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

Miguel Almunia
University of Warwick

Benjamin Lockwood
University of Warwick

Kimberley Scharf
University of Warwick

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Abstract

This paper estimates the tax-price elasticity of giving using UK administrative tax return data, exploiting variation from a large tax reform. We estimate both the intensive and extensive-margin elasticity, using a novel instrumental variables strategy. Then, we derive new conditions to evaluate the welfare consequences of changes in the generosity of the subsidy to donations. We find a small intensive-margin elasticity of -0.2 and a substantial extensive-margin elasticity of -0.8, yielding a total elasticity of about -1. These estimates mask considerable heterogeneity: high-income individuals respond more on the intensive margin, while the extensive-margin response is stronger among low-income taxpayers.

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*Contact: M.Almunia@warwick.ac.uk, B.Lockwood@warwick.ac.uk, K.Scharf@warwick.ac.uk (corresponding author). We thank Clément de Chaisemartin, Ivan Fernandez-Val, Bo Honoré, Roland Rathelot, 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. 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 £1.8 billion in 2015-16.

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 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 (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.[1]

In our empirical analysis, we use 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 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

[1]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).

£150,000, and also created a short bracket with a 60% rate above £100,000. Using these data, we first estimate the intensive-margin elasticity, focusing on the subsample of donors. Second, we estimate the extensive-margin elasticity on the entire sample. Finally, as a consistency check, we estimate the total elasticity directly using negative binomial and Poisson regression methods.

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 -0.2, and an extensive-margin price elasticity of -0.8, resulting in a total price elasticity of approximately -1. These results are robust to alternative estimation methods, as described below.

We also estimate the price and income elasticity of giving by income level, age groups and gender.[2] 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, we also find that extensive margin price and income 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 elasticity price response dominates the rise in the intensive margin one, with the sum of the two falling from -1.6 for the bottom 25 percent to -0.4 for the top 5 percent. These results make clear that focusing on the intensive margin only when estimating responses by income group may be misleading.

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.[4] Our results show

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[2] As regards age, the intensive-margin price elasticity is highest for those aged 40-65 (-0.22) and substantially smaller for those over 65 years (-0.11). The extensive margin price elasticities decline with age. So, overall, the total price elasticity is clearly declining with age. Finally, the gender differences are somewhat smaller; we find that the total price elasticity is somewhat greater for men than women, but the differences are small.

[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] Moreover, 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)

that taking into account the extensive margin, lower-income groups appear to be more responsive to tax subsidies than the rich, suggesting that this effect may not be large. However, note that high-income taxpayers still benefit disproportionately from the tax subsidies.

A second contribution of our paper is methodological. Following the existing 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 assess censoring via the use of the Poisson and negative binomial estimators, which can accommodate zeros in the dependent variable. Our study is also the 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 compatible with tax incentives being set optimally if the policymaker values the public goods provided by private donations less than government provision. Alternatively, the elasticity estimates we obtain can be taken as an indication that the incentives for charitable giving in the UK should, if anything, be extended rather than reduced.

This study relates to an extensive literature on charitable donations in general, and on the price elasticity of giving in particular.[5] Many of the existing studies that use variation in tax policies 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.[6] One reason for this 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 having a tax-based incentive for giving. As a result, most US taxpayers choosing itemized deductions donate to charity.[7] 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.[8] No study so far has examined 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.[9] 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.

[5] 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.

[6] 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 assess censoring via the use of the Poisson and negative binomial estimators, which can accommodate zeros in the data.

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

[8] 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 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.

[9] 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.

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.[10] 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, s/he 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 $\tau_b/(1-\tau_b)$.

In addition to the match component, higher-rate taxpayers can claim a deduction equal to the (gross) amount donated times 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 $1-\tau_h$.[11]

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

[10] 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.

[11] If the taxpayer donates one pound, s/he 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

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

same price as in a system where donations are fully deductible.[12]

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.[13] The highest marginal rate before this reform was 40%. 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. [14] 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 applying have suffered minor modifications over time.[15] 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. [16] 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, as explained below in Section 2.4.

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

[12] 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).

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

[14] 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.

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

[16] 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.

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.[17] 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 is 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 at source by employers, and individual taxpayers do not need to file a tax return.[18] 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.[19] While the fiscal cost of Gift Aid is substantial, approximately £1.78 billion in 2015/16,[20] the fiscal cost of Payroll Giving is quite modest: only £0.04bn.[21]

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

[18] Employers estimate each individual's end-of-year tax liability of each individual employee 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.

[19] 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.

[20] 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.

[21] 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,

Figure 2 shows the share of SA taxpayers reporting positive donations by pre-tax income (top panel) and age (bottom panel). In both cases, we show the donor shares separately for men and women. Taxpayers with gross income below £45,000 (with some variation across years) are in the basic rate bracket, so their reported donations do not lead to any additional tax relief. Beyond that point, the proportion of donors increases with income up to £100,000, and then it levels off at around 30%. At each level of income, women are about five percentage points more likely to give than men. The share of donors also increases with age (bottom panel), being highest for retirees. Women are more likely than men to donate from ages 25 to about 60, while men above 70 feature a much higher probability of giving. Note that the sample of older taxpayers is strongly selected towards high-income (and potentially high-wealth) individuals, which explains the high proportion of donors in that subsample.

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.[22]

We can analyze the broad patterns in the data by looking at the graphical diff-in-diff evidence around the 2010 tax reform. To do this, we define four groups of taxpayers, according to their adjusted net income in the year before 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.

Figure 4 plots the evolution of average donations over time for these four groups. The top panel includes all taxpayers, and the bottom panel only donors. Donations are in real terms and we normalize the outcome 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.[23] The key finding is

and they are more likely to be male (66% vs. 53%), although there is virtually no difference in the average age (49 years).

[22] 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.

[23] In these graphs, we exclude outliers, defined as those with annual donations larger than £1 million (850 observations in the entire sample period, about 100 per year). The reason to exclude these extreme observations is that they tend to obscure the overall trends. In the regression analysis, we always include all observations, but outliers do not have a strong influence on the results as we mostly use log-log

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 *total* price 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 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 $\varepsilon_{INT} \approx -1.2$.

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.[24]

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.

In the rest of the paper, we denote the individual's tax liability at any taxable income x by $T(x)$. Then, given full deductibility of charitable donations, the tax liability for

specifications. They could have an impact on the Poisson regressions because the dependent variable is in levels, but we check this and the differences are negligible.

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

individual i at time period t is $T(z_{it} - g_{it})$, where z_{it} is taxable income. Taking the difference in individual i's tax liability at time t and dividing by Δg then obtains that individual's period t tax-price of giving relative to after-tax consumption, p_{it}, that is:

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

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 $u(c, g, l)$.[25] We assume that $u(\cdot)$ has the usual properties, i.e. strictly increasing in all variables 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

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

Then, the problem faced by the individual is to choose $c, g \geq 0$ and $l \in [0, \bar{l}]$ to maximize utility $u(c, g, l)$ subject to (2) and $z = w(\bar{l} - l)$. To make the argument as

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

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[26]–the optimal donation choice can be written as $g^* = g(p, y)$, where 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[27]:

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

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 it optimizes.*[28] 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 of 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

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

[27]This is proved in the Appendix.

[28]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 $\tau_1 A + \tau_2(\bar{z} - A)$.

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 observed, giving:

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

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.[29] 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. We describe later in this section 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:

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

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.[30] In (6), our main focus is the extensive margin price and income elasticities,

[29] 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.

[30] As an alternative, the elasticities ε_{EXT}, η_{EXT} could be estimated from a Probit model. However,

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).

Endogeneity of the Tax Price and Disposable Income

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. We address the potential endogeneity of price and income in several steps.

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

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

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.

It is usually argued in the charitable donations literature that the first-pound tax-price of giving also fulfills the exclusion restriction because it has no impact on giving other than through its correlation with the last-pound price. However, this assumption is likely to be violated in our setting, because, as is clear from (4), p^f_{it} itself depends on earned income z_{it}, which is also likely to change with the tax reform.

So, in order to obtain unbiased estimates of the tax-price elasticity of giving, we implement an 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

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.

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 log change in 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 log change in the 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.[31] 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.[32] 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 ($k = 3$).[33]

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 $k = 1$,

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

[32] 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.

[33] 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.

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.[34]

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 below potential violations of this assumption.[35] Notice, finally, that we do not implement a similar estimation strategy for the extensive margin estimation because the differenced specification would not be a sensible specification with a binary dependent variable.

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 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. The estimated equation in this case is:

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

[34] Weber (2014) discusses this issue in the context of the taxable income elasticity literature. She finds that the one-lag instrument is generally endogenous, but using higher lags (2nd, 3rd and 4th in her study) fulfils the exclusion restriction.

[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.

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–as specified in expression (5)–is that it allows 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. we discuss the results of these regressions in Section 4.7, we describe the procedure in more detail in the Appendix, and we report the results in Tables A.1 and A.2.

We address two more potential issues, related to dynamic effects 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 main 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 as a robustness check. 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 with the benchmark case of estimating equation (5) by OLS, not using any instruments for p_{it} and taking net disposable income y_{it} as exogenous. Table 2 reports the results of eight different specifications. The first four specifications include only $\ln p_{it}$ as a regressor, and the last four specifications also include $\ln y_{it}$. In each set of four specifications, we start with the most basic reduced form and build upwards to understand the effects of each different set of controls. Specification (1) includes only individual fixed effects, (2) adds in year fixed effects to (1), (3) adds other controls to (1), and finally specification (4) allows for individual fixed effects, year effects, and controls. In all specifications, we cluster standard errors at the individual level. Looking across all of the first four specifications, we see that ε_{INT} is negative, fairly stable in the range $(-0.29, -0.24)$, and highly significant.

In specifications (5)-(8), where we add $\ln y_{it}$, the estimate of ε_{INT} is less stable; it changes sign (becomes positive) and in column (6) it is insignificant. Recall that we expect the OLS estimate of ε_{INT} to be biased upwards because a donation can move the individual into a lower tax bracket and thus generate a higher price of charitable giving, mechanically resulting in a positive correlation between g_{it} and p_{it}.

The instrumental variables (IV) results are reported in Table 3, where we estimate equation (5) using p^f_{it} as an instrument for p_{it}. Specifications (1)-(8) follow the same structure as Table 2. If we consider the first four specifications, we see that the IV estimates of ε_{INT} are larger in absolute value than in the OLS case (as expected), around -0.6. In columns (5)-(8), where we control for net disposable income, the estimates of ε_{INT} are also larger in absolute value than in the OLS case. The point estimate is stable across the different combinations of year effects and controls, in the range $(-0.38, -0.33)$, and highly significant. Finally, our estimate of η_{INT} is generally stable and significant at about 0.12.

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. In Table

4, we report the OLS estimates, where we do not instrument p_{it} by p^f_{it}. Specifications (1)-(8) follow the same progression as Tables 2 and 3. We report both the coefficients β, γ in (6) and the associated elasticities ε_{EXT}, η_{EXT} in (7), evaluated at the mean value of all the explanatory variables. Looking at specifications (1)-(4) first, we see that except for specification (1), the estimate of ε_{EXT} is quite stable at around -0.71. When we add a control for net disposable income in specifications (5)-(8), the estimate of ε_{EXT} changes to about -0.52, while the estimate of η_{EXT} is approximately 0.06 (all highly significant).

In Table 5, we report the results of estimating (6) instrumenting p_{it} by p^f_{it}. In columns (2)-(4), the estimate of ε_{EXT} is about -0.92, and it goes down to approximately -0.79 when we also control for net disposable income in columns (6)-(8). Note that this is more negative than the corresponding OLS estimate of -0.52. Again, this is expected given the upward bias associated with the OLS estimator. Finally, the estimate of η_{INT} is quite stable at about 0.036, and highly significant.

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. Table 6 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 eight different specifications. Columns (1)-(4) report OLS estimates, where we include the log change in the first-pound price of giving, $\ln(p^f_{it}/p^f_{i,t-k})$, without instrumenting. In columns (1)-(2), we do not control for the log change in net disposable income, $\ln(y_{it}/y_{i,t-k})$, while in columns (3)-(4) we do. Meanwhile, in columns (1) and (3) we do not include any additional controls, but in (2) and (4) we control for age, age divided by 100 and squared, a female dummy and a dummy for using a tax advisor. The same structure applies to columns (5)-(8), where we report the IV estimates in which we construct an instrument for the change in price using the lagged value of taxable income, as explained in Section 3.2.

The top panel of Table 6 shows the results for $k = 1$. The OLS estimate of the intensive-margin price elasticity in column (1) is -0.29, and the additional controls barely affect the point estimate. When we control for the log change in income in columns (3) and (4), the estimated price elasticity ε_{INT} becomes -0.17 and still highly significant. The income elasticity is 0.08. In the IV specifications, the price elasticity is more stable at about -0.14 when not controling for income (columns 5-6), and about -0.18 when we do control for income (columns 7-8).

The middle and bottom panels of Table 6 report the results for the cases with two and three lags ($k = 2, 3$), respectively. The OLS estimates of the price elasticity are a little larger in absolute value: -0.22 for $k = 2$ and -0.29 for $k = 3$, in the specifications controling for income changes and other controls (columns 3-4). Looking at the IV estimates in columns (5)-(8), we observe a similar pattern. The price elasticity becomes larger in absolute value with the length of the lag. Focusing on the estimates from column 8, we find $\varepsilon_{INT} = -0.21$ when $k = 2$ and $\varepsilon_{INT} = -0.36$ when $k = 3$. In both cases, the income elasticity is stable around $\eta_{INT} = 0.11$.

The finding of larger price elasticity estimates for the longer lags, even if the difference is not too large, goes against the standard intuition (e.g., Randolph, 1995) that the long-term elasticity should be smaller than the short-term one, since the latter is supposedly more affected by re-timing and shifting behaviours.[37] We explore this issue further in the robustness checks performed in Section 4.7

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 regression methods to obtain estimates of the total elasticity directly.

We use these Poisson results as a robustness check on our main results. 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 Poisson pseudo-maximum likelihood method (Gourieroux, Monfort and Trognon, 1984; Cameron and Trivedi, 2005), 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.[38] Note finally that the Poisson estimator leads to some loss of data, as observations that are always zero, conditional on the cross-section index i, do not contribute to the maximum likelihood formula (Cameron and Trivedi, 2005). In our case, this means that all observations of taxpayers that do not report positive donations in any year are dropped, reducing the sample size to 13.5 million observations from 1.9 million unique taxpayers.

The results are shown in Table 7. The structure of the table is similar to previous ones to facilitate comparison. Specifications (1)-(4) report regressions where the last-

[37] One caveat is that the sample size is reduced as we include more lags, because fewer periods with data are available and also due to individual attrition over time.

[38] Indeed, donations in our data appear not to be Poisson distributed, as the variance of donations is much larger than the mean; for the Poisson, these two are equal. However, we estimate robust standard errors, so our inference should be unaffected by this.

pound price $\ln p_{it}$ is included (comparable to the OLS specifications), and regressions (5)-(8) use the first-pound price $\ln p_{it}^{f}$ directly (comparable to the IV specifications). For the last-pound price, the total elasticity estimates are positive, indicating that the endogeneity problem due to the correlation between $\ln p_{it}$ and g_{it} is particularly acute in this specification. For the first-pound price estimates, the overall price elasticity ε has the expected negative sign, and it falls in size as more regressors are added. For our preferred specification in column (8), the total price elasticity ε is -0.95. Also, the income elasticity η is quite high at 0.56. Both estimates are highly significant.

The results for the negative binomial regressions are shown in Table 8. Again, specifications (1)-(4) report regressions where the last pound price $\ln p_{it}$ is included, and regressions (5)-(8) use the first-pound price $\ln p_{it}^{f}$ directly. The total price elasticity is now negative in columns (1)-(4), with point estimates in the range $(-1.53, -1.32)$ when not controling for income, and $(-0.61, -0.53)$ when we add in $\ln y_{it}$. In regressions (5)-(8), the estimated price elasticities are larger in absolute value, replicating the differences between OLS and IV estimates from the baseline regressions. For the preferred specification in column (8), which includes year fixed effects and additional controls, the total price elasticity ε is -1.16. The total income elasticity η is somewhat lower than in the Poisson case (0.17), and more in line with the elasticities obtained with the baseline and differenced specifications.

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

To construct 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. 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.[39] For age, we construct only three groups: taxpayers younger than 40, between 40 and 65, and older than 65.

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

Table 9 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 the intensive-margin price elasticity tends to increase as incomes rise. 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. Intensive margin income elasticities also rise, but the dependence on income is less marked.

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 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 9 that when the intensive and extensive price elasticities are added together, the overall price elasticity is declining across income groups.

As a robustness check, we also investigate the total price and income elasticities by income group using the Poisson and Negative Binomial approaches. Table 10 shows that for our preferred Negative Binomial specification, the overall price elasticity of donations clearly falls across income groups, consistently with our baseline estimates. On the other hand, the overall income elasticity of giving shows no clear pattern across income groups.

We now turn to discuss Table 11, which shows the variation of the elasticities by gender and age. Looking first at gender, we see that the intensive-margin price elasticity is somewhat larger for men (-0.19) than for women (-0.14), while the income elasticity is almost the same. The extensive-margin price and income elasticities on the other hand, seem slightly higher for women than men. As regards age, the intensive-margin price elasticity is highest for those aged 40-65 (-0.22) and substantially smaller for those over 65 years (-0.11). 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 clearly declining with age.

As a robustness check, we also investigate the total price and income elasticities by gender and age using the Poisson and Negative Binomial approaches. Table 12 shows that for our both the Negative Binomial and Poisson specifications, the overall price elasticity of elasticity of donations is lower for women than for men, and clearly falls across age groups, consistently with the baseline results.

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 and Negative Binomial methods in Tables 7 and 8 can be compared to the sum of the IV estimates of ε_{INT} from Tables 3 and 6, and the IV estimates of ε_{EXT} from Table 5. Given that using $\ln p_{it}$ leads to bias, we compare those estimates to the Poisson and Negative Binomial specifications where we use lnp^f_{it} directly. Specification (8) from Tables 3 and 5 gives $\varepsilon_{INT} = -0.35$, $\varepsilon_{EXT} = -0.79$, giving a total $\varepsilon_{INT} + \varepsilon_{EXT} = -1.14$. This is very close to the negative binomial estimate of $\varepsilon = -1.16$. Focusing now on the income elasticity, specification (8) from Tables 3 and 5 gives $\eta_{INT} = 0.12$, $\eta_{EXT} = 0.04$, giving a total $\eta_{INT} + \eta_{EXT} = 0.16$. This again compares well with the negative binomial estimate of $\eta = 0.17$.

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 smaller (in absolute value) intensive-margin price elasticity (-0.20) than the -0.35 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).

Third, we can ask whether allowing for heterogeneous price and income responses by income makes a difference. One way to do this is to note that for the purposes of designing the optimal subsidy to charitable giving, a sufficient statistic is the weighted average of the total price elasticity across income groups, where the weights are the shares on total donations of the different groups.[40]

We first construct the weighted average of the total price elasticity across income groups using the intensive and extensive margin estimates from Table 9. In particular, we

[40] To see this, note that with n income groups $i = 1, ..., n$, total donations $g = \sum_{i=1}^{n} g_i$. Differentiating both sides of this expression with respect to p, the price of giving, and re-arranging, we see that the overall price elasticity of giving is $\varepsilon = \sum_i s_i \varepsilon_i$, where $s_i = \frac{g_i}{\sum_i g_i}$ is the share of group i in total giving, and ε_i is the price elasticity of donations for group i. A similar calculation can be done for the income elasticity.

choose the first-difference with the first-pound price as the intensive margin specification. This results in a total weighted price elasticity of -0.42. We can compare this to the unweighted total price elasticity, i.e. the extensive margin estimate -0.79 from column (8) of Table 5 plus the intensive margin estimate -0.18 from column (8) of Table 6, giving a total of -0.97. We can perform a similar comparison for the Poisson and Negative Binomial specifications. When we construct the weighted average of the total price elasticity across income groups, we get -0.79 with the Poisson estimation, and -0.89 with the Negative Binomial estimation. The unweighted estimates were -0.95 with the Poisson estimation (col. 8, Table 7) and -1.16 with the Negative Binomial estimation (col. 8, Table 8). In all cases, we find that allowing for heterogeneous responses by different income groups tends to decrease the policy-relevant aggregate elasticity.

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 random-effects Probit and adding the Mills ratio as an additional regressor in (5). We report the results of the intensive-margin regression in Table A.2 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 ±£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:

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

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_{it}^f 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 3 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 5 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 3). 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 adaptation of the model of 3.1 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 possibility 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 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

$$dW = -\bar{g}dp + (\alpha V' - (1-\gamma)p)\,\bar{g}_p dp + V'dG \tag{17}$$

$$= \left(V' - 1 - V'\frac{\alpha + p - 1}{p}\varepsilon + (1-\gamma)\varepsilon\right)\bar{g}dp \tag{18}$$

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.

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

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 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 empirical analysis, $\varepsilon_{INT} + \varepsilon_{EXT}$ has been estimated at around -1. 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 the social planner discounts the mix of collective goods that are funded with private donations relative to the "socially preferred" mix (that is, if $\alpha < 1$). And this conclusion remains valid whether or not we think that the planner attaches an intrinsic social value to the act of giving, as reflected in a positive weight, γ, on warm-glow utility in social welfare. On the other hand, if it actually were the case that $\alpha = 1$, then the policy conclusion we should draw from an estimate of $\varepsilon_{INT} + \varepsilon_{EXT}$ in excess of unity is that the subsidy must have been set at a sub-optimal level, and therefore there is scope for increasing it on social welfare grounds.

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 -0.2, and an extensive-margin price elasticity of -0.8, resulting in a total price elasticity of approximately -1. 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 elasticity estimates can only be rationalized as compatible with tax incentives being set optimally if the policymaker values the public goods provided by private donations less than government provision. Alternatively, the elasticity estimates we obtain can be taken as an indication that the incentives for charitable giving in the UK should, if anything, be extended rather than reduced.

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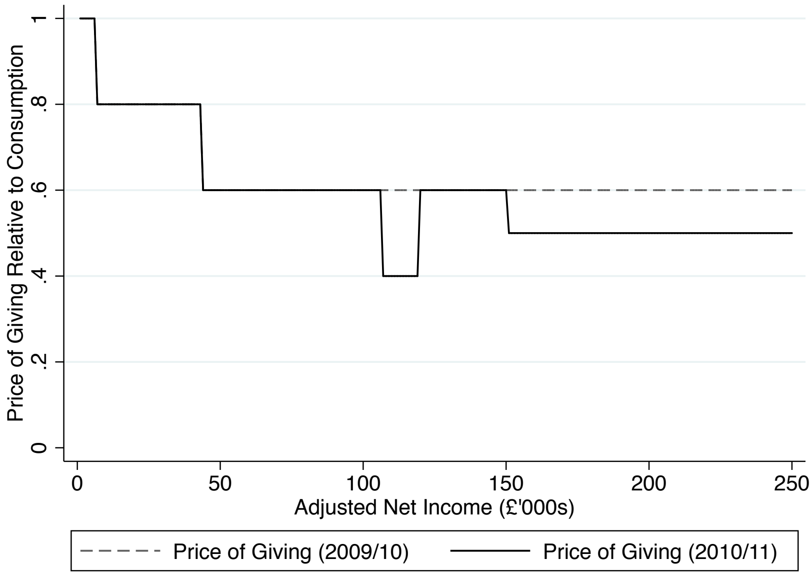
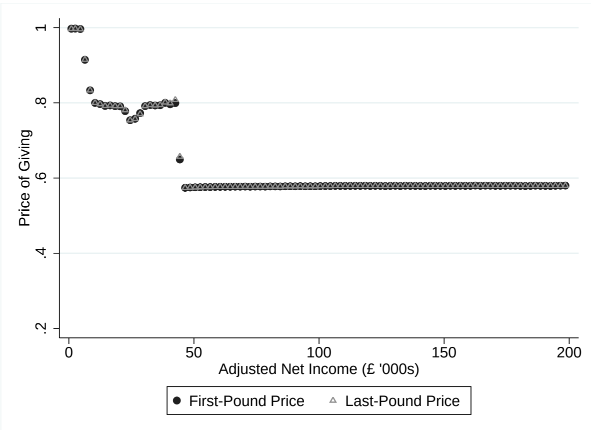
Figures

Figure 1: Price of Giving by Income Level

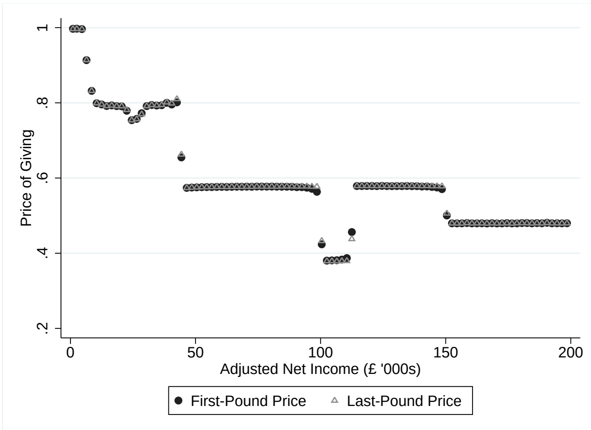
(a) Statutory Tax Price of Giving, Before and After 2010 Reform



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

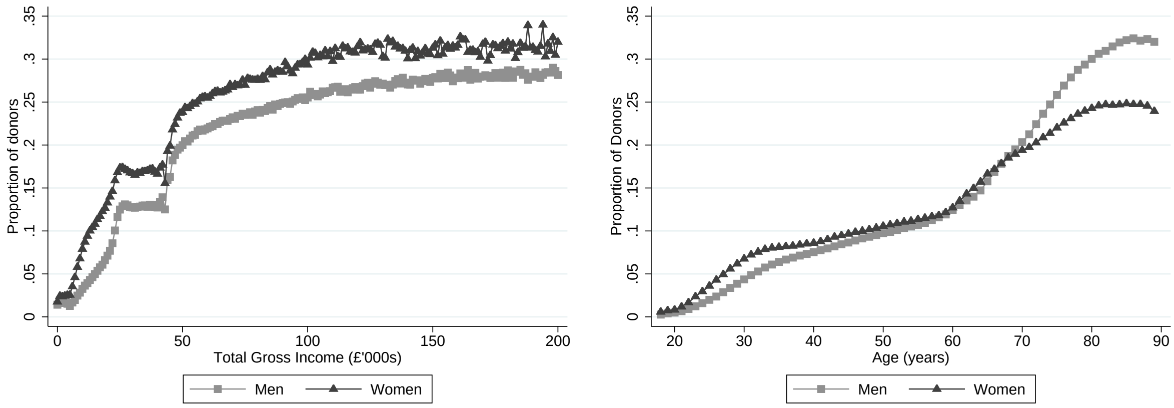


(c) Measured Price of Giving (2010/11)



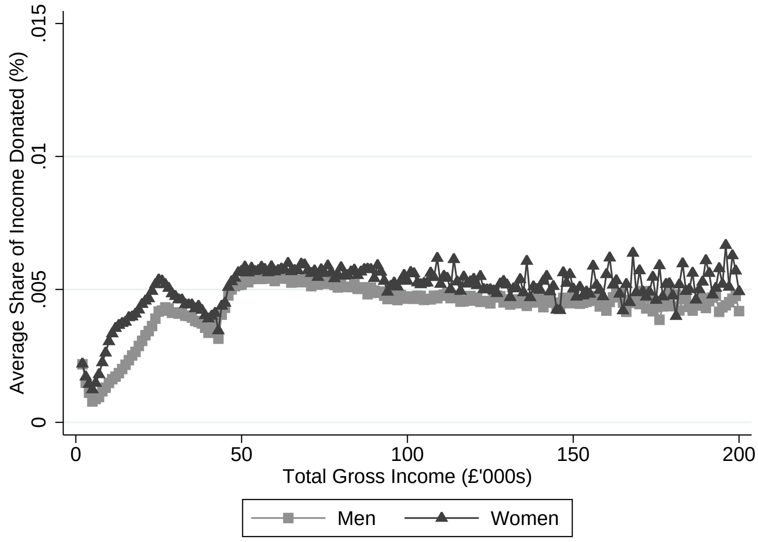
Notes: the top panel (a) plots the statutory price of giving in the fiscal years 2009/10 and 2010/11, i.e. before and after the April 2010 tax reform. The picture shows that there are two groups of taxpayers affected by the reform: those with adjusted net income (z) between £100,000 and 112,950, and 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, Age and Gender



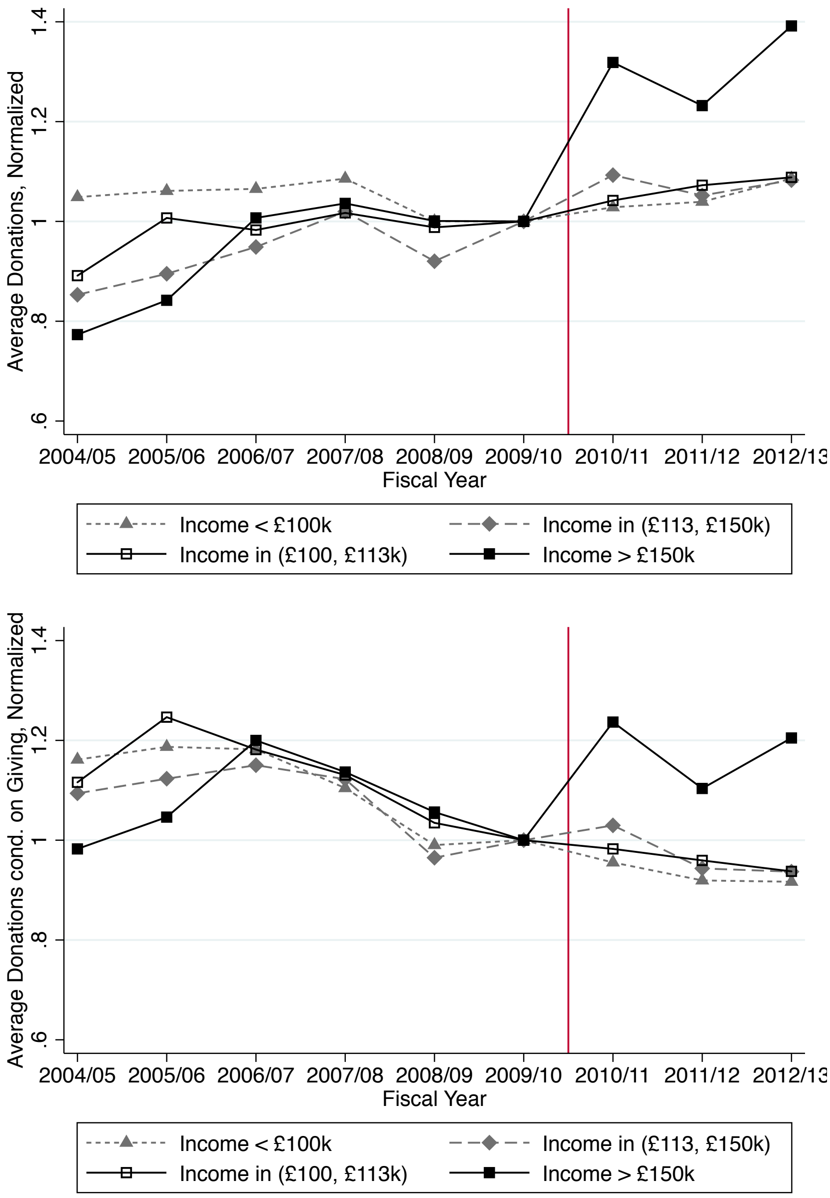
Notes: the left panel plots the proportion of taxpayers reporting positive donations (donors), against total gross income in bins of £1,000. Solid triangles represent the averages for women and light-grey squares represent the averages for men. Taxpayers with gross income below £45,000 are generally in the basic rate bracket, so they do not get any additional tax relief by reporting their donations on the self-assessment form. The right panel shows the proportion of donors by age, in one-year bins. Women are more likely than men to donate from age 25 to about 60, while men above 70 years feature a much higher probability of giving. Note that the sample of older taxpayers is strongly selected towards high-income (and potentially high-wealth) taxpayers, explaining the very high proportion of donors in that subsample.

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**
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

Notes: this table reports summary statistics for the complete dataset of self-assessment income tax returns for the fiscal years between 2004/05 and 2012/13 (nine years). 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. The ratio in the number of observations in the second and first rows indicates that 10.97% of the taxpayer-year observations include a positive amount of donations. **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 (i) net income, minus (ii) the grossed-up amount of Gift Aid donations and pension contributions, plus (iii) 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). The official definition of this concept from HMRC can be found at www.gov.uk/guidance/adjusted-net-income. **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 (OLS), Baseline Specification

	Dependent Variable: Log Donations ($\ln g_{it}$)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.247***	-0.278***	-0.292***	-0.267***	0.055***	0.003	-0.016***	0.016***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Log Disposable Income					0.169***	0.156***	0.154***	0.157***
					(0.001)	(0.001)	(0.001)	(0.001)
Individual FE	y	y	y	y	y	y	y	y
Year FE	n	y	n	y	n	y	n	y
Other controls	n	n	y	y	n	n	y	y
Observations	8,275,307	8,275,307	8,240,273	8,240,273	8,275,307	8,275,307	8,240,273	8,240,273
R-squared	0.002	0.034	0.030	0.034	0.012	0.043	0.039	0.043
Unique IDs	2,095,064	2,095,064	2,082,159	2,082,159	2,095,064	2,095,064	2,082,159	2,082,159

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 3: Intensive-Margin Elasticity (IV), Baseline Specification

	Dependent Variable: Log Donations ($\ln g_{it}$)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.583***	-0.593***	-0.611***	-0.583***	-0.328***	-0.359***	-0.383***	-0.345***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Log Disposable Income					0.130***	0.118***	0.116***	0.119***
					(0.001)	(0.001)	(0.001)	(0.001)
Individual FE	y	y	y	y	y	y	y	y
Year FE	n	y	n	y	n	y	n	y
Other controls	n	n	y	y	n	n	y	y
Observations	7,652,940	7,652,940	7,624,586	7,624,586	7,652,940	7,652,940	7,624,586	7,624,586
R-squared	-0.001	0.031	0.027	0.032	0.009	0.040	0.036	0.041
Unique IDs	1,472,697	1,472,697	1,466,472	1,466,472	1,472,697	1,472,697	1,466,472	1,466,472

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 $\ln p^f_{it}$; $\ln y_{it}$ 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 4: Extensive-Margin Elasticity (OLS)

	Dependent Variable: Donor Dummy, $D_{it} \equiv (g_{it} > 0)$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.061***	-0.081***	-0.082***	-0.081***	-0.030***	-0.059***	-0.059***	-0.060***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log Disposable Income					0.010***	0.006***	0.007***	0.007***
					(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity, ε_{EXT}	-0.541***	-0.715***	-0.715***	-0.709***	-0.267***	-0.527***	-0.518***	-0.521***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Implied Income Elasticity, η_{EXT}					0.085***	0.057***	0.060***	0.057***
					(0.000)	(0.000)	(0.000)	(0.000)
Individual FE	y	y	y	y	y	y	y	y
Year FE	n	y	n	y	n	y	n	y
Other controls	n	n	y	y	n	n	y	y
Observations	73,319,687	73,319,687	71,850,001	71,850,001	73,319,687	73,319,687	71,850,001	71,850,001
Unique IDs	14,149,861	14,149,861	13,700,463	13,700,463	14,149,861	14,149,861	13,700,463	13,700,463
R-squared	0.0490	0.0364	0.0478	0.00651	0.0548	0.0408	0.0500	0.00979

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 5: Extensive-Margin Elasticity (IV)

	Dependent Variable: Donor Dummy, $D_{it} \equiv (g_{it} > 0)$							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.084***	-0.104***	-0.105***	-0.105***	-0.060***	-0.090***	-0.090***	-0.091***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log Disposable Income					0.007***	0.004***	0.005***	0.004***
					(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity, ε_{EXT}	-0.745***	-0.922***	-0.920***	-0.915***	-0.533***	-0.801***	-0.789***	-0.794***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Implied Income Elasticity, η_{EXT}					0.065***	0.036***	0.039***	0.036***
					(0.000)	(0.000)	(0.000)	(0.000)
Individual FE	y	y	y	y	y	y	y	y
Year FE	n	y	n	y	n	y	n	y
Other controls	n	n	y	y	n	n	y	y
Observations	73,319,687	73,319,687	71,850,001	71,850,001	73,319,687	73,319,687	71,850,001	71,850,001
Unique IDs	14,149,861	14,149,861	13,700,463	13,700,463	14,149,861	14,149,861	13,700,463	13,700,463
R-squared	0.049	0.036	0.048	0.006	0.055	0.041	0.050	0.010

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 $\ln p^f_{it}$, and the rest of variables are defined as in Table 4 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table 6: Intensive-Margin Elasticity: Regressions in Differences

	Dependent Variable: Log change in Donations ($\ln(g_{it}/g_{i,t-k})$)							
	OLS estimates				*IV estimates*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
First Difference ($k=1$)								
Log change in First-Pound Price	-0.289***	-0.288***	-0.173***	-0.171***	-0.149***	-0.139***	-0.188***	-0.176***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.010)	(0.010)	(0.009)	(0.009)
Log change in Disposable Income			0.082***	0.082***			0.080***	0.081***
			(0.001)	(0.001)			(0.001)	(0.001)
Observations	5,216,321	5,198,174	5,204,515	5,186,411	5,216,321	5,198,174	5,204,515	5,186,411
R-squared R-squared	0.003	0.004	0.006	0.006	0.002	0.003	0.006	0.006
Second Difference ($k=2$)								
Log change in First-Pound Price	-0.396***	-0.393***	-0.226***	-0.221***	-0.150***	-0.132***	-0.232***	-0.213***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.011)	(0.011)	(0.010)	(0.010)
Log change in Disposable Income			0.110***	0.110***			0.109***	0.111***
			(0.001)	(0.001)			(0.002)	(0.002)
Observations	3,463,375	3,451,745	3,456,133	3,444,530	3,463,375	3,451,745	3,456,133	3,444,530
R-squared	0.006	0.007	0.010	0.012	0.003	0.004	0.010	0.012
Third Difference ($k=3$)								
Log change in First-Pound Price	-0.481***	-0.476***	-0.297***	-0.287***	-0.205***	-0.176***	-0.378***	-0.355***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.015)	(0.016)	(0.013)	(0.013)
Log change in Disposable Income			0.123***	0.124***			0.114***	0.116***
			(0.002)	(0.002)			(0.002)	(0.002)
Observations	1,955,897	1,949,354	1,951,991	1,945,460	1,955,897	1,949,354	1,951,991	1,945,460
R-squared	0.008	0.010	0.014	0.016	0.006	0.007	0.014	0.016
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

Notes: standard errors in parentheses, clustered at the individual level. The estimated 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 $k = 1,2,3$ 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; $\Delta \ln p^f_{it} \equiv \ln\left(p^f_{it}(z_{it})/p^f_{it-k}(z_{it-k})\right)$ 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 $\ln\left(p^f_{it}(z_{it-k})/p^f_{it-k}(z_{it-k})\right)$ as described in Section 3.2. Statistical significance: ***=1%, **=5%, *=10%.

Table 7: Total Elasticity: Poisson Regressions

	Dependent Variable: Donations in Levels (g_{it}) *Endogenous Price of Giving (Last-Pound)*				*Exogenous Price of Giving (First-Pound)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Last-Pound Price	0.662***	0.735***	1.204***	1.275***				
	(0.166)	(0.167)	(0.144)	(0.141)				
Log First-Pound Price					-1.670***	-1.603***	-1.018***	-0.947***
					(0.088)	(0.088)	(0.090)	(0.091)
Log Disposable Income			0.636***	0.632***			0.564***	0.561***
			(0.033)	(0.032)			(0.063)	(0.036)
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	13,645,910	13,585,847	13,645,910	13,585,847	13,645,910	13,585,847	13,645,910	13,585,847
Unique IDs	1,963,164	1,953,903	1,963,164	1,953,903	1,963,164	1,953,903	1,963,164	1,953,903

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 8: Total Elasticity: Negative Binomial Regressions

	Dependent Variable: Donations in Levels (g_{it}) *Endogenous Price (last-pound)*				*Exogenous Price (first-pound)*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Last-pound Price	-1.316***	-1.530***	-0.533***	-0.606***				
	(0.005)	(0.004)	(0.006)	(0.007)				
Log First-pound Price					-1.573***	-1.798***	-1.080***	-1.161***
					(0.004)	(0.005)	(0.006)	(0.006)
Log Disposable Income			0.189***	0.239***			0.121***	0.167***
			(0.001)	(0.001)			(0.001)	(0.001)
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	13,645,910	13,585,847	13,645,910	13,585,847	13,645,910	13,585,847	13,645,910	13,585,847
Unique IDs	1,963,164	1,953,903	1,963,164	1,953,903	1,963,164	1,953,903	1,963,164	1,953,903

Note: bootstrapped 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 9: 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)
Log change in First-Pound Price	0.089	-0.048	-0.055**	-0.098***	-0.220***
	(0.065)	(0.043)	(0.025)	(0.013)	(0.028)
Log change in 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 6. 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 4 and 5 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table 10: Total Elasticities by Income Range: Poisson and Negative Binomial

	Dependent Variable: Log Donations ($\ln g_{it}$)				
	$p0-p25$	$p25-p50$	$p50-p75$	$p75-p95$	$p95-p100$
Negative Binomial	(1)	(2)	(3)	(4)	(5)
Log Price of Giving	-1.852***	-1.624***	-0.719***	-0.736***	-0.745***
	(0.027)	(0.022)	(0.013)	(0.009)	(0.011)
Log Disposable Income	0.085***	0.243***	0.295***	0.252***	0.076***
	(0.003)	(0.004)	(0.003)	(0.002)	(0.003)
Poisson					
Log Price of Giving	-2.216***	-1.120***	-0.514***	-0.413***	-1.208***
	(0.099)	(0.053)	(0.042)	(0.024)	(0.173)
Log Disposable Income	0.164***	0.413***	0.437***	0.531***	0.582***
	(0.016)	(0.018)	(0.023)	(0.016)	(0.044)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	754,910	1,970,915	3,847,126	4,932,990	2,079,906
Unique IDs	125,025	296,276	561,094	695,029	276,479

Notes: this table estimates total elasticities using the Negative Binomial and Poisson specifications. 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 the variables are defined as in the notes to Tables 7 and 8. The income groups are defined as in the note to Table 9. The average pre-tax incomes at the relevant percentiles are $p25$ =£8,389, $p50$ =£17,126, $p75$ =£33,747, and $p95$ = £96,163. Statistical significance: ***=1%, **=5%, *=10%.

Table 11: 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)
Log change in First-Pound Price	-0.192***	-0.140***	-0.204***	-0.226***	-0.118***
	(0.011)	(0.017)	(0.033)	(0.013)	(0.014)
Log change in Disposable Income	0.082***	0.081***	0.082***	0.072***	0.104***
	(0.002)	(0.002)	(0.004)	(0.002)	(0.004)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	3,358,795	1,827,616	588,690	2,711,995	1,885,726
R-squared	0.007	0.006	0.010	0.006	0.006

	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	-0.073***	-0.088***	-0.076***	-0.069***	-0.059***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Log Disposable Income	0.005***	0.006***	0.005***	0.005***	0.016***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity, ε_{EXT}	-0.653***	-0.724***	-1.273***	-0.625***	-0.263***
	(0.002)	(0.004)	(0.007)	(0.003)	(0.004)
Implied Income Elasticity, η_{EXT}	0.041***	0.046***	0.078***	0.046***	0.071***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	47,406,495	24,443,506	20,581,542	39,550,708	11,717,751
Unique IDs	8,905,195	4,795,268	5,789,633	8,003,184	2,467,174
R-squared	0.011	0.014	0.014	0.011	0.007

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 6. 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 4 and 5 above. The implied price and income elasticities are evaluated at the means of all the explanatory variables. Statistical significance: ***=1%, **=5%, *=10%.

Table 12: Total Elasticities by Age and Gender: Poisson and Negative Binomial

	Dependent Variable: Log Donations ($\ln g_{it}$)				
	Men	Women	Age $<$ 40	Age 40 $-$ 65	Age $>$ 65
Negative Binomial	(1)	(2)	(3)	(4)	(5)
Log Price of Giving	-1.070***	-0.879***	-1.101***	-0.959***	-0.891***
	(0.006)	(0.010)	(0.012)	(0.009)	(0.006)
Log Disposable Income	0.153***	0.250***	0.157***	0.179***	0.123***
	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)
Poisson					
Log Price of Giving	-1.036***	-0.356***	-1.324***	-0.867***	-0.900***
	(0.115)	(0.118)	(0.320)	(0.102)	(0.195)
Log Disposable Income	0.540***	0.634***	0.601***	0.536***	0.531***
	(0.039)	(0.072)	(0.108)	(0.040)	(0.140)
Individual FE	y	y	y	y	y
Year FE	y	y	y	y	y
Other controls	y	y	y	y	y
Observations	8,497,798	5,088,049	2,307,553	7,068,175	3,462,729
Unique IDs	1,201,588	752,315	446,348	1,113,730	560,224

Note: this table estimates total elasticities by age and gender using the Negative Binomial and Poisson specifications. 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 the variables are defined as in the notes to Tables 7 and 8. The income groups are defined as in the note to Table 9. Statistical significance: ***=1%, **=5%, *=10%.

ONLINE APPENDIX

NOT INTENDED FOR PUBLICATION IN JOURNAL

"The Price Elasticity of Charitable Deductions: Evidence from UK Tax Records"

Miguel Almunia, Benjamin Lockwood and Kimberley Scharf

University of Warwick

April 2017

A Derivation of Equation (4).

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

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

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

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

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 $\epsilon_{INT}, \eta_{INT}$ 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 practice, these are current and lagged values of the log of the first-pound price of giving, and the log of real disposable income.

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 first report report the estimates of the coefficients δ_{ti} in the selection equation (21) in Table A.1. 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.1. 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.1 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.

So, this gives us four possible specifications for (22). In A.2, 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, the are not too different from our preferred elasticity estimates from the first-difference specification reported in 6 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: 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	-0.299***	-0.471***	-0.374***	-0.321***	-0.284***	-0.259***	-0.245***	-0.230***	-0.220***	-0.213***
	(0.009)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)
lnpf_2006	-0.180***	-0.143***	-0.279***	-0.222***	-0.205***	-0.170***	-0.148***	-0.149***	-0.144***	-0.137***
	(0.010)	(0.013)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
lnpf_2007	-0.026***	-0.003	-0.012	-0.144***	-0.065***	-0.045***	-0.011	0.009	0.014	0.012
	(0.010)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)
lnpf_2008	0.035***	0.063***	0.077***	0.061***	-0.058***	0.007	0.024**	0.047***	0.053***	0.053***
	(0.009)	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
lnpf_2009	-0.354***	-0.283***	-0.267***	-0.285***	-0.320***	-0.488***	-0.412***	-0.394***	-0.360***	-0.350***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)
lnpf_2010	-0.276***	-0.210***	-0.211***	-0.197***	-0.209***	-0.239***	-0.422***	-0.344***	-0.315***	-0.292***
	(0.009)	(0.011)	(0.011)	(0.011)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
lnpf_2011	0.106***	0.156***	0.172***	0.180***	0.132***	0.120***	0.118***	-0.008	0.082***	0.109***
	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)
lnpf_2012	-0.054***	-0.007	-0.001	0.006	-0.023***	-0.021**	-0.010	-0.039***	-0.179***	-0.103***
	(0.007)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
lnpf_2013	-0.239***	-0.210***	-0.188***	-0.179***	-0.204***	-0.199***	-0.202***	-0.202***	-0.236***	-0.400***
	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
lnyd_2005	0.062***	0.160***	0.102***	0.083***	0.061***	0.051***	0.048***	0.045***	0.042***	0.040***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnyd_2006	0.034***	0.039***	0.084***	0.054***	0.036***	0.030***	0.025***	0.020***	0.019***	0.018***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
lnyd_2007	0.022***	0.010***	0.021***	0.057***	0.031***	0.022***	0.017***	0.017***	0.014***	0.011***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
lnyd_2008	0.020***	0.004***	0.009***	0.019***	0.053***	0.028***	0.020***	0.017***	0.014***	0.011***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
lnyd_2009	0.026***	0.014***	0.016***	0.019***	0.025***	0.056***	0.036***	0.025***	0.021***	0.018***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
lnyd_2010	0.009***	-0.002*	-0.001	0.001	0.001	0.008***	0.039***	0.017***	0.010***	0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
lnyd_2011	0.041***	0.027***	0.029***	0.033***	0.028***	0.031***	0.044***	0.080***	0.060***	0.049***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
lnyd_2012	0.026***	0.016***	0.017***	0.018***	0.015***	0.016***	0.020***	0.031***	0.066***	0.045***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
lnyd_2013	0.048***	0.036***	0.039***	0.039***	0.037***	0.038***	0.041***	0.047***	0.064***	0.116***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Constant	-4.369***	-4.603***	-4.707***	-4.752***	-4.373***	-4.284***	-4.348***	-4.409***	-4.498***	-4.545***
	(0.015)	(0.017)	(0.017)	(0.017)	(0.016)	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)
Observations	36,749,736	4,083,304	4,083,304	4,083,304	4,083,304	4,083,304	4,083,304	4,083,304	4,083,304	4,083,304

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.2: Two-Step Model: Intensive-Margin Elasticities

	(1)	(2)	(3)	(4)
Inverse Mills Ratio (IMR):	Pooled One effect	Pooled Diff effects	Annual One effect	Annual Diff effects
Price Elasticity of Giving	-0.236***	-0.239***	-0.201***	-0.164***
	(0.006)	(0.006)	(0.006)	(0.009)
Income Elasticity of Giving	0.139***	0.138***	0.138***	0.136***
	(0.002)	(0.002)	(0.002)	(0.002)
P-value on IMR terms	0.000	0.000	0.000	0.000
Observations	5,014,687	5,014,687	5,014,687	5,014,687
R-squared	0.102	0.102	0.100	0.100

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%.

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	-0.657***	-0.646***	-0.399***	-0.384***	-0.827***	-0.811***	-0.449***	-0.424***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.008)	(0.008)	(0.009)	(0.009)
Log Disposable Income			0.113***	0.115***			0.178***	0.180***
			(0.001)	(0.001)			(0.002)	(0.002)
$\ln p_{it} - \ln p_{it-1}$					0.199***	0.196***	0.081***	0.076***
					(0.004)	(0.004)	(0.004)	(0.004)
$\ln p_{it+1} - \ln p_{it}$					-0.158***	-0.152***	-0.059***	-0.051***
					(0.004)	(0.004)	(0.004)	(0.004)
$\ln y_{it} - \ln y_{it-1}$					-0.000	0.001	-0.063***	-0.063***
					(0.001)	(0.001)	(0.001)	(0.001)
$\ln y_{it+1} - \ln y_{it}$					-0.028***	-0.027***	0.024***	0.026***
					(0.001)	(0.001)	(0.001)	(0.001)
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	7,068,726	7,043,070	7,068,726	7,043,070	5,180,839	5,162,627	5,180,839	5,162,627
R-squared	0.032	0.033	0.040	0.041	0.021	0.021	0.033	0.034
Unique IDs	1,418,215	1,412,374	1,418,215	1,412,374	1,125,669	1,121,548	1,125,669	1,121,548

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*			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Price of Giving	-0.086***	-0.110***	-0.096***	-0.097***	-0.156***	-0.158***	-0.139***	-0.139***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Log Disposable Income			0.004***	0.004***		0.005***	0.005***	
			(0.000)	(0.000)		(0.000)	(0.000)	
$\ln p_{it} - \ln p_{it-1}$					0.045***	0.046***	0.039***	0.039***
					(0.000)	(0.000)	(0.000)	(0.000)
$\ln p_{it+1} - \ln p_{it}$					-0.036***	-0.036***	-0.030***	-0.030***
					(0.000)	(0.000)	(0.000)	(0.000)
$\ln y_{it} - \ln y_{it-1}$					-0.000***	-0.000***	-0.002***	-0.002***
					(0.000)	(0.000)	(0.000)	(0.000)
$\ln y_{it+1} - \ln y_{it}$					-0.002***	-0.002***	-0.000***	-0.000***
					(0.000)	(0.000)	(0.000)	(0.000)
Implied Price Elasticity (ε_{EXT})	-0.781***	-0.987***	-0.871***	-0.863***	-1.246***	-1.240***	-1.103***	-1.096***
	(0.002)	(0.002)	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Implied Income Elasticity (η_{EXT})			0.033***	0.033***		0.042***	0.043***	
			(0.000)	(0.000)		(0.001)	(0.001)	
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	69,910,138	68,505,746	69,910,138	68,505,746	44,638,562	43,912,055	44,638,562	43,912,055
Unique IDs	14,044,157	13,602,522	14,044,157	13,602,522	9,636,776	9,464,800	9,636,776	9,464,800
R-squared	0.053	0.010	0.044	0.013	0.048	0.032	0.052	0.036

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%.