Estimating Effect of Tax Incentives on Charitable Giving Considering Self-Selection of Tax Relief in South Korea

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Tax Incentives on Donations

- Governments set a tax relief for charitable giving
  - if subsidizing charitable giving induces a large increase in donations, it is desirable for public good provision.
- Key parameter to evaluate social welfare: the price elasticity of charitable donations (Saez, 2004)
  - giving price: relative price to the private consumption

Literatures: Price Elasticity of Giving

- Large empirical literatures examining the giving price elasticity estimate log-log demand function to derive the giving price elasticity
- Two types of data
  1. tax filing data: Randolph, 1995; Auten et al., 2002; Fack and Landais, 2010; Bakija and Heim, 2011; Almunia et al., 2020
  2. panel survey data: Rehavi and Shack, 2013; Yoruk, 2013; Zampelli and Yen, 2016; Backus and Grant, 2019
- Issue: Although many of these papers consider the endogeneity issue such as the endogenous change of the marginal tax rate by the amount of giving, they pay less attention to the problems caused by the fact that tax payers have to declare their charitable giving to receive tax relief on charitable giving.

Literatures: Tax Compliance

- Existence of compliance costs to apply measures of tax relives because everyone will apply the measures if there is no compliance cost.
  - tax payers apply the measures of tax relives only if their benefits from the measures exceed the compliance costs.
- Recent papers insist this point and suggest that the measures of tax relives may not work as the policy makers expected
- They also suggest compliance costs (e.g. record-keeping cost and a fee for accountants) are considerably high.
  - individual income tax (Benzarti, 2020); corporate income tax (Zwick, 2021); charitable giving (Fack and Landais, 2016;Gillitzer and Skov, 2018; Almunia et al., 2020)

What Our Paper Did

- We bridge price elasticity of giving and self-selection of tax incentive
  - As long as we know, there is no paper in the literature of giving price elasticity consider the self selection problem
- We estimate the giving price elasticity using the South Korean (Korea, hereafter) survey panel data called the National Survey of Tax and Benefit (NaSTaB)
- Why South Korea?
  1. Compliance costs for wage earners and self-employed workers are different (IV)
  2. We could consider the sample of low-income households, which are sometimes omitted from the tax filer data.
  3. We can exploit the South Korean tax reform in 2014 as a main identification strategy of price change (income deduction $\rightarrow$ tax credit)

What Our Paper Found

Using the IV representing the compliance cost,

1. Intensive-margin price elasticities are in the range between XXX and XXX
   - FE model w/o IV: XXX (similar value to the estimates in the existing literature)
2. Extensive-margin price elasticities are in the range between YYY and YYY
   - FE model w/o IV: YYY

We examine well-known issues in the robustness check

- intensive-margin tax-price elasticities are in the range of -2 and -1.5
- extensive-margin tax-price elasticities are in the range of -5 and -1.7

Institutional background and Sources of Endogeneity

Framework

Consider that a household with pre-tax income y_i has a choice between private consumption x_i and charitable giving g_i.

Their budget constraint can be shown as

$$x_i + g_i = y_i - R_i K_i - R_i T(y_i, g_i) - (1 - R_i) T(y_i). \tag{1}$$

- T is tax amount which depends on the pre-tax income and charitable giving. Assume $T_y(\cdot) > 0$ and $T_{yy}(\cdot) > 0$.
- R_i is the dummy which takes 1 if i declares the tax relief and 0 otherwise.
- K_i is a fixed compliance cost for the declaration of charitable giving.
  - In the literature about the giving price elasticity, most of papers implicitly assume $R_i = 1$ and $K_i = 0$.

Decision Rule of Tax Relief

$$R_i = \begin{cases} 1 \text{ if } T(y_i, g_i) + K_i < T(y_i) \\ 0 \text{ if } T(y_i, g_i) + K_i \geq T(y_i). \end{cases} \tag{2}$$

where

$$T(y_i, g_i) = \begin{cases} T(y_i - g_i) & \text{if tax relief is applied by income deduction.} \\ T(y_i) - mg_i & \text{if tax relief is applied by tax credit.} \end{cases} \tag{3}$$

Giving Price

Let us differentiate the budget constraint (1) by x_i and g_i. Then, it derives that the giving price (relative to the private consumption) is $\frac{dx_i}{dg_i} = 1 + R_i T_g(y_i, g_i)$, which we denote p.

$$p = \begin{cases} 1 - R_i T'(y_i - g_i) & \text{if tax relief is applied by income deduction.} \\ 1 - R_i m & \text{if tax relief is applied by tax credit.} \end{cases} \tag{4}$$

Hereafter, let us q to show the amount of tax relief for each declared giving (i.e. $p = 1 - R_i q$ and $q = -T_g(y_i, g_i)$). The government can change q by the tax reform.

Marginal Tax Rate

Table 1: Marginal Income Tax Rate

Income/Year	2008	2009	2010 ~ 2011	2012 ~ 2013	2014 ~ 2016	2017	2018
(A) ~ 1200	8%	6%	6%	6%	6%	6%	6%
(B) 1200 ~ 4600	17%	16%	15%	15%	15%	15%	15%
(C) 4600 ~ 8800	26%	25%	24%	24%	24%	24%	24%
(D) 8800 ~ 15000	35%	35%	35%	35%	35%	35%	35%
(E) 15000 ~ 30000							38%
(F) 30000 ~ 50000				38%	38%	38%	40%
(G) 50000 ~						40%	42%

Notes: Marginal income tax rates applied from 2008 to 2018 are summarized. The income level is shown in terms of 10,000 KRW, which is approximately 10 United States dollars (USD) at an exchange rate of 1,000 KRW to one USD.

Korean Tax System (1)

- To mitigate the administrative cost, the Korean National Tax Service introduce different taxation methods and different ways of giving declaration for wage earners and self-employed workers.
- There is a difference of compliance cost of tax relief between self-employed and wage earners
  - self-employed workers have to understand tax system to precisely populate tax return and retain the certificate until they submit tax return
  - wage earners need not to understand tax system and can submit the certificate at any time.

Korean Tax System (2)

Wage earners:

- Wage earners pay income tax by tax withholding and can declare their giving via their company at anytime
- Instead of them, their company is supposed to close the comprehensive income tax return including giving declaration through year-end settlement

Self-employed workers:

- Self-employed workers have to calculate the amount of income earned during a year and pay income tax through tax return by May of the following year.
- To receive tax relief on charitable giving, they have to submit the certificate of donations when they submit tax return.

2014 Tax Reform (1)

- Before 2014, tax relief on charitable giving is conducted by income deduction in Korea.
  - tax payer facing the higher marginal income tax rate can enjoy the lower giving price for each 1 KRW of donation
- In 2014, aiming at the relaxation of regressivity of giving price, the Korean government reformed tax system, where the tax credit was introduced instead of income deduction.
  - 15% of the total amount of charitable giving has been allowed as a tax credit,

2014 Tax Reform (2)

- Compared to tax credit system, the high income household, whose (average) income tax rate is more than 15%, get benefit from charitable giving under the income deduction system.
- However, middle or low income households would enjoy tax relief in tax credit system more than income deduction system.
- We exploit the variation of giving price brought from the policy change as a main identification source to estimate the giving price elasticity.

Data: National Survey of Tax and Benefit (NaSTaB)

About NaSTaB

- NaSTaB is annual panel data conducted by Korea Institute of Taxation and Finance
- The survey will be administered to 5,634 households from across the country
  - 5,634 heads of household and economically active household members aged 15 and older complete the survey
- Our study uses data from (1) 2013 to 2018 and (2) excluding respondents under the age of 23
  - This is because we focus on the 2014 tax reform

Descriptive Statistics

	N	Mean	Std.Dev.
Income and giving price			
Annual taxable labor income (unit: 10,000KRW)	36189	1747.26	2696.77
First giving relative price	36198	0.86	0.04
Charitable giving			
Annual chariatable giving (unit: 10,000KRW)	36199	35.64	153.20
Dummary of donation > 0	36199	0.24	0.42
Dummy of declaration of a tax relief	36199	0.10	0.30
Individual Characteristics			
Age	36199	53.45	16.22
Female dummy	36199	0.43	0.50
University graduate	36198	0.42	0.49
High school graduate dummy	36198	0.31	0.46
Junior high school graduate dummy	36198	0.27	0.44
Wage earner dummy	27394	0.56	0.50

Income Distribution and Giving Price

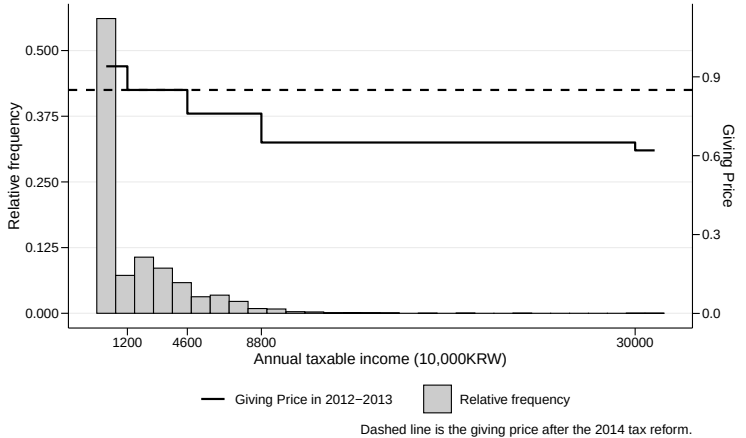

Figure 1: Income Distribution in 2013 and Relative Giving Price. Notes: The left and right axis measure the relative frequency of respondents (grey bars) and the relative giving price (solid step line and dashed line), respectively. A solid step line and a dashed horizontal line represents the giving price in 2013 and 2014, respectively.

Identification of Price Elasticity

We can create three income groups based on a change of tax incentive due to 2014 tax reform.

1. $<$ 120 million KRW
   - expand tax incentive (reduce giving price)
2. [120 million KRW, 460 million KRW]
   - tax incentive did not change
3. $>$ 460 million KRW
   - shrink tax incentive (increase giving price)

Summary of Giving Behavior

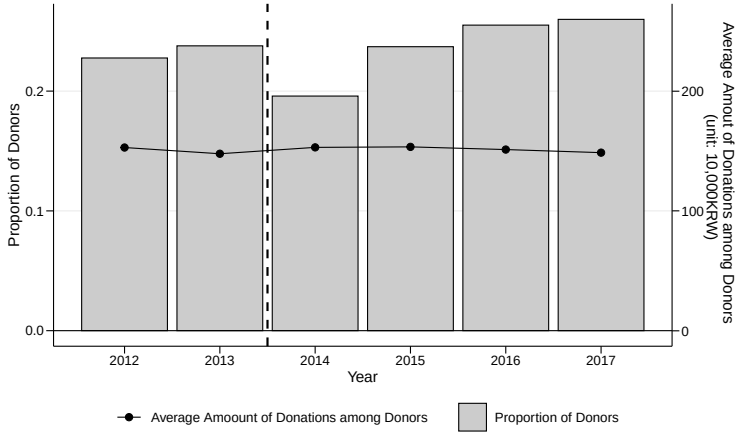

Figure 2: Proportion of Donors and Average Donations among Donors. Notes: The left and right axises measure prooortion of donors (grey bars) and the average amount of donations among donors (solid line), respectively.

Summary of Giving Amount by Three Income Groups

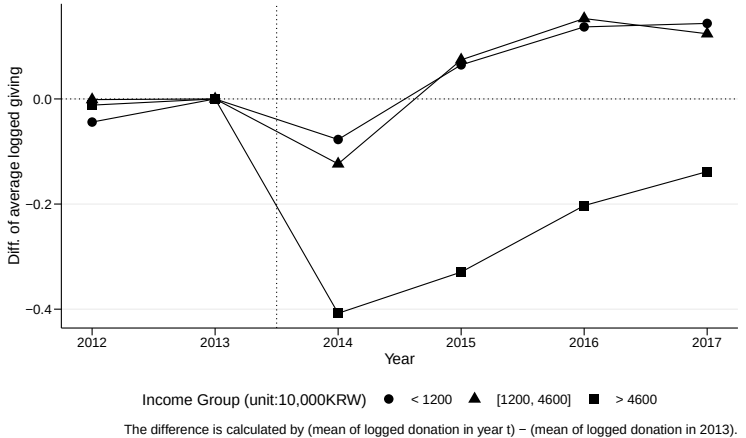

Figure 3: Average Logged Giving by Three Income Groups. Notes: We created three income groups, with the relative price of giving rising (circle), unchanged (triangle), and falling (square) between 2013 and 2014. The group averages are normalized to be zero in 2013.

Summary of Giving Amount by Three Income Groups (Conditional on Donors)

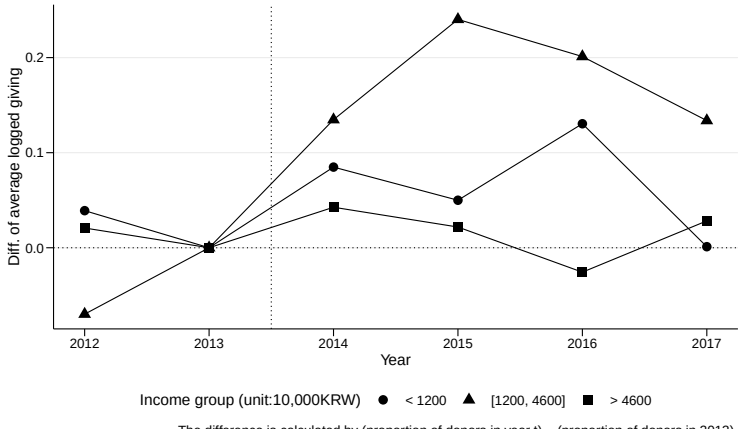

Figure 4: Average Logged Giving by Three Income Groups Conditional on Donors. Notes: We created three income groups, with the relative price of giving rising (circle), unchanged (triangle), and falling (square) between 2013 and 2014. The group averages are normalized to

Summary of Proportion of Donors by Three Income Groups

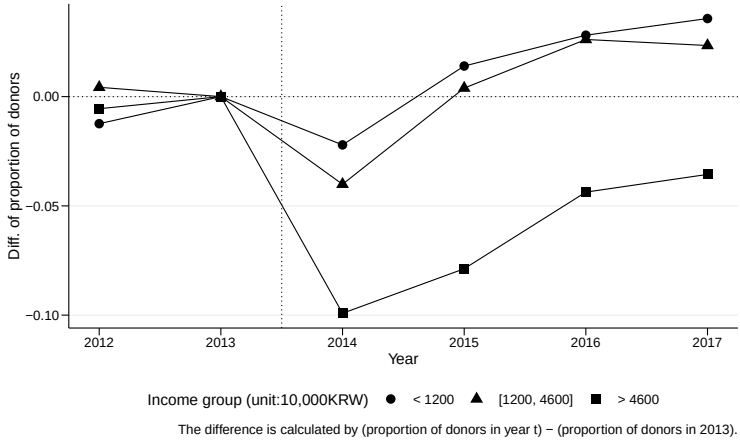

Figure 5: Proportion of Donors by Three Income Groups. Notes: We created three income groups, with the relative price of giving rising (circle), unchanged (triangle), and falling (square) between 2013 and 2014. The group averages are normalized to be zero in 2013.

Distribution of Giving Amount by Application of Tax Relief

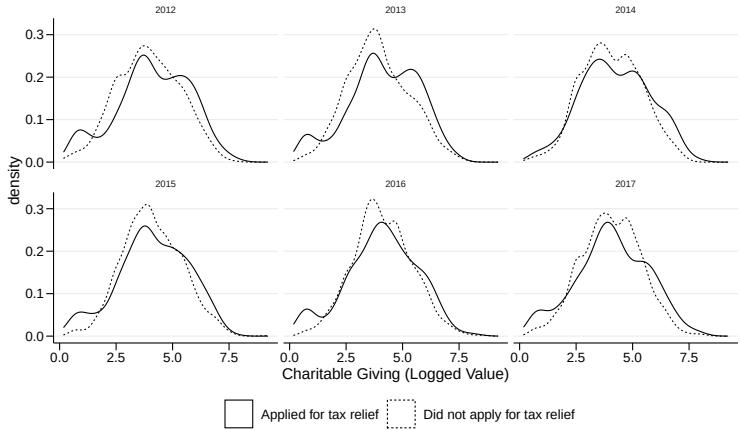

Figure 6: Estimated Distribution of Charitable Giving among Donors in Each Year

Compliance Rate by Wage Earners or Not

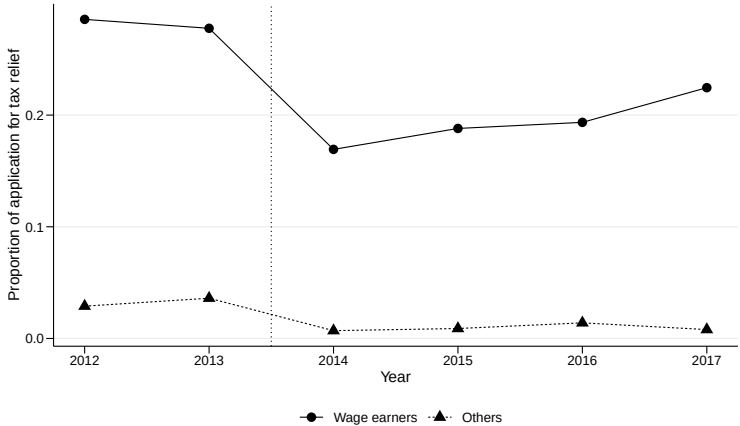

Figure 7: Share of Tax Relief by Wage Earners. Notes: A solid line is the share of applying for tax relief among wage eaners. A dashed line is the share of applying for tax relief other than wage earners.

Compliance Rate by Wage Earners or Not (Conditional on Donors)

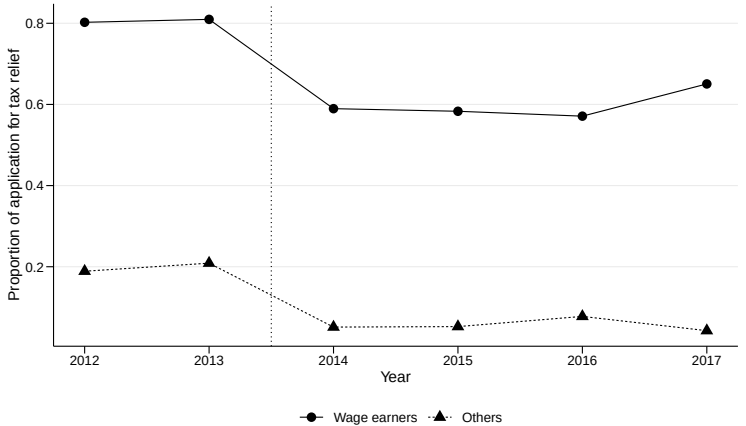

Figure 8: Share of Tax Relief by Wage Earners Conditional on Donors. Notes: A solid line is the share of applying for tax relief among wage eaners. A dashed line is the share of applying for tax relief other than wage earners.

Empirical Strategy

Two Types of Price Elasticity

Following Almunia et al. (2020),

1. Intensive-margin price elasticity: What percentage increase in donor contributions would result from a 1% price increase?
2. Extensive-margin price elasticity: What percentage increase in the donor ratio would result from a 1% price increase?

We use an identification strategy that combines two methods: (1) DID using changes in tax incentives due to the 2014 tax reform and (2) IV that captures whether or not a donation deduction is claimed due to filing costs.

Intensive-Margin Price Elasticity

Two-way FE model:

$$\ln g_{it} = \theta_i + \gamma(R_{it} \times \ln(1 - q_{it})) + \beta X_{it} + \lambda_t + u_{it}, \tag{5}$$

- X_{it} is a vector of covariate including pre-tax income y_{it}
- θ_i and λ_t are individual and time FE, respectively
- u_{it} is idiosyncratic error
- $\ln g_{it}$ is log-valued of amount of donations
- R_{it} is a dummy of application for tax relief
- q_{it} is tax incentive

Extensive-Margin Price Elasticity

$$D_{it} = \theta_i + \delta(R_{it} \times \ln(1 - q_{it})) + \beta X_{it} + \lambda_t + \eta_{it}, \tag{6}$$

- D_{it} is a dummy indicating a donor
- The parameter of interest is δ. Since the outcome variable is binary, this parameter cannot be directly interpreted as elasticity.
- Extensive-margin price elasticity is obtained by $\hat{\delta}/\bar{D}$. ($\bar{D}$ is the sample mean of D_{it})

Two Endogenous Problem

We will discuss how to resolve following two endogenous problems:

1. price depends on giving amount when income deduction is applied
2. self-selection of application for tax incentive

Endogenous Applicable Giving Price

- We use changes in tax incentives due to the 2014 tax reform as an exogenous variation of price
- Endogeneity of prices cannot be completely ruled out because we use data when income deduction was applied.
- The donation price when the tax relief is applied would be as follows:

$$1 - q_{it} = \begin{cases} 1 - T_t'(y_{it} - g_{it}) & \text{if} \quad t < 2014 \\ 1 - m & \text{if} \quad t \geq 2014 \end{cases}, \tag{7}$$

- Price also depends on the amount of the donation (g_{it}) during the period when the income deduction is applied.
  - This is called *last*-unit price

Resolve Endogenous Applicable Giving Price

- Following previous studies, we use *first*-unit price as an alternative to (or as IV for) last-unit price.
- First-unit price is giving price with the donation amount as zero.

$$1 - q_{it}^{f} = \begin{cases} 1 - T_t'(y_{it} - 0) & \text{if} \quad t < 2014 \\ 1 - m & \text{if} \quad t \geq 2014 \end{cases} . \tag{8}$$

- the last-unit price and first-unit price coincide during the period when the tax credit is applied, since the donation price is independent of the donation amount.

Self-Selection of Tax Incentive

- All donors should claim income deduction/tax credit if there is no compliance cost because they can obtain benefit of tax savings
- Our data suggests that compliance cost is likely a major obstacle in application for tax relief.
  - 24% donor, but 10% donors claimed income deduction/tax credit
  - The distribution of donations conditional on donors does not change significantly depending on whether or not the tax relief is applied.

Resolve Self-Selection of Tax Incentive

- We exploit the fact tax system differs between wage earners and self-employed workers, and use a wage earner dummy (WE_{it}) as a proxy for the compliance cost.
  - Self-employed workers have to understand tax system to precisely populate tax return and retain the certificate until they submit tax return
  - Wage earners need not to understand tax system and can submit the certificate at any time.
- It is necessary to assume that this variable is independent of u_{it} and η_{it} conditional on covariates.
  - the correlation between the salaried worker dummy and fixed effects is acceptable.
- We believe that being a salaried employee or not has no direct effect on donation behavior if we control for income and industry.

Three Estimation Methods to Resolve Two Endogenous Problem (1)

1. FE-2SLS with $\text{WE}_{it} \times \ln(1 - q_{it}^f)$ as an IV

$$\ln g_{it} = \theta_i + \gamma(R_{it} \times \ln(1 - q_{it}^f)) + \beta X_{it} + \lambda_t + u_{it}, \tag{9}$$

where $\text{WE}_{it} \times \ln(1 - q_{it}^f)$ is an insturument of $R_{it} \times \ln(1 - q_{it}^f)$

Three Estimation Methods to Resolve Two Endogenous Problem (2)

- Remaining two methods are based on propensity socre.
- Propensity score is obtained by the predicted probability of probit estimation of the following model:

$$R_{it} = 1[\alpha_0 + \alpha_1 WE_{it} + \alpha_2 \ln(1 - q_{it}^f) + \alpha_3 X_{it} + u_{it0} > 0] \tag{10}$$

- The propensity score $\widehat{P}_{it}$ is obtained by estimation using (1) full sample (pooled model) and (2) a subsample divided by years (separated model)
  - The former assumes coefficients are constant with rispect to year
  - The latter allows coefficients to depend on year

Three Estimation Methods to Resolve Two Endogenous Problem (3)

Again,

$$\ln g_{it} = \theta_i + \gamma(R_{it} \times \ln(1 - q_{it}^f)) + \beta X_{it} + \lambda_t + u_{it},$$

Remaining two estimation methods:

2. We use $\widehat{P}_{it} \times \ln(1 - q_{it}^f)$ as an instrument of $R_{it} \times \ln(1 - q_{it}^f)$
3. We use $\widehat{P}_{it} \times \ln(1 - q_{it}^f)$ instead of $R_{it} \times \ln(1 - q_{it}^f)$ as the explanatory variable.

Estimation Results

Main Results: Intensive-Margin Price Elasticity

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(first price)	−0.748***			−1.400***	−1.437***	−1.540***
	(0.225)			(0.411)	(0.363)	(0.375)
PS of applying tax relief x log(first price)		−1.544***	−1.515***			
		(0.388)	(0.367)			
log(income)	1.408	0.833	0.824	0.937	0.909	0.830
	(1.113)	(1.121)	(1.121)	(1.119)	(1.098)	(1.094)
First-stage: Instrument				0.638	1.075	0.984
				[468.1]	[534.6]	[662.2]
Num.Obs.	7004	6975	6975	6975	6975	6975
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at individual level. A square bracket is wald statistics of instrument.

Main Results: Extensive-Margin Price Elasticity

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(first price)	−2.800***			−0.464***	−0.563***	−0.738***
	(0.074)			(0.176)	(0.120)	(0.116)
PS of applying tax relief x log(first price)		−0.452***	−0.566***			
		(0.107)	(0.101)			
log(income)	0.975***	1.950***	1.844***	2.121***	2.072***	1.986***
	(0.233)	(0.279)	(0.278)	(0.279)	(0.261)	(0.256)
Implied price elasticity	-10.799***	-1.741***	-2.181***	-1.788***	-2.169***	-2.841***
	(0.287)	(0.411)	(0.388)	(0.678)	(0.463)	(0.448)
First-stage: Instrument				0.289	0.803	0.768
				[276.6]	[311.7]	[361.9]
Num.Obs.	27 017	26 863	26 863	26 863	26 863	26 863
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Robustness Check

- *Exclude Annoucement Effect*
  - intertemporal substitution due to annoucement of 2014 tax reform
  - We drop observations in 2013 and 2014
  - Estimated elasticity does not change significantly
- *Last-unit Price Elasticity*
  - The acutual price that decision-makers face is *last-unit* (especially, intensive-margin decision)
  - We use first-unit price as an instrument of last-unit one
  - Last-unit price elasticity is more elastic than first-unit price elasticity

Robustness Check (Cont'd)

Use Only Applicants Data

- To discuss mechanism, we estimate price elasticity with only applicants data
  - Since applicants always donate, we cannot estimate extensive-margin price elasticity
- Estimated intensive-margin price elasticity is slightly less elastic than main results.

Interpretation of IV Estimates (1)

- The larger the donation, the greater the tax savings
- Claim and the error term in the estimated model should be positively correlated
- Thus, we expect the elasticity estimated from the FE model to be more elastic than the elasticity estimated from the FE-2SLS model
  - Extensive-margin price elasticity is in line with our conjecture.
  - Intensive-margin price elasticity contradicts our expectation.

Interpretation of IV Estimates (2)

If we assume that price elasticity is heterogenous among tax-payers, FE-2SLS estimates average price elasticity of those who change their application behavior depending on the value of IV (LATE).

Interpretation of IV Estimates (3)

Let $R_{it}(z)$ be a dummy of application if $Z_{it} = z$. Then, assuming monotonicity ($R_{it}(1) \geq R_{it}(0)$), we classify tax-payers into three groups:

1. Never declarer: $R_{it}(1) = R_{it}(0) = 0$
2. Always declarer: $R_{it}(1) = R_{it}(0) = 1$
3. Start declarer: $R_{it}(1) = 1, R_{it}(0) = 0$

Price elasticity estimated by FE-2SLS is average price elasticity among start declarers.

Fraction of Applicants Type: Abadie's Theorem

Abadie (2003) shows

$$Pr[R_{it}(1) = 1, R_{it}(0) = 0] = E(\kappa_{it})$$

where

$$\kappa_{it} = 1 - \frac{R_{it}(1 - Z_{it})}{1 - P(Z_{it} = 1|X_{it})} - \frac{(1 - R_{it})Z_{it}}{P(Z_{it} = 1|X_{it})}$$

Fraction of Applicants Type: Results

Type of applicant	extensive	intensive
$R_{it}(1) = R_{it}(0) = 0$	40.34	21.37
$R_{it}(1) = R_{it}(0) = 1$	0.76	2.85
$R_{it}(1) = 1, R_{it}(0) = 0$	58.90	75.78

Price Elasticity of Three Types

- Never declarer
  - Since their giving price is always 1, intensive- and extensive-margin (within) price elasticity is infinite.
- Always declarer
  - Since they always donate, extensive-margin (within) price elasticity is zero.
  - Intensive-margin elasticity estimated by FE-2SLS is slightly less elastic than estimated by only applicants data.
  - Under monotonicity assumption, only applicants data includes always declarer and start declarer.
  - intensive-margin price elasticity among always declarers is slightly less elastic than among start declarers

Price Elasticity of Three Types

Relationship of price elasticity (in terms of absolute term) among three types:

$$\text{Always} < \text{Start} < \text{Never}$$

- Intensive-margin price elasticity estimated by FE outweigh always declarer and start declarer
  - FE $<$ FE-2SLS (in terms of absolute value)
- Extensive-margin price elasticity estimated by FE outweigh start declarer and never declarer
  - FE-2SLS $<$ FE (in terms of absolute value)

Appendix

Intensive-Margin Price Elasticity: Exclude Annoucement Effect

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(first price)	−0.765**			−1.560**	−1.505***	−1.548***
	(0.351)			(0.609)	(0.479)	(0.490)
PS of applying tax relief x log(first price)		−1.783***	−1.715***			
		(0.569)	(0.542)			
log(income)	0.041	−0.990	−0.955	−0.567	−0.541	−0.561
	(1.460)	(1.477)	(1.467)	(1.440)	(1.427)	(1.418)
First-stage: Instrument				0.638	1.075	0.984
				[468.1]	[534.6]	[662.2]
Num.Obs.	4863	4844	4844	4844	4844	4844
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at individual level. A square bracket is wald statistics of instrument.

Extensive-Margin Price Elasticity: Exclude Announcement Effect

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(first price)	−2.970***			−0.247	−0.607***	−0.744***
	(0.093)			(0.261)	(0.166)	(0.161)
PS of applying tax relief x log(first price)		−0.503***	−0.594***			
		(0.155)	(0.148)			
log(income)	1.134***	1.919***	1.837***	2.260***	2.110***	2.054***
	(0.278)	(0.328)	(0.327)	(0.320)	(0.293)	(0.290)
Implied price elasticity	-11.121***	-1.879***	-2.221***	-0.924	-2.271***	-2.782***
	(0.347)	(0.580)	(0.553)	(0.974)	(0.622)	(0.604)
First-stage: Instrument				0.276	0.828	0.798
				[156.2]	[181.1]	[202.3]
Num.Obs.	18 207	18 112	18 112	18 112	18 112	18 112
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Intensive-Margin Price Elasticity: Last-Unit Price

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(last price)	−0.516**			−1.603***	−1.745***	−1.846***
	(0.246)			(0.550)	(0.468)	(0.481)
PS of applying tax relief x log(last price)		−1.342***	−1.324***			
		(0.442)	(0.412)			
log(income)	1.584	0.880	0.865	0.755	0.655	0.583
	(1.190)	(1.191)	(1.192)	(1.185)	(1.154)	(1.153)
First-stage: Instrument				0.527	0.929	0.840
				[256.7]	[323.7]	[387.4]
Num.Obs.	6414	6392	6392	6392	6392	6392
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at individual level. A square bracket is wald statistics of instrument.

Extensive-Margin Price Elasticity: Last-Unit Price

	FE			FE-2SLS		
	(1)	(2)	(3)	(4)	(5)	(6)
Applying tax relief x log(last price)	−2.928***			−1.070***	−1.127***	−1.234***
	(0.073)			(0.175)	(0.121)	(0.119)
PS of applying tax relief x log(last price)		−0.853***	−0.896***			
		(0.112)	(0.105)			
log(income)	1.036***	1.680***	1.633***	1.919***	1.891***	1.840***
	(0.228)	(0.279)	(0.278)	(0.263)	(0.246)	(0.244)
Implied price elasticity	-12.063***	-3.506***	-3.685***	-4.399***	-4.634***	-5.074***
	(0.302)	(0.460)	(0.432)	(0.718)	(0.497)	(0.491)
First-stage: Instrument				0.274	0.775	0.739
				[260.9]	[301.1]	[347.9]
Num.Obs.	26 427	26 280	26 280	26 280	26 280	26 280
Instrument				WE x Price	PS x Price	PS x Price
Method of PS		Pool	Separate		Pool	Separate

Intensive-Margin Price Elasticity: Only Applicants

Table 2: Estimating Intensive-Margin Price Elasticities for Those Who Applied for Tax Relief

	(1)	(2)	(3)	(4)
log(first price)	−1.203***	−0.506		
	(0.390)	(0.847)		
log(last price)			−1.330***	−0.254
			(0.452)	(0.903)
log(income)	0.525	6.126	0.532	6.093
	(0.776)	(5.365)	(0.785)	(5.503)
1-year lag of price		0.369		0.487
		(0.884)		(0.911)
1-year lag of income		1.040		1.129
		(4.777)		(5.030)
1-year lead of income		−0.821		−0.826
		(0.907)		(0.904)
Instrument: log(first price)			0.942	-0.000
			[3083.6]	[0.0]
Num.Obs.	4079	1029	3972	1024

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at individual level. 1-year lead of price cannot be estimated because of collinearity

Intensive-Margin Price Elasticity: k-th Difference Model with Only Applicants

	1-year lag	2-year lag	3-year lag
	(1)	(2)	(3)
Difference of logged first price	−1.890*	−2.530***	−4.057***
	(1.107)	(0.895)	(0.720)
Difference of logged income	1.033	6.460**	5.659**
	(2.323)	(3.039)	(2.558)
Num.Obs.	4014	3903	3765
Std.Errors	Clustered (pid)	Clustered (pid)	Clustered (pid)
FE: area	X	X	X
FE: indust	X	X	X
FE: year	X	X	X

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered at individual level. Instrument is difference between lagged first price in year t and in year $t-k$ fixing income in year $t-k$.