Forecasting Geneva's donors and their charitable deductions

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Abstract. The present study builds upon existing research, introducing a novel research question and innovative statistical predictions. It constitutes the first comprehensive time-series analysis of tax incentives for charitable giving among donors in Switzerland and is among the few globally to project charitable deductions. Utilizing unique panel data covering the entire Geneva taxpayers' population from 2001 to 2011, we forecast future scenarios of donors and charitable deductions. This period also coincided with a legal reform that increased ceilings for charitable deductions. Various time-series forecasting models were applied, and the model with the lowest score (indicating superior performance: best model) was chosen to project future predictions. The best model predicts a total donation amount in the range of 79 to 114 million for the years 2012-2022. These projections provide insights into the scale of deductions, aiding in decisions related to tax incentives for charitable giving. Moreover, they shed light on the key factors influencing these predictions, enabling more informed decisions on the ceiling of tax incentives for charitable contributions.

Keywords: Tax Incentives, Donors, Forecasts, ETS and ARIMA models.

1 Introduction

Tax incentives for charitable giving are a prevalent feature of legal systems around the world [1]. The primary goal of such incentives, at least from an economic perspective, is to boost donations: it is for instance argued that the system that grants tax incentives for charitable donations increases transparency in the philanthropic sector [2,3]. 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 because of the legal standards establishing tax incentives for charitable giving or which donors these reforms intend to benefit [4].
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.
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 [5]. 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% [6]. The 20% federal deduction threshold was introduced on 1 January 2006 as part of a larger reform of the Swiss federal law [7], 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 [7]. 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 [8] increased to 20% in 2010 [8] and the deduction threshold for corporations increased from 10% to 20% [9].
In the work published in [10], 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 shifts focus from the legal context to the time influence by studying the timing of giving, concentrating on future projections of charitable deductions amounts and a number of donors, based on previous trends.

2 Material and Methods

2.1 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 variables, an entire description of them is provided in [4, 10] the specific 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, a new variable, "year", has been specifically created to enable a more in-depth longitudinal analysis for the current and future year of study, based on the panel data forecasting literature [11, 12]. A merging of the 11 different data sets, with the elimination of double IDs, if any, was performed to create an appropriate unique dataset:

- *"coded ID" ("identifiant")*: a coded ID for each taxpayers. This variable allows to follow the same taxpayer over time. 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 "*donor*" and it represents a subset of "*coded ID*", taxpayers' population we investigate.
- *"deductions for donations" ("versements_benevoles")*: the amount of deduction for charitable giving, representing the entire annual amount of the deducted donations or capped amount, if exceeding the deductible threshold.
- *"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 for this study, from year 2001 to year 2011.

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 due to their limited taxing liability there.
As reported in the previous study [4], 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 which is due to the rise in population and a substantial increase of 48% is recorded in 2009.

2.2 Methods

Forecasting methods applied to the amounts of deductions and the number of donors, to project the predicted figures in the next upcoming 10 years: 2012-2021.
The 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 [13]. Four different types of ETS models (from Simple Exponential Smoothing (SES) to Holt's Models), considering different trend effects (i.e. additive, additive with damped and multiplicative) since the presence of seasonality was not detected, 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 ones have been implied to select the best model for the forecast.

3 Results

Five forecasting methods: ETS model with several trend effects, have been implemented and compared using the error metrics to identify the one that is the most suitable to predict the amounts of deductions and with the 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 for the donations' forecast. While they have been incorporated for donors' forecast.
The model which performed the best, with the lowest AIC, BIC and MAPE error metrics term, was model 4) in Table 1 related to a Holt's model with additive damped effect and a multiplicative error to incorporate the increasing nature of the donations over

time. The result of this forecast over the predicted period can be seen in Figure 1, where the previously mentioned model with the 80% and 95% prediction intervals is shown.

Table 1. 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.

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

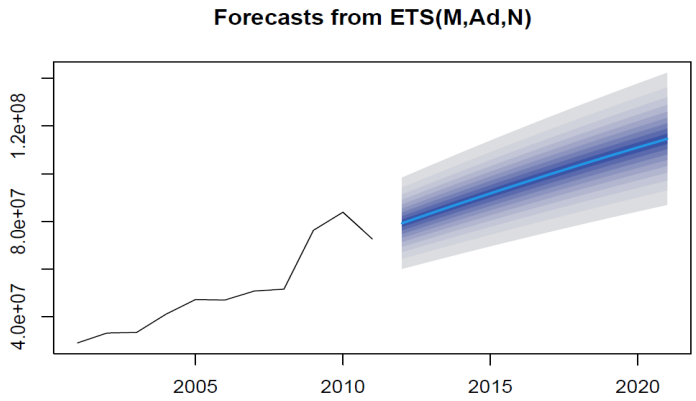

Figure 1. Donations' forecasts, over the year 2012-2021. The donations' forecast trend is moving from 79'170'591 CHF in 2012 to 114'651'701 CHF in 2021.

Table 2. Projections of the amount of donations over the following 10 years (2012-2021), resulting from the model ETS(M,Ad,N) with 80% and 95% prediction intervals.

Years	**Forecast**	**Lo 80% PI**	**Hi 80% PI**	**Lo 95% PI**	**Hi 95% PI**
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, 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 3. Comparison of the 5 forecasting models (simple exponential smoothing and Holt's model with and without damped effect for the trend, several errors and ARIMA model) implemented for donors' projections and their error metrics.

			Errors		
Forecasting models	***AIC***	*AICc*	*BIC*	*RMSE*	***MAPE***
1) SES	211.6988	215.1274	212.8925	3466.838	8.264631
2) ETS(A,A,N)	203.8104	215.8104	205.7999	2019.522	5.63453
3) ETS(A,Ad,N)	204.6256	225.6256	207.0130	1913.642	5.161422
4) ETS(Z,Ad,N)	201.7138	213.7138	203.7033	1963.346	3.66038
5) ARIMA(0,2,0)	**162.16**	162.73	162.36	1601.337	**2.202275**

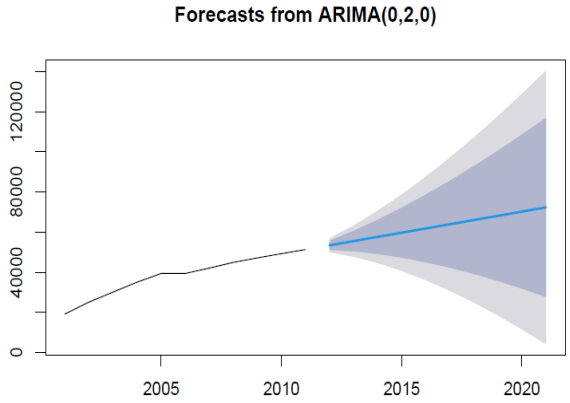

Figure 2. Donors' forecasts, over the year 2012-2021. The donors' forecast trend is ranging from 53'485 donors in 2012 to 72'349 donors in 2021.

For the donors' forecast, given the data pattern, a multiplicative error for a model with additive damped trend would not be supported, giving similar results as model 3) with an additive error instead. The best model to forecast the donors' prediction was an ARIMA model double differentiated, with no autoregressive or moving average part.

Table 4. Projections of the amount of donors over the following 10 years (2012-2021), resulting from the model ARIMA(0,2,0) with 80% and 95% prediction intervals.

Years	Forecasts	Lo 80% PI	Hi 80% PI	Lo 95% PI	Hi 95% PI
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

4 Discussion and Conclusion

This study builds up on [10] by focusing on forecasts future charitable deductions and donors that use tax incentives for charitable donations.
In terms of the future deductions, we estimate an increase in the deductions of charitable donations in the canton of Geneva, reaching around CHF 114'651'701 in 2021 (57,6% increase from 2011). It must be highlighted that the only estimates we could find are the ones for the total amount of private donations, and not only charitable donations, by the Swiss population which was more than CHF 2.05 billion in 2021 [14]. In 2021, the Swiss population was 8.7 million and Geneva had 511'921 inhabitants (not taxpayers). This represents 6% of the total Swiss population, 6% of the 2.05 billion is CHF 123 million : outcome slightly higher than our forecast, but comprehensive of total donations and not only deductions. Thus, ours are close and unique estimate.
In terms of future donors, we estimate that the donors will continue to increase in an important manner in Geneva, reaching 72'349 donors in 2021, representing almost four times the initial number of donors in 2001 (19'335).

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