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# More giving or more givers? The effects of tax incentives on charitable donations in the UK[☆]

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ABSTRACT

This paper estimates the effects of tax incentives on charitable contributions in the UK, using the universe of self-assessment income tax returns between 2005 and 2013. We exploit variation from a large reform in 2010 to estimate intensive- and extensive-margin tax-price elasticities of giving. Using a predicted-tax-rate instrument for the price of giving relative to consumption, we find an intensive-margin elasticity of about −0.2 and an extensive-margin elasticity of −0.1, yielding a total elasticity of about −0.3. To further explore the extensive-margin response, we propose a model with a fixed cost of declaring donations and obtain a structural estimate of that cost of around £47. We also study the welfare effects of tax incentives, extending the theoretical literature to allow for extensive-margin giving and for a fixed cost of declaring donations. Taking into account these factors, there is a case for increasing the subsidy on charitable giving in the UK.


## 1. Introduction

Most tax systems provide preferential treatment to charitable donations through deductions or tax credits. The goal of this subsidy is to support the private provision of goods and services considered beneficial for society. However, this policy is potentially costly for the government. For example, the cost of tax relief for charitable donations through the Gift Aid program in the UK was more than £1.8 billion in foregone revenue in 2015/16 (HMRC, 2018).

Standard economic theory suggests that subsidizing charitable giving may be desirable if it induces a large enough increase in donations (Saez, 2004). Hence, in order to evaluate the welfare implications of these tax reliefs, one of the key parameters needed is the elasticity of charitable donations with respect to their tax price (relative to consumption). Under full deductibility, the tax price of giving is simply one minus the marginal tax rate.

Although there is a large empirical literature focused on this tax-price elasticity dating back to Feldstein (1975), the large majority of studies have focused on intensive-margin donation responses, largely ignoring the extensive margin i.e. the decision to donate or not. This may be due to data limitations and, in the case of the US income tax, to the possibility of claiming a "standard deduction" instead of reporting itemized deductions. Moreover, those papers that do study the extensive margin have, to date, estimated some kind of censoring model, and these studies have not calculated an extensive-margin elasticity of giving with respect to the tax price i.e. the elasticity of the probability of giving a positive amount with respect to the tax price.[1]

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[1] It is possible to compute this elasticity from a model with censoring, at least at sample means for the explanatory variables. However, we are not aware of any existing study that does this calculation.

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0047-2727/

In this paper, we argue that this lack of attention to the extensive margin is problematic for several reasons.[2] First, in many countries the fraction of taxpayers who report deductions for charitable giving is relatively small, and so from a practical point of view, there is considerable scope for using the tax system to raise this fraction (Fack and Landais, 2010).[3]

Second, as we show formally in Section 5, the key parameter needed to evaluate the welfare effects of changes in the tax price of giving is the *total* tax-price elasticity of giving, which is the sum of the intensive- and extensive-margin tax-price elasticities. This point is theoretically straightforward, but it does not seem to have been made explicitly before.[4] The implication is that it is important to have a credible estimate of the extensive-margin elasticity for the purpose of making policy recommendations, because relying on the intensive-margin elasticity alone will give an under-estimate of the benefit of subsidizing charitable donations.

Third, we do not believe that censoring models adequately describe the decision at the extensive margin as to report any deduction for charitable giving on the tax return or not. The reason is that recent evidence suggests that there are optimization frictions in making deductions for charitable giving which case some donors not to deduct. In the UK, for example, the Charities Aid Foundation conducts a large annual survey of charitable giving behavior, which finds that the proportion of respondents making some monetary donation within a year is around 60% (Charities Aid Foundation, 2018). This is in stark contrast with the proportion of self-assessment taxpayers who report a deduction in our data, which is only 11%.[5] Again, in a recent paper, Gillitzer and Skov (2018) study a 2008 reform in Denmark that allowed pre-population of tax returns with donations recorded by charities. Comparing declarations before and after the reform, they conclude that about half the donors in the pre-2008 period were not reporting their donations. They attribute this to various optimization frictions, including compliance costs of keeping records on donations. Censoring models do not allow for the estimation of compliance costs of this kind.[6]

In this paper, we address all these issues. We use an administrative panel dataset of tax returns from the UK for the period 2005–2013 and exploit a large tax reform in 2010 to study how charitable donations respond to tax incentives at both the intensive and the extensive margins. We make a second original contribution by estimating a structural model of both margins of giving, with the objective of estimating the compliance costs of making a deduction. Finally, we present a welfare analysis of the tax price of charitable giving, taking into account compliance costs of reporting, and draw some conclusions for the UK.

For our empirical analysis, we have access to the universe of self-assessment income tax returns for the fiscal years 2004/05 through 2012/13. Self-assessment tax returns must be submitted by taxpayers above an income threshold (currently £100,000), the self-employed, and other taxpayers with substantial non-labor income or want to claim specific deductions. The administrative panel dataset we use contains more than 75 million taxpayer-year observations from more than 11 million distinct individuals. For an exogenous source of variation in the tax price, we exploit the 2010 UK income tax reform, which raised the top marginal tax rate from 40% to 50% for incomes above £150,000, and also created a short bracket with a 60% marginal rate above £100,000. The combination of a large administrative panel dataset and a salient tax reform provides an ideal setting for the estimation of the elasticity of charitable giving and the implicit cost of declaring donations using both reduced-form and structural approaches.

The estimation of the intensive-margin price elasticity of giving poses several well-known estimation challenges, such as the endogeneity of the price of giving and the simultaneous choice of income and donations. To jointly address these issues, we combine the standard "first-pound" price instrument (i.e., the hypothetical price with zero donations) with the IV strategy developed by Gruber and Saez (2002) in the context of taxable income elasticities. Specifically, we use lagged values of taxable income to construct an instrument for the *change* in the first-pound price of giving. This instrument isolates changes in price from income responses to the tax reform, 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 this literature.

Our reduced-form estimates of the intensive-margin price elasticity are in the range between −0.16 and− 0.28, depending on the specification. Regarding the extensive-margin elasticity, our reduced-form estimate is −0.09. Adding this to the intensive-margin elasticity yields a total elasticity of giving in the range between −0.25 and− 0.37. We explore how the price and income elasticities of giving vary by income level, given that high-income taxpayers make a disproportionate share of all donations (and therefore receive a large share of the tax reliefs). We find that the intensive-margin price elasticity increases in magnitude with income, while the opposite is true for the extensive-margin elasticity.

One key estimation challenge, particularly for the extensive margin, is the possibility, already discussed above, that some taxpayers make positive donations but choose not to claim the deduction in their tax return due to costs of making a deduction. If there is indeed under-reporting of donations, a standard reduced-form model will not be able to capture properly the extensive-margin response.

To address this, we develop a structural model that incorporates the cost of declaring donations in the taxpayers' optimization problem. In this model, the fixed cost of declaring charitable donations leads some individuals to report zero donations despite having donated positive amounts to charity in a given tax year. In our simulated method of moments approach, we use our reduced-form estimates to recover the structural parameters of our model. Using this structural model, we estimate that the fixed cost of declaring donations is £47, amounting to about 10% of the median declared donations in our data.[7] The model also allows us to evaluate counterfactual scenarios. For example, if the fixed cost of reporting donations were to be eliminated, the average reported donation would increase by 18%. With reduced costs of giving, the share of

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

[3] Even though the US is often cited as having a high proportion of taxpayers reporting charitable donations, the actual share is lower due to the choice between itemized and standard deductions. While 81% of itemizers reported charitable donations in 2015 (www.irs.com/articles/5-popular-itemized-deductions), itemizers only represent about 30% of all filers. Thus, only 25% of US taxpayers actually claim a deduction for donations in their tax returns.

[4] For example, in Saez (2004), the model allows for an extensive margin in giving, but there is no decomposition of the total tax-price elasticity or any discussion of the extensive margin.

[5] It is of course possible that as well as under-reporting of donations, there is tax evasion via over-reporting of donations. However, we do not know of any direct evidence that this occurs on a large scale in the UK. Rather, the main form of evasion is to disguise a tax-avoidance scheme as a charity, where the donors enter into arrangements to obtain a financial advantage for themselves, so their donations are recycled back to them, as well as allowing them to claim tax relief. The UK government introduced new anti-avoidance rules (the Tainted Charity Donations rules) in 2011 to prevent this kind of abuse.

[6] To see this, note that in the standard model of censoring – the Heckman selection model – applied to charitable giving, a donation occurs if a linear function of individual characteristics takes on more than a certain value, but without a structural model, this condition cannot be mapped back to a compliance cost.

[7] This estimated cost of declaring is similar in magnitude to recent non-parametric estimates of the cost of declaring charitable donations in Denmark (Gillitzer and Skov, 2018) and in the United States (Tazhitdinova, 2018).

the population declaring their donations would increase, as well as the average reported donations. The structural model also provides an estimate of the intensive-margin price elasticity of giving to be 0.14, which is close to, but slightly smaller than, our reduced-form estimate.

Our final contribution is to investigate the implications of the fixed cost of making deductions on the welfare effect of increasing the subsidy to charitable giving. For this purpose, we consider a simple setting based on the structural model, which allows for use of our structural estimates in assessing this question. We find that the standard results on the optimal level of the subsidy to charitable giving (e.g., Roberts, 1984; Saez, 2004) have to be modified when there is an optimization friction associated with making a deduction and so some individuals donate small amounts without deducting. We also show that given our estimates, there appears to be a welfare case for further increasing the subsidy to charitable giving in the UK.

Our paper relates to an extensive literature on charitable donations in general, and on the price elasticity of giving in particular. Many of the existing studies that exploit tax reforms to generate variation in the price of giving have focused on the United States, (e.g., Auten et al., 2002; Bakija and Heim, 2011; Randolph, 1995). These papers generally find large intensive-margin price elasticities, often above one in absolute value.[8] In another recent paper, Fack and Landais (2010) find a smaller elasticity, between 0.2 and 0.6, using a censored model applied to French data. Moreover, as already remarked, even though many existing econometric studies on tax return data use strategies to deal with censoring at zero donations, to our knowledge none of them has attempted to directly estimate an extensive-margin price elasticity of giving.

There is an experimental literature that does study the effects of changes in price of charitable giving on the extensive margin via matching treatments. For example, Karlan and List (2007), using a large field experiment in the US, find that a 1:1 match raises the proportion of givers by 22%. However, these treatments cannot give us estimates of the effect of a *small* change in the price starting at the initial price of charitable giving in the population of taxpayers, and it is this which is required for evaluation of policy reforms. There are also issues of external validity with any field experiment. For example, the subjects in Karlan and List (2007) were on average much older, more politically liberal, and more male than the average for the US.

This paper also fills a gap in the evidence on tax-price elasticities of giving for the United Kingdom, where there have been very few studies on this topic. Jones and Posnett (1991) use household survey data from the 1980s to estimate tax-price elasticities of giving. More recently, Scharf and Smith (2015) use an online survey of individual donors to elicit preferences in response to hypothetical variation in the price of giving. They separately estimate the elasticity of donations with respect to tax rebates and matched donations, obtaining much larger elasticities for the latter. Our paper is the first to use administrative tax-return data to study this topic in the UK, despite the fact that proposals for reforming the Gift Aid system have been under public debate in recent years (National Audit Office, UK, 2013).

The remainder of the paper is organized as follows. Section 2 describes the institutional context and data. Section 3 presents the reduced-form estimates. Section 4 derives a structural model of donations and reports estimates of the price elasticity of giving and the fixed cost of declaring donations. Section 5 derives a subsidy reform rule taking into account the extensive margin and optimization frictions, and Section 6 draws some conclusions.

[8] Clotfelter (1997) provides a thorough overview of the early literature, and Peloza and Steel (2005) implement a meta-analysis of pre-2005 studies.

## 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. Note that income is taxed at the individual level in the UK, and the fiscal year starts on April 6th and ends on April 5th of the following year. For simplicity, we sometimes refer to fiscal year 2004/05 as 2005, and similarly for other years.

### 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.[9] Gift Aid is composed of two parts, a match rate and a deduction. The combination of these two elements results in full tax deductibility of charitable donations, as we explain below.

When a UK taxpayer makes a donation to charity, she fills out a Gift Aid declaration form, which is given to the charity along with the donation. The charity can claim the income tax paid on the donated amount directly from HM Revenue and Customs (HMRC), the UK's tax administration. Specifically, for a donation of one pound, the charity receives $1/(1-\tau_b)$ pounds, where $\tau_b$ 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 amount donated (including the government match) times the difference between the basic rate of income tax $\tau_b$ and the higher rate, $\tau_h$. It is then easy to calculate that the price of giving for a higher-rate taxpayer is $1 - \tau_h$.[10]

Therefore, whether a UK taxpayer faces a basic marginal rate of income tax or a higher rate, the tax price of giving is always one minus her marginal tax rate, i.e. the same price as in a system where donations are fully deductible, such as the US income tax. [11] We explain how we calculate the tax price of giving in Section 2.4.

### 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. The highest marginal rate before this reform was 40%, which applied to all taxpayers with taxable income above £37,400, equivalent to £43,875 of gross income (adding the standard personal allowance). Starting in fiscal year 2010/11, an additional bracket with a 50% marginal tax rate was introduced for taxable income above

[9] 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 http://www.hmrc.gov.uk/individuals/giving/gift-aid.

[10] If the taxpayer donates one pound, she can claim a deduction equivalent to $(\tau_h - \tau_b)/(1 - \tau_b)$, giving a net cost to the taxpayer of $1 - (\tau_h - \tau_b)/(1 - \tau_b)$. Then, 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

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

[11] 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).

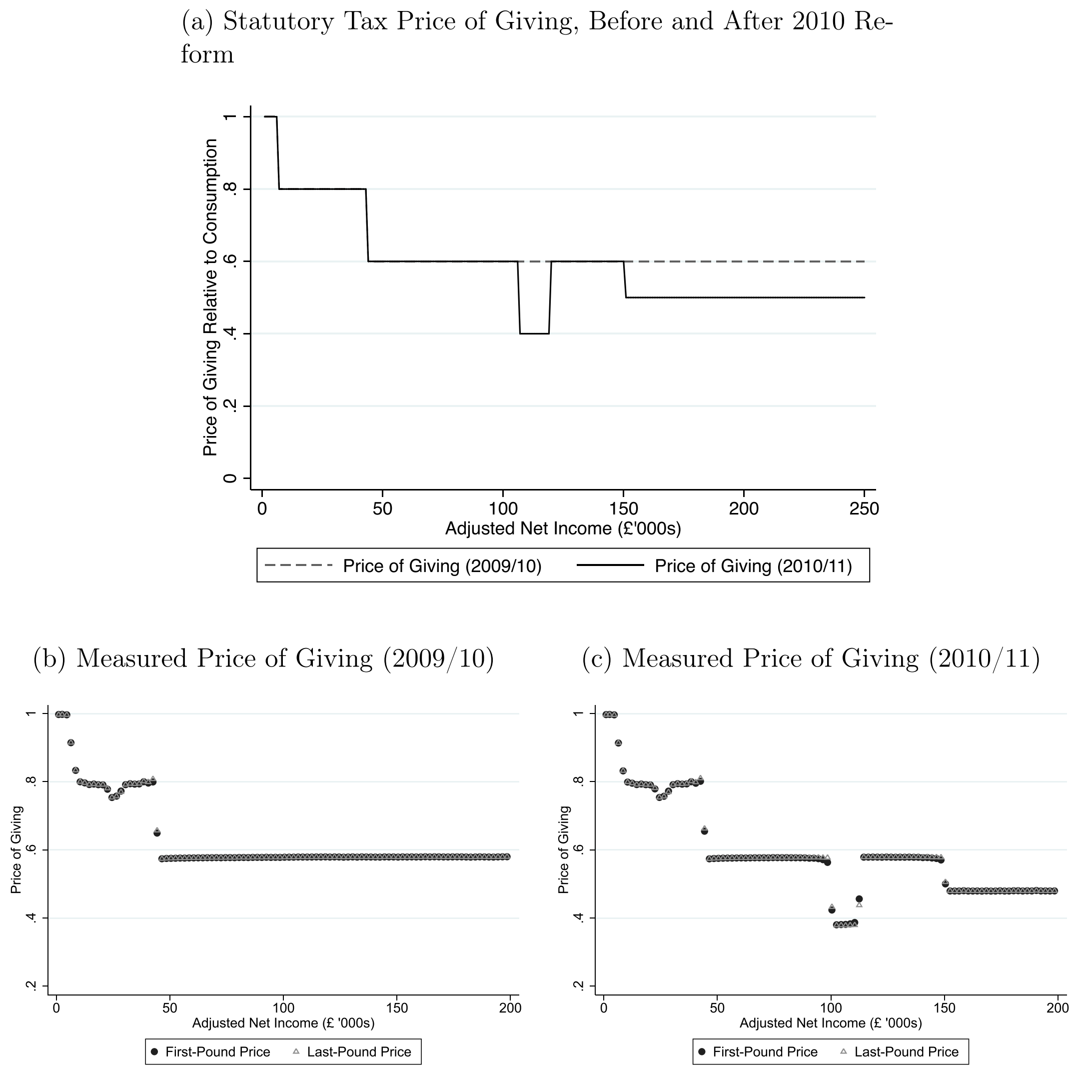


**Fig. 1.** Price of giving by income level. Notes: the top panel (a) plots the statutory price of giving in the fiscal years 2009/10 and 2010/11, i.e. before and after the April 2010 tax reform. The picture shows that there are two groups of taxpayers affected by the reform: those with adjusted net 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 £2000-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.

£150,000. The reform also established the phasing-out of the personal allowance by £1 for every additional £2 of income, for taxable income above £100,000. Therefore, the effective marginal tax rate increased to 60% for taxable income in the interval between £100,000 and £112,950.[12] The top panel of Fig. 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 ($\tau_b, \tau_h$) start applying have suffered minor modifications over time.[13] The basic tax rate $\tau_b$ was 22% between fiscal years 2004/05 and 2007/08, and it was reduced to 20% from 2008/09 onwards.[14] Between this reform and the beginning of the 2011/12 fiscal year, the matching rate provided by HMRC to all donations remained at 28% ($\frac{1}{1-0.22} \simeq 1.28$) in order to offer "transitional relief" to charities. Hence, the matching rate only came down to 25% in 2011/12. We incorporate all these reforms into our calculation of the marginal tax rate faced by each taxpayer.

One important issue is whether there could be anticipation effects to the April 2010 reform, potentially leading to inter-temporal shifting of donations. The government first announced in the Pre-Budget Report of 24 November 2008 that it planned to introduce a new top rate of 45% starting in April 2011. On 22 April 2009, it was announced that the additional rate would be 50% and be introduced one year

[12] The standard personal allowance was £6475 in 2010/11 and £7475 in 2011/12. There are higher personal allowances for older taxpayers and those with disabilities, but these are phased-out at much lower levels of income.

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

[14] Until 2007/08, there was also a starting rate of income and savings tax of 10% for the first £2000 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.

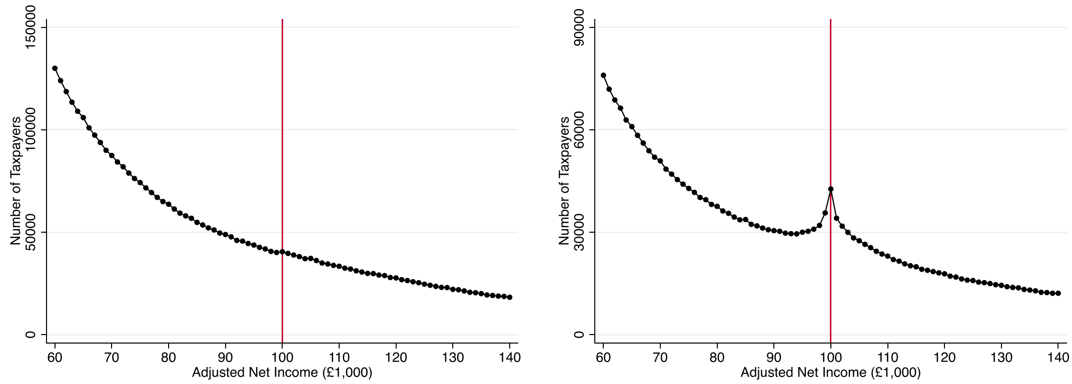


**Fig. 2.** Distribution of adjusted net income, before and after 2010 reform. Notes: this figure shows the distribution of adjusted net income for the population of self-assessment taxpayers in the UK. The left panel includes pre-reform years (2005–2010) and the right panel post-reform years (2011–2013). Bins are £1000 wide and the vertical red line marks the £100,000 threshold, which determines eligibility to file self-assessment for wage earners with no other sources of income, and is also a kink point where the marginal tax rate jumps from 40% to 60% in the post-reform period.

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

The UK income tax is collected via two systems: pay-as-you-earn (PAYE) and self assessment (SA). Under the PAYE system, employers calculate their employees' tax liability and withhold income tax so that taxpayers do not need to file a tax return. Taxpayers with non-wage sources of income (e.g., self-employment, partnerships, savings, dividends), those who want to claim specific tax benefits (such as charitable donations and contributions to private pension plans) and everyone with income above £100,000 must file a self-assessment tax return.[15] Throughout our sample period, about 25% of taxpayers file a SA return and the rest pay through PAYE, with the proportion of SA taxpayers rising steadily over time.

We focus our analysis on self-assessment taxpayers for several reasons. First, SA taxpayers can claim deductions for charitable donations directly on their tax return, while PAYE taxpayers would need to ask their employer to deduct donations directly from their pay through a program called Payroll Giving. While the annual fiscal cost of Gift Aid is substantial, approximately £1.78 billion in 2015/16, the fiscal cost of Payroll Giving is only £0.04 billion, indicating that very few taxpayers use the latter system.[16] Second, it is not possible to access the full population of PAYE taxpayers for research purposes, and no micro-level information on Payroll Giving is available. Finally, it is worth noting that SA taxpayers have higher average income than those on PAYE.[17]

In our empirical analysis, we use an anonymized administrative dataset containing the universe of self-assessment 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.[18] 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. Given the high quality of this administrative dataset, panel attrition is a minor concern in the analysis.

Fig. 2 shows the distribution of adjusted net income in the years before (left panel) and after (right panel) the 2010 reform.[19] The pre-reform distribution is smooth around £100,000, indicating that the vast majority of wage earners who are just below this income threshold already file a self-assessment return, so there is no sample selection at this threshold. The post-reform figure shows significant bunching of taxpayers around £100,000, suggesting that (at least some) taxpayers are aware of the kink point created by the reform, shifting the marginal tax rate from 40% to 60%.

Fig. 3 shows the share of SA taxpayers reporting positive donations by levels of gross income. The proportion of donors is very low for taxpayers facing the basic tax rate (i.e., those with gross income below £45,000, with some variation across years), and it reaches about 30% for higher incomes.[20] It is important to note that basic rate taxpayers do not have any incentive to report their charitable donations in the SA return, as they do not receive any additional tax relief. Therefore, it is surprising to observe taxpayers in this tax bracket reporting *any* donations at all. It might be that some taxpayers report them due to inertia (as the SA return requests information about donations) or inattention, but we cannot test these hypotheses in the current setting.

Including all basic-rate taxpayers in our regressions might lead to overestimation of the price elasticity of giving, because some taxpayers may only report their donations when they are in the higher tax brackets. Then, those with a positive income shock that moves them from the basic to the higher-rate bracket would mechanically increase their reported donations, coinciding with their higher tax rate (and hence lower price of giving). Given this potential bias, in

[15] 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.

[16] Of the full cost of Gift Aid, £1.30 billion correspond to the match component and £0.48 billion to the deduction component. Charities also get substantial tax relief through other exemptions (HMRC, 2018).

[17] They are also more likely to be male (66% vs. 53%), but there is virtually no difference in the average age (49 years).

[18] We extract the gender and age variables from a separate dataset named Valid-View, which is an extended version of SA203.

[19] Adjusted net income is defined as total taxable income before deducting the personal allowance and three tax reliefs: business losses and the "grossed-up" amounts of charitable donations and contributions to private pension plans. For more details, see www.gov.uk/guidance/adjusted-net-income.

[20] At each level of income, women are about five percentage points more likely to give than men.

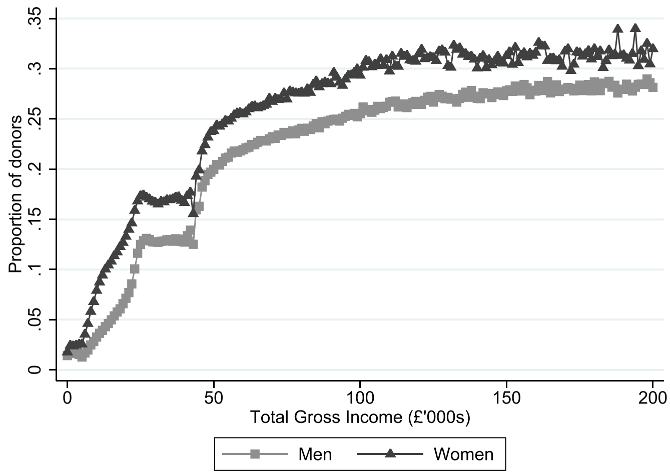


**Fig. 3.** Fraction of donors, by income and gender. Notes: this figure plots the proportion of taxpayers reporting positive donations (donors), against total gross income in bins of £1000. Solid triangles represent the averages for women and light-grey squares represent the averages for men. Taxpayers 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.

our main estimates we only consider taxpayers who were in the higher tax brackets for the whole period of our study. That allows us to focus on those taxpayers who have a tax incentive to report charitable donations in all periods. The only regressions where we include all self-assessment taxpayers are those where we estimate heterogeneous elasticities by income level in Section 3.4. Summary statistics are reported in Table 1: panel A covers the universe of self-assessment taxpayers and panel B covers the main estimation subsample of higher-bracket taxpayers.

In Fig. 4, we report average annual donations as a share of pre-tax income. This share is remarkably stable at 0.5% for all taxpayers above £50,000.[21] As a comparison, "itemizers" in the US income tax report donations equivalent to 3.2% of their total income, a ratio that is only reached by taxpayers in the top 0.01% of the income distribution in the UK.[22]

### *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.

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, $\Delta g$, to their observed donations, $g_{it}$, and then compare their resulting tax liability with their originally reported tax liability.

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

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

where $(1 - \tau_b)$ accounts for the match provided automatically to all donations by UK taxpayers, and the last term represents the additional reduction in the price of giving due to the deduction that is awarded to higher-rate taxpayers. Specifically, we calculate the decline in tax liability due to an increase of $\Delta g = £100$ in the amount donated, divided by 100. Note that the estimated tax prices of giving are robust to using other small values of $\Delta g$.

## 3. Reduced-form estimates

In this section, we present reduced-form estimates of the price elasticity of giving on both the intensive and the extensive margins. We first describe the standard instrumental variables (IV) strategy from the earlier literature, which uses the first-pound price of giving as an instrument for the observed price. Then, we construct a predicted-tax-rate instrument using lagged values of income to instrument for the change in the first-pound price of giving. We report estimates of the price elasticity of giving using both methods and discuss the potential limitations of each empirical strategy.

### *3.1. Empirical strategies*

A standard static theoretical analysis of the donation problem predicts that both the donation of individual $i$ at time $t$, and the decision whether to donate at all, will depend on the price of giving $p_{it}$ and income $y_{it}$. The panel structure of the data allow us to estimate the effects of 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 in a simple way that is broadly consistent with standard theory, when strictly positive donations are observed, we can estimate:

$$\ln g_{it} = \varepsilon_{INT} \ln p_{it} + \eta_{INT} \ln y_{it} + \delta X_{it} + \alpha_i + \alpha_t + u_{it} \quad (2)$$

where $p_{it}$ and $y_{it}$ are the tax price and disposable income of $i$ in year $t$, $\varepsilon_{INT}$ and $\eta_{INT}$ are the intensive-margin price and income elasticities of giving, $\alpha_i$ and $\alpha_t$ are individual and year fixed effects, and $u_{it}$ is $i$'s random error at time $t$. The individual fixed effects, $\alpha_i$, control for all time-invariant individual characteristics that may affect giving, such as generosity, religious affiliation or gender. The year fixed effects, $\alpha_t$, control for any events that affect all taxpayers at the same time (e.g. the financial crisis of 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.[23]

The extensive-margin response for individual $i$ at time $t$ can be estimated using a similar specification:

$$D_{it} = \beta \ln p_{it} + \gamma \ln y_{it} + \delta X_{it} + \alpha_i + \alpha_t + v_{it} \quad (3)$$

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

[21] Throughout the income distribution, women donate a slightly higher proportion of their income than men.

[22] For the US, we calculate the ratio using SOI tax statistics published by the IRS for the fiscal year 2014. Table 2.1 for that year is available at https://www.irs.gov/pub/irs-soi/14in14ar.xls. The figures for top income groups in the UK are reported in Appendix Table A.1.

[23] 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.

**Table 1**
Summary statistics.

| | Mean | Std. Dev. | p10 | p50 | p90 | Observations |
|---|---|---|---|---|---|---|
| *Panel A: Universe of self-assessment taxpayers* | | | | | | |
| Donations ($g$) | 211 | 25,632 | 0 | 0 | 59 | 75,646,776 |
| Donations (if $g > 0$) | 1927 | 77,376 | 63 | 382 | 2796 | 8,296,291 |
| Adjusted Net Income ($z$) | 36,072 | 878,780 | 3592 | 18,799 | 70,031 | 75,646,776 |
| Disposable Income ($y$) | 29,098 | 533,810 | 3873 | 17,186 | 55,886 | 75,646,776 |
| Price of Giving ($p$) | 0.79 | 0.14 | 0.60 | 0.78 | 1.00 | 75,646,776 |
| Age | 49.92 | 15.02 | 31 | 49 | 70 | 74,007,168 |
| Female | 0.34 | 0.47 | 0 | 0 | 1 | 75,646,776 |
| Used a Tax Advisor | 0.67 | 0.47 | 0 | 1 | 1 | 75,646,776 |
| *Panel B: Higher-bracket taxpayers (main estimation subsample)* | | | | | | |
| Donations ($g$) | 707 | 3685 | 0 | 0 | 1188 | 6,869,602 |
| Donations (if $g > 0$) | 2320 | 6389 | 89 | 593 | 5118 | 2,093,152 |
| Adjusted Net Income ($z$) | 154,746 | 401,238 | 56,006 | 97,368 | 254,366 | 6,869,602 |
| Disposable Income ($y$) | 110,514 | 289,111 | 45,399 | 72,615 | 173,409 | 6,869,602 |
| Price of Giving ($p$) | 0.58 | 0.06 | 0.50 | 0.60 | 0.60 | 6,869,602 |
| Age | 50.25 | 12.62 | 36 | 48 | 68 | 6,787,973 |
| Female | 0.18 | 0.39 | 0 | 0 | 1 | 6,869,602 |
| Used a Tax Advisor | 0.61 | 0.49 | 0 | 1 | 1 | 6,869,602 |

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

as in Eq. (2). This linear probability model seems appropriate in this setting because the fitted probabilities always lie within the (0, 1) interval.[24] In Eq. (3), our main focus is the extensive-margin price and income elasticities, which can be calculated as $\varepsilon_{EXT} = \beta/\bar{D}$ and $\eta_{EXT} = \gamma/\bar{D}$, where $\bar{D}$ is the sample mean of $D_{it}$ (i.e., the proportion of individuals in our sample that made donations in year $t$).

### 3.1.1. Identification challenges: pre-reform trends, endogeneity, simultaneity and censoring

Identification of the price elasticities of giving in Eqs. (2) and (3) comes from exogenous variation in the price of giving due to the 2010 tax reform. Essentially, we rely on a difference-in-differences strategy where the treatment group includes taxpayers who were affected by the reform, and the control group includes those who were not affected.

In order to check whether donations by the treatment and control groups followed parallel trends before the 2010 reform, Fig. 5 plots the evolution of average donations over time for four groups of taxpayers, according to their taxable income in the year prior to the reform (2009/10): (1) those with adjusted net income below £100,000, (2) between £112,950 and £150,000, (3) between £100,000 and £112,950, and (4) above £150,000. Groups (1) and (3) belong to the control group and groups (2) and (4) belong to the treatment group. The top panel of Fig. 5 includes all taxpayers, and the bottom panel only donors (i.e., those declaring positive donations). Donations are in real terms and we normalize them to one in the pre-reform year (2009/10) to facilitate interpretation.

There are two key findings from Fig. 5. First, the parallel trends assumption is broadly fulfilled, as the pre-reform trends in giving are similar for treatment and control groups (both conditional and unconditional on giving). Second, only taxpayers in group 4

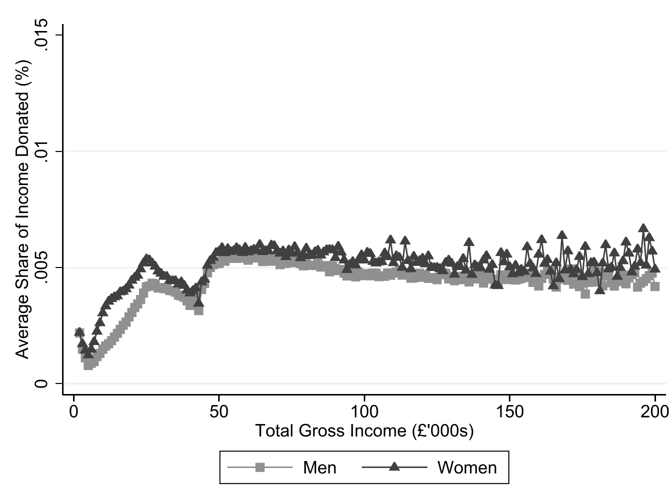


**Fig. 4.** Average share of income donated, by income and gender. Notes: this figure shows the average share of gross (pre-tax) income donated, by gender and by levels of gross income. Throughout the income distribution, women donate a slightly higher proportion of their income than men. The share donated grows with income up to about £50,000, and it is remarkably stable at about 0.5% for all taxpayers above that income level.

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

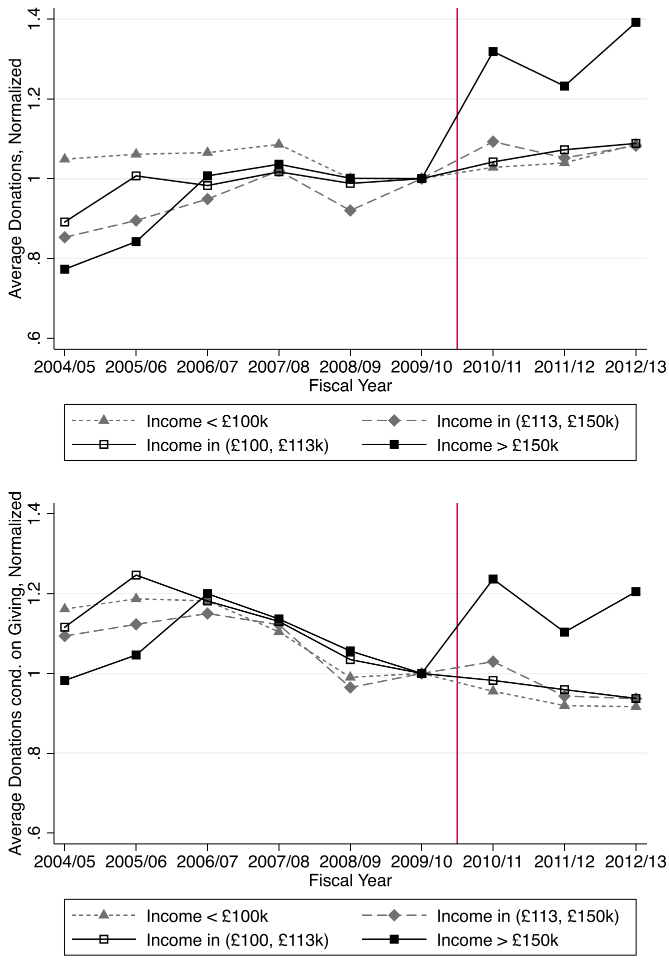


**Fig. 5.** Normalized average donations by income group. Notes: the top panel shows the evolution of average donations for four groups of taxpayers. Average donations are normalized to equal 1 in fiscal year 2009/10 (just prior to the April 2010 reform) for all groups. The groups are defined based on 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.

increased their average donations in response to the reform, while the other three groups followed roughly their pre-reform trends. This is surprising because taxpayers in group 2 experience a large drop in their price of giving from 0.6 to 0.4 after the reform. One possible explanation for their lack of response is that this change in the price of giving was less salient, since it is an artifact of the withdrawal of the personal allowance. However, we cannot text this hypothesis directly. Taken together, these patterns suggest that the tax reform had an effect on giving behavior at the top of the income distribution. However, we cannot infer precise estimates from them as they are likely a mix of intensive- and extensive-margin responses.

Despite the fact that the parallel trends assumption holds, estimating Eqs. (2) and (3) by ordinary least squares (OLS) is likely to yield biased estimates. This is due to (at least) three identification issues that have been widely discussed in the charitable giving literature: endogeneity of the price of giving, simultaneous choice of income and donations, and censoring in the dependent variable (in the intensive-margin equation). In what follows, we discuss how we deal with the first two issues, while we describe our approach to censoring in Section A.4.

The observed "last-pound" price of giving is potentially endogenous because an increase in donations could push the taxpayer to a lower tax bracket, yielding a mechanical negative correlation between the price and the amount donated. To address this issue, we follow the standard approach of using the "first-pound" price as an instrument for the last-pound price (which dates back to Feldstein and Taylor, 1976). Formally, the first-pound price can be defined as $p^f_{it}$, where $p^f_{it}$ is the right-hand side of Eq. (1), evaluated at $g_{it} = 0$.

Regarding the second issue, changes in income due to the tax reform could affect both donations – through a wealth effect – and the price of giving — through the marginal tax rate. To address the potential bias in the coefficient on price, we adapt the IV strategy developed by Gruber and Saez (2002) in the literature of taxable income elasticities. Specifically, we use lagged values of taxable income to construct an instrument for the *change* in the first-pound price of giving. Formally, the instrument is given by:

$$\ln\left(\frac{p^f_{it}(z_{i,t-k})}{p^f_{i,t-k}(z_{i,t-k})}\right) \tag{4}$$

where the numerator 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 actual taxable income for that year.

This instrument isolates changes in price from income responses to the tax reform, so it provides a cleaner identification of the effect of an exogenous change in the price of giving than the standard instruments that have been used in this literature. The first-stage coefficient is expected to be highly significant, as the instrument is strongly correlated with the actual change in the tax price of giving. Moreover, 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.[25]

When using this predicted-tax-rate instrument, the regression specification is the first-differenced version of Eq. (2):

$$\Delta \ln g_{it} = \varepsilon_{INT} \Delta \ln p^f_{it} + \eta_{INT} \Delta \ln y_{it} + \delta' \Delta X_{it} + \Delta u_{it}, \tag{5}$$

where $\Delta \ln g_{it} = \ln g_{it} - \ln g_{i,t-k}$ is the change in log donations, and similarly for the other variables. We instrument $\Delta \ln p^f_{it}$ by the variable Eq. (4). Also, $k$ is the number of periods over which we take differences. In the empirical analysis, we report results for all $k \in \{1, 2, 3\}$ so that we can compare differences between short-term $(k = 1)$ and medium-term $(k = 3)$ response to the reform.[26]

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.[27] Notice,

[25] In the first-differenced equation, i.e. when $k = 1$, this may be a concern because of anticipation responses to the tax reform. However, when we set $k = 2$ or $k = 3$, the exclusion restriction is more likely to be fulfilled. See Weber (2014) for a discussion of related issues.

[26] The taxable income literature has settled on 3-year differences as the standard 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.

[27] 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. "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.

**Table 2**
Intensive-margin elasticity, standard IV specification.

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

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

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

where $\ln g_{it}$ denotes log donations; $\ln p_{it}$ denotes the log of the last-pound price of giving, which is instrumented in all specifications by the log of the first-pound price of giving $\ln p^f_{it}$; $\ln y_{it}$ 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 $\alpha_i$, $\alpha_t$ are individual and year fixed effects, respectively. Statistical significance: *** = 1%, ** = 5%, * = 10%.

finally, that we do not implement a similar specification to estimate the extensive-margin elasticity because the dependent variable would no longer be binary, and therefore the interpretation is not straightforward.

### 3.2. Results from the standard IV specification

We begin by estimating Eq. (2) on all higher-rate taxpayers who report positive donations. We implement the standard first-pound price instrument and take disposable income (net of donations) as exogenous. The estimates are reported in Table 2.[28] The first three specifications include only $\ln p_{it}$ as a regressor, and the last three also include $\ln y_{it}$. Specification (1) includes only individual fixed effects, (2) adds year fixed effects, and (3) additionally includes controls for gender, age squared and using a tax advisor. We follow a similar progression in columns (4)–(6). In all specifications, we cluster standard errors at the individual level.

Looking across all specifications, we see that $\varepsilon_{INT}$ is always negative and highly significant. The estimate is sensitive to the inclusion of year effects.[29] Once these are included, the estimate is stable around −0.21 when not controlling for income (columns 2–3), and around −0.17 when controlling for income (columns 5–6).

Table 3 reports estimates of Eq. (3) to evaluate the extensive-margin elasticity, following the same structure as the previous table. We report both the coefficients $\beta, \gamma$ in Eq. (3) and the associated elasticities $\varepsilon_{EXT}$, $\eta_{EXT}$, evaluated at the mean value of all the explanatory variables.[30] These regressions include all higher-rate taxpayers, not only donors, and therefore have a much larger number of observations than those of Table 2.

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

As noted in the Introduction, this specification may not properly capture extensive-margin responses if there are fixed costs of claiming deductions, leading some donors to not report any donations. We discuss this issue at length in Section 4.

### 3.3. Results from the differenced specification

Here, we report the estimates of Eq. (5), where we estimate the effects of log changes in price and income on the log change in donations over a period of time, using the instrument for the log change in price described above. Table 4 reports the results in three different panels for the cases of one-, two-, and three-year differences ($k = 1, 2, 3$). For each case, we show four different specifications, all of which include both individual and year fixed effects. In the first two specifications, we only include the price variable, while in columns (3) and (4) we include the change in log net disposable income, $\ln(y_{it}/y_{i,t-k})$ (assuming zero donations). In each case, we report results with and without the additional controls for age squared, gender and the use of a tax advisor.

In the specifications where we do not control for the change in log income, the price elasticity $\varepsilon_{INT}$ becomes smaller (in absolute value) as we increase the lag over which changes are calculated. However, when we include the change in log income, $\varepsilon_{INT}$ becomes highly significant and stable across all lags $k$, at a value between −0.21 and −0.32. The income elasticity $\eta_{INT}$ is also highly significant and stable across all lags $k$, at values of between 0.13 and 0.21. These estimates are similar but somewhat larger in absolute value than those obtained with the standard specification in Table 2.

[28] Table A.2 in the online Appendix reports the results for the OLS specification. As predicted by our theoretical framework, the OLS estimates of $\varepsilon_{INT}$ are biased upwards compared to the IV estimates, yielding a positive and significant elasticity in column (6).

[29] One possible explanation for the importance of the year fixed effects in this setting are the trends in charitable giving around the financial crisis, which may have affected high-income taxpayers differently from medium- and lower-income taxpayers. Regressions without year fixed effects assign the entire change in giving by top earners (most affected by the tax increase) to the price change, yielding large price elasticity estimates (around − 0.8). Once we control for year fixed effects, we isolate the price effects and the elasticity estimates become smaller in absolute value.

[30] We report the OLS estimates for this specification in Table A.3 in the online Appendix. As in the intensive-margin case, the estimated price elasticities are biased upwards compared to the IV results, although the difference in this case is smaller.

**Table 3**
Extensive-margin elasticity, standard IV specification.

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

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

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

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

### 3.4. Heterogeneous elasticities

In this section, we report estimates of the price and income elasticity of giving by income level. We focus on this dimension of heterogeneity because most donations come from the highest-income taxpayers within the self-assessment group, and therefore they receive most of the tax relief.[31] During our sample period, 55% of donations are made by those above the 95th percentile of the income distribution, and 84% by those above the 75th income percentile.

One challenge to this exercise is that, for reasons explained in Section 2, our main estimation sample only includes taxpayers who were in the higher-rate tax brackets (above £45,000, approximately the 80th percentile of the income distribution) for the period under study. We now include taxpayers below that income threshold, with the caveat that the elasticity estimates for middle and lower income taxpayers could be biased. To construct stable income groups over time, we calculate the average real pre-tax income reported by each taxpayer across the whole sample period, and divide the sample (at the individual level) by percentiles. The first four groups include taxpayers with average income below the 25th percentile of the distribution, between the 25th–50th, 50th–75th and 75th–95th, respectively. The final group includes taxpayers above the 95th percentile.[32]

Table 5 reports the price and income elasticity estimates by income groups for both the intensive and extensive margins. In short, we find that the intensive-margin price elasticity of giving increases with income. Indeed, up to the 50th percentile, we cannot reject the hypothesis that the price elasticity is zero. This is consistent with results from the US (Bakija and Heim, 2011). It is also consistent with the institutional features of the taxation of donations for UK, where basic-rate taxpayers do not have a monetary incentive to report donations on their tax return. Intensive-margin income elasticities also rise with income, but the relationship is flatter.

Regarding 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. These results should be interpreted with some caution because the reporting incentives for basic-rate taxpayers are weak. However, the pattern does suggest that there might be some type of reporting cost preventing some taxpayers from declaring their donations. We return to this issue in Section 4.

### 3.5. Discussion

The total elasticity of giving with respect to price can be calculated by adding up the IV estimates of $\varepsilon_{INT}$ from Tables 2 and 4, and the IV estimates of $\varepsilon_{EXT}$ from Table 3. Regarding the intensive-margin elasticity, $\varepsilon_{INT}$, specifications that include year effects from Table 2 give estimates between −0.16 and −0.22, and specification (4) from Table 4 gives estimates between −0.21 and −0.28. For the extensive margin, specification (6) from Table 3 gives $\varepsilon_{EXT} = -0.09$. Adding these up gives a total price elasticity of giving ($\varepsilon_{INT} + \varepsilon_{EXT}$) between −0.25 and −0.37. This elasticity estimate is significantly different from −1, the "consensus" estimate obtained in US studies, with the notable recent exception of Hungerman and Wilhelm (2016), who obtain estimates similar to ours. In contrast, the estimates are close to the price elasticity found in France by Fack and Landais (2010). Keeping in mind that all prior studies focused exclusively on the intensive-margin elasticity, our findings are clearly towards the lower end of the distribution of available estimates.

It is worth noting that the estimates of the intensive-margin price elasticity obtained with the standard IV strategy from the literature

[31] In online Appendix Table A.4, we report additional heterogeneity analyses by gender and age.

[32] The average pre-tax incomes at the relevant percentiles are $p25 = 8389$, $p50 = 17,126$, $p75 = 33,747$, and $p95 = 96,163$.

**Table 4**
Intensive-margin elasticity: regressions in differences (IV).

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

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

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

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); $\alpha_i, \alpha_t$ 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. Statistical significance: *** = 1%, ** = 5%, * = 10%.

and our differenced specification are quite similar. The latter yields a slightly larger (in absolute value) intensive-margin price elasticity. Another interesting finding is that the estimated intensive-margin elasticity becomes larger as we increase the length of the time differences (from one to three years), suggesting that taxpayers may 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 retiming 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 et al. (2002).

In the online Appendix, we consider three potential issues that could affect our estimates: dynamic donation responses, potential bias due to taxpayers bunching at kink points and selection bias due to censoring. To account for dynamic responses, we explore specifications including leads and lags of the price and income variables. To ensure that bunching at kink points does not affect the estimates in a substantial way, we exclude taxpayers within £2000 intervals around each kink point. The results from these alternative specifications, reported in Tables A.5 and A.6, are again broadly in line with our main elasticity estimates. To deal with the potential selection bias of our intensive-margin elasticity estimates, we implement a Heckman-style two-step procedure proposed by Wooldridge, 1995. Even though there is some evidence of selection into giving, the alternative estimates of the intensive-margin price elasticity of giving are in the range between −0.20 and −0.26, in the same ballpark as our main estimates (see Table A.8).

## 4. Structural estimation

### 4.1. Theoretical framework

There are two possible reasons why we observe a zero deduction for charitable giving in our data. One is simply that the individual decides not to donate anything. The other is that a donation is made, but due to compliance costs or some other optimization friction, the deduction is not reported on the tax return. As already discussed in the Introduction, there is evidence that the second possibility is important in practice.

In this section, motivated by Gillitzer and Skov (2018), we develop a model with a simple lump-sum cost of deducting any donation. This fixed cost captures the attention and money costs of keeping track of and documenting the donations. We then implement a simulated method of moments procedure to estimate the structural parameters of this model, including the fixed cost.

We model an individual $i$ who values consumption $c_i$, her own donation to charity $g_i$, and aggregate donations $G$. This is reflected in the following utility function:

$$U(c_i, g_i, G) = c_i - D_i K + \theta_i \frac{g_i^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}} + V(G). \tag{6}$$

Also, we assume that $\gamma > 0$ and that $V$ is strictly increasing and concave. The dependence of utility on $g_i$ and $G$ via $u$ and $V$ captures warm glow and altruistic motives for giving respectively, as in Saez (2004).

**Table 5**
Heterogeneous elasticities by income range: intensive and extensive margins.

| | Dep. Var.: Change in Log Donations ($\ln g_{it}/\ln g_{i,t-k}$) | | | | |
|---|---|---|---|---|---|
| **Intensive Margin** | $p0$–$p25$ (1) | $p25$–$p50$ (2) | $p50$–$p75$ (3) | $p75$–$p95$ (4) | $p95$–$p100$ (5) |
| Change in Log First-Pound Price | 0.089 | −0.048 | −0.055** | −0.098*** | −0.220*** |
| | (0.065) | (0.043) | (0.025) | (0.013) | (0.028) |
| Change in Log Disposable Income | 0.045*** | 0.077*** | 0.088*** | 0.100*** | 0.114*** |
| | (0.004) | (0.004) | (0.003) | (0.003) | (0.004) |
| Individual FE | y | y | y | y | y |
| Year FE | y | y | y | y | y |
| Other controls | y | y | y | y | y |
| Observations | 100,089 | 526,510 | 1,483,141 | 2,167,162 | 909,509 |
| R-squared | 0.005 | 0.007 | 0.006 | 0.007 | 0.007 |
| | Dep. Var.: Donor Dummy I ($g_{it} > 0$) | | | | |
| **Extensive Margin** | $p0$–$p25$ (1) | $p25$–$p50$ (2) | $p50$–$p75$ (3) | $p75$–$p95$ (4) | $p95$–$p100$ (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, $\varepsilon_{EXT}$* | −1.583*** | −0.998*** | −0.455*** | −0.270*** | −0.170*** |
| | (0.018) | (0.010) | (0.005) | (0.002) | (0.004) |
| *Implied Income Elasticity, $\eta_{EXT}$* | 0.091*** | 0.092*** | 0.079*** | 0.075*** | 0.076*** |
| | (0.002) | (0.001) | (0.001) | (0.001) | (0.001) |
| Individual FE | y | y | y | y | y |
| Year FE | y | y | y | y | y |
| Other controls | y | y | y | y | y |
| Observations | 13,772,160 | 18,005,842 | 19,684,814 | 15,780,001 | 4,607,184 |
| Unique IDs | 3,385,342 | 3,422,862 | 3,434,745 | 2,757,835 | 699,679 |
| R-squared | 0.002 | 0.006 | 0.010 | 0.022 | 0.037 |

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

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

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

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

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

Here, in addition to variables already defined, $c_i$ is private consumption, and $\theta_i$ is a taste parameter measuring the strength of $i$'s warm glow motive.

Finally, $D_i = 1$ if the individual chooses to deduct $g_i$ from taxable income and $D_i = 0$ otherwise, and $K$ is the fixed cost, in units of private consumption, of making a deduction in its tax return. So, the reported deduction on the tax return is $g_i$ only if $D_i = 1$, and 0 otherwise. This fixed cost is the main focus of our analysis and captures the attention and money costs of keeping track of and documenting the donations.[33]

As we are modelling the UK tax system, donations are assumed fully deductible from taxable income. With this in mind, we can write the individual's budget constraint as follows:

$$c_i + g_i = y_i - D_i T(y_i - g_i) - (1 - D_i) T(y_i). \tag{7}$$

Here, $y_i$ is exogenous income, and $T(z)$ the income tax liability given any taxable income $z$. This budget constraint implies that if $D_i = 0$, the marginal price of giving an additional pound is 1, and if $D_i = 1$, the marginal price is one minus the marginal tax rate i.e. $1 - T'(y_i - g_i)$.

We now turn to the individual's optimization problem. Following Saez (2004), we assume that each individual is so small that she ignores her own contribution to aggregate donations $G$, and so the term $V(g)$ can be ignored.[34] Also, because utility is quasi-linear in private consumption, we can substitute Eq. (7) into Eq. (6) to write the individual's optimization problem as:

$$\max_{g_i, D_i} \left\{ y_i - g_i - D_i K - D_i T(y_i - g_i) - (1 - D_i) T(y_i) + \theta_i \frac{g_i^{1-\frac{1}{\gamma}}}{1 - \frac{1}{\gamma}} \right\}. \tag{8}$$

[33] To rule out a particular type of corner solution, we assume that everyone donates at least £1, regardless of whether they claim. One example of a popular small donation made by many people in the UK is grocery stores' charity collection box.

[34] This term comes into play in Section 5.

To characterize the solution to this problem, note first that it is clear from Eq. (8) that the deduction decision for a given donation is:

$$D_i = \begin{cases} 1, & T(y_i) - T(y_i - g_i) \geq K \\ 0, & T(y_i) - T(y_i - g_i) < K \end{cases}. \tag{9}$$

That is, the individual decides to deduct only if the tax saving from doing so exceeds the fixed cost.

We now turn to the optimal level of donations. Note from Eq. (9) that if $g_i$ is very small, the tax saving from deducting does not cover the compliance cost, as long as the tax function $T(\cdot)$ is strictly increasing in taxable income. This implies that conditional on deduction being observed, $g_i$ must exceed a strictly positive lower bound. However, we cannot solve for $g_i$ in closed form, because the tax schedule $T(\cdot)$ for the UK is non-linear.

We proceed by using this model to simulate the choice of $g_i$ and $D_i$ of 200,000 individuals whose income is drawn from nine different income groups given by our income data, and whose generosity parameter is drawn from a lognormal distribution. Formally, we assume

$$\theta_i = \exp(\mu + \xi_i), \xi_i \sim \mathcal{N}(0, \sigma^2). \tag{10}$$

Then, for this simulated data, we calculate the average $\ln g_i$ and $D_i$ for the pre-reform period. We also compute the regression coefficients $\varepsilon_{INT}$ in Eq. (2) and $\beta$ in Eq. (3) on our simulated data. In particular, we run the regression Eqs. (2) and (3), on our simulated data, using the first-pound price as an instrument. These regression coefficients will be the second set of moments that we wish to fit. The idea is to be able to fit our model to both (i) the pre-reform data; (ii) the intensive- and extensive-margin responses to the exogenous change in the tax price of giving caused by the reform, as measured by $\varepsilon_{INT}$ and $\beta$.

We then choose the structural parameters $(\gamma, K, \mu, \sigma)$ to minimize the weighted distance between the simulated and empirical moments. While each of the simulated moments depends on multiple parameters, we can give an intuitive idea of how each moment relates to each of the parameters of interest.

Our main parameters of interest are the fixed cost of declaring donations, $K$, and the elasticity of giving, $\gamma$. The share of individuals declaring their donations and the extensive-margin elasticity response of individual declaration decisions identify $K$. The coefficients on the cost of giving for the two IV regressions identify $\gamma$. The parameters that capture the distribution of generosity across the population are pinned down by the average amount of giving (conditional on giving) and the share of the population declaring their donations.

### 4.2. Estimation and results

We estimate the full model that we have laid out in Section 4.1 using an indirect inference approach (Gallant and Tauchen, 1996; Gourieroux et al., 1993). In our method of simulated moments (MSM) procedure, we simulate individuals over unobserved $\xi_i$ characteristics and use the percentiles of the income distribution in the population of self assessment tax returns to place simulated individuals in different tax brackets. We then minimize the weighted distance between the moments from our simulated data and the moments from the population of self assessment tax returns. Our structural estimates minimize the MSM criterion function, which takes the form:

$$L(\Theta) = h(\Theta)' W_N h(\Theta) \tag{11}$$

where $\Theta = (K, \gamma, \mu, \sigma)$ is the vector of structural parameters of interest. $h(\Theta)$ is the vector of $M$ moment conditions constructed as the difference between simulated moments computed over $S$ simulated individuals and empirical moments computed over the population of self assessment tax returns composed of $N$ individuals. As the weight matrix, we use the diagonal elements of the inverse variance-covariance matrix of empirical moments. For simplicity, and to assist identification, we set $\sigma$ equal to $\mu$. [35] All estimates are highly statistically significant.

For identification, we exploit the exogenous policy reforms in 2010 and the different prices of giving at different marginal tax rate brackets in the income tax schedule. The introduction of an additional marginal tax rate bracket for high-income earners, coupled with the removal of the personal allowance for individuals with incomes greater than £100,000 (thereby creating an additional bracket with a 60% tax rate) render our reduced-form difference-in-difference estimates from Section 3 suitable moments to match with the corresponding moments in simulated data.

Analogous to our preferred reduced-form estimates, we use the first-pound price of giving as instrument for the price of giving in the auxiliary regressions of (i) log of reported donations on the price of giving to identify $\gamma$ and (ii) the positive declaration dummy on the price of giving to identify the cost of declaring donations, $K$. The average generosity parameter $\mu$ and the dispersion of generosity across individuals in the population, $\sigma$, are identified by the cross-sectional variation in donations, which we capture using the mean and the median of the pre-reform level of reported donations. In addition, we use the share of individuals declaring their donations to help in identifying $K$. This mapping between the matched moments and estimated parameters is intuitive, but more generally, each moment is also related to the other elements of $\Theta$.

We obtain our estimates using a combination of quasi-MCMC (Chernozhukov and Hong, 2003) and the simplex method of Nelder and Mead (1965). We construct standard errors using the standard GMM gradient formula. We present our estimation results for the structural model in Table 6. The estimated fixed cost of declaring donations to the tax authority is £47, amounting to around 10% of the average declared donations in our data. This is a substantial cost which arises from a combination of inattention on the part of the taxpayers and the red tape involved in gathering the necessary paperwork related to Gift Aid in self assessment tax returns. It is also worth noting that this estimate of £47 is close to Gillitzer and Skov 's (2018) estimate of the average annual value of forgone tax benefits due to under-deduction of around US $59.

Using our structural model, a counterfactual policy experiment that eliminates this cost shows that absent the fixed cost of giving, the average donation would increase by 18%. Our estimated intensive-margin elasticity of giving is 0.14, which is close to, but slightly smaller than our reduced-form estimates. Finally, we estimate that the average generosity $\mu$ is around 16.

Our simulated moments are very close to their empirical counterparts. Empirically, we observe in the pre-reform period that 10.3% of the population declare their donations, compared with our simulation, where 9.9% declare their donations. In simulated data, the average log gross donations is 6.4, compared with 6.1 in the data. As our empirical moments that capture the coefficients on the price of giving in Eqs. (2) and (3), we use the regression coefficients in the first columns of Tables 2 and 3 (−0.89 and −0.74, with simulated counterparts −3.71 and −0.72, respectively). Our simulated moments are qualitatively similar to these estimates, with a larger magnitude on the simulated counterpart for the estimated price coefficient in Eq. (2). This should not surprise us given the static nature of our model rather than a more complex dynamic framework.

[35] This simplification does not have a substantive impact on the main parameters of interest.

**Table 6**
Estimates of structural parameters.

| | |
|---|---|
| Cost of declaring donations ($K$) | 46.699*** |
| | (0.075) |
| Elasticity of giving ($\gamma$) | 0.142*** |
| | (0.0003) |
| Average generosity across the population ($\mu$) | 15.960*** |
| | (0.725) |

Notes: This table reports the estimated structural parameters following the model and estimation methodology as described in Section 4. Standard errors in parentheses. Statistical significance: *** = 1%, ** = 5%, * = 10%.

## 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. The theoretical framework is an extension of our structural model, which allows us to use the structural estimates obtained in the previous section. Our analysis shows that standard results on the optimal level of the subsidy to charitable giving (e.g., Roberts, 1984; Saez, 2004) have to be modified when there is an optimization friction that makes reporting donations costly.

As in Section 4.1, we allow for a number of individuals $i$ indexed by a taste parameter $\theta_i$, which measures the individual's preference for donations. Each individual is assumed to have utility as in Eq. (6), but we generalize by allowing utility over donations, $u(\bullet)$, to be any strictly concave function, not just an iso-elastic one i.e.

$$U(c_i, g_i, G) = c_i - D_i K + \theta_i u(g_i) + V(G). \tag{12}$$

We also assume for simplicity that the tax system is proportional, with marginal tax $\tau$, so the budget constraint Eq. (7) simplifies to

$$c_i + D_i p g_i + (1 - D_i) g_i = p y_i,\ p = 1 - \tau, \tag{13}$$

where as before, $D_i = 0, 1$ records the decision to deduct.

In this setting, we can solve out for the individual's optimal donation and deduction decisions as functions of $p$. With these in hand, we can define a government objective $W$ in a standard way as the sum of indirect utility of all individuals, minus the cost of the tax subsidy to giving and any direct government grant $B$ to the charity. Note that $W$ takes into account both the "warm glow" benefit from giving via $\theta u(g)$ and the altruistic benefit via $V(G)$. All this is relatively standard and the exact formula for $W$ is given in Appendix A to the paper.

In Appendix A, we then develop a condition under which a decrease in the price (increase in the subsidy to charitable giving) will raise welfare, i.e., $\frac{dW}{dp} < 0$. To state this condition, we first define $g^0$ and $g^1$ as aggregate undeclared and declared donations respectively. [36]

Then, the condition says that the overall elasticity of declared donations with respect to the price $p$ needs to be large enough. Formally:

$$\varepsilon \geq \frac{\lambda - 1}{\lambda} + \frac{g_p^0}{g^1}, \varepsilon = -\frac{p g_p^1}{g^1}. \tag{14}$$

Here, $\lambda$ is the marginal cost of public funds, and $g_p^0, g_p^1$ are the derivatives of $g^0, g^1$ respectively with respect to $p$. Moreover, as shown in Appendix A, the overall elasticity $\varepsilon$ can be split into sum of the absolute value of $\varepsilon_{INT}$ and $\varepsilon_{EXT}$, where $\varepsilon_{INT}$ and $\varepsilon_{EXT}$ are defined as above:

$$\varepsilon = |\varepsilon_{INT}| + |\varepsilon_{EXT}|. \tag{15}$$

Condition (14) is a generalization of Roberts ' (1984) well-known condition, which says that an increase in the subsidy induces an increase in donations bigger than the cost of the subsidy iff $\varepsilon \geq 1$. It is a generalization in three ways. First, it allows for a weight on individual welfare, not just on government revenue, by allowing $\lambda < \infty$.

Second, it includes the term $\frac{g_p^0}{g^1} > 0$, which makes the condition on the elasticity tighter. This is because in our setting, due to the cost $K$, a decrease in $p$ will cause fewer individuals to make donations but not deduct them. This unambiguously reduces the government's payoff because (i) the government has to increase the direct grant $G$ to compensate in order to keep $V' = \lambda$; (ii) it also increases the revenue cost to the government as deductions increase.

Third, it includes the extensive-margin elasticity as part of the formula via Eq. (15). To our knowledge, the role of the extensive-margin elasticity in determining the condition for welfare-improving subsidies has not been noted before. While this point is theoretically straightforward, it has important policy implications. Specifically, calculations that ignore the extensive-margin elasticity will be biased against finding conditions under which the government should offer additional subsidies to charitable giving.

To check condition (14) for the UK, we can proceed as follows. First, from Section 3.5 above, the value of the sum of the absolute values of $\varepsilon_{INT}$ and $\varepsilon_{EXT}$ from our main estimates is between 0.25 and 0.37; from Eq. (15), this is our range of values for $\varepsilon$.

To calculate $(\lambda - 1)/\lambda$, we use Kleven and Kreiner (2006), which is a well-known study that estimates the marginal cost of public funds for the UK, allowing for both intensive- and extensive-margin responses to income taxes, and also for these responses to vary across the income distribution. This study gives a range of values for $\lambda$ of between 1.13 and 1.36 for a proportional change in the income tax across all brackets, yielding a range of values for $(\lambda - 1)/\lambda$ of 0.12 to 0.27.

As a final step, using our structural estimates, we can evaluate $\frac{g_p^0}{g^1}$ by considering a small shift of size $\delta$ in the marginal tax rate across the tax schedule. Given our discrete choice approach, the choice of $\delta$ is an important one, and we evaluate $\frac{g_p^0}{g^1}$ at the smallest possible $\delta$ that induces a shift in the share of taxpayers declaring their donations. We obtain an estimate of 0.01 for $\frac{g_p^0}{g^1}$.

So, it seems that condition (14) generally holds in the UK case. This implies that there is a case for increasing the subsidy to charitable giving in the UK. However, it should be noted that such a reform will be at a net financial cost to the government, as condition (14) does not hold at $\lambda = \infty$ in the UK case. It should also be noted that this conclusion is conditional on some other assumptions of the model, for example that the government views private donations and government support for charity as perfect substitutes. [37]

## 6. Conclusions

In this paper, we have analyzed an administrative panel of UK income tax returns for the period 2005–2013 to identify intensive-

[36] In deriving this condition, we assume, following Saez (2004), that the government can optimize its own lump-sum grant $B$ to the charity.

[37] It may be, for example, that the government views private contributions as less valuable than direct government support. This may be due to a paternalistic component of government objectives ("merit goods"), or due to a divergence between donors' preferences and the preferences of a majority-elected government (Horstmann and Scharf, 2008). This could be captured formally by weighting private contributions by $\alpha < 1$ in the function $V$ in the online Appendix.

and extensive-margin donor responses to the tax price of charitable giving. Using the 2010 major tax reform of the UK income tax schedule as a source of exogenous variation in the tax price, we have estimated the price elasticity of giving using reduced-form methods, obtaining an intensive-margin elasticity estimate in the range between −0.16 and −0.28 and an extensive-margin elasticity of about −0.09, yielding a total elasticity between −0.25 and −0.37.

Motivated by the low proportion of self-assessment taxpayers reporting charitable donations (11%) compared to available survey evidence for the UK suggesting that this proportion is about 60% in the population, we developed a structural model that incorporates the cost of declaring donations in the taxpayers' optimization problem. Using this structural model, we estimate that the fixed cost of declaring donations is £47, amounting to about 10% of the median declared donations in our data.

For our welfare analysis, we extended the theoretical framework of Saez (2004) to allow for extensive-margin giving and for a fixed cost of declaring donations. Taking into account these factors, and well-established estimates of the marginal cost of public funds for the UK, there is a case for increasing the subsidy on charitable giving in the UK.

## Appendix A. Derivation of Eqs. (14) and (15)

For convenience, we assume a continuum of individuals indexed by a taste parameter $\theta$ distributed continuously on the interval $\left[\underline{\theta}, \bar{\theta}\right]$, with density $f(.)$. All individuals are assumed to have the the same income $y$ for convenience. An individual of type $\theta$ will then choose $g$ and $D$ to maximize individual utility with $c$ substituted out via the budget constraint i.e. will maximize

$$\theta u(g) - Dpg - (1-D)g + py. \tag{A.1}$$

Define $g(p;\theta), g(1;\theta)$ to be the optimal levels of donation for choices $D = 1, 0$ respectively. The first argument of $g$ is the price of donating e,g, if $D=0$ then the price is 1. Then, we can write indirect utility for a donor of a type $\theta$, not including the fixed cost of making a deduction, or the term $V(g)$, as

$$v(p;\theta) = \theta u(g(p;\theta)) - pg(p;\theta),\ \ v(1;\theta) = \theta u(g(1;\theta)) - pg(1;\theta) \tag{A.2}$$

depending on whether they deduct or not. Then, it is easy to check that the individual of type $\theta$ will deduct iff

$$\Delta v(p;\theta) \equiv v(p;\theta) - v(1;\theta) \geq K. \tag{A.3}$$

It is then easy to see from Eqs. (A.2) and (A.3), using the properties of the indirect utility function, that

$$\frac{\partial \Delta v}{\partial \theta} = u(g(p;\theta)) - u(g(1;\theta)). \tag{A.4}$$

We will assume a "single-crossing" condition that the RHS of Eq. (A.4) is strictly increasing in $\theta$. This certainly holds for the iso-elastic specification of $u(.)$ of the structural model. Note also that without further restrictions on $u(.)$, $g(1;\theta) = 0$ is possible for $\theta$ low enough i.e. the individual may decide to make a zero donation. Then, there are values $\theta', \theta''(p)$ such that (i) individuals with $\theta \leq \theta'$ give nothing; (ii) individuals with $\theta \in (\theta', \theta''(p)]$ donate but do not declare; and (iii) individuals with $\theta > \theta''(p)$ donate and declare. In particular, $\theta''(p)$ is defined by

$$v(p;\theta'') - v(1;\theta'') = K$$

and so clearly, as $p$ rises, the benefit of declaring declines, so $\theta''$ is increasing in $p$. This is the extensive-margin response to the price of giving.

We now turn to identifying conditions under which the price of giving should be increased or decreased. As a first step, note that the aggregate donation to the charity, $G$, can be written

$$G = g^0(p) + g^1(p) + B, \quad g^1(p) = \int_{\theta''(p)}^{\bar{\theta}} g(p;\theta) f(\theta) d\theta,$$
$$g^0(p) = \int_{\theta'}^{\theta''(p)} g(1;\theta) f(\theta) d\theta$$

where $g^0(p), g^1(p)$ are total donations by non-declarers and declarers respectively, and $B$ is a government grant. The government's objective is then

$$W = V(G) + \int_{\theta''(p)}^{\bar{\theta}} (v(p;\theta) - K) f(\theta) d\theta + \int_{\theta'}^{\theta''(p)} v(1;\theta) f(\theta) d\theta - \lambda[(1-p)g^1(p) + B] \tag{A.5}$$

where $\lambda$ is the marginal cost of public funds. This is the integral of utilities across all types, minus the revenue cost of the subsidy, $(1-p)g^1(p)$, and the direct grant $B$, to the government. Note that only donations that are declared and thus attract the subsidy are costly in terms of public funds.

Now using Eq. (A.5), consider the effect of a small tax reform $dp$ on welfare:

$$dW = V'(g_p^0 + g_p^1)dp - g^1 dp - \lambda[-g^1 + (1-p)g_p^1]dp \tag{A.6}$$

where the $p$ subscript denotes a derivative with respect to $p$ and where we now suppress the dependence of $g^0, g^1$ etc. on $p$. So, we see from Eq. (A.6) that there are three effects of an increase in the price: first, aggregate provision of the public good is decreased; second, individual welfare is directly lowered, as the subsidy to giving is lower; third, the government subsidy to charitable giving is affected, measured by the term in the square brackets.

We further assume, following Saez (2004), that the grant $B$ is chosen optimally by government i.e. $V' = \lambda$ in which case Eq. (A.6) simplifies to

$$dW = \lambda(g_p^0 + g_p^1)dp + (\lambda - 1)g^1 dp - \lambda(1-p)g_p^1 dp. \tag{A.7}$$

So, from Eq. (A.7), after some manipulation, we see that a decrease in the price i.e. increase in the subsidy to charitable giving will raise welfare, i.e. $\frac{dW}{dp} < 0$ if

$$\varepsilon \geq \frac{\lambda - 1}{\lambda} + \frac{g_p^0}{g^1}, \quad \varepsilon = -\frac{pg_p^1}{g^1} \tag{A.8}$$

which is Eq. (14) in the paper, as required.

Finally, to derive Eq. (15), we differentiate $g^1(p)$ with respect to $p$ to get:

$$g_p^1 = \int_{\theta''(p)}^{\bar{\theta}} g_p(p;\theta) f(\theta) d\theta + g(p;\theta'') f(\theta'') \frac{\partial \theta''}{\partial p}. \tag{A.9}$$

After some straightforward rearrangement, we get

$$\varepsilon = -\frac{pg_p^1}{g^1} = -\frac{p}{g^1} \int_{\theta''(p)}^{\bar{\theta}} g_p(p;\theta) f(\theta) d\theta - \frac{p}{g^1} g(p;\theta'') f(\theta'') \frac{\partial \theta''}{\partial p}. \tag{A.10}$$

The first and second terms on the RHS of Eq. (A.10) are the absolute values of the (negative) intensive-margin and extensive-margin elasticities respectively.

## Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpubeco.2019.104114.

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