Slemrod (2007) provides an overview of this empirical research which focuses largely on the TCMP/NRP data from US tax returns.

fiscal year which concerned a topic known to be subject to limited third-party information. It concerned declarations for income from freelance work and secondary sources other than the taxpayers main employment. This category is also closely linked to topics related to profits from accrued rent on capital and assets.

The analysis uses detailed administrative longitudinal data of Dutch tax records. Our novel data allow us to follow individuals over the period 2002-2008 and observe yearly information on tax declarations for each item of the tax forms. The data also include a set of demographic and employment characteristics. While the main focus of the announcement for the tax authorities concerned income from freelance work and secondary sources, the ambiguous definition of certain tax topics may produce spillovers in other sections of the tax forms.

Our results point to strong increases in 2005 for income from freelance work. Separating the effect by individual characteristics we see that these increases are most pronounced for males, singles who are young to middle aged and who do not have children. In terms of employment characteristics, we find that the reactions are strongest in the service sector, where many jobs are temporary or for few hours, and in industry, where people may use a specific craft to engage in undeclared work within their personal network.

Looking at a sample with a complex tax profile, our analysis also shows jumps for related topics in other sections of the tax form. We see increases in declarations of additional property and residual non-categorized assets. To further assess spillover patterns of previously misreported income, we consider the effect of the auditing announcement campaign of 2007 which directly concerned some of the overlapping topics. One interpretation consistent with the patterns observed is that i) taxpayers try to lower their visibility whenever possible by reducing declarations in the targeted audit topics and ii) they declare previously misreported income across other sections of the tax form in an effort to minimize their tax burden. The patterns also suggest that when shifting funds across other tax sections is not possible, taxpayers will increase declarations in the targeted topics as theory predicts.

The remainder of this article proceeds as follows. The next section provides some background information on the Dutch tax system and the yearly announcement campaigns. Section 3 describes the data, and presents individual and employment characteristics of our sample. Section 4 introduces the empirical model used to estimate taxpayer reactions to yearly announcements. Section 5 explains the findings from our estimation and the final section concludes.

2 Dutch tax system and yearly announcements

Since 2001, the Dutch tax system separates tax declarations into three categories, or Boxes, as described in Table 1. About 70% of the Dutch population files taxes yearly and the tax is levied on the income minus any deductibles within each Box. Box 1 relates to

wages, profits, social security benefits and pensions. It follows a progressive tax over four tax brackets which in 2005 had cutoffs at €16,893, €30,357 and €51,762. The income in each bracket is taxed at 1.80%, 9.35%, 42% and 52%. For income under €30,357 there is also a 32.60% flat rate for social security contributions. The second category, Box 2, represents income from a substantial business interest which most often denotes a shareholding of at least 5% in a company. Box 2 income is subject to a flat tax of 25%. Finally, Box 3 combines income from savings and investments. The total amount in this Box can be allocated optimally between fiscal partners. Individually declared income in Box 3 over €19,522 is subject to a 30% flat tax which is taken on a fixed assumed return of 4% of the average yearly net value of the assets minus any liabilities.

Table 1: Income Tax in the Netherlands for 2005

Category	Bracket (€)	Tax Rate
Box 1: Income from home and work		
- profits from business or professional activities, income from main employment, income from other activities.	0-30,357 if aged < 65	32.60%
	0-16,893	1.80%
- income in the form of periodic payments (pensions, life annuity).	16,893-30,357	9.35%
- capital income from owner occupied dwelling and mortgage debt.	30,357-51,762	42%
- negative expenses for income provisions, negative personal deduction.	51,762-	52%
- deductions: commuting costs, childcare expenses, other work related expenditures, expenses for income provisions, mortgage debt on home.		
Box 2: Income from substantial interest		
- dividends and capital gains if taxpayer, either solely or with his or her partner, holds 5% of the issued capital in a company, directly or indirectly[1].	total share value	25%[2]
Box 3: Income from savings and investments[3]		
- bank and savings accounts (national and foreign). - stocks and other shares. - second home. - rental income, interest income and endowment insurance policy (other than that declared in Box 1 and Box 2). - deductions: interest on debt, educational expenses, charitable contributions.	max { 0, (total - 19,522) * 4% }	30%

[1] If the fiscal partner of a taxpayer holds a substantial business interest above 5% then any individual shares constitute a substantial interest, even if they do not amount to 5%. For instance, if a taxpayer holds a substantial business interest of 3% and the fiscal partner holds a substantial business interest of 7% then both taxpayers will be taxed at 25%. On the other hand, if one has a holding of 3% and the other has a holding of 4%, neither of them will be taxed in Box 2.
[2] 2007 was an exception as there was a reduced tax rate of 22% on the first €250,000.
[3] Income in Box 3 can be reallocated between fiscal partners but the final tax is levied on individual declarations.

The 2005 announcement intended to target a category listed in Box 1: income from freelance work (IFW). However, in the tax form, if taxpayers fill in declarations from IFW they are also required to fill in an additional category which bundles IFW returns with declarations of a second category in Box 1: profits from rented out assets (IRA). The specific titles of these two categories are 'Extra earnings or income as a freelancer, home assistant, artist or professional athlete' and 'Extra earnings or profits from assets made available'. Even if this second topic (IRA) was not directly targeted in the 2005

announcement, it would be brought to the attention of any taxpayers inquiring into IFW returns upon hearing the announcement. This second category linked to IFW includes earnings or profits from assets rented or made available to a fiscal partner, a blood relative or a substantial business interest[4]. IRA income only concerns property and other assets which were used to generate profit so it would not include a room sublet for living purposes. The 2007 announcement, which we use in the second stage of our analysis, concerned all items in Box 3 for which about 25%-30% of taxpayers declare returns yearly. The auditing campaign covered all items listed in the last panel of Table 1.

A key feature we exploit in this study is that there is an ambiguous interdependence between the three Boxes for some declarations. Any taxpayer declaring IFW or IRA must fill a separate category in which IFW and IRA are bundled together. In this category they are required to list in their Box 1 returns the amount of IRA and IFW which concern the topics of 'Other property', 'Other assets' and 'Debts'. 'Other property' includes profits from a rented out property other than a person's first or second home. 'Other assets' includes a large array of dividends and capital gains. 'Debt' includes mortgage and other forms of obligations. These three subtopics are also listed under Box 3. Furthermore, the appendix to Box 3 in the tax form explains that although there is overlap of these topics, there should be a clear separation of what is declared in each of Box 1, Box 2 and Box 3. The Tax Authorities provide that there are fiscal limitations in what income should be declared in each section but this is not evident to the taxpayer when reading the tax forms and their additional explanations.

The motivation for choosing spotlight topics varies each year. The Dutch tax authorities may select topics where they suspect high levels of fraud but they also have the intention to educate the public on complex tax topics. The announcement campaign always follows a strict timeline. The spotlight theme for fiscal year t is announced to the public in the first days of January in year $t+1$. Notifications of the spotlight topic are spread over newspapers, magazines, radio and television announcements, and are made evident on the front page of the tax authorities website. For the 2005 announcement, in addition to the widespread campaign, letters were sent to the $181,551$ taxpayers who declared IFW income in 2004. The letter informed people to take particular care in filling their returns for income from secondary sources such as freelance work income which come under Box 1. The Box 3 announcement in 2007 emphasized the categories of additional property, personal assets, savings and investments.

Anyone liable to pay taxes for year t in the Netherlands is supposed to fill in their declarations by April 1st of year $t+1$. If people do not send any tax declarations, these are filled in automatically using available third-party information which includes income, property, bank and other financial information. Some components of third party information such as savings in national banks are regular while others, such as information on offshore bank accounts, may vary year-to-year depending upon international banking

[4]A substantial business interest is defined here in the same way as in Box 2.

agreements. The tax authorities then analyze the tax declarations starting beginning July of year $t+1$ and generate audit flags. Flags are based on some characteristics of the returns, previous flags and differences between declarations and third-party information. It takes some time before the letters are sent out to the people who's tax declarations will be subject to audit. In most years, these letters are sent out between October of year $t+1$ and September of year $t+2$.[5] The threat of a higher probability is credible. The auditing campaign for the 2005 topic involved a thorough preliminary screening of all liable declarations for the spotlight IFW topic and a full audit of 25% of these declarations. The auditing campaign in 2007 went through stricter preliminary screening than in other years and saw a 100x increase in the number of full audits for Box 3 topics. When an auditor detects misreporting, the taxpayer is required to pay the full outstanding sum. If the underreporting is seen as intentional cheating then there can be an additional fine varying between 50%-100% of the evaded value. For underreporting due to negligence, the fine is 25%. In practice, fines are not often imposed since it is hard to prove intentional wrongdoing.

3 Data

The analysis uses longitudinal data from the Dutch tax authorities covering years 2002 to 2008 and include yearly individual tax declarations as well as indicators for whether someone was audited or corrected. We also observe some background variables such as gender, age, nationality, whether someone has a partner, the number of children, overall income, work sector, whether someone is self-employed, an indicator for whether someone's taxes are filed by tax professionals and the postcode.

We collect data on two samples of taxpayers subject to the subcategories targeted or affected by the 2005 announcement. The first group focuses on declarations concerning income from freelance work (IFW). We sample 5000 individuals *with replacement* each year from 2002-2008 from the pool of taxpayers declaring positive or negative returns in the IFW category. For each of these taxpayers we then append the tax information for all other years to produce a sample of 33,639 individuals observed over 7 years. Given the link between IFW and IRA, it may be possible that the IFW announcement produced spillovers for people holding IRA income. To investigate this possibility, we apply the same sampling procedure for income from rented assets (IRA). For this topic we sample 10,000 observations yearly for a total of 49,486 individuals. This sampling procedure generates representative yearly panels of taxpayers. In a last step we collect information for a random audit sample. This group includes individuals who were randomly selected for audit between 2002 and 2008. The tax authorities conduct random audits to gain an overview of evasion and other types of misreporting. Different populations were selected

[5]For the 2007 topic, the sample of people due for audit was initially too big to handle. As a result, letters were sent out after mid-April 2009.

Table 2: Declarations by individual characteristics (in euros)

	IFW Sample		IRA Sample		Rand. Sample		
	avg. IFW	frac.	avg. IRA	frac.	avg. IFW	avg. IRA	frac.
All:	2,894	100%	2,058	100%	125	12	100%
	(10,564)		(375,875)		(1,732)	(920)	
Gender:							
Female	2,695	53.8%	2,433	21.0%	134	9	41.9%
	(10,741)		(17,654)		(1,222)	(538)	
Male	3,125	46.2%	1,958	79.0%	118	15	58.1%
	(10,350)		(422,719)		(2,022)	(1,117)	
Partner:							
Single	1,764	26%	2,590	18.3%	54	4	34.4%
	(14,615)		(38,867)		(1,247)	(728)	
Partner	3,290	74.0%	1,938	81.7%	162	17	65.6%
	(8675)		(415,542)		(1,937)	(1,006)	
Migrant:							
Dutch	2,909	96.5%	2,007	97.5%	127	13	95.6%
	(10,648)		(380,510)		(1,752)	(939)	
Foreign	2,497	3.5%	4,015	2.5%	85	4	4.4%
	(7,933)		(75,998)		(1,230)	(270)	
Children:							
0	2,083	32.5%	-748	28.1%	57	6	42.6%
	(6,923)		(809,532)		(1,174)	(670)	
1	2,631	15.3%	2,456	14.7%	96	6	17.3%
	(8,390)		(27,228)		(1,217)	(845)	
2	2,984	36.0%	2,754	38.2%	167	19	30.0%
	(13,348)		(30,768)		(2,085)	(961)	
3+	3,893	16.2%	3,118	19.0%	271	23	10.1%
	(10,287)		(64,417)		(2,593)	(1,423)	
Age:							
-30	1,119	10.8%	803	3%	46	2	13.0%
	(3,716)		(8,067)		(1,117)	(139)	
30-50	2,947	46.3%	2,391	49.9%	125	10	40.4%
	(8,489)		(33,763)		(1,659)	(976)	
50-65	3,380	33.3%	1,728	37.0%	185	24	27.3%
	(14,489)		(615,187)		(2,264)	(1,083)	
65+	2,964	9.6%	1,993	10.1%	49	8	19.3%
	(8,824)		(74,403)		(1,302)	(853)	
N ind.	33,639		49,486		68,681		
N obs.	235,473		346,402		480,767		

Standard deviations in parenthesis.

for fiscal years 2003, 2005, 2006 and 2007. For each sampled year we again collected information on each individual's declarations from 2002 to 2008. Although this group excludes people registered as self-employed, it still provides a baseline upon which to compare the declarations and composition of our two samples of interest.

Summary statistics for each sample are presented in Table 2. We show separate statistics for the IFW, IRA and the sample of random audits. The first two columns present the average declaration in IFW by individual characteristics and their respective share in the IFW sample. The second pair of columns shows the same for IRA declarations in the IRA sample. The last three columns show the average declarations in IFW and IRA for the random sample and the respective shares by characteristic. The average declaration in IFW for the first sample is €2,894. We notice little variation by gender

or nationality but declarations do tend to be higher for people with partners and for parents. The sample also includes a relatively large share of females and people with partners compared to the random sample. Declarations for the IRA topic in the second sample are presented in columns 3 and 4. Although the average declaration is €2,058, we notice a very wide variation across the population. This variation seems most pronounced among males who represent a relatively large share of the IRA sample. Declarations also show a large variance for the categories of people: between 50-65, with partners, and people who do not have any children. People without children also seem to have on average higher debts than profits in IRA. Since it takes time to accumulate returns in IRA, we also see a smaller share of taxpayers and lower declarations for the population under age 30.

Table 3 categorizes declarations by employment characteristics. As would be expected, average declarations increase for both samples with total income. We notice negative average returns of -€4,830 and a large variation in IRA declarations for the people earning less than €30,000. This can be explained by the fact that asset returns in IRA, such as income from rented property are often paired with large debt or mortgage loan. Looking at the standard deviation in IRA declarations in this income bracket also suggests IRA returns represent a large component in earnings for some taxpayers. In the following frame, we split the statistics on employment into four categories: entrepreneur (E) or not entrepreneur (N), and declaring primary earnings (prim.) or not (other). The entrepreneur category includes people who registered as 'independent without personnel' or small firms.[6] Registering as an entrepreneur does not prevent people from being employed for someone else but requires filing taxes as a self-employed which in some situations can reduce tax liability. We see that about 10.9% of the IFW sample and 16.6% of the the IRA sample are registered as entrepreneurs. These are large shares relative to the random sample. Primary earnings include wages, bonuses, gratuities or sickness benefits and, for the self-employed, profits from entrepreneurial activities. They do not for instance include unemployment benefits. We notice that the IRA sample includes a relatively large share of individuals with primary earnings.

The following category looks at the use of tax professional services. We see that both samples seem to have a relatively large share of taxpayers utilizing tax professional services to file their returns. This difference is particularly pronounced for the IRA sample and would suggest that the two samples we analyze are composed of taxpayers with complex tax situations. Last, we split the returns by job sector categories. In the IFW sample, besides half the taxpayers for whom the job sector is unknown, we see that the largest share of people work in the service sector. We also see a relatively small share working in industry compared to the random sample. For the IRA sample, a striking feature is that close to 45% of the taxpayers work in the financial sector. This may be explained by the fact that returns from financial products can be classified under the IRA category. In

[6]Small firms are those with fewer than 5 employees.

addition, we also notice a large variation in declarations for workers in the retail sector.

Table 3: Declarations by employment characteristics (in euros)

	IFW Sample		IRA Sample		Rand. Sample		
	avg. IFW	frac.	avg. IRA	frac.	avg. IFW	avg. IRA	frac.
All:	2,894	100%	2,058	100%	125	12	100%
	(10,564)		(375,875)		(1,732)	(920)	
Total income:							
0-30,000	2,069	67.6%	-4,830	31.1%	85	-2	67.7%
	(4,612)		(672,807)		(1,061)	(792)	
30,000-60,000	3,871	22.7%	2,356	35.1%	152	17	27.4%
	(9,604)		(6,352)		(2,034)	(460)	
60,000-120,000	5,296	7.7%	5,410	22.8%	427	118	4.3%
	(12,632)		(12,693)		(3,568)	(1,779)	
120,000+	10,509	2.0%	13,661	11.0%	1,168	656	0.6%
	(55,683)		(55,344)		(9,360)	(6,025)	
Employment:							
other (N)	4,340	38.5%	1,574	16.9%	214	6	35.0%
	(15,223)		(32,176)		(2,338)	(591)	
prim. (N)	2,154	50.6%	2,234	66.5%	79	15	63.9%
	(6,962)		(497,121)		(1,270)	(1,106)	
other (E)	5,948	0.5%	885	0.5%	1,784	35	0.1%
	(14,354)		(20,698)		(8,039)	(325)	
prim. (E)	2,183	10.4%	1,903	16.1%	353	48	1.0%
	(7,228)		(30,172)		(4,397)	(941)	
Tax advisor:							
no advisor	2,219	45.5%	992	17.0%	98	0	82%
	(10,376)		(25,671)		(1,387)	(384)	
advisor	4,174	34.5%	2,276	83.0%	245	68	18.0%
	(10,797)		(412,486)		(2,806)	(2,005)	
Job sector:							
land	2,113	1.2%	2,127	1.8%	94	3	1.1%
	(5,618)		(37,424)		(1,348)	(1,436)	
industry	1,882	3.4%	2,593	4.1%	43	18	7.4%
	(5,569)		(23,771)		(666)	(696)	
instal	1,525	1.4%	3,014	3.8%	40	32	3.7%
	(4,479)		(19,355)		(938)	(1,229)	
wholesale	1,662	2.0%	3,335	5.6%	35	49	4.3%
	(5,497)		(34,752)		(581)	(1,561)	
retail	1,449	4.3%	-4,259	6.7%	54	14	5.4%
	(4,235)		(1,439,317)		(786)	(527)	
transport	1,488	1.3%	2,472	1.9%	27	11	3.1%
	(4,068)		(39,367)		(1969)	(293)	
finance	2,310	11.9%	3,227	43.4%	78	23	13.2%
	(10,340)		(51,448)		(1,482)	(1,729)	
service	2,516	23.0%	1,940	5.8%	150	5	17.9%
	(6,861)		(14,816)		(1,817)	(223)	
unknown	3,523	51.5%	1,268	27.0%	175	6	43.9%
	(12,790)		(36,417)		(2,061)	(684)	
N ind.	33,639		49,486		68,681		
N obs.	235,473		346,402		480,767		

Standard deviations in parenthesis. The *Employment* category omits observations in 2002 since these have no information concerning entrepreneur status. Job sector categories: land=agriculture and fisheries ; industry=industry and mineral extraction; instal=construction, installation and utilities; wholesale=wholesale and intermediate trade; retail=retail, catering and repair; transport=transport, storage and communication; finance=banking, insurance and business services; service=other services.

Table 4 presents the declarations of tax items in other sections of the tax forms for the three samples. For each sample, the first column presents the average yearly declarations

Table 4: Summary Statistics (in euros)

	IFW		IRA		Rand. Sample	
	avg.	frac.	avg.	frac.	avg.	frac.
Box 1 total	24,890	90.9%	45,717	96.2%	24,927	92.5%
	(37,696)		(380,889)		(51,384)	
IFW	2,894	55.9%	667	6.6%	125	3.1%
	(10,564)		(16,663)		(1,732)	
IRA	40	1.5%	2,058	59.8%	12	0.4%
	(3,654)		(375,875)		(920)	
Box 2 total	937	0.8%	15,543	9.5%	157	0.2%
	(32,001)		(203,546)		(12,542)	
Box 3 total	1,672	23.4%	9,057	51.1%	899	23.4%
	(23,715)		(41,667)		(4,848)	
other property	13,703	5.5%	164,291	28.2%	3,947	2.6%
	(383,738)		(1,195,008)		(70,884)	
other assets	1,069	1.3%	8,886	4.9%	504	0.8%
	(24,676)		(234,146)		(10,013)	
debts	15,011	9.8%	379,284	42.7%	3,266	5.2%
	(778,824)		$(1.43 * 10^8)$		(47,867)	
shares, bonds, etc.	23,217	16.0%	91,456	34.6%	9,429	13.6%
	(1,157,113)		(700,002)		(67,877)	
2nd home	2,922	2.1%	16,490	6.7%	1,154	1.0%
	(31,326)		(173,017)		(17,004)	
other claims & cash	2,929	4.2%	25,044	16.3%	1,349	2.4%
	(38,857)		(280,202)		(22,233)	
savings	21,575	28.2%	79,292	61.1%	18,691	27.3%
	(112,199)		(386,967)		(64,422)	
benefits claims	51	0.1%	339	0.3%	27	0.1%
	(4,523)		(40,202)		(1,493)	
capital insurance	340	1.5%	2,100	4.9%	131	1.0%
	(12,906)		(52,300)		(3,701)	
N ind.	33,639		49,486		68,681	
N obs.	235,473		346,402		480,767	

Standard deviations in parenthesis.

of items in the different Boxes. The second column presents the average yearly share of declarations larger than €100 or lower[7] than -€100 for each item. Looking at the IFW sample, we see that the fraction of taxpayers and the amount they declare in Box 1 is similar to that in the random sample. However, it seems that these taxpayers declare secondary IFW only half of the years (55.9%) which could indicate volatile or irregular returns in this field, or variations in declaration behavior. Moreover, declarations in IFW do not necessarily go in hand with declaring IRA returns (1.5%). In contrast to Box 1, declarations in Box 2 and Box 3 tend to be larger for the IFW sample than for the random sample. Last, the subitem 'shares, bonds, etc.', on top of higher average declarations, also shows a substantial share of extremely large declarations.

The declarations for the IRA sample on the other hand are remarkably different from those of the random sample. Taxpayers in this sample declare far higher returns on average in all topics. This is particularly pronounced for Box 2 and Box 3 where we also see a larger share of taxpayers filing returns in property related topics such as Box 2, 'other property' and 'debts'.

4 Empirical Approach

We are interested in whether taxpayers respond to the higher probability of audit in the announcement year by declaring returns differently in the affected topics. The first step in estimating the effects of the announcement on tax declarations exploits the longitudinal structure of the data. In the basic model we observe tax declarations on a topic y_{it} for taxpayer $i = 1, \ldots, N$ in year $t = 1, \ldots, T$.

$$y_{it} = \alpha_i + \beta A_t + \eta_t + u_{it} \tag{1}$$

We are interested in the parameter β on A_t which is an indicator taking value 1 in the announcement year and 0 in all other years. β describes the effect of the announcement on tax declarations. The identification of β hinges crucially on the exogenous choice of the announcement topic and also requires correctly modeling the time trend in declarations in non-announcement. In this model, the time trend η_t and individual effects α_i produce a prediction for declarations in the announcement year which is then compared to the actual declarations[8]. A significant β parameter indicates a deviation from the predicted trend in declarations in the sample.

An additional requirement to give a causal interpretation to β is that the announcement is unanticipated by taxpayers and is not affected by announcements in previous years

[7] The topics that can be negative are Box 1, Box 2, IFW, IRA and savings. If the subtopics in Box 3 sum up to a negative amount, the overall declaration is set to 0.

[8] Relating to the statistical detection literature, declarations in non-announcement years represent the 'training' data against which we compare declarations in the announcement year to search for outlier patterns.

touching on overlapping topics in the tax returns. Given that the topic announcements are only communicated in November within the tax office and are kept highly secretive it is unlikely that the public will gain knowledge and be able to adapt their behavior prior to January. Furthermore, it is not possible without running a certain risk of apprehension to adjust income and wealth for previous years since taxpayers are obliged by law to maintain records and statements of all earnings for up to five years in the past. It is also unlikely that previous announcement campaigns have important effects since there was a complete reform of the tax code in 2001 and the announcements in the years following concerned pension annuity payments (2003, 2004) and uncommon expenditures (2002) neither of which overlap with the topics we study.

Given that we use the full 2002-2008 observation period to estimate the time trend we must also assume that the announcements after 2005 are exogenous to declarations in 2005. As discussed in section 2, the 2007 announcement concerned certain topics overlapping with the 2005 announcement, in particular with IRA. To account for this, we present specifications with an additional variable to capture 2007 announcement effects. Besides controlling more appropriately for the time trend, the specification with two announcement indicators provides us with an opportunity to evaluate a second time the changes in declarations on the overlapping topics affected by both the 2005 and 2007 announcement. For 2008, the announcement concerned charitable donations which are separate from the topics we study in Box 1 and Box 3. The 2006 announcement concerned a specific type of deductible on mortgage debt for people who sell a house and buy a new one within the same fiscal year. This announcement may overlap slightly with some of the property subitems targeted in the 2005 and 2007 announcements but would lead to an underestimate of misreporting in those years. The influence of the 2006 announcement is unlikely to be large since it affects only a small fraction of house buyers in 2006. A last requirement is that the announcement is not confounded with another policy or shock occurring in the same year which would directly influence declarations in the affected topics. This amounts to assuming u_{it} is an idiosyncratic error term with mean 0.

In our model we ignore any long run announcement effects in post-announcement years. One such effect could be that the announcement produces learning effects. Learning effects could occur if the announcement induces a set of previously misreporting taxpayers to apply greater effort in understanding their true tax liability. If these taxpayers were misreporting by negligence rather than strategically evading taxes they may benefit from learning effects lasting beyond the announcement year. Assuming that most misreporting due to negligence produces underreporting of the true tax liability in years prior to the announcement, the presence of learning effects would lead to underestimating the magnitude of β. One way to account for learning effects would be to ignore all post announcement years when estimating the time trends. We prefer including the post-announcement years at the expense of possibly underestimating results in order to model the trend in declarations more flexibly with higher order polynomial terms.

By sampling our data from each year with replacement, we also ensure that our parameter β encompass the effects of people who declared returns in 2005 and who were previously filing taxes as well as previous non-filers. This estimated parameter can be used to infer the total yearly amount of misreported income for a *representative yearly population of taxpayers* liable to declare IFW or IRA taxes. This parameter estimate is likely to be more interesting for policy purposes than for instance the average misreported amount on a *representative population of all taxpayers* declaring IFW or IRA taxes over the period 2002 to 2008. Since IRA and IFW topics often include one time atypical earnings, the latter estimate would over-represent people who declare IRA or IFW once over the entire observation period.[9] Our estimated effect will also be a more relevant policy parameter than the average effect of the announcement *on the entire population of taxpayers in the Netherlands* since we do not consider a randomized experiment and the IFW and IRA populations targeted by the announcement are not representative of the entire population of taxpayers. However, the parameter β of announcement effects will still underestimate misreporting since we can not capture misreporting from fraudulent taxpayers who do not react to the announcements and keep returns hidden in all years.

Including a set of additional demographic or employment control variables is difficult in this setting since these same variables may be themselves correlated to misreporting. We can however explore heterogeneity in misreporting by adjusting equation (1) to look at the effect of announcements by individual and employment characteristics separately. When estimating these heterogenous effects we include controls in non-announcement years which act as level shifts on the time trend for the concerned group. In all estimations we account for serial correlation in declarations by clustering standard errors at the individual level.[10]

5 Results

Table 5 presents the results for the 2005 announcement on income from freelance work and income from rented assets. In the estimation we take the logarithm of IFW or IRA declarations as the dependent variable to account for extreme observations in declarations. With a logarithmic specification, β should be interpreted as the proportional causal effect of the announcement and letters sent. We correct the declarations close to zero based on the observed densities of the declarations by imputing a minimal absolute value of 100. This avoids generating large effects based on changes in declarations from observations close to zero. The first column presents the specification with a common linear trend in declarations and individual specific levels estimated by fixed effects. The results indicate that

[9] This would be the parameter obtained if we had pooled all people who declared at any moment IFW or IRA over the period 2002 to 2008 and then selected a random sample from this group.

[10] We also cluster standard errors at higher levels based on job sector and income level which usually turn out smaller. We prefer remaining on the conservative side and present those clustered at the individual level.

the announcement campaign in 2005 and the letters sent to people having declared IFW in 2004 leads to a 6% increase in IFW declarations. The second column produces slightly smaller effects when using a first-difference estimation to remove individual specific levels. We find significant positive effects of the announcement on IFW in both specifications. The results show that taxpayers in the IFW sample display similar behavioural responses to those found in an audit-announcement laboratory study by Alm, Jackson and McKee (2009). In their experiment subjects respond to pre-announced increases in audit probabilities by increasing declarations but only when these announcements are perceived as being credible.

Table 5: Effects of 2005 spotlight topic campaign on IFW and IRA declarations (dependent variable is $ln(y)$ declarations)

	(1) FE lin.	(2) FD lin.	(3) FD 3deg. poly.	(4) Rand. Trend	(5) FD Cluster
IFW (B1)					
05 announce.	0.063**	0.051**	0.040**	0.051**	0.045**
	(0.013)	(0.013)	(0.014)	(0.013)	(0.016)
t	0.612**	0.057**	-0.929	0.057**	cl
	(0.033)	(0.003)	(0.535)	(0.000)	
t^2			7.757*		cl
			(3.604)		
t^3			-1.961*		cl
			(0.801)		
R^2 overall	0.002	0.000	0.000	0.000	0.009
N ind.	33,639	33,639	33,639	33,639	33,639
N obs.	235,473	201,834	201,834	201,834	201,834
IRA (B1)					
05 announce.	0.084**	0.005	-0.018	0.005	0.008
	(0.015)	(0.015)	(0.016)	(0.015)	(0.013)
t	0.542**	0.041**	-0.884	0.041**	cl
	(0.035)	(0.004)	(0.627)	(0.000)	
t^2			8.551*		cl
			(4.212)		
t^3			-2.399**		cl
			(0.934)		
R^2 overall	0.001	0.000	0.000	0.000	0.064
N ind.	49,486	49,486	49,486	49,486	49,486
N obs.	346,402	296,916	296,916	296,916	296,916

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors.
(1) linear t FE (2) linear t FD (3) $3rd$ degree polynomial t FD (4) Random Trend (5) Cluster FD with 40 'job sector x box 1 income bracket' time trends.

The third column presents results from our preferred specification estimated by first-difference and allowing a 3rd degree polynomial in the time trend. The results reduce slightly from the ones with linear time trends indicating a 4% effect of the 2005 announcement on IFW declarations. To assess the robustness of these results, we allow for different specifications to capture time trends in declarations. Column 4 presents the random trend model (Heckman and Hotz, 1989) where we first remove individual levels by first-differences and then estimate individual specific trend parameters by fixed effects

(Wooldridge, 2005). This model allows us to estimate separate levels and linear trends for each individual. Column 5 produces a final set of results with cluster specific time trends which are allowed to vary by job sector and income level (40 clusters). For both of these specifications the effect of the 2005 spotlight campaign on IFW remains between $4\% - 5\%$.

For IRA, the fixed effect estimator shows significant positive spillover effects from the IFW announcement but these disappear in all the other specifications. The results in Table 5 give no indication of increases in IRA declarations in 2005 due to it's link with IFW. One reason for seeing no changes could simply be that people holding IRA do not believe they have a higher probability to be audited in their IRA declarations. However, as shown in the previous section, people in the IRA sample hold high returns of assets overlapping between Box 1, Box 2 and Box 3. A potential consequence which we explore in section 5.3 is that the announcement in 2005 has indirect spillover effects on overlapping topics in the tax declarations. Henceforth, we present only our preferred first-difference model in our results since we think it is the least sensitive to large spurious jumps in individual declarations.

5.1 IFW and individual characteristics:

In order to obtain a more detailed profile of the people in the IFW sample who react to the announcement in 2005 we separate the effects by individual characteristics. Obtaining a more detailed profile of the taxpayers reacting to the announcements allows the tax office to remodel more efficiently taxation mechanisms and auditing practices to prevent future misreporting. In Table 6 we study heterogenous treatment effects in the IFW sample by interacting the announcement effect with individual characteristics. When estimating heterogenous effects we include controls in non-announcement years which account for changes in declarations from switching between categories in non-announcement years. The effect of time invariant characteristics in non-announcement years are netted out by first-differences.[11] This produces a saturated model where a significant parameter should be interpreted as a significant difference in declarations between the announcement and non-announcement years conditional on the particular characteristic category.

The results indicate that declaration jumps correlate positively with males and young to middle aged taxpayers. These results seem to support previous empirical findings on tax evasion described in Slemrod (2007). The increases for singles however stands in opposition to previous work by Clotfelter (1983) and Feinstein (1991) who find married couples more liable to misreport declarations in the US TCMP data. Since misreporting effects are stronger among single people it is not surprising that we also find misreporting to correlate with having no children. A last observation is that non-Dutch nationals are less inclined to react to the announcements. In general, our results indicate that the

[11] We also estimated specifications with characteristic specific time trends which turn out similar to the ones with level shifts.

Table 6: Heterogenous effects for IFW sample by individual characteristics
(First difference estimation with logarithmic transformation of dependent variable

Gender		Partner		Migrant		Children		Age	
male	0.051*	single	0.082**	Dutch	0.041**	0	0.060*	-30	0.050
	(0.022)		(0.028)		(0.014)		(0.028)		(0.011)
female	0.031	partner	0.027	Foreign	0.016	1	0.023	30-50	0.056**
	(0.017)		(0.015)		(0.073)		(0.037)		(0.021)
						2	0.032	50-65	0.018
							(0.021)		(0.022)
						3+	0.042	65+	0.029
							(0.026)		(0.041)
controls	no		yes		no		yes		yes
t trends	yes		yes		yes		yes		yes
R^2	0.000		0.002		0.000		0.000		0.000
N ind.	33,639		33,639		33,639		33,639		33,639
N obs.	201,834		201,834		201,834		201,834		201,834

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Controls indicate time varying categories. Time trends are specified as 3rd degree polynomials.

average taxpayer misreporting IFW returns is quite independent. A relevant question which we can not answer here is whether these people misreport because they have limited responsibilities towards their family or whether people liable to evade taxes select themselves into an independent lifestyle.

5.2 IFW and employment characteristics:

Table 7 looks further into differences in the effect of the 2005 spotlight campaign on IFW declarations by employment characteristics. The results indicate that jumps in declarations are more pronounced for middle income earners. Slemrod et. al. (2001) point to similar findings suggesting that high income earners are more adept at legally avoiding taxes so tax evasion is more often seen for middle income earners. They also suggest that high income earners have the means to use more sophisticated illegal tax shelters. The results in the second column show a 7.8% significant increase in 2005 declarations only for workers with a 'primary' income who are not registered as self-employed or small firms. An explanation for this finding could be that self-employed taxpayers are presented with ample opportunities to evade taxes in their primary source of income since these are not verified by third-party reporting. For people who are not self-employed, their secondary income such as IFW is the only source which is not verified in other sources. This finding supports the model by Kleven et. al. (2011) and suggests that it is not necessarily specific characteristics of people who select into entrepreneurial activities that go in hand with dishonesty in tax declarations.

The third column produces results for taxpayers filing taxes with and without the

Table 7: Heterogenous effects for IFW sample by employment characteristics
(First difference estimation with logarithmic transformation of dependent variable

Total income		Employment		Tax advisor		Job sector	
0-30K	0.017	other N	0.032	none	0.074**	service	0.095**
	(0.016)		(0.020)		(0.016)		(0.028)
30K-60K	0.084**	prim. N	0.078**	advis.	-0.013	industry	0.210*
	(0.029)		(0.021)				(0.084)
60K-120K	0.142**	other E	-0.339			unknown	0.042*
	(0.048)		(0.291)				(0.017)
120K+	0.047	prim. E	0.049			other	D
	(0.091)		(0.037)				
Controls	yes		yes		yes		yes
t trends	yes		yes		yes		yes
R^2	0.004		0.003		0.001		0.001
N ind.	33,639		33,639		33,639		33,639
N obs.	201,834		168,195†		201,834		201,834

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Controls indicate time varying categories. Time trends are specified as 3rd degree polynomials.
†Since we do not have information on the entrepreneur status for 2002 we exclude one year from the estimation.

assistance of a formal tax professional service. The tax advisors in these organizations are more informed about the workings of the tax system and perhaps of the information held by the tax authorities. Since people declaring IFW have different sources of income, tax advisors may reduce tax misreporting or help their clients legally avoid taxes. Furthermore, for the tax advisors working in tax consultancy firms, the prospect of getting caught for helping clients fraudulently evade taxes could have repercussions on the entire firm. As such, their livelihood depends strongly on remaining within legal boundaries. This is apparent in the results where we see that the reactions to the 2005 campaign are mainly generated by taxpayers filing their taxes alone. We can, however, not exclude the possibility that certain individuals in this group still employ a tax advisor informally. In the last column of Table 7 we look at the 2005 reactions by job sector. We find strong effects for jobs in the service and industry sectors. Listed under the service sector are jobs in educational, cultural, social, religious or sports organizations. These organizations often employ workers temporarily or for very few hours per week. It may be that these short contracts are agreed in an informal manner to avoid cumbersome paperwork. Workers in industry may have skill in a craft for which they can earn income informally through their personal network. Since the worker and the client are often acquaintances, it is simple for the client to agree upon ignoring that the work will remain undeclared in taxes. In counterpart, the work is offered at a lower price than that which would be demanded from a formal contractor. We also see positive effects for people with unknown job sectors. All in all, the results fit within the basic model of crime where fraudulent acts arise when individuals are presented the opportunity and incentives to cheat.

5.3 IRA and substitution patterns:

The results observed in Table 5 suggest no significant reaction in the IRA to the 2005 IFW announcement. However, as described in section 2, there exists an ambiguous interdependence between IFW, IRA and other sections of the tax forms. In particular, some profits related to rented property and income from assets may also be allocated in Box 2 or Box 3. This is made evident on the tax form where taxpayers are explicitly asked to indicate the amount declared for 'other property', 'other assets' and 'debts' encompassed in their IFW and IRA declarations. It seems plausible that the effect of the announcements in 2005 indirectly involving IRA may spillover to declarations in other sections of the tax returns.

Table 8: Substitution effects for IRA sample in 2005
(First difference estimation with logarithmic transformation of dependent variable)

	(1) IRA	(2) Oprop	(3) Oassets	(4) Debts	(5) ShareBond	(6) Box2
2005 effect						
2005	-0.018	0.037**	0.011**	0.014	0.017*	0.042**
	(0.016)	(0.008)	(0.004)	(0.008)	(0.008)	(0.009)
t trend	yes	yes	yes	yes	yes	yes
R^2	0.000	0.000	0.000	0.001	0.002	0.008
N ind.	49,486	49,486	49,486	49,486	49,486	49,486
N obs.	296,916	296,916	296,916	296,916	296,916	296,916

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Time trends are specified as 3rd degree polynomials.
(1)**IRA:IRA (B1)** (2) **Oprop: other property (B3)** (3) **Oassets: other asssets (B3)** (4) **Debts: debts (B3)** (5) **ShareBond: shares, bonds, etc. (B3)** (6) **Box2: Box 2 (B2)**

Table 8 looks more deeply into related topics in tax declarations for the IRA sample. The results show patterns hinting towards spillover effects in declarations of other topics. In columns 1-4 we see that although there are no clear changes in 2005 for IRA declarations, there are significant positive jumps in 'other property' and 'other assets'. Assuming that in years without an announcement taxpayers allocate their income optimally among the different sections of the tax form, the shifts observed in the overlapping topics of Box 3 can plausibly result from the increased probability of audit for the IRA sample in Box 1. In addition, it must be the case that the 2005 IFW announcement constituted a realistic threat to being audited for the IRA sample. We see no significant effect on 'debts' but this may be due to two counteracting forces. 'Debts' enter negatively in tax returns and are known to be a topic very difficult to verify with third-party information. It may be that experienced taxpayers overdeclare debts in normal years but reduce these when facing a higher probability of audit in 2005. At the same time, declarations in 'other property' and 'other assets' are often paired with mortgage payments or other forms of debts which would suddenly increase as taxpayers increase their declarations in the other two

topics. Klepper and Nagin (1989) give similar arguments and more detailed explanations on how counteracting effects in the US TCMP tax data can explain declaration patterns for related tax topics. The fifth column shows an increase in declarations in 2005 for the topic 'shares, bonds, etc.'. This category, although not explicitly listed in Box 1 of the tax form, includes a wide array of financial products that may be declared in different sections. A last result further suggesting that the reaction in the IRA sample spills over to other topics shows itself in the last column of Table 8. We see that for Box 2, a section of the tax forms which overlaps with IRA and IFW topics, declarations also increase by 4.2%. As indicated in section 3, the IRA sample differs from the IFW sample and from the average population since it regroups individuals with high returns for all potentially overlapping topics. For an opportunistic taxpayer, these complex returns may provide the opportunity for substituting and rearranging tax declarations in a way to minimize exposure to audit.

Table 9: Substitution effects for IRA sample in 2005
(First difference estimation with logarithmic transformation of dependent variable)

	(1) 2ndHome	(2) ClaimCash	(3) Savings	(4) Benefits	(5) CapInsur	(6) IFW
2005 effect						
2005	0.005	0.007	0.001	0.000	0.005	-0.009
	(0.004)	(0.006)	(0.010)	(0.001)	(0.003)	(0.005)
t trend	yes	yes	yes	yes	yes	yes
R^2	0.000	0.000	0.000	0.000	0.001	0.000
N ind.	49,486	49,486	49,486	49,486	49,486	49,486
N obs.	296,916	296,916	296,916	296,916	296,916	296,916

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Time trends are specified as 3rd degree polynomials.
(1)**2ndHome: 2nd home (B3)** (2)**ClaimCash: other claims and cash (B3)** (3) **Savings: savings (B3)** (4) **Benefits: benefits claims (B3)** (5) **CapInsur: capital insurance (B3)** (6) **IFW: IFW (B1)**

To verify that the jumps in declarations are specific to overlapping IRA topics in Box 3, Table 9 looks at the changes in declarations for the other topics listed in Box 3 of the tax form. The categories '2nd home', 'other claims and cash', 'savings' and 'benefits claims' can not be directly substituted into either of the two Box 1 categories. Checking for reactions to the 2005 announcement campaign in these categories we find no significant changes. This supports the idea that the increases observed for the topics related to IFW and IRA are not simply due to general increases in all Box 3 topics.

There are two relevant questions to answer when observing these patterns. Assuming individuals in the IRA sample perceive a higher probability of audit in 2005, why do they not increase their declarations in IRA directly? And, if the patterns observed represent strategic evasion, how do individuals choose to reallocate their previously hidden income in other sections of the tax form? To answer the first question, one possibility is that

Table 10: Substitution effects for IRA sample in 2005 and 2007
(First difference estimation with logarithmic transformation of dependent variable)

	(1) IRA	(2) Oprop	(3) Oassets	(4) Debts	(5) ShareBond	(6) Box2
2005-2007 effects						
2005	-0.017	0.036**	0.010**	0.011	0.017*	0.071**
	(0.016)	(0.008)	(0.004)	(0.008)	(0.008)	(0.009)
2007	0.006	-0.021*	-0.014**	-0.073**	-0.013	1.001**
	(0.017)	(0.008)	(0.004)	(0.009)	(0.008)	(0.014)
t trend	yes	yes	yes	yes	yes	yes
R^2	0.000	0.000	0.000	0.001	0.002	0.042
N ind.	49,486	49,486	49,486	49,486	49,486	49,486
N obs.	296,916	296,916	296,916	296,916	296,916	296,916

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Time trends are specified as 3rd degree polynomials.
(1)**IRA:IRA (B1)** (2) **Oprop: other property (B3)** (3) **Oassets: other assets (B3)** (4) **Debts: debts (B3)** (5) **ShareBond: shares, bonds, etc. (B3)** (6) **Box2: Box 2 (B2)**

taxpayers believe their probability of audit increases with the amount declared in IRA. This would make sense since the 2005 IFW spotlight topic implicated the IRA category and the overlapping topics. Given that individuals in the IRA sample hold large returns in topics linked to IFW, they may try to reduce as much as possible their visibility and avoid being audited by declaring the previously underreported returns in other sections of the tax form. A similar argument is also advanced by Slemrod et. al. (2001) in their Minnesota study when trying to explain the observed decreases in declarations for high income tax filers who received threat of audit letters. They propose that these individuals are more adept at finding other havens to hide their returns. A second explanation to why we do not see the returns directly increase in IRA may have to do with taxpayers minimizing their tax burden. Once income in Box 1 enters the third tax bracket or higher (above €30,357), declarations in Box 1 are taxed considerably more than in Box 2 or Box 3. As presented in Table 1 of section 1, Box 1 is taxed at 42% or 52% whereas Box 2 is taxed at 25% and Box 3 is taxed at 30%.[12] The combination of not wanting to take the risk of hiding returns in a year with high audit probability while still wanting to minimize their tax burden would explain the observed patterns in declarations.

To assess the robustness of our interpretation, Table 10 takes a second look at the substitution patterns between categories by assessing reactions to the 2007 announcement campaign which targeted all topics in Box 3. In the model specification, we now add an additional indicator to capture deviations of declarations in 2007 from the underlying trend. Looking at columns 2-4 we see significant reductions in all three topics which can substitute between Box 1, Box 2 and Box 3. Moreover, whereas the Box 1 announcement

[12] Although these are nonlinear functions, amounts above a relatively low threshold will always be taxed higher in Box 1.

in 2005 leads to an ambiguous reaction in 'debts', the 2007 reaction is unambiguously decreasing. This could result from the combined effect of people reducing previously exaggerated declarations in 'debts' and also shifting other topics with attached debt out of Box 3.

Figure 1: IRA Substitution Patterns in 2005 and 2007 (Dutch tax authorities data)

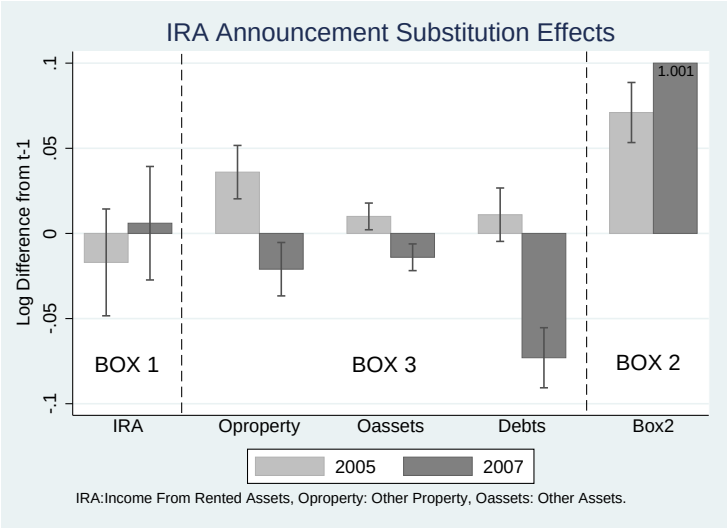

Table 11: Correlation table of Box 2 and Box 3 substitution effects

	Δ_{07}Box3PAD$\|\Delta_{07}$Box3PAD < 0	Δ_{07}Box2$\|\Delta_{07}$Box2 > 0
Δ_{05}Box3PAD	-0.26**	0.10**
Δ_{07}Box3PAD	1	-0.07**
Δ_{07}Box2	-0.07**	1
N obs.	5953	9247

* $p < 0.05$, ** $p < 0.01$.
Box3PAD: other property + other assets - debts in Box 3

Table 11 presents correlations in the declaration patterns between different topics and years. By studying individual correlations between declarations in Box 2 and Box 3 overlapping topics we can gain further insight into the patterns presented in Figure 1. To study the shifting behaviour we focus the analysis of correlations on a suspicious group, those individuals who decrease overlapping Box 3 declarations in 2007. Wealth related to the overlapping topics of 'other property' and 'other assets' should be expected to accumulate over time. While it can be expected that in any given year some people will suffer losses in these topics, these losses should not correlate (or correlate positively) with changes for topics in overlapping sections of the tax declarations. This provides us with a test to assess whether the shifting patterns in 2005 and 2007 are suspicious for this group. In the first column of Table 11 we consider individual correlations in aggregate

Box 3 overlapping income in 2007 for those individuals who decreased these declarations in 2007. The first row presents correlations with aggregate changes in Box 3 income in 2005 $Corr(\Delta_{07}\text{Box3PAD}|\Delta_{07}\text{Box3PAD} < 0, \Delta_{05}\text{Box3PAD})$. We notice a significant negative correlation in the yearly changes in declarations. This indicates that the people who decreased Box 3 overlapping declarations in 2007 had increased those declarations in 2005. Furthermore, looking at correlation results with Box 2 income shifts in 2007, $Corr(\Delta_{07}\text{Box3PAD}|\Delta_{07}\text{Box3PAD} < 0, \Delta_{07}\text{Box2})$, we see that these same individuals increased significantly their Box 2 declarations. These correlations can therefore rule out that the increases in Box 3 topics in 2005, the Box 3 decreases in 2007 and the Box 2 increases in 2007 are independent.

In the second column we consider further these correlations for the group of taxpayers who increase Box 2 declarations in 2007. This group only overlaps partially with the sample analyzed in the first column of Table 11. The first row indicates a significant positive correlation between the increase in Box 2 declarations in 2007 and the change in aggregate Box 3 declarations in 2005, $Corr(\Delta_{07}\text{Box2}|\Delta_{07}\text{Box2} > 0, \Delta_{05}\text{Box3PAD})$. Furthermore, we observe again a negative correlation between the individual increases in Box 2 and changes in aggregate Box 3 declarations in 2007 $Corr(\Delta_{07}\text{Box2}|\Delta_{07}\text{Box2} > 0, \Delta_{07}\text{Box3PAD})$. These correlations taken together can not reject the interpretation of the patterns suggesting that taxpayers may be strategically shifting income away from the section of the tax form targeted by the announcement.

Table 12: Substitution effects for IRA sample in 2005 and 2007
(First difference estimation with logarithmic transformation of dependent variable)

	(1) 2ndHome	(2) ClaimCash	(3) Savings	(4) Benefits	(5) CapInsur	(6) IFW
2005-2007 effects						
2005	0.004	0.007	0.001	0.000	0.005	-0.010
	(0.004)	(0.006)	(0.010)	(0.001)	(0.003)	(0.005)
2007	-0.009	0.019**	0.021	0.000	0.000	-0.002
	(0.005)	(0.007)	(0.011)	(0.001)	(0.003)	(0.006)
t trend	yes	yes	yes	yes	yes	yes
R^2	0.000	0.000	0.000	0.000	0.001	0.000
N ind.	49,486	49,486	49,486	49,486	49,486	49,486
N obs.	296,916	296,916	296,916	296,916	296,916	296,916

* $p < 0.05$, ** $p < 0.01$. Clustered standard errors. Time trends are specified as 3rd degree polynomials.
(1)**2ndHome: 2nd home (B3)** (2)**ClaimCash: other claims and cash (B3)** (3) **Savings: savings (B3)** (4) **Benefits: benefits claims (B3)** (5) **CapInsur: capital insurance (B3)** (6) **IFW: IFW (B1)**

Table 12 looks again at the 2007 announcement effects for the topics in Box 3 which do not overlap with IRA. As in 2005, we see no significant reactions in '2nd home', 'savings' or 'benefits claims'. With the exception of certain offshore bank accounts contained within savings, these three topics are also the ones in Box 3 with the most reliable third-party

information. As for 'IRA' in Table 10, we see no increases in 2007 'IFW' declarations due to substitution from Box 3. We do however see a significant increase in 'other claims and cash' which we interpret as a direct consequence of the higher audit probability in 2007 for Box 3. This last observation also gives support to the idea that when shifting funds between different tax sections is not possible, taxpayers declare previously underreported funds directly.

6 Conclusion

A fundamental problem in studying fraud is that there is typically no way to obtain a direct measure of an outcome variable since the actors engaged in corrupt or illicit behaviour attempt to hide trails of their activities. Researchers trying to uncover fraudulent behavior must therefore employ nonstandard approaches to generate measures of wrongdoing. Empirical studies on tax evasion in economics have used randomized experiments, alternative consumption outcomes and kinks in tax schedules to search for unusual patterns in tax reporting. These studies compare theoretical predictions from tax evasion models to actual declarations indicative of tax evasion behavior. Studies in the statistics literature have used other approaches based on predictions about number frequencies and latent models in randomized response surveys to draw inference on the share of tax evaders (Nigrini, 1996; van den Hout, Böckenholt and van der Heijden, 2010).

This paper looked into tax fraud and other misreporting in the Netherlands by evaluating taxpayer responses to publicly announced auditing campaigns in 2005 and 2007. To this end, we used administrative longitudinal data covering individual tax declarations over the period 2002-2008. Our econometric approach estimates effects of the announcements as year specific deviations from the underlying trend in declarations. We find that the 2005 announcement concerning income from freelance work generates a 4%-5% increase in declarations in that topic. Extrapolating to the average yearly population declaring income from freelance work, this is equivalent to underreported amounts of approximately €74 million a year. Looking deeper into this effect we find that it is correlated with many characteristics suggesting quite independent profiles of taxpayers. We see that the jump is positively correlated to being single, male, between 30-50 years old, and without children. The jump is also more pronounced for middle income taxpayers who are not self-employed and do not make use of tax professionals to file their returns. It also seems the misreporting occurs more often in the service sector, where jobs are often temporary, and in the industry sector, where specific crafts can be used for moonlighting activities.

We also explore spillover effects from the announcement for a sample of wealthy individuals with complex tax situations (income from rented assets sample). We argued that the ambiguous definition of certain tax topics linked to the 2005 announcement might lead this group to respond to the announcement by changing declarations in other sec-

tions than Box 1 of the tax form. The results show significant increases in Box 2 and Box 3 declarations for certain forms of property and assets which are difficult to verify in third-party information sources. As a robustness check we verify that non-overlapping items do not show any responses to the announcement. To further understand the shifting behavior between different sections of the tax reports we also looked at a second announcement campaign in 2007 concerning Box 3. The declarations for items in Box 3 which showed increases in 2005 show decreases in 2007. In addition, we also find increases in 2005 and 2007 for assets declared under Box 2. Altogether, these patterns support the proposition that taxpayers react with uncertainty to an unusual increase in their probability of being audited. Since they only have a partial knowledge of what information is held by the tax office, they do not know which selection criteria are used for audits in announcement years. A possibility advanced in this study is that they react strategically by declaring previously hidden wealth and shifting a portion of the income in targeted topics to other sections of the tax returns which have lower tax rates. Although the act of shifting is indicative of tax avoidance, the spontaneous appearance of previously undeclared funds shows evidence of tax evasion. We also find a direct effect of the 2007 announcement on the tax item 'other claims and cash' which jumps up. This increase and that observed for income from freelance work suggest that when there is no possibility to shift funds to reduce visibility then taxpayers will directly increase declarations for previously underreported income. Aggregating the different shifts in the IRA sample to the average yearly population declaring income from rented assets indicates a total increase in declarations of approximately €76 million in 2005 and of €142 million in 2007.

The type of complex shifting behavior we present presupposes certain taxpayers have a strong understanding of financial products that can be substituted between different sections of the tax forms. As shown in our data description, almost half of the sample holding income from rented assets work in the financial sector. Studying the tax paying activities of individuals with complex tax returns could provide insight into the different financial assets which are hard to trace. For income from freelance work, our results would suggest further considerations on how to restrict underreporting of additional earnings for individuals employed in the service and industry sectors.

This study will also hopefully provide some avenues for new research. For instance, one can look deeper into profiles and shifting behaviors by location, between partners or through networks. For researchers interested in behavioural models of taxpayers, our results also present an apparent contradiction. We suggest that taxpayers attempt to reduce (or at least do not increase) their declarations to avoid being audited in the announcement specific topic while still declaring the previously hidden assets in other sections of their tax reports. So taxpayers, in particular those with complex asset holdings, seem to have a good understanding of how to shift their assets and what financial information is available to the tax office in normal auditing years. On the other hand, they still remain unclear about their exact probability of being caught under unusual auditing circum-

stances. Last, researchers interested in optimal tax systems could use a more structural approach to evaluate the advantages of a tax system with yearly announcements. Thinking about the possible benefits of this tax model is particularly relevant if some taxpayers underreport by negligence. Announcements can produce a one time push in learning the tax code which could lead to long lasting learning effects of announcements. The theoretical underpinnings for such a model have already been suggested in the work of Lazear (2006) and Eeckhout, Persico and Todd (2010).

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