CESifo WORKING PAPERS

6591
2017

Original Version: July 2017
This Version: January 2018

More Giving or More Givers? The Effects of Tax Incentives on Charitable Donations in the UK

Miguel Almunia, Benjamin Lockwood, Kimberley Scharf

CESifo

Impressum:

CESifo Working Papers
ISSN 2364-1428 (electronic version)
Publisher and distributor: Munich Society for the Promotion of Economic Research - CESifo GmbH
The international platform of Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute
Poschingerstr. 5, 81679 Munich, Germany
Telephone +49 (0)89 2180-2740, Telefax +49 (0)89 2180-17845, email office@cesifo.de
Editors: Clemens Fuest, Oliver Falck, Jasmin Gröschl
www.cesifo-group.org/wp

An electronic version of the paper may be downloaded
· from the SSRN website: www.SSRN.com
· from the RePEc website: www.RePEc.org
· from the CESifo website: www.CESifo-group.org/wp

CESifo *Working Paper No. 6591*
Category 1: Public Finance

More Giving or More Givers? The Effects of Tax Incentives on Charitable Donations in the UK

Abstract

This paper estimates the intensive and extensive-margin tax-price elasticities of giving using UK administrative tax return data, exploiting variation from a large tax reform. Using a variety of estimation methods and new instruments for the tax-price of giving, we find an intensive-margin elasticity of about -0.25 and an extensive-margin elasticity of -0.1, yielding a total elasticity of about -0.35. These estimates mask considerable heterogeneity: high-income individuals respond more on the intensive margin, while the extensive-margin response is stronger for low-income taxpayers. We then derive new conditions to evaluate the welfare consequences of changes in the subsidy to donations. This analysis shows that these elasticities can only be rationalized as being optimal if the UK government places a large enough value on providing warm-glow opportunities for UK donors.

JEL-Codes: H240, H310, D640.

Keywords: tax policy, charitable giving.

Miguel Almunia
Department of Economics
University of Warwick
United Kingdom - CV4 7AL Coventry
M.Almunia@warwick.ac.uk

Benjamin Lockwood
Department of Economics
University of Warwick
United Kingdom - CV4 7AL Coventry
B.Lockwood@warwick.ac.uk

*Kimberley Scharf**
Economics Department
University of Birmingham
United Kingdom – Birmingham B15 2TT
K.Scharf@bham.ac.uk

*corresponding author

January 2018
We thank Clément de Chaisemartin, Ivan Fernández-Val, Bo Honoré, Jonny Mood, Rob Prideaux, Roland Rathelot, Petr Simecek, Kevin Staub, Fabian Waldinger and Mark-Ottoni Wilhelm for useful suggestions and discussions. Daniel Díez Alonso provided excellent research assistance. We also thank the team at the HMRC Datalab for their invaluable help to access the data for the analysis. This work contains statistical data from HMRC, which is Crown Copyright. The research datasets used may not exactly reproduce HMRC aggregates. The use of HMRC statistical data in this work does not imply the endorsement of HMRC in relation to the interpretation or analysis of the information. Any remaining errors are our own.

1 Introduction

Most tax systems provide preferential treatment to donations to private charity through deductions or tax credits. Typically, this tax relief is expensive for the government, especially when deductions are fully deductible from tax as in the UK and the US. For example, in the UK, the cost of this tax expenditure was more than £1.8 billion in lost revenue in 2015/16.[1]

Of course, these subsidies can be desirable if they induce a large enough increase in donations. Hence, in order to evaluate the welfare implications of these tax reliefs, one of the key parameters is the elasticity of charitable donations with respect to their tax price relative to consumption. Although there is a large empirical literature focused on this tax price elasticity (Fack and Landais, 2016), previous estimates have focused on intensive margin donation responses, largely because of data limitations.

In this paper, we use administrative tax return data from the UK for the period 2005-13 and exploit a large tax reform in 2010 to study how charitable donations respond to tax incentives at the extensive margin, as well as the intensive margin. To our knowledge, this is the first paper to measure extensive-margin donation responses to tax-induced changes in the price of giving, alongside the intensive-margin donation responses.

Taking into account intensive-margin and extensive-margin donation responses to changes in the price of giving is important for a number of different reasons. First, estimates of donation responses at the intensive margin may be biased if they do not account for censoring of donations at zero. Second, as we show formally below, the key parameter in driving welfare effects when there is a change in the tax-price of giving is the *total* tax-price elasticity of giving, which is the sum of the intensive-margin and extensive-margin tax-price elasticities. Third, in several countries, most taxpayers who are eligible to deduct donations from their tax liabilities do not report any giving, suggesting that the extensive margin is important in practice (Fack and Landais, 2010; Gillitzer and Skov, 2016). In the specific case of the UK, only 11% of self-assessment taxpayers report positive donations, so tax policies that induce extensive-margin donation responses are particularly relevant.[2]

For our empirical analysis, we had access to the universe of self-assessment income tax returns for the fiscal years 2004/05 through 2012/13. Self-assessment tax returns must be submitted by taxpayers above an income threshold, the self-employed, and those with substantial non-earned income. This dataset contains more than 75 million taxpayer-year

[1] See www.gov.uk/government/statistics/cost-of-tax-relief.

[2] The lack of evidence on extensive-margin donation responses is also odds with the emphasis that is given to them in empirical studies that look at other behavioral responses to taxation questions (e.g., labor supply responses, see Blundell and Thomas, 1999).

observations from more than 11 million distinct individuals.

To have an exogenous source of variation in the tax price, we exploit the 2010 income tax reform in the UK, which raised the top tax rate from 40% to 50% for incomes above £150,000, and also created a short bracket with a 60% rate above £100,000. Using these data and a variety of estimation methods, including a new instrumental variables strategy, we estimate the intensive and extensive-margin tax-price elasticities of giving. Finally, as a consistency check, we estimate the total elasticity directly using a Poisson pseudo-maximum likelihood estimator (Silva and Tenreyro, 2006).

Our empirical findings show that the extensive-margin responses matters. Specifically, our main estimates of the intensive-margin price elasticity are in the range −0.21 to −0.28, and the extensive-margin price elasticity is −0.09. The sum of these two estimates yields a total price elasticity in the range −0.30 to −0.37. These estimates are consistent with those the Poisson pseudo-maximum likelihood estimator (PPML), which gives an overall elasticity of −0.43.

We also estimate the price and income elasticity of giving by income level, age groups, and gender. It is particularly interesting to investigate responses by income group because in the UK, as in many other countries, most donations come from the highest-income taxpayers, and therefore most of the tax expenditure on charitable contributions benefits these taxpayers.[3] We find that, consistent with results from the US (e.g., Bakija and Heim, 2011), the intensive-margin price elasticity tends to increase as incomes rise. In contrast, the extensive-margin price elasticity *falls* as incomes rise. For the bottom 25 percent of the income distribution, the extensive margin elasticity is about −1.6, decreasing (in absolute value) to −0.17 for the top 5 percent. Overall, the fall in the extensive margin price elasticity tends to dominate the rise in the intensive margin elasticity, with the sum of the two falling from −1.6 for the bottom income group percent to −0.4 for the income group (i.e., the top 5 percent. Conditional on assuming that reported donations of lower income taxpayers in our estimation sample reflect actual donations,[4] these results show that focusing only on the intensive margin when estimating responses by income group is misleading. In any case, our analysis suggests that policy implications depend on whether government intends for donation subsidies to increase new giving or existing giving. If the

[3]For example, within the self-assessment group of UK taxpayers over our sample period, 84 percent of donations are made by those above the 75th income percentile, and fully 55 percent of donations are made by those above the 95th percentile.

[4]This qualification is required since, unlike higher rate taxpayers, basic-rate taxpayers do not have an incentive to report donations, but they might start reporting them after a positive income shock that moves them to the higher bracket. There is some evidence to support this hypothesis, e.g. Gillitzer and Skov (2016) for Denmark and Li (2013) for the UK. The latter finds that in the UK in 2010/11 the poorest 20% of donors gave £76.2 per year. This is slightly larger than the stated donations of the poorest income group in our data. See www.manchester.ac.uk/discover/news/poor-more-generous-than-rich-in-recession-study-shows.

former, then our results suggest that the subsidy would be mainly achieving its objective only for lower income groups. If the latter the results suggest that the subsidy might achieve its objective mainly through donation responses from high income groups. In either case, note that high-income taxpayers still benefit disproportionately from the tax subsidies so this part of our study speaks to the ongoing debate about whether government support to private charity disproportionately promotes the philanthropic aims of the rich, a debate that is increasingly taking center stage in the policy debate in many countries.[5]

Regarding heterogeneity by age and gender, we do not find substantial differences across groups. The intensive-margin price elasticity is larger for men than for women, although the difference is small (-0.17 vs. -0.13), and the extensive-margin elasticities are almost identical. As regards age, the intensive-margin price elasticity is highest for those aged over 65 (-0.18) and substantially smaller for those 40-65 years (-0.14). The extensive margin price elasticities decline with age. Overall, the total price elasticity is U-shaped in age, being smallest for the 40-65 age group.

A second contribution of our paper is methodological. Following the existing charitable giving literature, we instrument the price of giving using the so-called "first-pound" price (i.e., the price of giving at zero donations), since the tax price of giving can be affected by the donation decision. We also tackle an additional endogeneity problem; the 2010 tax reform, which involved a large and salient change in the marginal tax rate for higher income earners, likely caused changes in pre-tax income due to labor supply and other responses. In turn, this income response *itself* can change the tax price.

To deal with this problem, we use lagged values of taxable income to construct an instrument for the tax-price of giving, adapting the strategy developed by Gruber and Saez (2002) to estimate the elasticity of taxable income. Using this instrument prevents taxable income responses to a tax reform from affecting the price of giving, so it provides a cleaner identification of the effect of an exogenous change in the price of giving than other instruments that have been used in previous literature. To the best of our knowledge, we are the first to apply this instrumental variables strategy in the context of charitable giving.

Another, perhaps more minor, innovation is that we address the issue of censoring at zero via the use of the Poisson pseudo-maximum likelihood estimator (Silva and Tenreyro, 2006), which can accommodate zeros in the dependent variable. Our study is also the

[5]It is well-known that the rich contribute to different kinds of goods than do the poor, and so tax incentives may result in rich donors driving charitable sector priorities in a way that is disproportionate to their actual financial contribution (see Horstmann, Scharf and Slivinski, 2007; Horstmann and Scharf, 2008, who show how distributional conflict and segregation can be channeled through political mechanisms when societies are characterized by income heterogeneity and heterogeneous preferences for different kinds of public goods).

first, to our knowledge, to apply these estimators to charitable giving data.

Finally, we derive new conditions to evaluate the welfare consequences of tax-induced changes in the price of giving, and to assess whether the level at which tax relief is offered can be rationalized as being optimal. For our welfare analysis, we extend the theoretical framework of Saez (2004) to allow for extensive-margin giving responses, and for the government to value donations and a direct subsidy from the government differently. We show that the relevant policy elasticity is the sum of the intensive and extensive-margin elasticities. Moreover, we show that our elasticity estimates can only be rationalized as being compatible with tax incentives being set optimally if the policymaker values highly enough warm-glow opportunities that are provided by the tax subsidy for giving.

This study relates to an extensive literature on charitable donations in general, and on the price elasticity of giving in particular. [6] Many of the existing studies that exploit tax reforms to generate variation in the price of giving have focused on the United States and, as far as we know, none have estimated an extensive margin tax-price elasticity of giving. [7] One reason for the lack of focus on the extensive margin might be that the design of the US income tax system allows taxpayers to choose between a standard deduction and an itemized deduction, with only those taxpayers opting for itemized deductions have a tax-based incentive for giving. As a result, most US taxpayers choosing itemized deductions donate to charity.[8] In the case of the UK, any individual with a positive tax liability can benefit from the tax incentives for giving, as explained in Section 2.1 below.

This paper also fills a major gap in the evidence on tax price elasticities of giving for the United Kingdom – indeed, we only know of two contributions focusing on UK donors (Jones and Posnett, 1991; Scharf and Smith, 2015). [9] No study so far has examined

[6] That literature has exploited variation in the price of giving due to policy reforms (to estimate the tax-price elasticity) and also lab and field experiments (usually to estimate match-price elasticities). A recent study by Hungerman and Wilhelm (2016) combines both approaches.

[7] See Peloza and Steel (2005) for an overview of pre-2005 studies. Notable recent empirical investigations of intensive-margin tax price elasticities are Randolph (1995), Auten, Sieg and Clotfelter (2002) and Bakija and Heim (2011) for the US, and Fack and Landais (2010) for France. Apart from the fact that these studies estimate only intensive margin elasticities, there are also other methodological differences to our study. Bakija and Heim (2011) obtain exogenous variation in the tax price by using the fact that the tax price of giving differs across states at a given point in time in the US, focusing exclusively on the intensive margin. Fack and Landais (2010) use a difference-in-difference identification, comparing the evolution of contributions for groups of households with similar income, but different taxable status due to differences in family size. Several studies allow for censoring in the data (i.e., the fact that some households donate nothing) in their estimates of the intensive margin, using parametric or non-parametric methods (Bradley, Holden and McClelland, 2005). Fack and Landais (2010) tackle the censoring problem using a censored quantile regression estimator. In contrast, here we directly estimate the overall elasticity using the Poisson pseudo-maximum likelihood estimator, and check the robustness of the intensive-margin results with a two-step selection model.

[8] In 2015, eighty-one percent did so (see `www.irs.com/articles/5-popular-itemized-deductions`).

[9] Jones and Posnett (1991) used a sample of households from the UK's 1984 Family Expenditure Survey to estimate household price elasticities of giving associated with gifts. At that time, however, the only

the effects of tax deductibility of donations using UK taxpayer data, despite the fact that proposals for reforming UK tax relief provisions for giving have been repeatedly put forward and heatedly debated. [10] Our study thus fills a serious evidence gap.

The remainder of the paper is organized as follows. Section 2 describes the institutional context and data. Section 3 lays out a conceptual framework and empirical strategy. Section 4 discusses the main empirical findings. Section 5 derives a subsidy reform rule taking into account the extensive margin, and Section 6 draws some policy conclusions.

2 Institutional Context and Data

In this section, we describe the tax incentives for charitable giving in the UK income tax, and the administrative dataset that we use in the estimation.

2.1 Gift Aid

The UK income tax system provides for the full deduction of charitable donations from taxable income through the Gift Aid program, which was introduced in the UK's Finance Act of 1990.[11] Gift Aid is composed of two parts, a match rate and a deduction. The combination of these two elements results in full tax deductibility of charitable donations, as we explain below.

When a UK taxpayer makes a donation to charity, she fills out a Gift Aid declaration form, which is given to the charity along with the donation. The charity can claim the income tax paid on the donated amount directly from HM Revenue and Customs (HMRC), the UK's tax administration. Specifically, for a donation of one pound, the charity receives $1/(1-\tau_b)$ pounds, where τ_b is the basic rate of tax (20% for most of our study period). For the donor, the tax-price of giving in terms of forgone consumption is then $1-\tau_b$. This part of the Gift Aid scheme is sometimes known as the match component, because the government effectively matches every pound donated to a charity at a rate equal to $\tau_b/(1-\tau_b)$.

form of tax-deductible giving was via a gift made by Deed of Covenant, which involved a donation to a charity by means of a binding covenant for a period greater than three years. There were also upper limits on the amounts deductible against tax. Both of these constraints make it less likely that donations will respond to tax price incentives. A recent study by Scharf and Smith (2015) used a survey instrument to obtain donor responses to hypothetical variation in the price of giving.

[10] See National Audit Office (2013). Previous to this report, in April 2012, George Osborne, the British Chancellor of the Exchequer, announced that starting in April 2013 there would be a cap on tax relief for giving of the greater of 25% of an individuals total income £50,000. The plan, not supported by solid evidence on its likely effects, created an uproar from the UK's charitable sector, donors and the media. In May 2012, Osborne did a U-turn on the proposal and dropped the plan to cap reliefs.

[11] The main guidance for UK taxpayers on Gift Aid is (i) the guidance notes for the basic income tax form SA100, and (ii) the web page www.hmrc.gov.uk/individuals/giving/gift-aid.

In addition to the match component, higher-rate taxpayers can claim a deduction equal to the (gross) amount donated times the difference between the basic rate of income tax τ_b and the higher rate, τ_h. It is then easy to calculate that the price of giving for a higher-rate taxpayer is $1 - \tau_h$.[12]

Therefore, whether a UK taxpayer faces a basic marginal rate of income tax or a higher-rate, the tax-price of giving is always one minus her marginal tax rate, i.e. the same price as in a system where donations are fully deductible.[13] We explain how we calculate the tax-price of giving in Section 3 below.

2.2 The April 2010 Income Tax Reform

We exploit a major reform of the UK income tax, which took place in April 2010, as the key source of variation for our empirical strategy.[14] The highest marginal rate before this reform was 40%, which applied to all taxpayers with taxable income above £37,400.[15] Starting in fiscal year 2010/11, an additional bracket with a 50% marginal tax rate was introduced for taxable income above £150,000. The reform also established the withdrawal of the personal allowance by £1 for every additional £2 of income, for taxable income above £100,000 (note that income is taxed at the individual level in the UK). Therefore, the effective marginal tax rate increased to 60% for taxable income in the interval between £100,000 and £112,950.[16] The top panel of Figure 1 shows the statutory price of giving at different levels of taxable income for the years 2009/10 and 2010/11, immediately before and after the tax reform. The bottom panels show the average price of giving by income bins in our data, which track the statutory price almost exactly.

There were a few smaller changes to the income tax schedule during our sample period. The kinks in the tax schedule at which the basic and higher rates of tax (τ_b, τ_h) start

[12] If the taxpayer donates one pound, she can claim a deduction equivalent to $(\tau_h - \tau_b)/(1 - \tau_b)$, giving a net cost to the taxpayer of $1 - (\tau_h - \tau_b)/(1 - \tau_b)$. But, due to the match, to ensure that the charity gets one pound, the taxpayer only needs to give $1 - \tau_b$, so the price of giving for a higher-rate taxpayer can be expressed as

$$p = (1 - \tau_b)\left(1 - \frac{(\tau_h - \tau_b)}{1 - \tau_b}\right) = 1 - \tau_h.$$

[13] There is also limited scope for carry-back of Gift Aid. An individual filing her tax return for year t can ask for her Gift Aid donations made in the first few months of year $t+1$ to be accounted for tax deduction purposes as having been made in the previous year, under two conditions: (i) having paid enough tax in year t to cover both the Gift Aid donations of year $t+1$ and year t; (ii) at the time of the donation, not having filed the income tax form for year t (so only donations made before 31st October, or 31st of January if filing online, are eligible).

[14] The fiscal year goes from April 6th of one year through April 5th of the following year.

[15] Adding the standard personal allowance of £6,475, this is equivalent to £43,875 in gross income for the year 2009/10.

[16] The standard personal allowance was £6,475 in 2010/11 and £7,475 in 2011/12. There are higher personal allowances for older taxpayers, but these are phased-out at much lower levels of income.

applying have suffered minor modifications over time.[17] The basic tax rate τ_b was 22% in fiscal years 2004/05 and 2007/08, and it was reduced to 20% from 2008/09 onwards.[18] Between this reform and the beginning of the 2011/12 fiscal year, the matching rate provided by HMRC to all donations remained at 28% ($\frac{1}{1-0.22} \simeq 1.28$) in order to offer "transitional relief" to charities. Hence, the matching rate only came down to 25% in 2011/12. We incorporate all these reforms into our calculation of the marginal tax rate faced by each taxpayer.

One important issue is whether there could be anticipation effects to the April 2010 reform, potentially leading to inter-temporal shifting of donations. The government first announced in the Pre-Budget Report of 24 November 2008 that it planned to introduce a new top rate of 45% starting in April 2011. On 22 April 2009, it was announced that the additional rate would be 50% and be introduced one year earlier, in April 2010. Therefore, it is possible that in the fiscal year 2009/10, donations were delayed in order to claim the higher relief introduced in the following fiscal year. We allow for this in robustness checks by including the change in the tax price over the previous year as a regressor.

2.3 Data and Descriptive Statistics

We use an anonymized administrative dataset containing the universe of self-assessment (SA) income tax returns for the fiscal years 2004/05 through 2012/13, made available to us through the HMRC Datalab. The main dataset we use is called SA203, which contains the key items of the SA tax return.[19] Given the high quality of the administrative data, panel attrition is a minor concern in this paper. Once a taxpayer files a self-assessment return, she receives the forms from HMRC in every subsequent year, as long as she remains eligible to file through this system. Entry into the dataset is fairly stable in the period under analysis, and only a small fraction of taxpayers (less than 2%) have gaps in reporting between years.

We focus our analysis on SA taxpayers because their behavioral response to the changes in Gift Aid incentives around the April 2010 reform are the most relevant for revenue purposes. About 25% of UK income taxpayers use self-assessment, while the remaining 75% are in the pay-as-you-earn system (PAYE). Under PAYE, income tax is withheld

[17] The tax schedule for recent years can be consulted at www.gov.uk/government/collections/tax-structure-and-parameters-statistics.

[18] Until 2007/08, there was also a starting rate of income and savings tax of 10% for the first £2,000 of taxable income. Since 2008/09, this starting rate has only been applicable to savings income. The starting rate is not relevant for the matching rate in Gift Aid, which is tied to the basic rate as explained above.

[19] We extract the gender and age variables from a separate dataset named ValidView, which is an extended version of SA203 with additional variables.

at source by employers, and individual taxpayers do not need to file a tax return.[20] SA taxpayers can claim deductions for donations directly on their tax return, but those on PAYE only have the option to deduct donations from their gross pay through a program called Payroll Giving.[21] While the fiscal cost of Gift Aid is substantial, approximately £1.78 billion in 2015/16,[22] the fiscal cost of Payroll Giving is quite modest: only £0.04bn.[23]

Figure 2 shows the share of SA taxpayers reporting positive donations by levels of gross income, with separate lines for men and women. At each level of income, women are about five percentage points more likely to give than men. The proportion of donors is very low for taxpayers facing the basic tax rate (i.e., those with gross income below £45,000, with some variation across years), and it reaches about 30% for higher incomes. Notice that basic rate taxpayers do not have any incentive to report their charitable donations in the SA return, as they do not receive any additional tax relief. Therefore, it is surprising to observe taxpayers in this tax bracket reporting *any* donations at all. It might be that some taxpayers report them due to inertia (as the SA return requests information about donations) or inattention, but we cannot test these hypotheses in the current setting.

Including all basic-rate taxpayers in our regressions might lead to overestimation of the price elasticity of giving. To see this, notice that some taxpayers only report donations when they are in the higher brackets. Then, those with a positive income shock that moves them from the basic to the higher rate bracket will mechanically increase their reported donations coinciding with their higher tax rate (and hence lower price of giving). Given this potential bias, in our main estimates we only consider taxpayers who were in the higher tax brackets for the whole period of our study. That way, we have a clean focus on those taxpayers who have a tax incentive to report any charitable donations. In the online appendix, we present all the estimates for the universe of SA taxpayers, which yield similar intensive-margin elasticities but larger extensive-margin elasticities, for reasons discussed in Section 4.

We also drop outlier donations over £100,000 in any year, which represent 0.01% of

[20] Employers estimate each individual employee's end-of-year tax liability based on information provided by the employees. The full list of criteria that determine which taxpayers are required to file a self-assessment return can be found at: www.gov.uk/self-assessment-tax-returns/who-must-send-a-tax-return.

[21] Notice that claiming the tax deduction is only relevant for taxpayers in the higher rate of tax, because the basic rate element of the tax relief is administered through the match described above.

[22] Of these £1.78 billion, £1.30bn correspond to the match component and £0.48bn to the deduction component. Charities also get substantial tax reliefs through other exemptions, such as business rates (£1.79bn), VAT (£0.3bn) and Stamp Duty (real-estate tax, £0.28bn). All statistics for 2015/16 extracted from www.gov.uk/government/statistics/cost-of-tax-relief.

[23] Moreover, the micro-level information on PAYE taxpayers using Payroll Giving is not available to researchers. It is worth noting that SA taxpayers have, on average, higher income than those on PAYE, and they are more likely to be male (66% vs. 53%), although there is virtually no difference in the average age (49 years).

the overall sample, and 0.1% of the restricted sample on which we do the main regression estimation. This has no effect on the intensive and extensive margin estimates. However, the Poisson estimates, where the dependent variable is in levels, are more sensitive to outliers as we discuss later.

In Figure 3, we report the average donation as a share of pre-tax income, again separating men and women. Throughout the income distribution, women donate a slightly higher proportion of their income than men. The share donated is remarkably stable at 0.5% for all taxpayers above £50,000. As a comparison, "itemizers" in the US income tax report donations equivalent to 3.2% of their total income.[24]

Figure 4 plots the evolution of average donations over time for four groups of taxpayers, according to their taxable income in the year prior to the reform (2009/10): (1) those with adjusted net income below £100,000, (2) between £112,950 and £150,000, (3) between £100,000 and £112,950, and (4) above £150,000. The first two groups were not directly affected by the reform, assuming that their income levels would have stayed the same in terms of their income ranges. In contrast, taxpayers in groups 3 and 4 saw their marginal tax rates increase from 40% to 60% and 50%, respectively. The top panel includes all taxpayers, and the bottom panel only donors. Donations are in real terms and we normalize them to one in year 2009/10 in order to easily see the percentage change in donations just after the reform, which gives us an order of magnitude for the total elasticity we estimate later with regression methods.

The key finding from these figures is that only taxpayers in the new top bracket (group 4) increased their average donations in response to the reform, while the other three groups follow roughly constant trends. This is noteworthy for taxpayers in group 2, who saw their price of giving decline by 33% after the reform. One possible explanation for their lack of response is that this change in the price was less salient (since it is an artifact of the withdrawal of the personal allowance).

In the top panel, we observe that average donations of group 4 increased by about 30% in the year after the reform, while those of groups 1 and 3 increased by somewhere between 5% and 10%. Therefore, the change in donations for group 4 attributable to the tax change would be roughly 20-25%. Since the price of giving drops by 16.6% (from 0.6 to 0.5) for this group, the implied elasticity (i.e., accounting for both the intensive and extensive margins) would be in the range $\varepsilon \in (-1.5, -1.2)$. In the bottom panel, we observe that there is a downward trend in average donations (conditional on giving) for all groups starting around 2007/08, most likely due to the impact of the Great Recession on UK taxpayers. The increase in group 4's average donations is about 23%, while group

[24]Calculated using SOI tax statistics published by the IRS for the fiscal year 2014. Specifically, see Table 2.1 for that year, available at `www.irs.gov/pub/irs-soi/14in14ar.xls`.

3's average increase by 3%. Doing a similar calculation as before, the *intensive-margin* price elasticity coming out of this graphical diff-in-diff analysis would be $\varepsilon_{INT} \approx -1.2$.

These patterns suggest that the tax reform had an effect on giving behavior, but we do not take them at face value because they may be biased for a variety of reasons and they likely mix intensive and extensive-margin responses. We discuss in Section 3 below how we address the empirical challenges to estimate tax-price elasticities.

2.4 Calculating the Tax Price of Charitable Giving

The administrative dataset does not contain the marginal tax rate faced by each taxpayer and there is no publicly available tax calculator for the UK income tax (such as the NBER's TAXSIM for the US) that can be applied to this particular dataset. Hence, we construct our own tax calculator in order to determine the tax price of giving faced by each taxpayer, following the income tax guidance provided by HMRC. Our calculator uses the information available in the SA dataset and incorporates all of the details of UK personal income tax provisions to estimate the overall tax liability for each taxpayer.[25]

In order to calculate the individual tax-price of giving for an individual i at time t (represented by the subscript it in the mathematical expressions below), we follow standard methods from the literature on responses to tax reforms (Bakija and Heim, 2011; Kleven and Schultz, 2014). Specifically, for each individual i at time period t we add a fixed amount, Δg (e.g. £100), to their observed donations, g_{it}, and then compare their resulting tax liability at time t with their originally reported tax liability at time t.

Denoting the individual's tax liability at any taxable income z by $T(z)$, we calculate the individual's period t tax-price of giving relative to after-tax consumption, p_{it}, as follows:

$$p_{it} \equiv 1 - \tau_b - \frac{[T(z_{it} - g_{it}) - T(z_{it} - g_{it} - \Delta g)]}{\Delta g}, \tag{1}$$

where $(1 - \tau_b)$ accounts for the match provided automatically to all donations by UK taxpayers, and the last term represents the additional reduction in the price of giving due to the deduction that is awarded to higher-rate taxpayers. Specifically, we calculate the decline in tax liability due to an increase of Δg pounds in the amount donated, divided by Δg.

[25] We provide more details on the structure of the tax calculator in the Appendix.

3 Conceptual Framework and Empirical Strategy

In this section, we set up the conceptual framework that will guide our empirical estimation. We then explain our estimation strategy, discussing a number of econometric challenges and how we address each of them.

3.1 Conceptual Framework

This conceptual framework is fairly standard, except that we allow explicitly for labor earnings to be endogenous in the donation equation, and pay careful attention to how to correctly calculate the effect of income on donations in this event. This is important, given that our empirical strategy relies on a large tax reform which probably changed individual pre-tax income (through adjustment on various margins) as well as changing the price of charitable donations.

Individuals care about consumption c, donations g and leisure l, so we write individual utility as $u(c, g, l)$.[26] We assume that $u(\cdot)$ is strictly increasing in all arguments and strictly quasi-concave. Here, g is to be interpreted as the donation received by the charity; this is without loss of generality, as donations made and received are proportional.

In turn, leisure is negatively related to labor income $z = w(\bar{l} - l)$, where $\bar{l}$ is the time endowment of the individual and w is the wage. As already remarked in Section 2.1, the tax treatment of charitable donations in the UK income tax is equivalent to full deductibility of donations against tax. Then, taxable income is $z - g$, and tax paid is $T(z - g)$, where the tax function $T(\cdot)$ takes into account all other deductions and allowances. The budget constraint is then

$$c + g = z - T\left(z - g\right). \tag{2}$$

The problem faced by the individual is to choose $c, g \geq 0$ and $l \in \left[0, \bar{l}\right]$ to maximize utility $u(c, g, l)$ subject to (2) and $z = w(\bar{l} - l)$. To make the argument as clearly as possible, we assume that there are just two tax brackets. The basic rate τ_b applies when taxable income $z - g \leq A$, where A is the personal allowance, and the higher rate τ_h applies to higher incomes. Also, define $\bar{z} = w\bar{l}$ to be full income, or maximum potential earnings. Let the optimal choices be c^*, g^*, z^*.

Then, it is easy to show that–ignoring the case where individuals bunch at a kink in the tax schedule[27]–the optimal donation choice can be written as $g^* = g(p, y)$, where

[26] We model individuals instead of households because income is taxed at the individual level in the UK.

[27] In the empirical analysis, we conduct a robustness check excluding observations around the kinks in the tax schedule, as reported below.

p is the *tax price* of giving, defined as one minus the marginal rate of tax paid by the individual:

$$p(z^* - g^*) = \begin{cases} 1 - \tau_b, & z^* - g^* \leq A \\ 1 - \tau_h, & z^* - g^* > A \end{cases} \tag{3}$$

where z^* is the choice of pre-tax income. Moreover, using the fact that $z = \bar{z} - wl$, the income variable y can be shown to be[28]:

$$y(z^* - g^*) = \begin{cases} (1 - \tau_b)\bar{z}, & z^* - g^* \leq A \\ (1 - \tau_h)\bar{z} + (\tau_h - \tau_b)A, & z^* - g^* > A \end{cases} \tag{4}$$

So, the exogenous income variable which determines donations is a particular form of disposable income i.e. *after tax maximum potential earnings, evaluated at the actual tax bracket chosen by the individual when she optimizes.*[29] This gives rise to two endogeneity problems.

First, the tax price of giving itself depends on the amount of giving g^* from (3). This is a well-known problem in the literature, and is dealt with by instrumenting p by the so-called *first-pound* price, as discussed further in Section 3.2 below.

A second problem, which (to our knowledge) has been ignored in the literature, is that from (3), the tax price also depends on pre-tax income z^*, which is endogenous. In particular, following a tax reform, pre-tax income may change in such a way as to move the individual to another tax bracket and thus change the tax price of giving.

Finally, note from (4) that the income variable y is based on maximum potential earnings. The implicit assumption in the literature is indeed that actual income z^* is fixed at $\bar{z}$, in which case y is correctly measured by *disposable income at zero donations*. This is the standard definition of disposable income used in the charitable donations literature (e.g. Bakija and Heim, 2011). We follow this definition in our empirical strategy, as our main focus is dealing with the endogeneity of the tax price.

3.2 Empirical Strategy

The panel structure of the data allow us to estimate the effects of time t changes in an individual's tax-price of giving on donations at both the intensive and extensive margins. To estimate individual donors' intensive-margin donation responses, we take a log-linear approximation to the donation function $g^* = g(p, y)$ when strictly positive donations are

[28]This is proved in the Appendix.

[29]That is, if $z^* - g^* \leq A$, so the individual is in the first tax bracket, then the relevant income is $\bar{z}$ minus tax payable if the first bracket applied at $\bar{z}$, namely $\tau_1 \bar{z}$. Or, if $z^* - g^* > A$, so the individual is in the second bracket, then the relevant income is $\bar{z}$ minus tax payable if the second bracket applied at $\bar{z}$, namely $\tau_1 A + \tau_2(\bar{z} - A)$.

observed, giving:

$$\ln g_{it} = \varepsilon_{INT} \ln p_{it} + \eta_{INT} \ln y_{it} + \delta X_{it} + \alpha_i + \alpha_t + u_{it} \tag{5}$$

where p_{it}, y_{it} are the tax price and disposable income of i in year t as described in (3),(4) above, ε_{INT} and η_{INT} are the intensive-margin price and income elasticities of giving, α_i and α_t are individual and year fixed effects, and u_{it} is i's random error at time t. The individual fixed effects, α_i, control for all time-invariant individual characteristics that may affect giving, such as generosity, religious affiliation or gender. The year fixed effects, α_t, control for any events that affected all taxpayers at the same time (e.g. the financial crisis in 2008-09). The vector of individual control variables, X_{it}, includes a dummy for having used a tax advisor in the past and the square of age, which allows us to investigate whether the effect of age on donations increases or diminishes with age.[30] This equation provides unbiased estimates of the intensive-margin price and income elasticities $(\varepsilon_{INT}, \eta_{INT})$ under the assumptions that (i) price, p_{it}, and income, y_{it}, are exogenous, and (ii) there is no bias from selection into giving, as we estimate (5) on the subsample of donors. Later in this section we describe how we address each of these identification challenges.

The extensive margin response for individual i at time t is estimated using the following linear probability model:

$$D_{it} = \beta \ln p_{it} + \gamma \ln y_{it} + \delta X_{it} + \alpha_i + \alpha_t + v_{it} \tag{6}$$

where D_{it} is a dummy that takes on the value one if a positive donation is observed $(g_{it} > 0)$ and zero otherwise, with other variables as in (5). The linear probability model seems appropriate in this setting because the fitted probabilities always lie within the $(0, 1)$ interval.[31] In (6), our main focus is the extensive margin price and income elasticities, which can be calculated as

$$\varepsilon_{EXT} = \frac{\beta}{\overline{D}}, \ \eta_{EXT} = \frac{\gamma}{\overline{D}} \tag{7}$$

where $\overline{D}$ is the sample mean of D_{it} (i.e., the proportion of individuals in our sample that made donations in year t).

[30] We use $(age/100)^2$ instead of age^2 to facilitate the interpretation of the regression coefficient on this variable. We do not include a linear term for age because the combination of individual and year fixed effects mechanically controls for age.

[31] As an alternative, the elasticities ε_{EXT}, η_{EXT} could be estimated from a Probit model. However, due to the incidental parameters problem, the fixed-effects model is biased in this case, meaning that we must use a random effects approach. The results obtained using this model are similar to the ones reported for the linear probability model and are available upon request.

Endogeneity and Functional Form Issues

The conceptual framework outlined above indicates that z, c and g are all jointly determined via individual optimization. As already explained in Section 3.1, this implies that the tax price and disposable income p_{it}, y_{it} are both endogenous, implying that OLS estimation of (5) would yield biased coefficients.

In particular, as is clear from (3) above, p depends on the level of donations g^*, because a donation can move the taxpayer down to a lower tax bracket, thus lowering $T'(z^* - g^*)$ and raising the price p. This issue creates a potential upward bias in ε_{INT} if we estimate (5) by OLS. This is well-known in the literature on charitable donations (dating back to Feldstein and Taylor, 1976), and a standard way of dealing with this issue is to use the "first-pound" price of giving, p^f_{it}, as an instrument for the "last-pound" (observed) price. As mentioned earlier, this is defined as the tax price of giving evaluated at $g_{it} = 0$. Let $p_{it}(z_{it} - g_{it})$ be defined as in (3), but indexed by i, t. Then the first-pound price is

$$p^f_{it}(z_{it}) \equiv p_{it}(z_{it} - g_{it})|_{g_{it}=0} \equiv 1 - T'(z_{it}). \tag{8}$$

The intuition here is that using the first-pound tax-price of giving as an instrument removes the variation in price that is due to donations. This instrument is likely to yield a very strong first-stage because the first-pound and last-pound tax-prices of giving are highly correlated.

A second and equally serious problem relates to the functional standard double-log functional form in (6). While this is a standard specification in the literature, if we have the functional form of the regression wrong, then each of the estimated price and income elasticities can be some mixture of price effects and income effects (Feenberg, 1987). This is an especially big problem if our identification for the price elasticity is coming primarily from changes in income.

To deal with this, we introduce a novel instrumental variables strategy, which consists of using lagged values of income to predict the change in the tax price of giving. In this way, the instrument exploits only the exogenous variation created by the tax reform while removing any variation due to the taxable earnings response. Formally, the alternative estimation strategy relies on first taking differences of equation (5):

$$\Delta \ln g_{it} = \varepsilon_{INT} \Delta \ln p^f_{it} + \eta_{INT} \Delta \ln y_{it} + \delta' \Delta X_{it} + \Delta u_{it} \tag{9}$$

where $\Delta \ln g_{it} = \ln \left(\frac{g_{it}}{g_{i,t-k}} \right)$ is the change in log donations (similar for the other variables) and k is the number of periods over which we calculate the changes.

When estimating equation (9) in two stages, for $k \in \{1, 2, 3\}$, we first use

$$\ln \left(\frac{p^f_{it}(z_{i,t-k})}{p^f_{i,t-k}(z_{i,t-k})} \right) \tag{10}$$

as an instrument for the actual change in the log of first-pound price, which is given by

$$\ln \left(\frac{p^f_{it}(z_{it})}{p^f_{i,t-k}(z_{i,t-k})} \right). \tag{11}$$

That is, the numerator in the instrument contains the first-pound price that individual i would have faced in year t if she had declared her year $(t-k)$ taxable income (evaluated in real terms) in year t instead of her year t taxable income.[32] The denominator is simply the first-pound price faced in the base year, $t-k$, which is the same for the instrument (10) and the endogenous variable (11). This instrumental variables strategy is closely related to the one proposed by Gruber and Saez (2002), which has been used extensively in the taxable income elasticity literature (Saez, Slemrod and Giertz, 2012) and other settings, but to our knowledge never to estimate charitable giving elasticities.[33] In the empirical analysis, we report results for all $k \in \{1, 2, 3\}$ so that we can compare differences between short-term responses $(k = 1)$ to the reform and medium-term responses $(k = 3)$.[34]

The first-stage regression coefficient is expected to be highly significant, as the instrument is strongly correlated with the actual change in the tax-price of giving since many taxpayers remain in the same tax bracket over time. Second, pre-reform income fulfills the exclusion restriction as long as it is not correlated with current donations, other than through the current tax price of giving. In the first-differenced equation, i.e. when $k = 1$, this may be a concern because of anticipation responses to the tax reform. But when we set $k = 2$ or $k = 3$, the exclusion restriction is much more likely to be fulfilled.

Under this IV strategy, the identifying assumption is that there are no other time-varying factors that differentially affect taxpayers in the groups affected and unaffected by the tax reform. In other words, we assume that average donations in the two groups would have followed similar trends over time in the absence of the tax reform. We discuss

[32]To construct this variable, we use the tax calculator described in Section 2.4, applying a variation of formula (1).

[33]For example, Rao (2016) uses this type of IV strategy to estimate the effects of R&D tax credits on firm investment in R&D.

[34]The taxable income literature has settled on $k = 3$ as the standard lag period to evaluate responses to tax reforms so as to avoid capturing re-timing and shifting responses in the years immediately before and after the reform.

below potential violations of this assumption.[35] Notice, finally, that we do not implement a similar specification to estimate the extensive margin elasticity because the dependent variable would no longer be binary, and therefore the interpretation is not straightforward.

Censoring, Selection Bias, and Dynamics

In our baseline specification, we have taken an *ad hoc* approach to censoring, by simply estimating the intensive and extensive margin effects separately. An alternative approach would have been to estimate a single equation allowing for the fact that the dependent variable can be zero. One potential approach here would be to use a Tobit specification. However, this is unsatisfactory for several well known reasons, such as the incidental parameters problem and the strong functional-form assumptions.[36]

For these reasons, we use the Poisson pseudo-maximum likelihood (PPML) approach to deal with censoring. This approach deals with all of the problems with the Tobit specification just mentioned: there is no incidental parameters problem, the distributional assumptions on the error term are much weaker, the elasticities are constant, and the dependent variable is in levels and can take value zero (Silva and Tenreyro, 2006). The estimated equation in this case can be written as:

$$g_{it} = exp\left(\varepsilon \ln p_{it} + \eta \ln y_{it} + \alpha_i + \alpha_t + \delta X_{it}\right) + u_{it} \tag{12}$$

where g_{it} denotes donations (in levels) and the other variables are defined as before. That is, the conditional mean of g_{it} is an exponential function of the covariates, rather than a linear function, as in OLS.

Due to the properties of logarithms, the coefficients ε and η in (12) can be interpreted as the total price and income elasticities of giving i.e. $\varepsilon = \varepsilon_{INT} + \varepsilon_{EXT}$ and $\eta = \eta_{INT} + \eta_{EXT}$. The main advantage of this model over the log-log model in equation (5) is that it allows

[35] Like any IV estimator, this identifies the local average treatment effect (LATE) on "compliers", as defined by Imbens and Angrist (1994). In our context, compliers are defined as taxpayers whose price of giving decreases in response to a positive income shock. Individuals making large donations that push them to a lower tax bracket are the "never-takers", because they do not receive the low-price treatment even when the instrument is activated. "Defiers" in this context would be taxpayers for whom a positive income shock reduces the price of giving. The latter scenario can be ruled out in our setting, so we do not worry about potential violations of the monotonicity assumption.

[36] Furthermore, not only are the tax-price elasticities of donations with respect to price and income non-constant in the Tobit framework, the log specification has added complications. In particular, the dependent variable can no longer be $\ln g_{it}$ as this is not defined when $g_{it} = 0$. The usual approach to deal with this is to modify the dependent variable to $\ln(g_{it} + a)$ with $a > 0$, and often with $a = 1$, which may itself affect the estimates. Second, even though the incidental parameters problem is less serious than in the Probit or Logit specifications, there is still some bias from adding individual fixed effects (Greene, 2004). Third, Tobit estimation requires assuming a Normal distribution of the errors, which is unlikely to hold in practice.

the dependent variable to take on a value of zero so that we can include both donors and non-donors in the regression. A drawback of this method is that it does not allow a decomposition of the aggregate effect of a change in the price of giving or income into an intensive or extensive part. However, as shown in Section 5, the overall tax-price elasticity of giving is a sufficient statistic for policy evaluation.

One potential concern with the separate estimation of the intensive and extensive-margin tax-price elasticities of giving, as specified in equations (5) and (6), is that donors may be selected in a way that could bias the estimation of the intensive-margin equation. That is, there may be unobserved factors that determine both the decision to donate at all and how much to donate. To deal with this potential issue, we allow for selection bias using a Heckman-type procedure adapted for panel data, proposed by Wooldridge (1995), where the inverse Mills ratio from the selection equation is included in the donation equation as an additional regressor. In this estimation, a dummy variable for employing a tax advisor enters the selection equation, but not the main donation equation. We discuss the results of these regressions in Section 4.7, and more details of the estimation procedure in the Appendix.

We address two more potential issues, related to dynamic donation responses and bunching at kink points. First, our baseline specification does not control directly for potential dynamic effects of changes in price and income on donations. In the existing life-cycle models of charitable giving (Randolph, 1995; Auten, Sieg and Clotfelter, 2002), it is argued that transitory and permanent changes in the price of giving (and income) could have different effects (although the predictions are somewhat different). Bakija and Heim (2011) propose using leads and lags of changes in price and income to account for transitory effects and obtain elasticities with respect to permanent shocks. We do not take their approach in our first-differenced regressions because our strategy for instrumenting current pre-tax income with lagged income relies on the exclusion restriction that lagged income (or anything that depends on lagged income, such as the lagged tax price) does not affect donations directly. But we do estimate their specification, which is a variant of equation (5), as a robustness check in the online Appendix.

Second, theory predicts that given a piece-wise linear tax schedule, some taxpayers will bunch at the kink points in the tax schedule (Saez, 2010). This could potentially bias our estimation, because the measures of price for these taxpayers will be affected by their change in taxable income due to bunching behavior. To address this, we re-estimate equations (5) and (6) excluding taxpayers within £2,000 of each kink point in the tax schedule. We discuss the results of these two robustness exercises in Section 4.7 below, and report the regression results in the Appendix.

4 Results

4.1 Intensive Margin: Baseline Specification

We begin by estimating equation (5) by instrumental variables, instrumenting p_{it} by the first pound price p^f_{it} and taking net disposable income y^f_{it} as exogenous. The results are reported in Table 2.[37]

The first three specifications include only $\ln p_{it}$ as a regressor, and the last three specifications also include $\ln y_{it}$. Specification (1) includes only individual fixed effects, (2) adds year fixed effects, and specification (3) allows for individual fixed effects, year effects, and controls for gender, age and using a tax advisor. We follow a similar progression in columns (4)-(6). In all specifications, we cluster standard errors at the individual level.

Looking across all specifications, we see that ε_{INT} is always negative and highly significant. The estimate is sensitive to the inclusion of year effects; when these are included, the estimate is around -0.22 without the inclusion of income, and is somewhat lower when y^f_{it} is included, falling to -0.16 in the final specification. Finally, our estimates of η_{INT} for the last three specifications are generally stable and significant at about 0.20. One explanation for the importance of the year fixed effects in these settings are the trends in charitable giving around the financial crisis, which may have affected high-income taxpayers differently from medium and lower-income taxpayers. Overall giving slowed down during the worst of the financial crisis in 2008-2010 and started to recover in 2011, coinciding with the drop in the price of giving for high-income taxpayers. Regressions without year fixed effects assign the entire change in giving by top earners (those affected by the tax increase) to the price change, yielding large price elasticity estimates both at the intensive margin (-0.829) and the extensive margin (-0.676). Once we control for year fixed effects, we isolate the price effects and the elasticity estimates become smaller in absolute value.

4.2 Extensive Margin: Baseline Specification

We now report and discuss estimates of equation (6), to evaluate the extensive-margin elasticity. As already discussed, we estimate this as a linear probability model. The results are reported in Table 3, which has the same structure as the previous table. We report both the coefficients β, γ in (6) and the associated elasticities ε_{EXT}, η_{EXT} in (7),

[37] Table A.1 in the online Appendix reports the results for the OLS specification. As predicted by our theoretical framework, the OLS estimates of ε_{INT} are biased upwards compared to the IV estimates, yielding a positive and significant elasticity in specification (6).

evaluated at the mean value of all the explanatory variables.[38] These regressions include all higher-rate taxpayers, not only donors, and therefore have a much larger number of observations than those of Table 3.

Looking across all specifications, we see that ε_{EXT} is always negative and highly significant. Moreover, as for the intensive margin case, the results are sensitive to the inclusion of year dummies. When year fixed effects are included, the extensive margin price elasticity ε_{EXT} is quite stable between -0.14 and -0.09, and the income elasticity is between 0.06 and 0.08. So, while the extensive margin price elasticity is about two-thirds of the intensive margin one, the extensive margin income elasticity is substantially lower at about one third of the intensive margin one.

4.3 Intensive Margin: Differenced Specification

Here, we report the estimates of equation (9), where we estimate the effects of log changes in price and income on the log change in donations over a period of time, using an instrument for the log change in price that is designed to purge the effect of any endogenous income responses to the tax reform on the price of giving, as described above. Table 4 reports the results in three different panels for the cases of one, two, and three lags ($k = 1, 2, 3$). For each case, we show four different specifications. All of these include both individual and year fixed effects; in view of the sensitivity of the preceding results to year fixed effects, here we include them from the outset. In the first two specifications we only include the price variable, while in columns (3) and (4) we include the change in log net disposable income, $\ln(y_{it}/y_{i,t-k})$. In each case, we report results with and without the additional controls (age, gender and tax advisor).

Looking across all specifications, the first notable feature is that when we do not control for the change in log income, the price elasticity ε_{INT} becomes smaller (in absolute value) as we increase the lag over which changes are calculated. However, once we include the change in log income, ε_{INT} becomes highly significant and stable across all lags k, at a value between -0.21 and -0.32. The income elasticity η_{INT} is also highly significant and stable across all lags k, at values of between 0.13 to 0.21. In our preferred specifications of columns (3) and (4), both the price and income elasticities become slightly larger in absolute value with the length of the lag. These estimates are somewhat larger in absolute value than those obtained with the traditional log-log specification in Tables 2 and 3.

[38] We report the OLS estimates for this specification in Table A.2 in the online Appendix. As in the intensive-margin case, the estimated price elasticities are biased upwards compared to the IV results, although the difference in this case is smaller.

4.4 Total Elasticity: Poisson Specification

In Sections 4.1 and 4.2, we have estimated the intensive and extensive-margin elasticities separately. An alternative approach, described in 3.2, is to use Poisson pseudo-maximum likelihood (PPML) regression methods to obtain estimates of the total elasticity directly. As noted before, this estimator has the advantage of allowing the dependent variable to take value zero, while it requires much weaker distributional assumptions than traditional estimators, such as Tobit.

The key assumption of the Poisson approach is that the conditional mean of g_{it} can be written as in expression (12), where donations are in levels (not in logs, as before) and $exp(\cdot)$ is the exponential function. Due to the properties of logarithms, the coefficients ε, η can be interpreted as the total price and income elasticities of giving i.e. $\varepsilon = \varepsilon_{INT} + \varepsilon_{EXT}$, $\eta = \eta_{INT} + \eta_{EXT}$.

This can be estimated by the PPML method (Gourieroux, Monfort and Trognon, 1984; Silva and Tenreyro, 2006), which is consistent under the assumption that (12) is the correct specification of the conditional mean. That is, the data need not follow a Poisson distribution.[39] Note finally that the Poisson estimator leads to some loss of data, as the observations from taxpayers with zero donations all years do not contribute to the maximum likelihood formula (Cameron and Trivedi, 2005). In our case, this reduces the estimation sample to 2.9 million observations (compared to 6.8 million in the extensive-margin estimation of Table 3).

The results are shown in Table 5. We include the log of the first-pound price, $\ln p_{it}^{f}$, directly in the regressions to obtain the most comparable specification to the previous results. This is a reduced-form specification rather than an instrumental variables one, because the IV-Poisson estimator does suffer from an incidental parameters problem when combined with the individual fixed effects. The estimated total elasticity is consistently negative and highly significant. For our preferred specification in column (4), which includes log disposable and other controls, the total price elasticity ε is -0.43, while the income elasticity η is 0.26. We calculate robust standard errors in all specifications and both estimates are highly significant in all cases.

4.5 Heterogeneous Elasticities

In this section, we report estimates of the price and income elasticity of giving by income level, age groups and gender. It is particularly interesting to investigate responses by income group because most donations come from the highest-income taxpayers within

[39] Indeed, donations in our data do not appear to follow a Poisson distribution, as the variance is larger than the mean. We estimate robust standard errors in all our PPML regressions to address this issue.

the self-assessment group. For example, over our sample period, 55 percent of donations are made by those above the 95th percentile of the income distribution, and 84 percent by those above the 75th income percentile.

However, we face a problem in investigating responses by income group, given that in our main estimates we only include taxpayers who were in the higher tax brackets for the whole period of our study. Specifically, this restricts taxpayers to be in the upper end of the income distribution, since taxpayers earning £45,000 are approximately the 80th percentile of that distribution. Therefore, to be able to observe the effects throughout the whole distribution, the regression estimates presented in this section include *all* self-assessment taxpayers.

To construct income groups that are stable over time, we calculate the average real pre-tax income reported by each taxpayer across the whole sample period, and divide the sample (at the individual level) by percentiles. The first four groups include taxpayers with average income below the 25th percentile of the distribution, between the 25th-50th, 50th-75th and 75th-95th, respectively. The final group includes taxpayers above the 95th percentile.[40] For age, we construct only three groups: taxpayers younger than 40, between 40 and 65, and older than 65.

Table 6 shows the price and income elasticity estimates by income groups for both the intensive and extensive margin. In the intensive-margin case, we estimate the first-difference specification, which is our preferred specification, for reasons discussed in Section 3.2 above. Looking at the first row of the upper panel of the table, we see that for the top three income groups the intensive-margin price elasticity increases as incomes rise. Indeed, up to the 50th percentile, we cannot reject the hypothesis that the price elasticity is zero. Intensive margin income elasticities also rise, but the dependence on income is less marked.

This is consistent with results from the US, where there is some evidence (e.g., Bakija and Heim, 2011) that high-income donors are more responsive to tax incentives than middle and lower-income individuals. It is also consistent with the institutional features of the taxation of donations for UK, where for standard-rate taxpayers, there is no reason to itemize donations on the tax return.

However, as regards the extensive margin, the pattern of both price and income elasticities across income groups is the reverse. Both the price and income elasticities *fall* as incomes rise, with the decrease in the price elasticities being particularly sharp. This is, as far as we know, a new finding. As already remarked, there are are virtually no existing estimates of extensive margin price elasticities of giving, and certainly none disaggregated

[40]The average pre-tax incomes at the relevant percentiles are $p25$ =£8,389, $p50$ =£17,126, $p75$ =£33,747, and $p95$ = £96,163.

by income group.

As already noted, it is the *overall* price elasticity that is relevant for the design of subsidies to charitable giving, and we see from Table 6 that this overall elasticity masks differences in intensive and extensive margin responses across income groups: when the intensive and extensive price elasticities are added together, the overall price elasticity is declining across income groups.

We now turn to variation of the elasticities by gender and age. For these estimates, we use the restricted dataset with only high-bracket taxpayers. Table 7 shows the variation of the elasticities by gender and age. Again, the intensive margin elasticity is estimated using our preferred first-difference estimator. Looking first at gender, we see that the intensive-margin price elasticity is somewhat larger for men (-0.17) than for women (-0.13), while the income elasticity is almost the same. The extensive-margin price and income elasticities on the other hand, seem the same for men and women. As regards age, the intensive-margin price elasticity is highest for those aged over 65 year. The extensive margin price elasticities decline with age. Adding the intensive and extensive margin price elasticities together, we see that the total price elasticity is somewhat greater for men than women, and that the total price elasticity is U-shaped in age, being smallest for the 40-65 age group.

4.6 Discussion

We have now obtained a number of different estimates of the intensive, extensive, and total price and income elasticities. Here, we summarize our findings.

First, the total elasticity results obtained with Poisson method in Table 5 can be compared to the sum of the IV estimates of ε_{INT} from Table 4, and the IV estimates of ε_{EXT} from Table 3. Specification (4) from Table 4 gives ε_{INT} between -0.211 and -0.283, and specification (6) from Table 3 gives $\varepsilon_{EXT} = -0.094$. Summing these gives a total $\varepsilon_{INT} + \varepsilon_{EXT}$ of between -0.315 and -0.377. This is very close to the corresponding specification (4) in Table 5, where the overall price elasticity is -0.431. This elasticity estimate is significantly different from -1, the "consensus" estimate obtained in US studies, with the notable recent exception of Hungerman and Wilhelm (2017). In contrast, the estimates are close to the price elasticity found in France by Fack and Landais (2010). Keep in mind that all prior studies focused exclusively on the intensive-margin elasticity, which places our findings in the lower-end of the available estimates.

Focusing now on the income elasticity, specification (4) from Table 4 gives η_{INT} between 0.129 and 0.201, and specification (6) from Table 3 gives $\eta_{EXT} = 0.065$. Summing these gives a total $\eta_{INT} + \eta_{EXT}$ of between 0.194 and 0.266. This is very close to the corresponding specification (4) in Table 5, where the overall income elasticity is 0.263.

Second, we can compare the intensive-margin estimates obtained in Sections 4.1 and 4.3. Doing so, we find that the differenced specification yields a larger (in absolute value) intensive-margin price elasticity than the estimate obtained using the standard panel specification from the literature. The estimated intensive-margin elasticity becomes larger as we increase the period of estimation, suggesting that (at least some) taxpayers learn about the effects of the reform over time, rather than immediately. In any case, the differences in the estimates between the $k = 1$ and $k = 3$ cases is not too large. This suggests that short-run re-timing responses are not too important in this setting, contrary to the results obtained by Randolph (1995), but broadly in line with the results of Auten, Sieg and Clotfelter (2002).

4.7 Robustness Checks

Here, we report some robustness checks on our results, as discussed in Section 3.2.

First, we consider the potential selection bias in the intensive-margin equation. Our separate estimation of (5) and (6) is a valid procedure as long as error terms u_{it}, v_{it} are independent. However, this is a restrictive assumption that may not hold in practice. We explicitly model selection using a two-step selection model proposed by Wooldridge (1995). This involves estimating (6) as a correlated random effects Probit and adding the inverse Mills ratio as an additional regressor in (5). We report the results of the intensive-margin regression in Table A.6 in the Appendix. The four specifications vary in their construction of the Mills ratio. The point estimates for the intensive-margin price elasticity ε_{INT} are all in the range $(-0.24, -0.16)$, almost identical to the estimates obtained with the differenced regressions. The income elasticity η_{INT} is about 0.14, only slightly larger than in the other methods.

Second, the conceptual framework from Section 3.1 predicts that some taxpayers will bunch at the kink points in the tax schedule. The relevant thresholds in our setting are at $z =$ £100,000 and $z =$£150,000, and also around the kink between the basic and higher tax rates (located at $z \approx$ £40,000, with some variation across years). We investigate whether bunching in taxable income around kink points of the tax schedule has an effect on the estimated price elasticities by re-estimating regressions (5) and (6) excluding individuals in an interval of $\pm$£2,000 around each kink point.

Third, taxpayers may anticipate price changes or partly shift donations over time. We investigate these potential dynamic effects following the methodology of Bakija and Heim (2011), by introducing lagged and future changes in the price of contributions and in net disposable income. Specifically, we modify equation (5) to estimate:

$$\ln g_{it} = \varepsilon_{INT} \ln p_{it} + \eta_{INT} \ln y_{it} + \delta X_{it} + \alpha_i + \alpha_t \\ +\gamma_1 \Delta \ln p_{it} + \gamma_2 \Delta \ln p_{it+1} + \gamma_3 \Delta \ln y_{it} + \gamma_4 \Delta \ln y_{it+1} + u_{it}, \tag{13}$$

and we make analogous changes to equation (6) for the extensive margin.

The results for the latter two robustness exercises are reported in Tables A.3 (intensive margin) and A.4 (extensive margin) in the Appendix. Table A.3 re-estimates (5) using p^f_{it} as an instrument for p_{it}. In columns (1)-(4), we exclude individuals around kink points. We find that the intensive-margin price elasticity slightly increases in absolute value: from -0.58 and -0.34 in columns (4) and (8) of Table 2 to -0.65 and -0.38 in columns (2) and (4) of Table A.3, respectively. For the extensive-margin case, columns (1)-(4) of Table A.4 re-estimate (6), again using the IV specification and excluding potential bunchers. The estimates of the extensive-margin price elasticity also increase a little in absolute value: from -0.91 and -0.79 in columns (4) and (8) of Table 3 to -0.99 and -0.86 in columns (2) and (4) of Table A.4, respectively. Given that the changes in both intensive and extensive-margin elasticities are modest, these results are consistent with bunchers not changing their donations much in response to a change in the tax price of giving.

In columns (5)-(8) of Tables A.3 and A.4, we report the results for the dynamic specifications. The coefficients on the lagged and future changes ($\gamma_1, ..., \gamma_4$) are statistically significant in most cases, but they are small in size compared to the estimates of the persistent price and income elasticities ($\varepsilon_{INT}, \varepsilon_{EXT}$). The permanent intensive-margin elasticity is -0.42 (column 8 of Table A.3), which is a bit larger in absolute value than the equivalent estimate without the lagged and future changes (-0.34; column 8 of Table 2). The same applies to the permanent intensive-margin income elasticity (0.18 vs. 0.12). These results are consistent with those obtained in the differenced regressions with one vs. three lags.

5 Subsidy Reforms

In this section, we assess whether the current level of subsidy for charitable giving in the UK is too low, too high, or about right, given our estimates. For this purpose, we consider a simple setting which allows for: (i) alternative modes of provision, that is, public versus private; (ii) a full accounting of warm glow motives in social welfare; (iii) the fact that public funds have an opportunity cost in excess of unity as they must be raised through distortionary taxes (outside the model); (iv) the idea that private provision does not substitute one-for-one for public provision.

On the individual side, we now allow for a number of individuals, indexed by a taste parameter $\theta \in [\underline{\theta}, \overline{\theta}]$, which measures the individual's preference for donations. Also, we specialize the model of Section 3.1 by assuming that u is linear in consumption and independent of l i.e.

$$u(c, g, l; \theta) = \theta u(g) + c \tag{14}$$

This implies the individual will supply the maximum amount of labor, and that income z will be set to its maximum feasible value, $\bar{z}$. Next, we assume that the wage is unity, and that the tax system is proportional, with marginal tax τ, so the budget constraint is $c + pg = p\bar{z}$, where $p = 1 - \tau$. Substituting this budget constraint into (14), we see that a individual of type θ chooses

$$g(p; \theta) = \left\{ arg \max_{g \geq 0} \theta u(g) - pg \right\}. \tag{15}$$

where the solution $g(p; \theta)$ only depends on p. Note that without further restrictions on $g(.)$, $g(p; \theta) = 0$ is possible for θ low enough i.e. the individual may decide to make a zero donation. Indirect utility for a donor of a type θ is therefore

$$v(p; \theta) = u(g(p; \theta)) - pg(p; \theta) \tag{16}$$

We now suppose that the government's policy objective is individual welfare, plus a pay-off from the public good aspect of donations as in Saez (2004). Given the quasi-linearity of individual utility, the usual measure of individual welfare is the expected value of (16), with respect to θ. We will interpret $v(.)$ in (16) as the individual utility from the warm-glow element of giving, excluding the collective consumption element of giving. The collective consumption value of the public good(s) funded by donations is the social value of the goods and services funded by charitable donations, plus any grant G from government, and is captured by a function

$$V(\alpha\overline{g} + G), \quad \overline{g}(p) = \int_{\underline{\theta}}^{\overline{\theta}} g(p; \theta) f(\theta) d\theta$$

where $\overline{g}(p)$ are average donations, G is a government grant, $\alpha \in [0, 1]$, and $V'(\cdot) > 0$, $V''(\cdot) \leq 0$. The parameter α measures the extent to which the mix of collective goods that is funded by private donations is aligned with the government's own preferred mix.[41]

[41]This divergence may reflect a paternalistic component of government objectives ("merit goods"), or it may be due to a divergence between donors' preferences and the preferences of a majority-elected government. See Horstmann and Scharf (2008) for more on this and also the discussion at the end of the next section.

The government's objective is then

$$W = V(\alpha\overline{g}(p) + G) - p\overline{g}(p) + \gamma \int_{\underline{\theta}}^{\overline{\theta}} g(p;\theta) f(\theta) d\theta$$

where $\gamma \in [0,1]$ measures the extent to which warm-glow motives enter into the government's objective. The modelling rationale for allowing for less-than-full weighting of warm-glow utility in social welfare and of private donations in $V(\cdot)$ is that, with $\alpha = 1$ and $\gamma = 1$, the above specification would make it optimal (by construction) to route all provision through private donations, simply because donations generate warm-glow utility that direct funding through government grant does not generate. Partial weighting introduces trade-offs that make the problem no longer trivial. In characterising the optimal choice of p (and hence s), we additionally assume that $V'(\overline{g}(1) + G) > 1$, i.e. that given a zero subsidy, and for $\alpha = 1$ and $\gamma = 0$, it would be socially desirable to raise the level of public good provision. This rules out the possibility of a negative optimal subsidy.

Rather than look at the optimal choice of p, we will consider a small reform, dp, in the price of charitable giving, taking into account that the grant G must adjust given the government budget constraint $(1-p)\bar{g} + G = E$ where E is fixed revenue. It is easily calculated that taking the government budget constraint into account, the effect on W of a change in p is

$$\begin{aligned} dW &= -\bar{g}dp + (\alpha V' - (1-\gamma)p)\,\bar{g}_p dp + V' dG \qquad (17) \\ &= \left(V' - 1 - V' \frac{\alpha + p - 1}{p}\varepsilon + (1-\gamma)\varepsilon \right) \bar{g} dp \qquad (18) \end{aligned}$$

where

$$\varepsilon = -\frac{p\bar{g}_p}{\bar{g}} = \varepsilon_{INT} + \varepsilon_{EXT}$$

is the absolute value of the elasticity of average charitable giving with respect to the price. Note also that because some individuals may be at a corner and give zero at some prices, this elasticity is the sum of the intensive and extensive margin elasticities $\varepsilon_{INT}, \varepsilon_{EXT}$.

Note finally that an increase in the price, p, of donations is like a decrease in the subsidy $s = 1 - p$. So, we can conclude that an increase in the subsidy increases welfare if and only if the sum of the intensive and extensive margin elasticities is sufficiently high i.e.

$$\varepsilon_{INT} + \varepsilon_{EXT} > \frac{V' - 1}{V'} \cdot \frac{1 - s}{\alpha - s - (1-s)(1-\gamma)/V'} \qquad (19)$$

So, note that we have a kind of "sufficient statistic" result; to determine whether the subsidy should be increased or decreased, we do not need to know the individual elasticities $\varepsilon_{INT}, \varepsilon_{EXT}$, but just their sum. If the second-order conditions for a social-welfare maximizing level of s between zero and unity are satisfied, then the optimal level of subsidy will be one that equalizes the left- and right-hand sides of (19). Since $V' > 1$, the first fraction on the right-hand side of (19) is less than one. If $\alpha = 1$ and $\gamma = 0$, the right-hand side becomes one, and so we recover Roberts (1984) unity elasticity rule. For $\gamma = 1$ (i.e. if warm-glow utility has full weight in social welfare), an estimate of $\varepsilon_{INT} + \varepsilon_{EXT}$ in excess of unity can only be rationalized as being consistent with the choice of an optimal s if $\alpha < 1$. For $\alpha = 1$ (i.e. if donations have the same social value as publicly provided collective goods), the right-hand side of (19) becomes $(V' - 1)/(V' - 1 + \gamma)$, which is always less than or equal to unity, and so an estimate of $\varepsilon_{INT} + \varepsilon_{EXT}$ in excess of unity can never be rationalized as being consistent with an optimal choice of s if $\alpha = 1$, regardless of the value of γ.

In our preferred empirical specification, $\varepsilon_{INT} + \varepsilon_{EXT}$ has been estimated to be between -0.30 and -0.37 then, in light of the above discussion, we must then conclude that the observed level of subsidy (which can be taken as the marginal tax rate of a higher rate taxpayer, between 0.4 and 0.5) can only be welfare maximizing if $\gamma > 0$ and sufficiently large, that is, the social planner needs to put enough weight on warm glow to compensate for the low elasticity and, possibly, for $\alpha < 1$.

The notion that the UK government is indeed providing private warm glow opportunities to private donors, that is, that $\gamma > 0$ is supported by its own policies and rhetoric on "big society",[42] which includes explicit proposals for actions aimed at the public provision of warm glow opportunities for donors and charities.

6 Conclusions

In this paper, we have analysed a unique panel of UK administrative income tax returns for the period 2005-2013 to identify intensive and extensive-margin donor responses to the tax price of charitable giving. Using a major tax reform of the UK income tax schedule as a source of exogenous variation in the tax price, we have estimated tax price and income elasticities, using various specifications, and a novel methodology that allows us to control for changes in incomes induced by labor supply responses to the tax reform.

Our empirical findings show that the extensive margin matters. Specifically, most of the response to a change in the tax price is at the extensive margin; we estimate an intensive-margin price elasticity of about -0.25, and an extensive-margin price elasticity

[42]For example, one of the UK government's explicit policy objectives is to "Build the Big Society". Explicit within that aim is its desire to "take a range of measures to encourage charitable giving and philanthropy". See `www.gov.uk/government/uploads/system/uploads/attachment_data/file/78979/building-big-society_0.pdf`.

of -0.10, resulting in a total price elasticity of approximately -0.35. These results are robust to alternative estimation methods. We also estimate the price and income elasticity of giving by income level, age groups and gender.

For our welfare analysis, we extended the theoretical framework of Saez (2004) to allow for extensive-margin giving responses and for the government to value donations and a direct subsidy from the government differently. Then, we showed that the relevant policy elasticity is the sum of the intensive and extensive-margin elasticities. Moreover, we showed that our preferred elasticity estimates can only be rationalized as being compatible with tax incentives set optimally if the policymaker places enough value on the warm-glow opportunities afforded to taxpayers through the tax incentive.

References

Auten, Gerald, Holger Sieg, and Charles Clotfelter. 2002. "Charitable Giving, Income, and Taxes: An Analysis of Panel Data." *American Economic Review*, 92(1): 371–382.

Bakija, Jon, and Bradley Heim. 2011. "How Does Charitable Giving Respond to Incentives and Income? New Estimates from Panel Data." *National Tax Journal*, 64(2): 615–750.

Blundell, Richard, and MaCurdy Thomas. 1999. "Labor Supply: A Review of Alternative Approaches." *Handbook of Labor Economics*, 1559–1695.

Bradley, Ralph, Steven Holden, and Robert McClelland. 2005. "A Robust Estimation of the Effects of Taxation on Charitable Contributions." *Contemporary Economic Policy*, 23(4): 545–554.

Cameron, Colin, and Pravin Trivedi. 2005. *Microeconometrics: Methods and Applications.* Cambridge University Press.

Fack, Gabrielle, and Camille Landais. 2010. "Are Tax Incentives for Charitable Giving Efficient? Evidence from France." *American Economic Journal: Economic Policy*, 2(2): 117–141.

Fack, Gabrielle, and Camille Landais. 2016. *Charitable Giving and Tax Policy.* Oxford University Press.

Feenberg, Daniel. 1987. "Are Tax Price Models Really Identified: The Case of Charitable Giving." *National Tax Journal*, 40(4): 629–633.

Feldstein, Martin, and Amy Taylor. 1976. "The Income Tax and Charitable Contributions." *Econometrica*, 6: 1201–1222.

Gillitzer, Christian, and Peer Skov. 2016. "The Use of Third-Party Information Reporting for Tax Deductions: Evidence and Implications from Charitable Deductions in Denmark." Working paper.

Gourieroux, Christian, Alain Monfort, and Alain Trognon. 1984. "Pseudo-Maximum Likelihood Methods: Applications to Poisson Models." *Econometrica*, 701–720.

Greene, William. 2004. "Fixed Effects and Bias Due to the Incidental Parameters Problem in the Tobit Model." *Econometric Reviews*, 23(2): 125–147.

Gruber, Jon, and Emmanuel Saez. 2002. "The Elasticity of Taxable Income: Evidence and Implications." *Journal of Public Economics*, 84(1): 1–32.

Horstmann, Ignatius, and Kimberley Scharf. 2008. "A Theory of Distributional Conflict, Voluntarism and Segregation." *Economic Journal*, 118: 427–453.

Horstmann, Ignatius, Kimberley Scharf, and Al Slivinski. 2007. "Can Private Giving Promote Economic Segregation?" *Journal of Public Economics*, 91: 1095–1118.

Hungerman, Daniel, and Mark Ottoni Wilhelm. 2016. "The Price Elasticity of Charitable Giving: Toward a Reconciliation of Disparate Literatures." mimeo, Lilly Family School of Philanthropy.

Imbens, Guido W, and Joshua D Angrist. 1994. "Identification and Estimation of Local Average Treatment Effects." *Econometrica*, 62(2): 467–475.

Jones, Andrew, and John Posnett. 1991. "Charitable Donations by UK Households: Evidence from the Family Expenditure Survey." *Applied Economics*, 23(2): 343–351.

Kleven, Henrik, and Esben Schultz. 2014. "Estimating Taxable Income Responses using Danish Tax Reforms." *American Economic Journal: Economic Policy*, 6(4): 271–301.

National Audit Office, UK. 2013. "Gift Aid and Reliefs on Donations." https://www.nao.org.uk/report/gift-aid-reliefs-donations-2/.

Peloza, John, and Piers Steel. 2005. "The Price Elasticities of Charitable Contributions: A Meta-Analysis." *Journal of Public Policy & Marketing*, 24(2): 260–272.

Randolph, William. 1995. "Dynamic Income, Progressive Taxes, and the Timing of Charitable Contributions." *Journal of Political Economy*, 103: 709–738.

Rao, Nirupama. 2016. "Do Tax Credits Stimulate R&D Spending? The Effect of the R&D Tax Credit in its First Decade." *Journal of Public Economics*, 140: 1–12.

Roberts, Russell. 1984. "A Positive Model of Private Charity and Public Transfers." *Journal of Political Economy*, 136–148.

Saez, Emmanuel. 2004. "The Optimal Treatment of Tax Expenditures." *Journal of Public Economics*, 88(12): 2657–2684.

Saez, Emmanuel. 2010. "Do Taxpayers Bunch at Kink Points?" *American Economic Journal: Economic Policy*, 2(3): 180–212.

Saez, Emmanuel, Joel Slemrod, and Seth Giertz. 2012. "The Elasticity of Taxable Income with Respect to Marginal Tax Rates: A Critical Review." *Journal of Economic Literature*, 50(1): 3–50.

Scharf, Kimberley, and Sarah Smith. 2015. "The Price Elasticity of Charitable Giving: Does the Form of Tax Relief Matter?" *International Tax and Public Finance*, 22(2): 330–352.

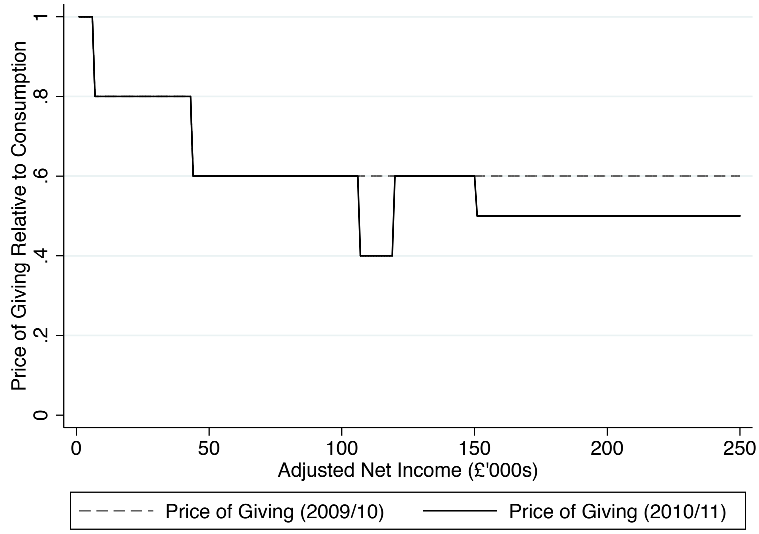
Silva, JMC Santos, and Silvana Tenreyro. 2006. "The Log of Gravity." *The Review of Economics and Statistics*, 88(4): 641–658.

Wooldridge, Jeffrey. 1995. "Selection Corrections for Panel Data Models under Conditional Mean Independence Assumptions." *Journal of Econometrics*, 68(1): 115–132.

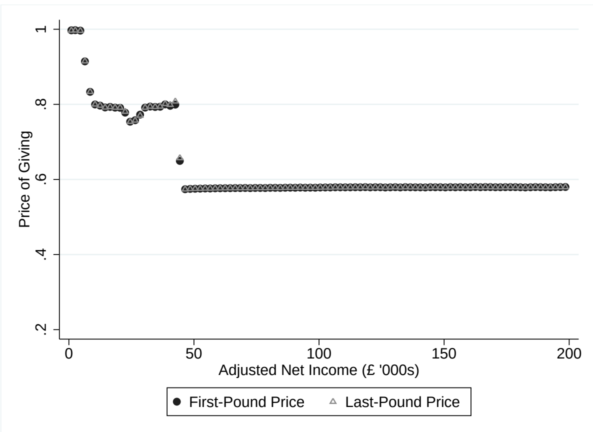
Figures

Figure 1: Price of Giving by Income Level

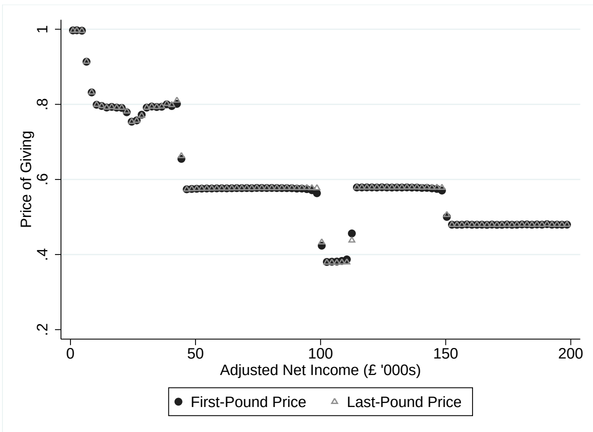
(a) Statutory Tax Price of Giving, Before and After 2010 Reform



(b) Measured Price of Giving (2009/10)

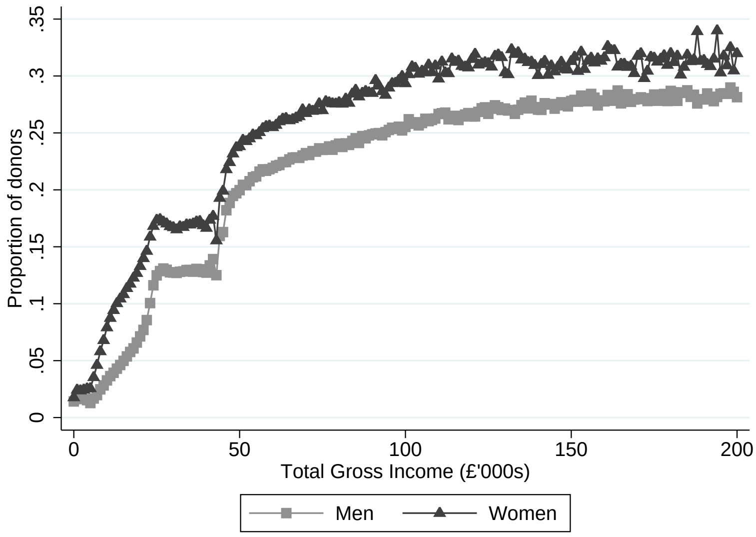


(c) Measured Price of Giving (2010/11)



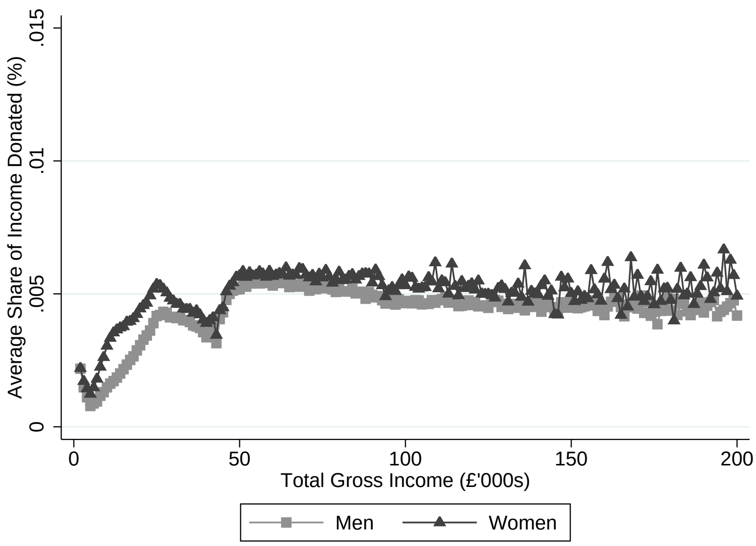
Notes: the top panel (a) plots the statutory price of giving in the fiscal years 2009/10 and 2010/11, i.e. before and after the April 2010 tax reform. The picture shows that there are two groups of taxpayers affected by the reform: those with adjusted net income (z) between £100,000 and 112,950, and those with $z >$ £150,000. The bottom panels (b and c) show the actual average price of giving observed in the data using our tax calculator. We create £2,000-wide bins of adjusted net income in the horizontal axis and calculate the average first-pound and last-pound prices in each bin. As expected, the averages are nearly identical in each bin for the two price measures. The small dip in the price of giving around £30,000 is due to the withdrawal of the extra personal allowance awarded to individuals above 65 years. Some bins include taxpayers on either side of a tax kink, which explains why their average price of giving is different from the contiguous bins.

Figure 2: Fraction of Donors, by Income and Gender



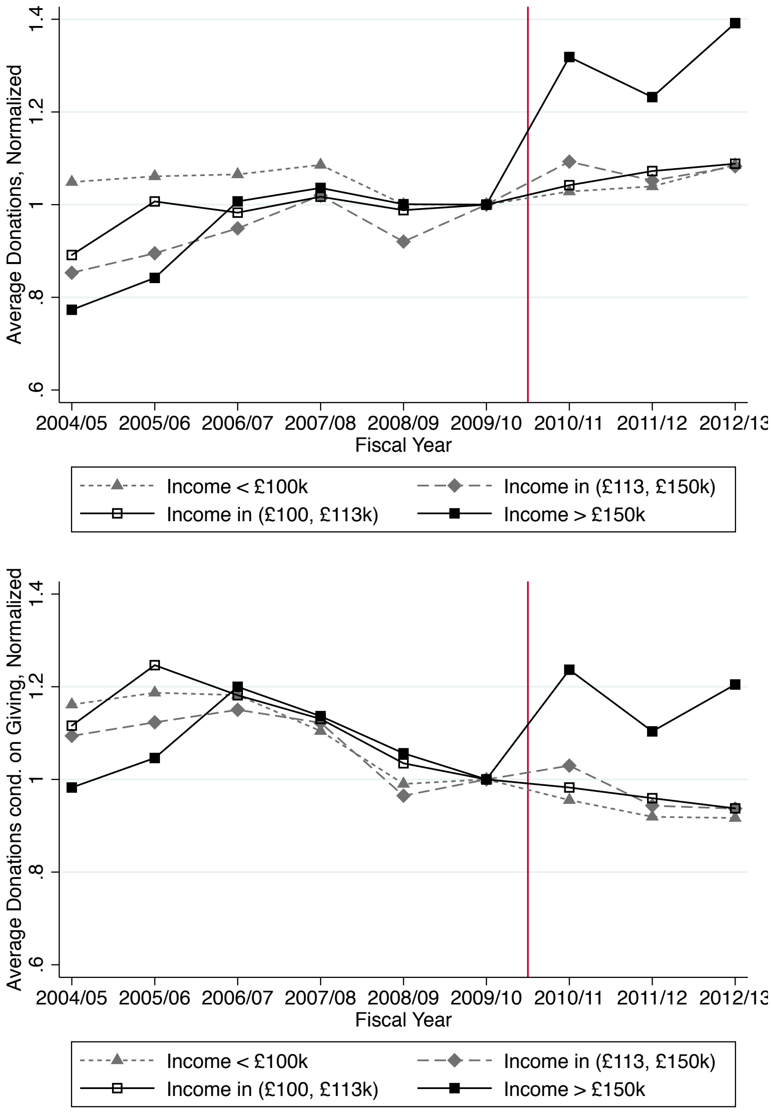
Notes: this figure plots the proportion of taxpayers reporting positive donations (donors), against total gross income in bins of £1,000. Solid triangles represent the averages for women and light-grey squares represent the averages for men. Taxpayers with gross income below £45,000 are generally in the basic rate bracket, so they do not get any additional tax relief by reporting their donations on the self-assessment form.

Figure 3: Average Share of Income Donated, by Income and Gender



Notes: this figure shows the average share of gross (pre-tax) income donated, by gender and by levels of gross income. Throughout the income distribution, women donate a slightly higher proportion of their income than men. The share donated grows with income up to about £50,000, and it is remarkably stable at about 0.5% for all taxpayers above that income level.

Figure 4: Normalized Average Donations by Income Group



Notes: the top panel shows the evolution of average donations for four groups of taxpayers. Average donations are normalized to equal 1 in fiscal year 2009/10 (just prior to the April 2010 reform) for all groups. The groups are defined based on how taxpayers might have been affected by the tax reform depending on their adjusted net income (z) in fiscal year 2009/10. Taxpayers with net income $z \in (0, 100]$ thousand pounds in 2009/10 were not affected by the reform, and neither were those with net income $z \in (113, 150]$ thousand pounds. The evolution of normalized average donations for these two groups are depicted in grey. Taxpayers with net income $z \in (100, 113]$ in year 2009/10 were affected by the reform, as the marginal tax rate for that income range went from 40% to 60% (so their tax-price of giving declined from 0.6 to 0.4). Similarly, taxpayers with net income $z \in (150, \infty)$ saw their marginal tax rate increase from 40% to 50% (so their tax-price of giving declined from 0.6 to 0.5). The bottom panel shows the evolution of normalized average donations only for individuals reporting positive donations (i.e., donors). The groups are defined as above, and the group averages are also normalized to be one in fiscal year 2009/10 for all groups.

Tables

Table 1: Summary Statistics

	Mean	Std. Dev.	p10	p50	p90	Observations
Panel A: Universe of Self-Assessment Taxpayers						
Donations (g)	211	25,632	0	0	59	75,646,776
Donations (if $g > 0$)	1,927	77,376	63	382	2,796	8,296,291
Adjusted Net Income (z)	36,072	878,780	3,592	18,799	70,031	75,646,776
Disposable Income (y)	29,098	533,810	3,873	17,186	55,886	75,646,776
Price of Giving (p)	0.79	0.14	0.60	0.78	1.00	75,646,776
Age	49.92	15.02	31	49	70	74,007,168
Female	0.34	0.47	0	0	1	75,646,776
Used a Tax Advisor	0.67	0.47	0	1	1	75,646,776
Panel B: Higher-Bracket Taxpayers (Main Estimation Subsample)						
Donations (g)	707	3,685	0	0	1,188	6,869,602
Donations (if $g > 0$)	2,320	6,389	89	593	5,118	2,093,152
Adjusted Net Income (z)	154,746	401,238	56,006	97,368	254,366	6,869,602
Disposable Income (y)	110,514	289,111	45,399	72,615	173,409	6,869,602
Price of Giving (p)	0.58	0.06	0.50	0.60	0.60	6,869,602
Age	50.25	12.62	36	48	68	6,787,973
Female	0.18	0.39	0	0	1	6,869,602
Used a Tax Advisor	0.61	0.49	0	1	1	6,869,602

Notes: this table reports summary statistics for the universe of self-assessment income tax returns for the fiscal years between 2004/05 and 2012/13 (Panel A), and for the subsample of taxpayers that always facing a marginal tax rate of 40% or higher (Panel B). For each variable, we report the mean, standard deviation, the 10th, 50th and 90th percentiles and the total number of non-missing observations. **Donations** (g) are measured in pounds and are expressed gross of the Gift Aid match. The second row shows summary statistics for donations among donors, i.e. taxpayers reporting $g > 0$ in a given year. **Adjusted net income** (z) is the measure of income that is used for the calculation of income-related deductions to the personal allowance. It is equal to net income minus the grossed-up amount of Gift Aid donations and pension contributions, plus any tax relief received for certain payments (e.g., trade union quotas). In turn, net income is the sum of all employment income, profits, pensions, and income from property, savings and dividends, after subtracting related deductions (e.g., trading losses and gross payments to pension schemes). **Disposable income** is defined as total gross income minus the total tax liability, setting donations to zero. As described in the text, we can write this down as $y = z - T(z)$, where we set $g = 0$ to ensure that, when including this variable in the regression, tax incentives for giving are incorporated only in the price of giving, rather than in disposable income. The **price of giving** (p) is defined as one minus the marginal tax rate. Note that the summary statistics for the first- and last-pound price of giving are essentially identical, so we only report them once. **Age** is measured in years and **female** takes value one for women and zero for men. There are some errors in these two variables in the original SA302 data. For example, age is sometimes reported inconsistently by taxpayers across years. In those cases (about 8% of all observations), we calculate the implied year of birth for each observation and assign the most frequent value for all observations of a given taxpayer. Since age is missing for all years for some taxpayers, we have some missing values for about 2% of observations. We do a similar exercise with the female dummy, as some taxpayers report a different gender across years. This might be due to the fact that HMRC assigns gender based on first names when that variable is missing. **Used a Tax Advisor** is a dummy variable that takes value one if the taxpayer used a tax advisor to file their return at any point in the past. Hence, this does not refer only to the current year.

Table 2: Intensive-Margin Elasticity (IV), Baseline Specification

	Dependent Variable: Log Donations ($\ln g_{it}$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Price of Giving	-0.890***	-0.223***	-0.189***	-0.829***	-0.185***	-0.160***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Log Disposable Income				0.254***	0.205***	0.195***
				(0.003)	(0.003)	(0.003)
Individual FE	y	y	y	y	y	y
Year FE	n	y	y	n	y	y
Other controls	n	n	y	n	n	y
Observations	1,966,204	1,966,204	1,957,876	1,966,204	1,966,204	1,957,876
R-squared	0.006	0.052	0.054	0.017	0.059	0.060
Unique IDs	345,533	345,533	343,821	345,533	345,533	343,821

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$\ln g_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \alpha_i + \alpha_t + \delta' X_{it} + u_{it}$$

where $\ln g_{it}$ denotes log donations; $\ln p_{it}$ denotes the log of the last-pound price of giving, which is instrumented in all specifications by the log of the first-pound price of giving $\ln p_{it}^f$; $\ln y_{it}$ is the log of disposable income setting $g = 0$; X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t are individual and year fixed effects, respectively. Statistical significance: ***=1%, **=5%, *=10%.

Table 3: Extensive-Margin Elasticity (IV)

	Dependent Variable: Donor Dummy, $D_{it} \equiv (g_{it} > 0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Price of Giving	-0.224***	-0.044***	-0.033***	-0.206***	-0.038***	-0.029***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log Disposable Income				0.047***	0.026***	0.020***
				(0.000)	(0.000)	(0.000)
Implied Price Elasticity, ε_{EXT}	-0.735***	-0.145***	-0.108***	-0.676***	-0.124***	-0.094***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Implied Income Elasticity, η_{EXT}				0.155***	0.085***	0.065***
				(0.001)	(0.001)	(0.001)
Individual FE	y	y	y	y	y	y
Year FE	n	y	y	n	y	y
Other controls	n	n	y	n	n	y
Observations	6,869,602	6,869,602	6,787,973	6,869,602	6,869,602	6,787,973
Unique IDs	1,341,324	1,341,324	1,310,284	1,341,324	1,341,324	1,310,284
R-squared	0.0002	0.0041	0.0248	0.0022	0.0058	0.0235

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$D_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \delta^{'} X_{it} + \alpha_i + \alpha_t + u_{it}$$

where $D_{it} \equiv 1(g_{it} > 0)$ is a dummy variable that takes value one for positive donations and zero otherwise; $\ln p_{it}$ denotes the log of the last-pound price of giving, which is instrumented by the log of the first-pound price of giving $\ln p_{it}^{f}$, and the rest of variables are defined as in Table 2 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table 4: Intensive-Margin Elasticity: Regressions in Differences (IV)

	Dep. Var.: Log change in Donations ($\ln(g_{it}/g_{i,t-k})$)			
	(1)	(2)	(3)	(4)
First Difference ($k = 1$)				
Change in Log First-Pound Price	-0.164***	-0.156***	-0.224***	-0.213***
	(0.016)	(0.016)	(0.016)	(0.016)
Change in Log Disposable Income			0.133***	0.129***
			(0.003)	(0.003)
Observations	2,008,682	2,000,382	2,008,682	2,000,382
R-squared	0.001	0.002	0.003	0.004
Second Difference ($k = 2$)				
Change in Log First-Pound Price	-0.105***	-0.094***	-0.230***	-0.211***
	(0.018)	(0.018)	(0.017)	(0.018)
Change in Log Disposable Income			0.181***	0.175***
			(0.003)	(0.003)
Observations	1,299,998	1,294,756	1,299,998	1,294,756
R-squared	0.001	0.003	0.006	0.008
Third Difference ($k = 3$)				
Change in Log First-Pound Price	-0.003	0.018	-0.317***	-0.283***
	(0.024)	(0.025)	(0.023)	(0.024)
Change in Log Disposable Income			0.210***	0.201***
			(0.004)	(0.004)
Individual FE	y	y	y	y
Year FE	y	y	y	y
Other controls	n	y	n	y
Observations	738,685	735,739	738,685	735,739
R-squared	0.000	0.002	0.008	0.010

Notes: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$\Delta \ln g_{it} = \varepsilon_{INT} \Delta \ln p_{it}^{f} + \eta_{INT} \Delta \ln y_{it} + \delta^{'} \Delta X_{it} + \alpha_i + \alpha_t + v_{it}$$

where $k = 1, 2, 3$ years, as indicated at the top of each panel. The dependent variable $\Delta \ln g_{it} \equiv \ln(g_{it}/g_{it-k})$ denotes the log change in donations between years $t-k$ and t; $\Delta \ln p_{it}^{f} \equiv \ln \left(p_{it}^{f}(z_{it})/p_{it-k}^{f}(z_{it-k}) \right)$ denotes the log change in the price of giving between years $t-k$ and t; $\Delta \ln y_{it} \equiv \ln (y_{it}/y_{it-k})$ denotes the log change in disposable income (setting $g_{it} = 0$); $\Delta X_{it} \equiv (X_{it}/X_{it-k})$ denotes the change in the control variables (age/100 squared, female and tax advisor dummies); α_i, α_t denote individual and year fixed effects, respectively; and v_{it} represents a random error term. In the IV specifications (columns 5-8), the log change in the price of giving is instrumented by $\ln \left(p_{it}^{f}(z_{it-k})/p_{it-k}^{f}(z_{it-k}) \right)$ as described in Section 3.2. Statistical significance: ***=1%, **=5%, *=10%.

Table 5: Total Elasticity: Poisson Regressions

	Dependent Variable: Donations in Levels (g_{it})			
	(1)	(2)	(3)	(4)
Log First-Pound Price	-0.516***	-0.452***	-0.486***	-0.431***
	(0.018)	(0.018)	(0.018)	(0.018)
Log Disposable Income			0.277***	0.263***
			(0.007)	(0.007)
Individual FE	y	y	y	y
Year FE	y	y	y	y
Other controls	n	y	n	y
Observations	2,962,967	2,948,881	2,962,967	2,948,881
Unique IDs	418,077	415,856	418,077	415,856

Note: robust standard errors in parentheses. The estimated equation is

$$g_{it} = \exp(\varepsilon \ln p_{it} + \eta \ln y_{it} + \delta^{'} X_{it} + \alpha_i + \alpha_t) + u_{it}$$

where g_{it} denotes donations (in levels); $\ln p_{it}$ denotes the log price of giving (in columns 5-8, we use the first-pound price, $\ln p^f_{it}$); $\ln y_{it}$ denotes the log of disposable income (setting $g = 0$); X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t denote individual and year fixed effects, respectively. Statistical significance: ***=1%, **=5%, *=10%.

Table 6: Heterogeneous Elasticities by Income Range: Intensive and Extensive Margin

	Dep. Var.: Change in Log Donations ($\ln g_{it}/\ln g_{i,t-k}$)				
	$p0-p25$	$p25-p50$	$p50-p75$	$p75-p95$	$p95-p100$
Intensive Margin	(1)	(2)	(3)	(4)	(5)
Change in Log First-Pound Price	0.089	-0.048	-0.055**	-0.098***	-0.220***
	(0.065)	(0.043)	(0.025)	(0.013)	(0.028)
Change in Log Disposable Income	0.045***	0.077***	0.088***	0.100***	0.114***
	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	100,089	526,510	1,483,141	2,167,162	909,509
R-squared	0.005	0.007	0.006	0.007	0.007

	Dep. Var.: Donor Dummy I($g_{it}>0$)				
	$p0-p25$	$p25-p50$	$p50-p75$	$p75-p95$	$p95-p100$
Extensive Margin	(1)	(2)	(3)	(4)	(5)
Log Price of Giving	-0.034***	-0.054***	-0.054***	-0.056***	-0.050***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Log Disposable Income	0.002***	0.005***	0.009***	0.015***	0.022***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity, ε_{EXT}	-1.583***	-0.998***	-0.455***	-0.270***	-0.170***
	(0.018)	(0.010)	(0.005)	(0.002)	(0.004)
Implied Income Elasticity, η_{EXT}	0.091***	0.092***	0.079***	0.075***	0.076***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	13,772,160	18,005,842	19,684,814	15,780,001	4,607,184
Unique IDs	3,385,342	3,422,862	3,434,745	2,757,835	699,679
R-squared	0.002	0.006	0.010	0.022	0.037

Notes: the **top panel** reports the intensive-margin elasticities by levels of income. For the income groups, we calculate the average real pre-tax income reported by each taxpayer across the whole sample period, and divide the sample (at the individual level) by percentiles. All intensive-margin elasticities are estimated using the differenced specification with $k = 1$ year. The estimation equation is

$$\Delta \ln g_{it} = \varepsilon_{INT}\Delta \ln p^f_{it} + \eta_{INT}\Delta \ln y_{it} + \delta^{'}\Delta X_{it} + \alpha_i + \alpha_t + v_{it}$$

where all variables are defined as in the note to Table 4. The **bottom panel** reports extensive-margin elasticities estimated using a linear probability model. The estimation equation is

$$D_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \delta^{'} X_{it} + \alpha_i + \alpha_t + u_{it}$$

where the first-pound price $\ln p_{it}$ is instrumented by the first-pound price $\ln p^f_{it}$, and the other variables are defined as in the notes to Tables A.2 and 3 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table 7: Heterogeneous Elasticities by Age and Gender: Intensive and Extensive Margin

	Dep. Var.: Change in Log Donations ($\ln g_{it}/\ln g_{i,t-k}$)				
	Men	Women	Age < 40	Age $40-65$	Age > 65
Intensive Margin	(1)	(2)	(3)	(4)	(5)
Change in Log First-Pound Price	-0.170***	-0.132***	-0.155***	-0.142***	-0.184***
	(0.009)	(0.018)	(0.022)	(0.010)	(0.022)
Change in Log Disposable Income	0.196***	0.192***	0.277***	0.176***	0.182***
	(0.004)	(0.008)	(0.009)	(0.004)	(0.009)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	1,576,733	390,233	293,051	1,225,235	411,327
R-squared	0.059	0.064	0.081	0.051	0.040

	Dependent Variable: Donor Dummy I($g_{it} > 0$)				
	Men	Women	Age < 40	Age $40-65$	Age > 65
Extensive Margin	(1)	(2)	(3)	(4)	(5)
Log Price of Giving	-0.030***	-0.031***	-0.038***	-0.024***	-0.023***
	(0.001)	(0.003)	(0.003)	(0.001)	(0.004)
Log Disposable Income	0.020***	0.020***	0.032***	0.016***	0.013***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Implied Price Elasticity, ε_{EXT}	-0.101***	-0.094***	-0.174***	-0.079***	-0.046***
	(0.004)	(0.009)	(0.014)	(0.005)	(0.007)
Implied Income Elasticity, η_{EXT}	0.066***	0.061***	0.145***	0.054***	0.026***
	(0.001)	(0.003)	(0.004)	(0.001)	(0.002)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	5,621,250	1,247,409	1,593,786	4,438,534	836,339
Unique IDs	1,079,304	256,750	512,543	931,479	151,643
R-squared	0.0273	0.0123	0.00735	0.000216	0.00291

Notes: the **top panel** reports the intensive-margin elasticities by gender and age. All intensive-margin elasticities are estimated using the differenced specification with $k = 1$ year. The estimation equation is

$$\Delta \ln g_{it} = \varepsilon_{INT} \Delta \ln p^f_{it} + \eta_{INT} \Delta \ln y_{it} + \delta' \Delta X_{it} + \alpha_i + \alpha_t + v_{it}$$

where all variables are defined as in the note to Table 4. The **bottom panel** reports extensive-margin elasticities estimated using a linear probability model. The estimation equation is

$$D_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \delta' X_{it} + \alpha_i + \alpha_t + u_{it}$$

where the first-pound price $\ln p_{it}$ is instrumented by the first-pound price $\ln p^f_{it}$, and the other variables are defined as in the note to Tables A.2 and 3 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

ONLINE APPENDIX

NOT INTENDED FOR PUBLICATION IN JOURNAL

"More Giving or More Givers? The Effects of Tax Incentives on Charitable Donations in the UK"

Miguel Almunia, Benjamin Lockwood and Kimberley Scharf

University of Warwick and University of Birmingham

January 2018

A Derivation of Equation (4).

Assume first that $z^* - g^* \leq A$. Then, from (2), the budget constraint facing the individual is

$$\begin{aligned} c + g = z - \tau_b(z - g) \qquad & \Rightarrow c + (1 - \tau_b)g = z(1 - \tau_b) \\ & \Rightarrow c + (1 - \tau_b)g + wl(1 - \tau_b) = (1 - \tau_b)\bar{z} \end{aligned}$$

using $z = \bar{z} - wl$ in the second line. So, in this case, exogenous income is $(1 - \tau_b)\bar{z}$, as claimed. Now assume that $z^* - g^* > A$. Then, by a similar argument, one can write the budget constraint as

$$\begin{aligned} c + g = z - \tau_h(z - g - A) - \tau_b A \qquad & \Rightarrow c + (1 - \tau_h)g = z(1 - \tau_h) + (\tau_h - \tau_b)A \\ & \Rightarrow c + (1 - \tau_h)g + wl(1 - \tau_h) = (1 - \tau_h)\bar{z} + (\tau_h - \tau_b)A \end{aligned}$$

using $z = \bar{z} - wl$ in the second line. Again, in this case, exogenous income is $(1 - \tau_h)\bar{z} + (\tau_h - \tau_b)A$, as claimed.

B Regression Results Correcting for Selection Bias

A potential problem with the baseline results is that they do not allow for correlation in the error terms u_{it}, v_{it} in equations (5), (6). If there is correlation, then the key coefficients $\varepsilon_{INT}, \eta_{INT}$ in (5) could be biased when ignoring selection bias. In this Appendix, as a robustness check, we estimate (5) controlling for selection into giving, following the procedure proposed by (Wooldridge, 1995) specifically to correct for selection bias in panels, which is in three steps.

1. For each t separately, estimate the equation

$$Pr(D_{it} = 1 \,|Z_{i1}, ...Z_{iT}) = \Phi(\delta_{t0} + Z_{i1}\delta_{t1} + ...Z_{iT}\delta_{tT}) \tag{20}$$

where Z_{it} is a vector of variables that determines the decision to give. In our estimation, these are log of the first-pound price of giving, the log of real disposable income (setting donations to zero, as in the main regressions), and a dummy variable indicating whether the taxpayer used a tax advisor in preparing the tax return.

2. Construct the inverse Mills ratio variable

$$\lambda_{it}(\hat{\delta}_{t0} + Z_{i1}\hat{\delta}_{t1} + ...Z_{iT}\hat{\delta}_{tT}) = \frac{\phi(\hat{\delta}_{t0} + Z_{i1}\hat{\delta}_{t1} + ...Z_{iT}\hat{\delta}_{tT})}{\Phi(\hat{\delta}_{t0} + Z_{i1}\hat{\delta}_{t1} + ...Z_{iT}\hat{\delta}_{tT})} \tag{21}$$

3. Estimate the following equation by pooled OLS:

$$\ln D_{it} = \varepsilon \ln P_{it} + \eta \ln Y_{it} + \theta' X_{it} + \alpha_t + Z_{i1}\psi_1 + ...Z_{iT}\psi_T + \gamma_t \lambda_{it} + e_{it} \tag{22}$$

By construction, e_{it} has mean zero. Then, the estimates of ε, η, in equation (22) will be consistent.

We hypothesize that the tax advisor dummy will affect the decision to give but not how much to give, and so we exclude it from the X_{it} in equation (22). Thus, X_{it} comprises only the log of the first-pound price and income. The tax advisor dummy helps in the identification of the ψ_t coefficients.

We first report report the estimates of the coefficients δ_{ti} in the selection equation (21) in Table A.5. We consider two different specifications. The first is similar to the Wooldridge procedure, but treats the panel as a pooled times-series cross-section. That is, the Probit (20) is estimated on the entire sample. In this case, we impose $\delta_{ti} = \delta_i, i = 1, ..., T.$. The result of this are shown in column (1) of Table A.5. It is clear that both current and lagged values of the first-pound price and disposable income are important in determining D_{it}. The second estimates reported in the remaining columns of Table A.5 report the estimates of δ_{ti} when δ can vary with i. Again, is clear that both current and lagged values of the first-pound price and disposable income are important in determining D_{it}.

We now turn to steps 2 and 3. Clearly, the two ways of estimating the selection equation give us two different inverse Mills ratios, which we refer to as *pooled* and *annual* respectively. In turn, for each of these two, we can estimate (22) in two ways. First, we can impose the restriction that the coefficient on the inverse Mill ratio is not time-varying i.e $\gamma_t = \gamma$, and second, we can allow γ_t to be time-varying. We refer to these as the *one effect* and *diff effects* specifications respectively.

This gives us four possible specifications for (22). In A.6, we report the coefficient estimates $\varepsilon_{INT}, \eta_{INT}$ which are also the intensive-margin price and income elasticities for each of these four specifications. We see that these estimates are quite stable across the four specifications. Also, they are not too different from our preferred elasticity estimates from the first-difference specification reported in 4 above. Finally, we report an-F-test for the joint significance of the $\lambda_{it} + e_{it}$ in (22). These are always highly significant.

Appendix Tables

Table A.1: Intensive-Margin Elasticity (OLS specification)

	Dependent Variable: Log Donations ($\ln g_{it}$)					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Price of Giving	-0.618***	-0.035***	-0.005	-0.557***	0.004	0.025***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Log Disposable Income				0.263***	0.209***	0.199***
				(0.003)	(0.003)	(0.003)
Individual FE	y	y	y	y	y	y
Year FE	n	y	y	n	y	y
Other controls	n	n	y	n	n	y
Observations	2,093,152	2,093,152	2,082,867	2,093,152	2,093,152	2,082,867
R-squared	0.008	0.053	0.055	0.018	0.059	0.060
Unique IDs	472,481	472,481	468,812	472,481	472,481	468,812

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$\ln g_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \alpha_i + \alpha_t + \delta' X_{it} + u_{it}$$

where $\ln g_{it}$ denotes log donations; $\ln p_{it}$ denotes the log of the last-pound price of giving; $\ln y_{it}$ is the log of disposable income setting $g = 0$; X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t are individual and year fixed effects, respectively. Statistical significance: ***=1%, **=5%, *=10%.

Table A.2: Extensive-Margin Elasticity (OLS specification)

	Dependent Variable: Donor Dummy, $D_{it} \equiv (g_{it} > 0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Price of Giving	-0.204***	-0.032***	-0.021***	-0.186***	-0.025***	-0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log Disposable Income				0.048***	0.026***	0.020***
				(0.001)	(0.001)	(0.001)
Implied Price Elasticity, ε_{EXT}	-0.670***	-0.105***	-0.068***	-0.611***	-0.083***	-0.054***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Implied Income Elasticity, η_{EXT}				0.158***	0.086***	0.066***
				(0.002)	(0.002)	(0.002)
Individual FE	y	y	y	y	y	y
Year FE	n	y	y	n	y	y
Other controls	n	n	y	n	n	y
Observations	6,869,602	6,869,602	6,787,973	6,869,602	6,869,602	6,787,973
Unique IDs	1,341,324	1,341,324	1,310,284	1,341,324	1,341,324	1,310,284
R-squared	0.007	0.034	0.037	0.010	0.035	0.037

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$D_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \delta' X_{it} + \alpha_i + \alpha_t + u_{it}$$

where $D_{it} \equiv 1(g_{it} > 0)$ is a dummy variable that takes value one for positive donations and zero otherwise; $\ln p_{it}$ denotes the log of the last-pound price of giving; $\ln y_{it}$ is the log of disposable income setting $g = 0$; X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t are individual and year fixed effects, respectively. Since the dependent variable is binary, the coefficients on $\ln p_{it}$ and $\ln y_{it}$ represent semi-elasticities. To obtain the implied price and income elasticities, we divide by the proportion of donors and evaluate at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table A.3: Intensive-Margin Elasticity: Robustness Checks

	Dependent Variable: Log Donations ($\ln g_{it}$)							
	Excluding Intervals Around Kinks				*Adding Lead/Lags of Changes in p, y*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.226***	-0.177***	-0.175***	-0.139***	-0.309***	-0.228***	-0.278***	-0.222***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.019)	(0.020)	(0.019)	(0.020)
Log Disposable Income			0.210***	0.199***			0.284***	0.272***
			(0.003)	(0.003)			(0.006)	(0.006)
$\ln p_{it} - \ln p_{it-1}$					0.035***	0.014	0.044***	0.029***
					(0.011)	(0.011)	(0.011)	(0.011)
$\ln p_{it+1} - \ln p_{it}$					-0.055***	-0.032***	-0.031***	-0.015**
					(0.007)	(0.007)	(0.007)	(0.007)
$\ln y_{it} - \ln y_{it-1}$					0.001	0.005*	-0.098***	-0.091***
					(0.003)	(0.003)	(0.003)	(0.003)
$\ln y_{it+1} - \ln y_{it}$					-0.054***	-0.050***	0.050***	0.049***
					(0.003)	(0.003)	(0.003)	(0.003)
Individual FE	y	y	y	y	y	y	y	y
Year FE	y	y	y	y	y	y	y	y
Other controls	n	y	n	y	n	y	n	y
Observations	1,853,526	1,845,726	1,853,526	1,845,726	1,333,436	1,328,131	1,333,436	1,328,131
R-squared	0.053	0.055	0.059	0.060	0.043	0.044	0.049	0.050
Unique IDs	333,989	332,335	333,989	332,335	264,523	263,422	264,523	263,422

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$\ln g_{it} = \varepsilon \ln p_{it} + \eta \ln y_{it} + \delta' X_{it} + \alpha_i + \alpha_t + u_{it}$$

where $\ln g_{it}$ denotes log donations, $\ln p_{it}$ denotes the log price of giving, which is instrumented by the log first-pound price, $\ln p^f_{it}$; $\ln y_{it}$ is the log of net disposable income (setting $g_{it} = 0$); X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t are individual and year fixed effects, respectively. In columns (1-4), we exclude observations where the taxable income is within £2,000 of each kink point in the tax schedule, to avoid potential biases due to bunching behavior. In columns (5-8), we add leads and lags of changes in price and income to account for transitory effects and obtain elasticities with respect to permanent shocks. In those specifications, the coefficient on log price can be interpreted as the effect on long-run giving of a permanent change in the tax price that remains in place for at least three years. Statistical significance: ***=1%, **=5%, *=10%.

Table A.4: Extensive-Margin Elasticity: Robustness Checks

	Dependent Variable: Donor Dummy, $D_{it} \equiv (g_{it} > 0)$							
	Excluding Intervals Around Kinks				*Adding Lead/Lags of Changes in P, Y*			
	-0.250***	-0.032***	-0.039***	-0.027***	-0.092***	-0.066***	-0.085***	-0.063***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.003)	(0.003)	(0.003)
Log Disposable Income			0.026***	0.020***			0.032***	0.024***
			(0.000)	(0.000)			(0.001)	(0.001)
$\ln p_{it} - \ln p_{it-1}$					0.029***	0.021***	0.029***	0.022***
					(0.002)	(0.002)	(0.002)	(0.002)
$\ln p_{it+1} - \ln p_{it}$					-0.018***	-0.010***	-0.014***	-0.008***
					(0.001)	(0.001)	(0.001)	(0.001)
$\ln y_{it} - \ln y_{it-1}$					0.001*	0.002***	-0.010***	-0.007***
					(0.000)	(0.000)	(0.000)	(0.000)
$\ln y_{it+1} - \ln y_{it}$					-0.004***	-0.003***	0.007***	0.006***
					(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity (ε_{EXT})	-0.832***	-0.106***	-0.128***	-0.088***	-0.282***	-0.203***	-0.261***	-0.193***
	(0.004)	(0.005)	(0.005)	(0.005)	(0.008)	(0.008)	(0.008)	(0.008)
Implied Income Elasticity (η_{EXT})			0.086***	0.066***			0.097***	0.074***
			(0.001)	(0.001)			(0.002)	(0.002)
Individual FE	y	y	y	y	y	y	y	y
Year FE	y	y	y	y	y	y	y	y
Other controls	n	y	n	y	n	y	n	y
Observations	6,597,261	6,517,565	6,597,261	6,517,565	4,316,287	4,279,200	4,316,287	4,279,200
Unique IDs	1,346,697	1,315,294	1,346,697	1,315,294	849,926	841,752	849,926	841,752
R-squared	0.000387	0.0260	0.00628	0.0246	0.00313	0.0254	0.00356	0.0241

Note: standard errors in parentheses, clustered at the individual level. The estimated equation is

$$D_{it} = \varepsilon \ln p^f_{it} + \eta \ln y_{it} + \alpha_i + \alpha_t + \beta X_{it} + u_{it}$$

where $D_{it} \equiv 1(g_{it} > 0)$ is a dummy variable that takes value one for positive donations and zero otherwise$\ln p_{it}$ denotes the log price of giving, which is instrumented by the log first-pound price, $\ln p^f_{it}$; $\ln y_{it}$ is the log of net disposable income (setting $g_{it} = 0$); X_{it} is a vector of control variables including $(age/100)^2$, a female dummy and a tax advisor dummy; and α_i, α_t are individual and year fixed effects, respectively. The implied extensive-margin elasticities are evaluated at the sample mean of all covariates. In columns (1-4), we exclude observations where the taxable income is within £2,000 of each kink point in the tax schedule, to avoid potential biases due to bunching behavior. In columns (5-8), we add leads and lags of changes in price and income to account for transitory effects and obtain elasticities with respect to permanent shocks. In those specifications, the coefficient on log price can be interpreted as the effect on long-run donation behavior of a permanent change in the tax price that remains in place for at least three years. Statistical significance: ***=1%, **=5%, *=10%.

Table A.5: Two-Step Model: Selection Equation

VARIABLES	(1) Pooled Probit	(2) Probit 2005	(3) Probit 2006	(4) Probit 2007	(5) Probit 2008	(6) Probit 2009	(7) Probit 2010	(8) Probit 2011	(9) Probit 2012	(10) Probit 2013
lnpf_2005	-0.226***	-0.417***	-0.300***	-0.255***	-0.212***	-0.192***	-0.194***	-0.168***	-0.157***	-0.162***
	(0.009)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
lnpf_2006	-0.152***	-0.138***	-0.274***	-0.199***	-0.169***	-0.151***	-0.124***	-0.122***	-0.114***	-0.107***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
lnpf_2007	-0.107***	-0.085***	-0.106***	-0.241***	-0.144***	-0.123***	-0.092***	-0.067***	-0.072***	-0.056***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
lnpf_2008	-0.144***	-0.106***	-0.112***	-0.128***	-0.253***	-0.175***	-0.150***	-0.137***	-0.124***	-0.114***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
lnpf_2009	-0.318***	-0.254***	-0.242***	-0.263***	-0.283***	-0.424***	-0.365***	-0.353***	-0.330***	-0.331***
	(0.008)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
lnpf_2010	-0.335***	-0.272***	-0.287***	-0.279***	-0.279***	-0.308***	-0.458***	-0.388***	-0.375***	-0.358***
	(0.008)	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
lnpf_2011	0.046***	0.084***	0.093***	0.100***	0.077***	0.064***	0.056***	-0.063***	0.014*	0.033***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
lnpf_2012	-0.040***	0.005	0.008	0.005	-0.010	-0.010	-0.009	-0.037***	-0.166***	-0.094***
	(0.007)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
lnpf_2013	-0.176***	-0.145***	-0.142***	-0.137***	-0.149***	-0.144***	-0.151***	-0.149***	-0.184***	-0.337***
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
lnyd_2005	0.094***	0.193***	0.139***	0.115***	0.093***	0.081***	0.074***	0.072***	0.068***	0.062***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2006	0.042***	0.043***	0.088***	0.062***	0.046***	0.037***	0.034***	0.027***	0.028***	0.026***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2007	0.014***	-0.001	0.007***	0.044***	0.025***	0.015***	0.009***	0.011***	0.004*	0.004**
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2008	-0.003*	-0.022***	-0.020***	-0.009***	0.030***	0.005**	-0.002	-0.005**	-0.008***	-0.009***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2009	0.028***	0.015***	0.015***	0.016***	0.027***	0.065***	0.042***	0.028***	0.021***	0.015***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2010	-0.020***	-0.029***	-0.030***	-0.030***	-0.029***	-0.022***	0.015***	-0.011***	-0.021***	-0.025***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2011	0.044***	0.027***	0.029***	0.033***	0.032***	0.031***	0.045***	0.086***	0.061***	0.048***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2012	0.023***	0.011***	0.014***	0.011***	0.010***	0.012***	0.012***	0.023***	0.069***	0.041***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
lnyd_2013	0.063***	0.052***	0.048***	0.049***	0.047***	0.050***	0.051***	0.058***	0.075***	0.139***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
adv_2005	0.009	0.008	0.042***	0.044***	0.018**	0.008	0.010	-0.002	-0.010	-0.018**
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
adv_2006	-0.057***	-0.072***	-0.094***	-0.065***	-0.038***	-0.046***	-0.059***	-0.053***	-0.049***	-0.051***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
adv_2007	-0.017*	-0.015	-0.020*	-0.049***	-0.033***	-0.006	-0.012	-0.011	-0.011	-0.004
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
adv_2008	-0.072***	-0.060***	-0.069***	-0.071***	-0.138***	-0.091***	-0.051***	-0.056***	-0.058***	-0.053***
	(0.010)	(0.013)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
adv_2009	-0.027**	-0.024	-0.019	-0.024	-0.036**	-0.093***	-0.038***	-0.011	0.002	0.002
	(0.012)	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)	(0.014)	(0.014)	(0.014)
adv_2010	-0.054***	-0.036**	-0.044***	-0.037**	-0.040***	-0.044***	-0.118***	-0.063***	-0.049***	-0.052***
	(0.013)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
adv_2011	-0.033**	-0.020	-0.034**	-0.047***	-0.019	-0.022	-0.038**	-0.085***	-0.039**	0.006
	(0.013)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
adv_2012	-0.099***	-0.081***	-0.088***	-0.073***	-0.093***	-0.098***	-0.090***	-0.109***	-0.169***	-0.085***
	(0.013)	(0.017)	(0.016)	(0.016)	(0.016)	(0.016)	(0.015)	(0.015)	(0.015)	(0.016)
adv_2013	-0.189***	-0.179***	-0.157***	-0.168***	-0.165***	-0.163***	-0.168***	-0.182***	-0.195***	-0.326***
	(0.009)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Constant	-3.994***	-4.180***	-4.191***	-4.193***	-3.972***	-3.886***	-3.907***	-3.982***	-4.034***	-4.071***
	(0.015)	(0.018)	(0.018)	(0.018)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Observations	34,850,763	3,872,307	3,872,307	3,872,307	3,872,307	3,872,307	3,872,307	3,872,307	3,872,307	3,872,307

Note: standard errors clustered at the individual level. This table reports the results from the selection equation in the two-step selection model described in Appendix B. Column (1) reports the results for a pooled probit estimated on the entire period 2005-2013. Columns (2-10) report the results for annual probits conducted on the data for each individual year, from 2004/05 through 2012/13. Statistical significance: ***=1%, **=5%, *=10%.

Table A.6: Two-Step Model: Intensive-Margin Elasticities

Inverse Mills Ratio (IMR):	(1) Pooled One effect	(2) Pooled Diff effects	(3) Annual One effect	(4) Annual Diff effects
Price Elasticity of Giving	-0.201***	-0.213***	-0.229***	-0.260***
	(0.006)	(0.006)	(0.006)	(0.006)
Income Elasticity of Giving	0.145***	0.142***	0.160***	0.157***
	(0.002)	(0.002)	(0.002)	(0.002)
P-value on IMR terms	0.000	0.000	0.000	0.000
Observations	4,963,034	4,963,034	4,963,034	4,963,034
R-squared	0.101	0.101	0.100	0.101

Note: this table reports the results from the main equation of the two-step selection model described in Appendix B, using a balanced panel of taxpayers for the period 2004/05-2012/13. The regressions are estimated only on the subsample of donors (i.e., observations with $g_{it} > 0$, including the estimated inverse Mills ratios (IMR) as controls. Hence, the coefficients can be interpreted as intensive-margin elasticities of price and income. Column (1) includes the IMR obtained from the pooled probit regression. Column (2) includes the IMR obtained from the pooled probit regression, interacted with year dummies to allow the effect of selection to vary by year. Column (3) includes the IMRs obtained from the annual probit regressions, restricting the coefficient to be the same across years. Column (4) includes the IMRs obtained from the annual probit regressions, allowing the coefficients vary across years. The latter is our preferred specification, and it is the baseline model derived by Wooldridge (1995). Standard errors clustered at the individual level. Statistical significance: ***=1%, **=5%, *=10%.