Charitable deductions: modelling of longitudinal taxpayers' data for time-regularity estimation and future predictions

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Research Article

Keywords: Time, Tax Incentives, Geneva Deducters, Forecast, ETS models, Regularity

Posted Date: August 8th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3225036/v1

Abstract

The present study is the continuation of an existing one, with a new research question and novel statistical predictions. It represents the first large-scale time-series analysis of tax incentives for charitable giving in Switzerland for regular donors, and one of the few charitable deductions' projections globally. Using unique panel data of the entire Geneva taxpayers' population, from 2001 to 2011, we concentrate on the frequency of donations, by analyzing the characteristics of regular donors. This period also encompassed a legal reform that raised ceilings for charitable deductions. Taxpayers who deducted only once represent 29% of the study population, while the remaining 71% indicate taxpayers deducting more than once. We also observe that regular donors are not driven by the ceilings for tax incentives, however, wealth is an important variable characterizing the donations' frequency. Moreover, time-series forecasting models have been used to project the future amount of donations and donors. A total amount of donations in a range of (79, 114) million in 2012-2022 has been predicted from the best model. These figures help understanding the magnitude of deductions and they allow to take better decision of the ceiling of tax incentives for charitable giving, while highlighting the main relevant factors.

Introduction

Tax incentives for charitable giving are a prevalent feature of legal systems around the world (OCDE, 2020). The primary goal of such incentives, at least from an economic perspective, is to boost donations (even though other policy objectives can and often are being followed simultaneously: it is for instance argued that the system that grants tax incentives for charitable donations increases transparency in the philanthropic sector (Reiser, Dana Brakman, and Steven A. Dean, 2023). However, legislative proposals are often vague on this point. Indicating that they want to increase charitable giving in general, they often fail to say how exactly donors' giving behavior is expected to change as a result of the legal standards establishing tax incentives for charitable giving or which donors these reforms intend to benefit (Lideikyte-Huber, Pittavino and Peter, 2021).

To date, it is still not entirely known how well tax incentives for charitable donations succeed in influencing taxpayers' behavior. Relatively few studies, particularly in Europe, examine the characteristics of donors who respond to tax incentives for charitable giving, and even fewer studies concentrate on changes in donors' reactions to actual changes in tax law. There has been little research done globally on the behavior of donors in the upper income and wealth brackets. Such information, however, is valuable for policy makers, because to effectively boost giving through tax incentives, they must first understand how donors react to them.

Current Swiss law allows taxpayers deducting, up to a certain threshold, charitable contributions from their taxable income for individuals and for corporations. This deduction is subject to a threshold which is currently 20% of the net taxable income or profits for federal income tax purpose, with a minimum donation requirement of 100 CHF (Federal Act of 14 December 1990 on Direct Federal Taxation (DFTA), AS 1991 1184, Art. 33a DFTA). According to the Federal Constitution, cantons can fix their own income tax rates, but most of the cantonal tax thresholds are also fixed at same threshold of 20% (Art. 129 of the Swiss Federal Constitution). It is not possible to deduct donations to political parties under this norm; member contributions and other payments of up to CHF 10,300 to a political party are deductible as general deductions under another legal norm (Art. 33 para. 1 (i) DFTA). The 20% deduction threshold was introduced on 1 January 2006 as part of a larger reform of the Swiss federal law (Swiss civil code - modifications), replacing the previous threshold of 10%. This reform has also carried out other major modifications of federal tax law norms related to charitable giving, introducing a deduction of charitable non-cash donations was introduced and allowing the deductions of donations to the Swiss Confederation, the cantons, the communes, and their institutions (Swiss civil code- modifications). The general aim of this reform was to encourage donors "to give up part of their wealth", due to the fact that private wealth had risen sharply in the previous years and the previous tax incentives were considered insufficient to encourage individuals to part with an "important" portion of their wealth (Report 2003, p. 7428, 7426-7427; Schiesser initiative). Such a justification was the only tax policy objective expressly stipulated by the legislator; thus, at least one of the goals of the reform was to boost donations (the general goal of the 2006 reform was "the liberalization of the Swiss foundation law in order to boost the establishment of foundations") (Report 2003, p. 7426; Lideikyte-Huber and Pittavino, 2022). After the reform at the federal level, cantonal law modifications were introduced; in the canton of Geneva, the 5% deduction threshold of taxable net individual income (Personal Income Tax Act – V) increased to 20% in 2010 (Personal Income Tax Act of September 27, 2009, FR : Loi sur l'imposition des personnes physiques du 27 septembre 2009 ; LIPP ; D 3 08, in force : 01.01.2010). and the deduction threshold for corporations increased from 10% to 20% (Corporate Income Tax Act of September 23, 1994).

The deductible donation must be paid to a legal entity that receives a tax exemption for pursuing public interest or service aims (Arts 33a and 56 let. g DFTA). The conditions for this type of entity's tax exemption are laid out in the legislation and, in particular, in case law. One of the primary requirements is that the entity cannot pursue economic aims since they cannot be regarded as being in the

interest of the general public (Art. 56 let. g DFTA). For instance, maintaining sizable shareholdings in business firms is in principle considered an economic goal; it can only be accepted if it is subordinate to the entity's pursuit of public interest goals, and it is necessary to achieve them.

In the work published in 2022 Lideikyte-Huber and Pittavino, the authors of this paper analyzed the characteristics of donors' giving in relation to their income and in the framework of an income tax law reform. The objective of the present paper, which is a follow-up analysis, shifts focus from legal context to the time influence. In the current work, we study the timing of giving, concentrating on the frequency of deductions over the 11 years' time period and on future projections of deductions amount and a number of donors, based on previous trends together with the statistical analysis of the factors mainly influencing the deductions among regular deducters.

MATERIAL (DATA DESCRIPTION and SUBSETS)

I. Data Description

Our analysis is based on information from taxpayer returns over 11 years from the year 2001 until 2011 that the Tax Administration of the Canton of Geneva (TACG) confidentially gave us for this study. The selected variables provide information on the entire population of taxpayers in the Canton of Geneva (approximately 250'000 households). A different data set was provided for each year under study, 11 in total. Each data set comprised the same nine variables, an entire description of them is provided in Lideikyte-Huber and Pittavino (2022) and Lideikyte-Huber, Pittavino and Peter (2021); the ones particularly used in the present study are described and listed below with their original name provided in brackets. For this specific follow-up study, two new variables have specifically been created ("year" and "freqded") to allow a more in-depth longitudinal analysis for the year of study and the characterization and computation of the frequency of donation over the study period. A merging of the 11 different data set, with the elimination of double IDs, if any, was performed to create the appropriate unique dataset:

- "coded ID" ("identifiant"): a coded ID for each taxpayers. This variable allows to follow the same taxpayer over time, except in four specific cases[1]. The same coded ID is used for a given taxpayer for each fiscal year. As Switzerland has a joint filing system, married couples are considered and treated as one taxpayer in the same way as a single non-married individual, and they have only one coded ID (in this paper, any deducting taxpayer, couple, or individual is referred to as "deducter").
- "year of birth" ("annee_de_naissance"): the year of birth of a taxpayer (which is either an individual or a household, depending on marital status). For married couples, it is the year of birth of the "principal" taxpayer, usually the man.
- "income_bracket" ("bareme_revenu") - the binary (0/1) indication of a possible "splitting" of income tax rate in the tax income computation, showing if a taxpayer is a couple (1) and not a single individual (0).
- "global net taxable income" ("revenu_net_imposable_taux"): the net taxable income (after all deductions) applied to set the tax rate; this includes the totality of any foreign income.
- "gross wealth" ("fortune_brute"): global gross wealth of the taxpayer.
- "deductions for donations" ("versements_benevoles"): the amount of deduction (if any) for charitable giving, representing the entire annual amount of the deducted donations (in case it is less than the deductible threshold) or capped amount of annual donations, if exceeding the deductible threshold.
- "intermediary net income for deductible donations" ("Sous_total_ded_dons"): this variable serves as a key reference point for calculating deductions that are under, equal or more than the legal threshold (10% or 20%, depending on the year). It could only be digitally extracted from the databases of the Geneva Tax Administration for the tax years 2010 and 2011. For the previous years, it was determined by internal calculations performed by the Cantonal Geneva Tax Administration (TAGC), based on the elements of the tax base that are included in its definition (Information provided by TAGC).
- "year under study" ("year"): this new variable has been generated for the purpose of this study to keep track of the evolution by year of the collected data. It indicates the 11 years under consideration for this study, from year 2001 to year 2011.
- "frequency of deductions" ("freqded"): innovative additional variable created to count the frequency a given ID repeated the charitable deductions over the study period.

This data was selected for taxpayers residing in the Canton of Geneva as well as for taxpayers residing in another Swiss canton or abroad, however still taxed in Geneva. The information above does not allow us to distinguish between these different categories of taxpayers. In addition, as from the 2009 tax year, taxpayers who are usually taxed at source ("*impots à la source*", dedicated taxation practice for newcomers in Switzerland) have the possibility of filing a return, if they meet certain conditions, and are then treated as

resident taxpayers ("*quasi-residents*"). These taxpayers are approximately 2,000 in 2009, 4,000 in 2010 and 5,600 in 2011. The variables provided by TACG does not allow us to identify quasi-resident taxpayers (Loi sur l'imposition des personnes physiques (LIPP-V)).

As reported in the previous study (Lideikyte Huber, Pittavino and Peter, 2021), the total number of taxpayers in the canton of Geneva has steadily increased, from 234,117 in 2001 to 266,336 in 2011. The share of the taxpayers deducting charitable donations more than doubled, passing from 8.3% in 2001 to 19.3% in 2011, with a steep increase in 2005 (deducting taxpayers reaching 16.3%). Concerning the general pattern of deductions during the studied period, the total amount of yearly charitable deductions increased significantly, from CHF 29,133,697 in 2001 to CHF 72,741,235 in 2011 (amounts non-adjusted for inflation) which is due to the rise in population and a substantial increase of 48% is recorded in 2009.

In the present analysis we use the terminology of "deducters" to indicate the taxpayers who contributed to charitable donations and used a tax-incentive (deduction) in relation to their donation, since we want to investigate this specific subset of taxpayers' population.

II. Data subset and description by frequency of deducters and deductions' ceiling

The last described variable "freqded" has been generated to allow analyzing the data with an innovative perspective by highlighting the frequency of donations from the deducters, over the 11 years under study.

Table 1 indicates the frequency of deductions by each deducter, the total number of deducters within each frequency and the resulting percentage of deducters. We observe that 29.4% of deducters (corresponding to a total of 30'319 deducters) are donating only once. The remaining 70.6% of deducters are donating more than once, showing knowledge of the tax incentives for charitable deductions, a related interest for this fiscal advantage and a start of a repeated behavior within their donations. With this targeted analysis, it was possible to identify a specific group of deducters who donated over the entire time span period of 11 years. This subgroup corresponds to 5948 taxpayers, who represents the 2.54% of the starting Geneva taxpayers' population from 2001 - those people were continuously giving from 2001 to 2011. This subgroup of deducters will be called "deducters11" from now on and it will be compared to the subgroup of deducters identified in our previous study (Lideikyte-Huber and Pittavino, 2022), who are more interested in targeting the ceiling of deductions, referred to as 'deducters' subset'.

The figures related to the frequency of deductions have also been represented in the bar plot in Figure 1, where for each frequency there is shown the total number of deducters. This graph shows the decaying pattern of the frequency of deductions for all deducters, showing as the majority of people who deducted once, repeated the process in time for more than once and this reflects a repeated behavior in the deducters and an awareness of the tax incentives by the whole taxpayer's population. However, this decaying pattern flattens considerably. It is interesting to observe that the number of donors who give very regularly, from 5 to 11 years during the studied period, is very similar. For instance, the number of donors who give once every two years and every year is nearly the same.

Table 1. Frequency of deductions, total number, and percentage of deducters.

Frequency of deductions	Total number	Percentage
1	30319	29.4
2	15597	15.1
3	10994	10.7
4	8530	8.3
5	7003	6.8
6	5739	5.6
7	5378	5.2
8	4677	4.5
9	4467	4.3
10	4490	4.4
11	5948	5.8

In Table 2 are reported the figures for the frequency of deductions for deducters interested in reaching the ceiling of 4% and more. From the third column is possible to see how 49% of deducters reaching this legal ceiling are donating only once. Moreover, among the 3.1% who are regularly donating over the 11 years under study, they represent only 5% of the totality of regular deducters "*deducters11*". These first results highlight that taxpayers reaching the legal ceiling are not belonging to regular deducters. Half of taxpayers reaching the above ceiling are donating only once, as also shown in Figure 2. While from now on we will call "*deducters11-ceiling*" the regular deducters reaching the ceiling of donations for tax incentives.

Table 2. Frequency of deductions, total number, percentage deducters over total deducters who donated the legal ceiling of 4% and more and percentage over regular deducters.

Frequency of deductions	Total number	Percentage	Percentage over regular deducters
1	4667	49.0	15.4
2	1459	15.3	9.4
3	826	8.7	7.5
4	604	6.3	7.1
5	424	4.5	6.1
6	323	3.4	5.6
7	265	2.8	4.9
8	235	2.5	5.0
9	213	2.2	4.8
10	202	2.1	4.5
11	297	3.1	5.0

III. Deducters11 by the income bracket

The third variable described above ("splitting") and presented in our dataset shows whether the tax payer household is entitled to specific rates that are applicable to spouses, registered partners (same-sex couples) or taxpayers who live in the same household as their minor or adult children, or a close relative who is a family dependent. By analyzing all the deducters, the deducters11 and deducters11-ceiling, this variable always shows an equally distributed population between these characteristics... even with a prevalence of joint filling. This indicates that the regularity of deductions is typical of family rather than single taxpayers, as it was instead relieved by the previous study by looking at the population's subset features.

3. METHODS

Two different classes of statistical methods have been used with two different aims. Firstly, regression methods with and without interaction: linear bivariable models applied to two subgroups of deducters: "*deducters11*" and "*deducters11-ceiling*" to identify the main significant variables driving the charitable deductions in regular deducters, who aren't and are reaching the ceiling threshold. Secondly, forecasting methods applied to the amount of deductions and the amount of donors, to project the predicted figures in the next upcoming 10 years: 2012-2021.

The entire data set was already analyzed in detail in Lideikyte-Huber and Pittavino (2022). For the Exploratory Data Analysis (EDA) we proceeded to focus on the new subset datasets "deducters11" and "deducters11-ceiling". The main summary statistics (e.g., mean, SD, min, max, median) have been checked and computed. Since some of the variables represents almost the same quantity (i.e., ""global net taxable income" ("revenu_net_imposable_taux"), "intermediary net income for deductible donations" ("Sous_total_ded_dons")), they are sharing the same part of the variance to describe the response and it resulted in a very high multicollinearity between some pairs of variables. To measure the amount of variance explained by each one of them for the resulting model the variance inflation factor (VIF) (Ref. to VIF) has been calculated. This quantity was computed to select the optimal set of variables for our analysis. This is an indication of the presence of multicollinearity. Two variables: X1: "global net taxable income" and X2: "gross wealth" resulted with an overall Mean for the VIF of 2.75.

IV. Bivariable linear regression analysis with and without interactions

The first method used to analyze the data for the frequency of deductions: “deducters11” and “deducters11-ceiling” was a bi-variable linear regression analysis between income (X1) and wealth (X2), resulted from the VIF check, with and without interaction (Faraway J. Julian, 2004 and 2016, Pittavino Marta et al, 2017a and 2017b).

For the “deducters11” first sub-dataset we have:
Y_i = deductions for donations, i = 1, .. , 5948

$$1)\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i1} X_{i2} + \varepsilon_i$$

Model 1), with interaction.

$$2)\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon_i$$

Model 2), without interaction.
with $\varepsilon_i \sim N(0, \sigma^2)$, independent and identically distributed (iid).

For the “deducters11-ceiling” second sub-dataset we have:
Y_i = deductions for donations, i = 1, .. , 297

$$3)\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i1} X_{i2} + \varepsilon_i$$

Model 3), with interaction.

$$4)\quad Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \varepsilon_i$$

Model 4), without interaction.
with $\varepsilon_i \sim N(0, \sigma^2)$, independent and identically distributed (iid).

Given the panel nature of our data set and the repetition over time for the frequency of deductions description bi-variable linear regression models with random effect: Linear Mixed Models (LMM) have been also performed, to incorporate better the subject variability, with and without interaction for income and wealth. LMM have been fitted to check if there was subject variability. Two types of LMM models have been implemented, with a random intercept and with random slope for each year of deductions.

We also performed robust regression analysis, with and without interaction, for both the two datasets “deducters11” and “deducters11-ceiling” to further confirm and check our findings.

v. Forecasting methods with applications in philanthropy

The second class of methods used to make predications of the current values for the next upcoming 10 years were the ETS (Error-Trend-Seasonality) and the ARIMA Models (Hyndman, 2021).

Four different type of ETS models, starting from the Simple Exponential Smoothing to Holt’s Models, that take into account different trend effects (i.e. additive, additive with damped and multiplicative) have been fitted to compute the amount of donations for the upcoming 10 years (2012-2022). Five different error metrics (i.e. AIC, AICc, BIC, RMSE and MAPE) have been calculated and the smallest one have implied to select the best model for the forecast.

For the projection of the amount of donors, an ARIMA model (Hyndman, 2021) was also fitted.

Results

4.1 Outcome from the LM models for 11-years’ deductions: regularity results

From Table 3 we can observe how the interaction between income and wealth is significant on a global level of all the regular deducters, indicating that higher income and wealth positive influence deductions or vice versa. The income variable per se has a negative effect on deduction, showing that wealth is the main variable influencing the deductions for regular deducters.

LMM have been fitted to check if there was subject variability, but they did not show an improvement in variance and/or in the model coefficient and especially in the variance description. Even if the resulting standard error for each coefficient was slightly smaller, they were not giving an added value to the results obtained with Model 1 and Model 2.

While if we observe results from Table 4, referring to the subset *deducters11-ceiling*, the interaction between income and wealth is no longer significant and only income is a statistically significant variable from the resulting p-value smaller than 0.05. These results confirm the findings from Lideikyte-Huber2022 where income was the only significant factor for deducters interested in reaching the ceiling. While for regular deducters among time, income has a negative effect on deductions, while his interaction with wealth and wealth itself is significant and positive.

For the robust regression analysis similar results as the ones shown in Table 3 and 4 were found. Moreover, since in the group of regular deducters there are taxpayers with similar characteristics, there were not so many outliers. We preferred to privilege the efficiency of the ordinary least square method rather than the robustness, considering the reduced number of extreme values.

Table 3. Table with the beta estimates: β and the p-values: p for 'Net Income for deductible donations': Inc, 'Gross Wealth': Wth and their Interaction: 'Int', with the adjusted R2: R2Adj resulting from the standard bi-variable linear regression model with and without interaction fitted for the subset of *deducters11* for all years and for each year under study.

	Linear models with interaction							Linear models without interaction				
Deducters11	βInc	pInc	βWth	pWth	βInt	pInt	R2Adj	βInc	pInc	βWth	pWth	R2Adj
All 11 years	***-4.3x10-3***	<0.05	9.2x10-4	<0.05	1.9x10-11	<0.05	0.31	-4.4x10-3	<0.05	9.7x10-4	<0.05	0.30
All 11 years[1]	***-8.0x10-3***	-	1.3x10-3	-	1.4x10-11	-	-	-1.4x10-3	-	1.4x10-3	-	-
All 11 years[2]	**-7.9x10-3**	-	1.3x10-3	-	1.5x10-11	-	-	-2.9x10-3	-	1.5x10-3	-	-
2001	***-2.2x10-3***	<0.05	4.7x10-4	<0.05	2.5x10-11	<0.05	0.56	6.5*10-3	<0.05	5.5x10-4	<0.05	0.51
2002	2.8x10-3	<0.05	4.1x10-4	<0.05	2.2x10-11	<0.05	0.62	9.5*10-3	<0.05	5.0x10-4	<0.05	0.61
2003	5.3x10-3	<0.05	3.2x10-4	<0.05	***-1.5x10-12***	<0.05	0.66	4.7*10-3	<0.05	3.2x10-4	<0.05	0.66
2004	4.4x10-3	<0.05	2.9x10-4	<0.05	1.2x10-11	<0.05	0.69	8.6*10-3	<0.05	3.3x10-4	<0.05	0.68
2005	**-2.8x10-3**	<0.05	2.7x10-4	<0.05	3.7x10-11	<0.05	0.74	1.1*10-2	<0.05	3.8x10-4	<0.05	0.65
2006	6.8x10-3	<0.05	4.5x10-4	<0.05	***-9.7x10-12***	<0.05	0.62	2.3*10-3	<0.05	4.2x10-4	<0.05	0.59
2007	2.9x10-3	<0.05	3.5x10-4	<0.05	3.0x10-12	<0.05	0.66	4.5*10-3	<0.05	3.6x10-4	<0.05	0.66
2008	***-6.9x10-3***	<0.05	7.7x10-4	<0.05	2.3x10-11	<0.05	0.58	4.9*10-3	<0.05	8.2x10-4	<0.05	0.53
2009	***-5.4x10-3***	0.02	7.5x10-4	<0.05	8.3x10-11	<0.05	0.48	3.8*10-2	<0.05	9.8x10-4	<0.05	0.43
2010	***-1.9x10-2***	<0.05	1.9x10-3	<0.05	3.7x10-11	<0.05	0.40	3.0*10-4	0.74	2.0x10-3	<0.05	0.38
2011	1.3x10-2	<0.05	5.3x10-4	<0.05	***-1.9x10-11***	<0.05	0.23	4.4*10-3	<0.05	4.5x10-4	<0.05	0.21

[1]LMM: Linear Mixed Model with a random intercept.

[2]LMM: Linear Mixed Model with a random slope for the years.

Table 4. Table with the beta estimates: β and the p-values: p for 'Net Income for deductible donations': Inc, 'Gross Wealth': Wth and their Interaction: 'Int', with the adjusted R2: R2Adj resulting from the standard bi-variable linear regression model with and without interaction fitted for the subset of *deducters11-ceiling* globally (All) and for each year under study.

	Linear models with interaction							Linear models without interaction				
Deducters11	βInc	pInc	βWth	pWth	βInt	pInt	R2Adj	βInc	pInc	βWth	pWth	R2Adj
All years-ceiling	5.1x10-3	*0.07*	8.1x10-4	<0.05	1.4x10-10	<0.05	0.76	3.6x10-2	<0.05	3.6x10-2	<0.05	0.73
All years-ceiling[1]	5.1x10-3	-	8.1x10-4	-	1.4x10-10	-	-	3.6x10-2	-	1.3x10-3	-	-
All 11 years ceiling[2]	5.1x10-3	-	8.1x10-4	-	1.4x10-10	-	-	3.6x10-2	-	1.3x10-3	-	-
2001-ceiling	5.0x10-2	<0.05	2.5x10-6	***0.37***	7.3x10-13	***0.19***	0.95	5.0x10-2	<0.05	1.6x10-6	***0.55***	*0.97*
2002-ceiling	4.9x10-2	<0.05	7.0x10-6	**0.30**	1.3x10-12	**0.11**	0.98	4.9x10-2	<0.05	8.7x10-6	**0.19**	0.99
2003-ceiling	5.0x10-2	<0.05	8.5x10-6	**0.04**	2.5x10-13	**0.64**	0.98	4.9x10-2	<0.05	9.0x10-6	0.02	0.99
2004-ceiling	4.9x10-2	<0.05	5.4x10-6	**0.08**	3.5x10-13	**0.40**	1	5.0x10-2	<0.05	5.9x10-6	**0.06**	1
2005-ceiling	4.9x10-2	<0.05	9.8x10-7	**0.61**	8.5x10-13	**0.10**	1	4.9x10-2	<0.05	1.8x10-6	**0.33**	1
2006-ceiling	4.9x10-2	<0.05	1.6x10-6	**0.45**	2.6x10-13	**0.47**	1	5.0x10-2	<0.05	1.7x10-6	**0.38**	1
2007-ceiling	5.0x10-2	<0.05	2.5x10-6	**0.39**	-1.3x10-13	**0 .45**	1	4.9x10-2	<0.05	4.9x10-7	**0.67**	1
2008-ceiling	4.9x10-2	<0.05	2.1x10-5	<0.05	6.9x10-13	<0.05	1	4.9x10-2	<0.05	9.2x10-6	0.004	1
2009-ceiling	7.6x10-2	<0.05	1.3x10-3	<0.05	-9.1x10-11	<0.05	0.99	3.5x10-2	<0.05	1.4x10-3	<0.05	0.99
2010-ceiling	9.8x10-2	<0.05	6.4x10-4	<0.05	-5.3x10-11	<0.05	0.99	7.3x10-2	<0.05	7.0x10-4	<0.05	0.99
2011-ceiling	1.0x10-1	<0.05	-1.4x10-4	0.04	2.5x10-10	<0.05	0.99	2.3x10-1	<0.05	-9.3x10-4	<0.05	0.99

[1]LMM: Linear Mixed Model with a random intercept.

[2]LMM: Linear Mixed Model with a random slope for the years.

Given the small sample size of 297 regular deducters who are reaching the deductions threshold: "deducters11-ceiling" and the small set of variables, the models are giving a perfect fit, with an R2 of 1.

4.2 Outcome from the Forecast Models for the deductions and donors' amount

The five forecasting methods, described in the Methods Sections, have been checked, and compared using the MAPE (Mean Absolute Percentage Error) to identify the one that is the most suitable to predict the amount of deductions and also that corresponded to best data fit. ARIMA models have also been fitted, however they behaved as SES by always producing the same output, therefore they have been discarded. The model which performed the best, with the lowest AIC, BIC and MAPE error metrics term, was model 4) in Table 5 related to a Holt's model with additive damped effect and a multiplicative error to encapture the increasing nature of the donations over

time. The result of this forecast over the predicted period can be seen in Figure 3, where the previously mentioned model with the 95% and 80% prediction intervals is shown.

Table 5. Comparison of the 5 forecasting models (simple exponential smoothing, Holt's model with and without damped effect for the trend) implemented for donations' projections and their error metrics.

Forecasting Models (below) Errors (aside)	**AIC**	AICc	BIC	RMSE	**MAPE**
1. SES	389.1287	392.5573	390.3224	11'028'513	16.50398
1. ETS(A,A,N)	381.3582	393.3582	383.3477	6'458'918	10.24257
1. ETS(A,Ad,N)	383.3466	404.3466	385.7340	6'455'514	9.902257
1. **ETS(Z,Ad,N)**	**378.9578**	*399.9578*	**381.3451**	*6'511'752*	**9.147868**
1. ETS(M,M,N)	383.5166	395.5166	385.5061	8'064'655	12.53688

Table 6. Projections of the amount of donations over the following 10 years (2012-2021), resulting from the best forecasting model ETS(M,Ad,N), with 80% and 95% confidence intervals (Lo and Hi).

Years	Deductions' forecast	Lo 80% CI	Hi 80% CI	Lo 95% CI	Hi 95% CI
2012	79'170'591	64'241'346	94'099'835	56'338'282	102'002'900
2013	83'438'939	67'704'809	99'173'068	59'375'664	107'502'213
2014	87'621'919	71'099'002	104'144'837	62'352'298	112'891'541
2015	91'721'240	74'425'310	109'017'170	65'269'398	118'173'082
2016	95'738'574	77'685'091	113'792'057	68'128'155	123'348'994
2017	99'675'561	80'879'676	118'471'447	70'929'736	128'421'387
2018	103'533'809	84'010'368	123'057'249	73'675'283	133'392'334
2019	107'314'891	87'078'445	127'551'336	76'365'918	138'263'863
2020	111'020'351	90'085'160	131'955'542	79'002'739	143'037'962
2021	114'651'701	93'031'739	136'271'664	81'586'822	147'716'581

We did not forecast more than 10 years, first of all because, since we had information from the previous 11 years, we did not want to go too far in time to limit the uncertainty.

Table 7. Comparison of the 6 forecasting models (simple exponential smoothing and Holt's model with and without damped effect for the trend) implemented for donors' projections and their error metrics.

Forecasting Models (below)	Errors (aside)	**AIC**	AICc	BIC	RMSE	**MAPE**
1. SES		211.6988	215.1274	212.8925	3466.838	8.264631
1. ETS(A,A,N)		203.8104	215.8104	205.7999	2019.522	5.63453
1. ETS(A,Ad,N)		204.6256	225.6256	207.0130	1913.642	5.161422
1. ETS(M,M,N)		201.7138	213.7138	203.7033	1963.346	3.66038
1. ARIMA(0,2,0)		**162.16**	162.73	162.73	1601.337	**2.202275**

In this specific case, given the data pattern, a multiplicative error for a model with additive damped trend would not be supported, giving the same results as model 3) with an additive error instead.

Table 8. Projections of the amount of donors over the following 10 years (2012-2021), resulting from the best forecasting model ARIMA(0,2,0), with 80% and 95% confidence intervals (Lo and Hi).

Years	Donors' forecast	Lo 80% CI	Hi 80% CI	Lo 95% CI	Hi 95% CI
2012	53485	51216.21	55753.79	50015.19	56954.81
2013	55581	50507.84	60654.16	47822.27	63339.73
2014	57677	49187.97	66166.03	44694.15	70659.85
2015	59773	47346.34	72199.66	40768.06	78777.94
2016	61869	45043.22	78694.78	36136.19	87601.81
2017	63965	42322.14	85607.86	30865.11	97064.89
2018	66061	39216.34	92905.66	25005.64	107116.36
2019	68157	35752.23	100561.77	18598.18	117715.82
2020	70253	31951.45	108554.55	11675.84	128830.16
2021	72349	27832.17	116865.83	4266.38	140431.62

DISCUSSION AND CONCLUSION

This study builds up on Lideikyte-Huber and Pittavino, 2022, where the focus was on the legal framework and on the deducters' characteristics in relation to their income and wealth. The current work focuses on the regularity of deductions by donors that use tax incentives for charitable donations, and forecasts future charitable deductions.

One of the conclusions of Lideikyte-Huber and Pittavino, 2022 was identifying a subset of donors that were seemingly responsive to tax incentives for charitable donations - their deductions were close to the maximum legal threshold of the tax incentive. The main driver of deductions was their taxable income to which the tax incentives were related. This subset of donors was making a substantial part of annual deductions in Geneva. However, most of those donors were irregular (297 out of 5948 were deducting donations during the entire period).

In the present study, we focus on the subset of donors that we call "deducters11" that are extremely regular donors (giving and deducting donation every year) and "deducters11-ceiling", who reach the ceiling of deductions. We compared the subgroup of deducters identified in our previous study Lideikyte-Huber and Pittavino, 2022. "Deducters11" correspond to 5948 taxpayers, who represent the 2.54% of the entire Geneva taxpayers' population from 2001. The fundamental finding of the present study is that this constancy is mainly influenced by wealth, and not income. In fact, 95% of regular deducters do not reach the deductible threshold for charitable deductions. That signifies that they do not adapt their donations to the maximum available tax incentive. While for the "deducters11-

ceiling" we still have similar findings from the previous study, where income is the main driving variable and wealth is not even significant.

Wealth being an important factor for regular deducters, the question arises whether a parallel tax incentive linked to wealth, and not to income, could be envisaged to boost donations for this segment of donors. Such a solution, proposed in legal publications (Lideikyte-Huber and Peter, 2022), could be substantiated by the present empirical analysis.

Deductions by income brackets variable indicate that the regularity of deductions is typical of multiple-person taxpayer household (see the definition of "splitting" above") rather than single taxpayers, as opposed to the previous study that analyzed deductions related to the income tax incentive.

In terms of the future deductions, we estimate that the deductions of charitable donations will continue to increase in an important manner in the canton of Geneva, reaching around CHF 114'651'701 in 2021 (57,6% increase from 2011). It must be highlighted that no data on tax deductions is available to verify those predictions and no estimates exist that would be based on tax data similar to the one that is used in the present paper. The only estimates we could find are the ones for the total amount of private donations by the Swiss population was more than CHF 2.05 billion in 2021 (Spendenreport Schweiz, 2022). Those estimates however predict the total amount of donations and not only the deducted donations (75% of households in French-speaking Switzerland report donating in 2021 (Spendenreport Schweiz, 2022), whereas in our study, we observe that only 19% of taxpayer households claimed deductible donations in 2011; this percentage could have changed between 2011 and 2021 but increase to 75% seems unlikely). The present paper estimates of the amount of charitable deductions (and not general estimates on donations) are therefore unique.

Declarations

COMPETING INTERESTS

No competing interest is declared.

AUTHOR CONTRIBUTIONS STATEMENT

M.P. conceived the experiment and the follow-up analysis, M.P. conducted the experiment by preparing and merging the data, M.P. analyzed the data, M.P. and G.L-H interpreted the results. M.P. and G.L-H. wrote and reviewed the manuscript.

ACKNOWLEDGEMENTS

This project is financed by the Swiss National Science Foundation (SNSF) (grant number 182839). The authors greatly thank Professor Henry Peter, the Head of the Geneva Centre for Philanthropy (GCP), for his continuous support. The authors are also extremely grateful to the Tax Administration of the Canton of Geneva (TACG) for providing the data for this study.

Our sincere thanks also go to Professor Roy Welsch of the Massachusetts Institute of Technology (MIT), Boston for his advice on statistical modeling.

DATA AVAILABILITY STATEMENT

Data necessary to replicate the results of this article are available upon request from the corresponding author, subject to a written agreement to share such data by the Tax Administration of the Canton of Geneva.

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Figures

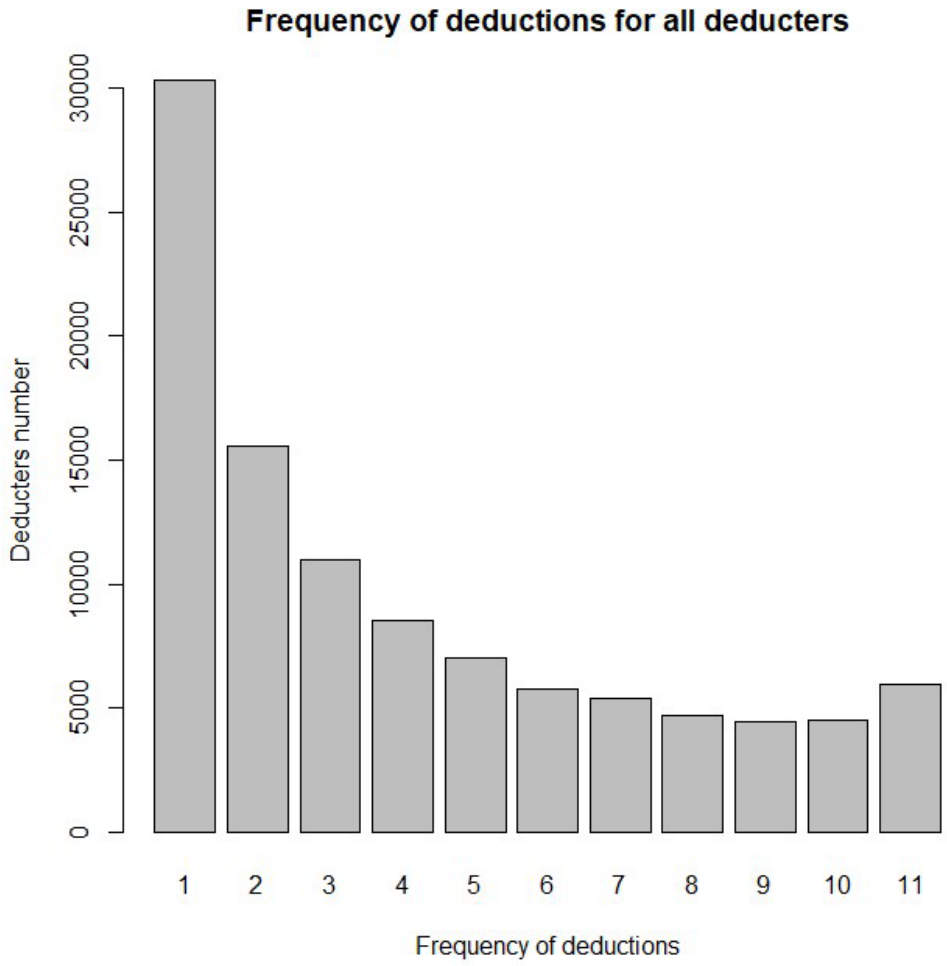

Figure 1

Bar plot representing the frequency of deductions by each deducters over a total of 11 years, under study.

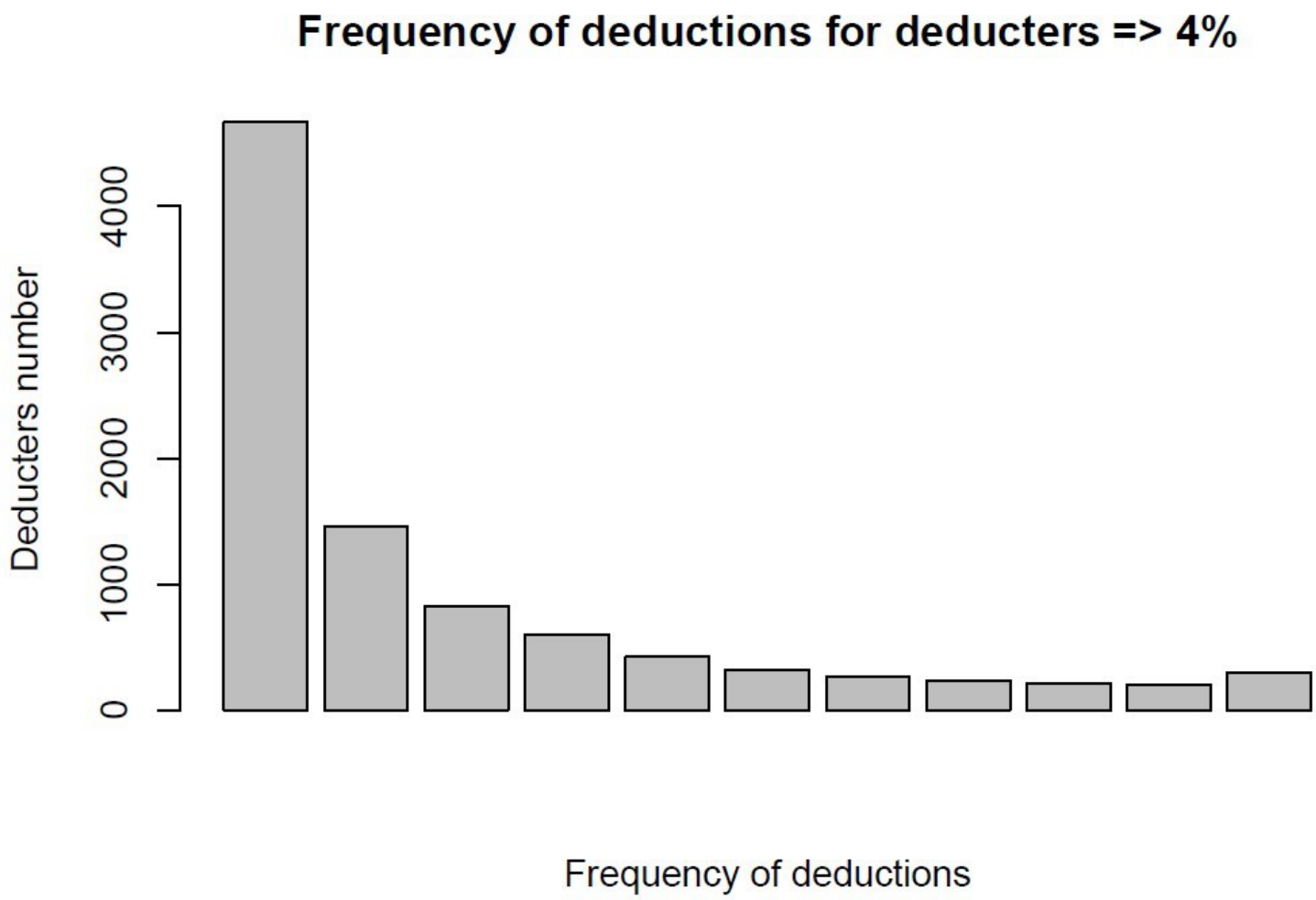

Figure 2

Bar plot representing the frequency of deductions by each deducters, who donated the legal ceiling of 4% and more, over a total of 11 years, under study.

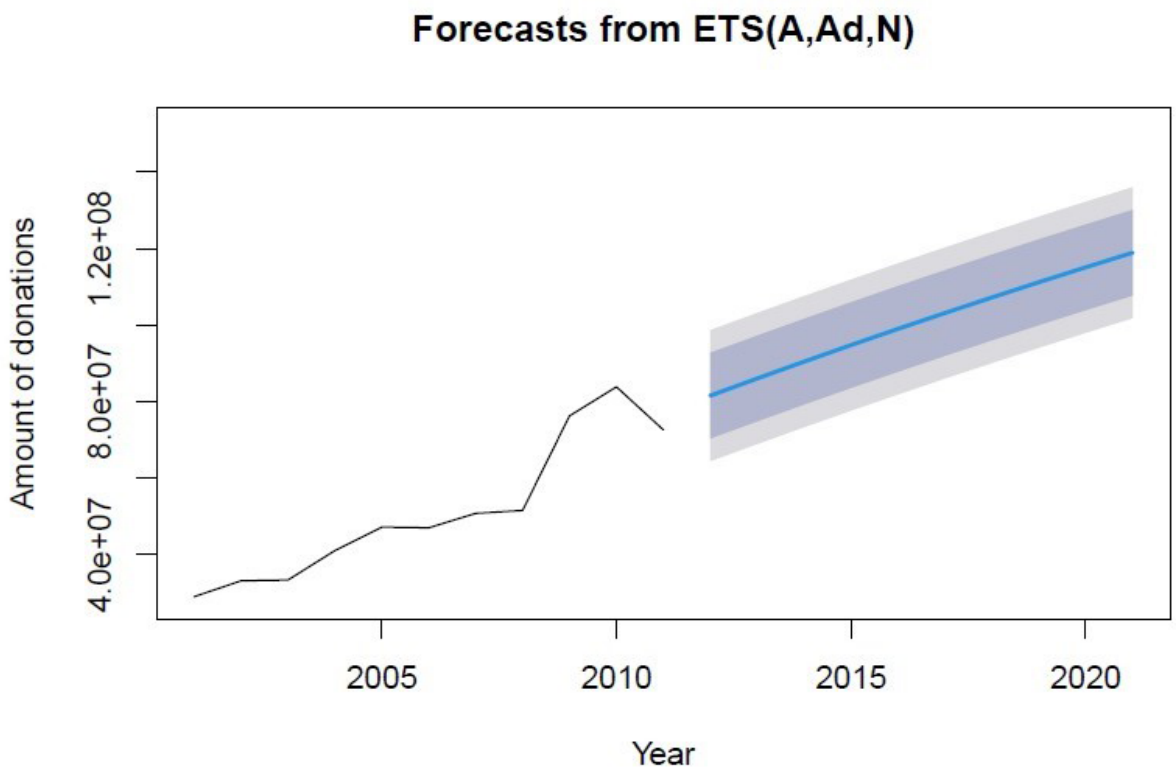

Figure 3

Donations' forecasts, over the year 2012-2021. The donations' forecast trend is moving from 79'170'591 million in 2012 to 114'651'701 million in 2021.