It's Good Weather for More Government:

The Effect of Weather on Fiscal Policy

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Abstract

I show that the weather condition on election day affects future fiscal policy. When it rains during state elections, there is an increase in the relative income of voters, which is followed by an increase in expenditure and debt. The increase in expenditure is directed towards a larger police and safety budget. This result is compatible with a model of complementarity between consumption and public goods. In the model, high-income voters support an increase in safety budget because they benefit more from it than low-income voters.

Keywords: public goods, government size, fiscal policy, weather

JEL classification: D7, H0, H4, H7

1 Introduction

I show that the weather condition on election day has long-lasting effects on fiscal policy. If it is raining during state elections, state-level expenditure increases 1.4% on the following 2 years. The increase in expenditure is directed towards safety and the police without any significant change in welfare, education, and health expenditures.

To understand these results, I also show that the weather conditions on the election day change the pool of voters. When it is raining during state elections, the turnout of low-income voters decreases while the turnout of high-income voters increases. Therefore, the weather conditions generate an exogenous variation in the income of the median voter.

I explain these results using a model of endogenous fiscal policy and complementarity between consumption and public goods. In the model, agents vote every period to choose the provision of a public good. An increase in public goods provision benefits high-income individuals due to its complementarity with private consumption. Therefore, an increase in the income of the median voter leads to a larger government, as observed in the data.

I then use the model to study the effect of alternative turnout policies. The model predicts that a compulsory voting policy would decrease government size and welfare. Since voter turnout is higher among high-income individuals, the government size is larger than a low-income agent would prefer. By introducing a compulsory voting law, there is a decrease in the income of the median voter and a decrease in the provision of public goods. Still, this effect decreases welfare because the current government size is below the optimal.

The main contribution of this paper is to the literature investigating the relation between median voter income and fiscal policy. In a large pile of research, previous work has found a positive[1] negative[2] or no relation at all between inequality and government size.[3] Still, only few papers claim to identify a causal relation between inequality and fiscal policy. The main challenge is to find an exogenous shifter to the median voter income capable of dealing with the omitted variable bias and simultaneity concerns. Notable exceptions to address these concerns are Boustan et al. (2013) and Borge and Rattsø (2004) who use pre-period inequality as an instrument to future inequality.[4] In this paper, I propose a new instrument to identify how inequality relates to fiscal policy by instead relying on variations in the median voter income from changes in the pool of voters.

This paper is also related to the literature studying the effect of the weather conditions on voter turnout. The effect of the weather conditions on the election day varies according

[1] Boustan et al. (2013), Corcoran and Evans (2010), Scervini (2012), Karabarbounis (2011), Kerr (2014), Shelton (2007), Gründler and Köllner (2017), Borge and Rattsø (2004), Milanovic (2000), Alesina and Rodrik (1994), Chernick (2005), and Schwabish (2008)

[2] Moffitt et al. (1998), Gouveia and Masia (1998), Ramcharan (2010)

[3] Rodrigùez (1999).

[4] For a survey of the literature, see Borck (2007) and Lind (2005).

to the institutional setting. While some have found rain on the election day to affect voter turnout and favor right-wing parties (Lind (2020), Arnold and Freier (2016), and Gomez et al. (2007)), others have found it to favor left-wing parties (Artés (2014) and Henderson and Brooks (2016)) or not to affect the turnout at all (Persson et al. (2014)). As far as I am aware, this is the first paper studying the effect of the weather conditions on US state elections. This is a special setting because the total voter turnout is not affected but the voter composition is, thus allowing us to isolate the effect of median voter income from average voter turnout.

This paper is organized as follows. In the second section, I discuss the data and in the third section I show the empirical strategy. The fourth section contains the empirical results. The final two sections contain the model, the calibration strategy, and the numerical results.

2 Data

This project uses three major datasets: voter statistics, government fiscal policy, and weather data. Statistics on voter turnout and voter income are from the CPS Voter Supplement, a biennial survey covering a representative sample of US voters run in November of every Congressional and Presidential election year since 1964. We also use the CPS to calculate the demographics characteristics of the population.

Statistics on state and local fiscal policy are from the Annual Survey of State and Local Government Finances conducted by the Census Bureau. This dataset contains detailed information on the revenue and expenditures of US states, cities, and counties since 1960. In particular, I observe revenue from different tax sources, debt, and expenditure on education, health, police, and safety.

Information on the weather conditions on the election day is from the Global Summary of the Day (GSOD) dataset collected by the National Centers for Environmental Information. The GSOD contains daily weather statistics from 591 weather stations located in the US. I average the report of each weather station at the county level to construct a dataset containing information on precipitation and temperature on the election day across US counties between 1976 and 2016. Merging data on voter income, government fiscal policy, and weather on the election day, I recover a biennial unbalanced panel of 47 states from 1978 to 2016.

3 Empirics

In this section, I study how changes in the voter composition induced by the weather affect future fiscal policy.

3.1 Empirical Model

I study the relation between weather conditions and voter composition using the following regression

$$\log\left(y_{s,t}\right) = \alpha rain_{s,t} + X'_{s,t}\beta + \mu_s + \mu_t + \epsilon_{s,t} \tag{1}$$

where $y_{s,t}$ is an outcome of state s in election year t, the outcomes of interest are the income of the median voter and voter turnout, $X'_{s,t}$ is a set of controls, μ_s is a state fixed effect, and μ_t is an election fixed effect. $rain_{s,t}$ is the share of the population exposed to rain on the election day. $rain_{s,t}$ is given by

$$rain_{s,t} = \frac{\sum_{c=1}^{C(s)} I\{preciptation_{c,s,t} > 0\} \times population_{c,s,t}}{\sum_{c=1}^{C(s)} population_{c,s,t}} \tag{2}$$

where $I\{preciptation_{c,s,t} > 0\}$ is a dummy taking one if it is raining in county c of state s in election t, $population_{c,s,t}$ is the population in county c of state s in year t, and $C(s)$ is the number of counties in state s.

I study the relation between weather conditions and fiscal policy with the following regression

$$\log\left(y_{s,t}\right) = \theta rain_{s,t} + X'_{s,t}\beta + \mu_s + \mu_t + \epsilon_{s,t} \tag{3}$$

where $y_{s,t+1}$ is a fiscal outcome of state s in election year $t+1$ as a share of GDP. The parameter of interest is θ. It captures the causal effect of changes in the composition of voters caused by the weather in election t on fiscal policy in $t+1$. [5]

[5] As controls I use the averages of male share, age, whites, married, years of education, and a dummy for governor election, and lagged fiscal outcome. Standard errors are clustered at the state level.

3.2 Empirical Results

3.2.1 Rainfall and Median Voter Income

The results in table 1 indicate that rainfall on the election day does not affect the voter turnout but changes the composition of voters. Table 1 presents the estimates of regressing rainfall on voter turnout and the relative characteristics of the median voter. Column 1 of table 1 shows that the voter turnout in local elections is not affected by rainfall.

Although it does not affect the voter turnout, rainfall on the election day affects the relative income of the median voter. Columns 2 and 3 of table 1 show that rainfall leads to a higher-income and higher-salary median voter. If it rains on the election day through the whole state, i.e., $rain = 1$, the relative income of the median voter is 2.2% larger. Columns 4 and 5 show that the education and the age of the median voter are not affected. Table 5 in the appendix shows that the effect of rainfall on voter turnout and median voter income is robust to different functional form specifications and controls.

Appendix A.2 uses microdata to show that rainfall leads to a lower turnout of low-income voters and a higher turnout of high-income voters. As a consequence, the total turnout is unchanged and the income of the median voter increases.

Table 1: **Rainfall, Turnout, and Voter Composition**

	(1)	(2)	(3)	(4)	(5)
	$Turnout$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Salary}}{Avg.Salary}\right)$	$log\left(\frac{\text{Median Voter Educ.}}{Avg.Educ.}\right)$	$log\left(\frac{\text{Median Voter Age}}{Avg.Age}\right)$
rain	0.00207	0.0227**	0.0299**	0.00484	-0.00237
	(0.00436)	(0.00919)	(0.0141)	(0.00363)	(0.00307)
N	493	486	486	493	493
R^2	0.876	0.283	0.957	0.666	0.814
Mean Dep. Var	.599	-.006	9.595	.052	.302
SD Dep. Var	.106	.077	.575	.043	.053
Mean Indep. Var	.31	.306	.306	.31	.31
SD Indep. Var	.463	.461	.461	.463	.463

This table shows the relation between rainfall on the election day, the turnout, and the relative characteristics of the median voter. The first column contains voter turnout, i.e., the share of total voters participating in the election, the second column has the relative income of the median voter, the third column contains the relative labor income of the median voter, the fourth column contains the relative years of education, and the final column the relative age. Controls are the share of males, average age, the share of whites, the share married, average years of education, and a dummy for governor election. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 and 2012. Standard errors in parentheses. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010.

3.2.2 Rainfall, Median Voter Income and Fiscal Policy

This section shows that the change in the composition of voters leads to **a** higher expenditure on safety and the police.

Expenditure, Revenue, and Debt According to table 2, rainfall on the election day leads to an increase in expenditure, debt, and interest, without any effect on revenue. Table 2 shows the estimates of empirical model 3. If it is raining throughout the whole state,i.e., $rain = 1$, the expenditure will be 1.4% larger in 4 years without any significant effect on revenue.

The second panel of Table 2 shows the 2SLS estimates of using the weather as an instrument for median voter income. Under standard political economy models, the fiscal policy implemented is the one preferred by the median voter.[6] Therefore, a change in the weather conditions on the election day affects future fiscal policy by changing the median voter.

[6] This is the case in Meltzer and Richard (1981), de Souza (2021), Krusell and Rios-Rull (1997), Azzimonti (2011), Corbae et al. (2009), Bachmann and Bai (2013) and Pecoraro (2017), among others.

According to table 2, increasing the relative income of the median voter by 1% increases the expenditure by 0.6% with no significant effect on revenue. As a consequence, increasing the relative income of the median voter by 1% increases state debt by 1.6% and interest payments by 1.8%.

Table 2: **Effect of Median Voter Income on Expenditure, Revenue, and Debt**

	(1)	(2)	(3)	(4)	(5)
	$log\,(Expenditure)$	$log\,(Revenue)$	$log\,(TaxRevenue)$	$log\,(Debt)$	$log\,(InterestPayments)$
			Reduced Form		
$rain$	0.0146**	0.00557	0.00639	0.0342***	0.0369***
	(0.00571)	(0.00862)	(0.00456)	(0.0106)	(0.0128)
R^2	0.924	0.876	0.874	0.919	0.915
			2SLS		
$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	0.637**	0.193	0.246	1.613**	1.839**
	(0.289)	(0.356)	(0.174)	(0.768)	(0.865)
R^2	0.840	0.867	0.858	0.771	0.789
N	486	486	486	486	486

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy. The first column contains state expenditure, the second column contains revenue, the third column contains tax revenue, the fourth column has state debt, and the fifth column contains total interest rate payments. All outcome variables are relative to GDP and 2 years after the election. The first panel contains the reduced form estimates of regressing rainfall on the election day on future fiscal policy. The second panel contains the two-stage least squares estimates using rainfall on the election day as an instrument to the median voter income. The controls are the share of males, average age, the share of whites, the share married, average years of education, lagged fiscal policy, and a dummy for governor election. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors in parentheses. Standard errors are clustered at the state level. + $p<0.15$, * $p<0.10$, ** $p<0.05$, *** $p<0.010$

Redistribution and Public Goods Provision According to table 3, rainfall on the election day does not affect the redistributive policy but leads to an increase in public goods provision. Therefore, contrary to what is predicted by standard political economy models, rainfall leads to an increase in the income of voters but has no effect on redistribution. Based on columns 1 and 2 of table 3, the change in voter composition caused by rainfall does not affect overall welfare expenditure or cash transfers. In addition, columns 3 and 4 also show that rainfall does not affect the provision of health or education services.

The increase in expenditure is directed to a larger safety budget. According to table 3, if it is raining on the election day, the police budget increases by 2.3% and safety increases by 2.7%. In terms of median voter income, a 1% increase in voter income will result in a 1% increase in safety expenditures and a 1% increase in police expenditures.

Table 3: **The Effect of Median Voter Income on Redistribution and Public Goods Provision**

	(1)	(2)	(3)	(4)	(5)	(6)
	$log\,(Welfare)$	$log\,(CashTransfer)$	$log\,(Education)$	$log\,(Health)$	$log\,(Police)$	$log\,(Safety)$
			Reduced Form			
rain	0.00474	0.0284	0.00863+	-0.0120	0.0233***	0.0271***
	(0.0176)	(0.0377)	(0.00574)	(0.0142)	(0.00894)	(0.00880)
R^2	0.922	0.855	0.923	0.905	0.942	0.944
			2SLS			
$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	0.170	0.765	0.400+	-0.480	1.003**	1.186**
	(0.847)	(0.646)	(0.119)	(0.476)	(0.048)	(0.031)
R^2	0.917	0.850	0.899	0.896	0.858	0.820
N	486	486	486	486	486	486

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy. The first column contains the welfare expenditure, the second column the cash transfer expenditure, the third column the expenditure with education, the forth column the health expenditure, the fifth column the expenditure with the police, and the final column the safety expenditure. The second panel contains the two-stage least squares estimates using rainfall on the election day as an instrument to the median voter income. The controls are the share of males, average age, the share of whites, the share married, average years of education, lagged fiscal policy, and a dummy for governor election. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors in parentheses. Standard errors are clustered at the state level. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010

Other Fiscal Outcomes Section A.3 in the appendix shows that changes in the median voter income do not affect the tax structure.

Robustness Section A.4 shows that the prediction that an increase in the median voter income leads to a debt financed increase in safety expenditures is robust to different functional forms, the addition of controls, the removal of outliers, and the use of alternative instruments.

3.3 Discussion

The previous section taught us that a rise in the relative income of the median voter increases total government expenditure. This expenditure increase is financed by an increase in debt accompanied by a larger interest payment.

This result is at odds with standard political economy models. According to the literature studying government size and inequality pioneered by Meltzer and Richard (1981), high income agents are against larger governments because they face the burden of income taxes and have little gain from redistributive transfers or public goods.

In the next section, I present a model capable of rationalizing the empirical results. The model builds on Meltzer and Richard (1981) adding wealth inequality and complementarity between private and public consumption. According to the model, high income agents support large governments because public goods are a complement to consumption. I calibrate the model to reproduce the estimated effect of median voter income on expenditure and use it to study how a compulsory voting policy, which would drastically change the composition of voters, would affect government size and welfare.

4 Model

This section describes the model. The first goal of the model is to rationalize the empirical results. I show that high income individuals support larger government expenditure if consumption and public goods are complements. Therefore, an increased voter turnout of high income individuals leads to a larger government.

The second goal of the model is to quantify how changes in the turnout policy could affect government size. In the empirical section, I identify how small changes in the composition of voters affect fiscal policy. To quantify the effect of large changes in the composition of voters, I also need to take into account the potential general equilibrium and distributional effects of large policies. In the following section, the model is calibrated to reproduce the micro-elasticities and is used to make policy counterfactuals.

4.1 Economics

4.1.1 Demographics

There is a continuum with measure one of agents. Agents must choose consumption, c, and labor supply, n. They are heterogeneous in their labor productivity, ϵ, and assets, a, according to an exogenous distribution Γ.

The utility of an agent is given by

$$u(c, n, C_g) = \left[(1-\lambda)\,(c)^{\rho} + \lambda\,(C_g)^{\rho}\right]^{\frac{1}{\rho}} - \chi \frac{n^{1+\gamma}}{1+\gamma}$$

where C_g is the amount of public goods, χ governs the disutility of working, and γ is the Frisch elasticity. $\rho \in (-\infty, 1]$ determines the elasticity of substitution between consumption and public goods.[7] If ρ is negative, public goods and consumption are complements. In that case, the marginal utility of public goods is increasing in consumption.

4.1.2 Firms

There is a continuum of price taker firms. They have access to production technology given by

$$F(K, N) = K^{\alpha} N^{1-\alpha}$$

and must pay an interest rate r and wages w to maximize the profits. Maximization implies

$$r = \alpha K^{\alpha-1} N^{1-\alpha} - \delta \tag{4}$$
$$w = (1-\alpha) K^{\alpha} N^{-\alpha}$$

4.1.3 Government

The government taxes income at a linear tax rate τ_g and provides public goods C_g. The government budget constraint is given by

$$C_g = \tau_g (rK + wN) \tag{5}$$

where K is aggregate capital and N is aggregate labor supply.

[7] The elasticity of substitution between consumption and public goods is given by $\frac{1}{1-\rho}$.

4.1.4 Economic Equilibrium

The household problem is given by:

$$\Omega(a, \epsilon | \tau_g, C_g, r, w) = \max_{c,n} \left[(c)^\rho + (C_g)^\rho\right]^{\frac{1}{\rho}} - \chi \frac{n^{1+\gamma}}{1+\gamma} \tag{6}$$

s.t.

$$c = (1 + r(1 - \tau_g))a + (1 - \tau_g)w\epsilon n$$

The equilibrium conditional on fiscal policy is defined below.

Definition 4.1 (Equilibrium)**.** Given fiscal policy $\{\tau_g, C_g\}$, an economic equilibrium is defined by a value function, Ω, policy functions, $\{h_c, h_n, h_d, h_a\}$, and prices, $\{r, w\}$, such that:

1. Given fiscal policy, $\{\Omega, h_c, h_n, h_d, h_a\}$ solves the household problem given by 6;

2. Given prices, firms maximize profit 4;

3. Given prices, the labor and asset markets clear;

4. Government budget constraint is satisfied given by 5;

4.2 Election and Voter Turnout

At the beginning of the period, households choose the fiscal policy to be implemented by pairwise voting, which implies that the fiscal policy preferred by the median voter is the one implemented. As in the data, not all households vote. Households vote with probability $\Phi(\mu + \beta(wn_i + ra_i), 1)$, where Φ is the CDF of a normal distribution with mean $\mu + \beta(wn_i + ra_i)$ and variance 1. Notice that the probability of voter turnout correlates with income according to parameter β.

Voters are rational and take into account how the fiscal policy affects their disposable income and prices. The preference of agent (a, ϵ) over fiscal policy (τ_g, C_g) is

$$\Omega(a, \epsilon | C_g, \tau_g(C_g), r(C_g), w(C_g))$$

where $r(C_g)$ and $w(C_g)$ are the equilibrium interest rate and the wage under fiscal policy $(\tau_g(C_g), C_g)$, and $\tau_g(C_g)$ is the marginal tax rate that satisfies the government's budget constraint if the provision of public goods is C_g. The fiscal policy preferred by agent (a, ϵ) is given by:

$$C_g^*(a, \epsilon) = \arg\max_{C_g} \Omega(a, \epsilon | C_g, \tau_g(C_g), r(\tau_g, C_g), w(\tau_g, C_g)) \tag{7}$$

4.3 Politico-Economic Equilibrium

Definition 4.2 (Politico-Economic Equilibrium)**.** The Politico-Economic equilibrium is given by a fiscal policy, $\{\tau_g^*, C_g^*\}$, an economic equilibrium, $\{\Omega, h_c, h_n, r^*, w^*\}$, voters' preferences, $\{C_g^*, \tau_g(C_g), r(\tau_g, C_g), w(\tau_g, C_g)\}$, and a distribution of voter turnout, $\Gamma_{turnout}$, such that:

1. Given fiscal policy (τ_g^*, C_g^*), $\{\Omega, h_c, h_n, h_d, h_a\}$ solves the household problem given by 6;

2. Given C_g, $(\tau_g(C_g), r(C_g), w(C_g))$ is part of an economic equilibrium;

3. C_g^* solves the voter's problem given by 7;

4. The distribution of voters is given by

$$\Gamma_{turnout}(a, \epsilon) = \frac{\Gamma(a, \epsilon)\Phi(\mu + \beta(w^* \epsilon h_n(a, \epsilon) + r^* a))}{\int \Gamma(a, \epsilon)\Phi(\mu + \beta(w^* \epsilon h_n(a, \epsilon) + r^* a)}$$

5. Equilibrium fiscal policy $\{\tau_g^*, C_g^*\}$ is the median of C_g^* under distribution $\Gamma_{turnout}$.

5 Identification of Model Parameters

The model is calibrated using values from the literature and targeting relevant moments of the economy. The elasticity of substitution between consumption and public goods, which is the key parameter to quantify how compulsory voting would affect government size, is identified from the effect of **the** median voter income on expenditure, as estimated in section 3.

Preferences The parameters related to households' preferences are ξ, the disutility of labor supply, γ, the elasticity of labor supply, λ, the utility level on public goods, and ρ, the elasticity of substitution between consumption and public goods. χ and γ are calibrated using numbers from Corbae et al. (2009). λ is calibrated to reproduce the average government expenditure of 0.136.

Production Function I follow the standard of setting α to 1/3, following the approximated value of capital share in the past.

Inequality I assume that the distribution of assets, a, and labor productivity, ϵ, are independent and given by

$$log(a) \sim \mathbb{N}(\mu_a, \sigma_a)$$
$$log(\epsilon) \sim \mathbb{N}(\mu_\epsilon, \sigma_\epsilon)$$

The parameters of the asset distribution are calibrated to reproduce the distribution of non-labor income while the distribution of ϵ is calibrated to reproduce labor income inequality.

Voter Turnout $\mu_{turnout}$ and $\beta_{turnout}$ govern the average turnout and the correlation of turnout and income. These parameters are estimated with a probit regression of income on voter turnout.

5.1 Estimation of ρ

The key parameter to understand how compulsory voting would affect government size is the elasticity of substitution between consumption and public goods. If consumption and public goods are complements, high income citizens support larger governments and a policy increasing the turnout of low-income individuals would decrease the government size. To precisely estimate this parameter and quantify the effect of a compulsory voting policy, ρ is identified from the effect of median voter income on expenditure.

I calibrate ρ reproducing the same regressions run in the data in the model. For each simulation d, I draw a random correlation of voter turnout and income, $\beta^d_{turnout}$, which implies an election with the median voter of income m_d and equilibrium expenditure τ_d. After 100 simulations, I ran on the model generated data the regression:

$$\tau^d = \theta_{model} \log m_d + \epsilon_d$$

The parameter ρ is set such that θ_{model} reproduces the elasticity of expenditure to median voter income of 0.63.

Table 4: **Calibrated Parameters**

Parameter	Description	Target	Target Value	Parameter Value
		Preferences		
ρ	elasticity of substitution between c and C_g	effect of median voter income on government expenditure	0.637	-3.81
ξ	disutility of labor supply	Corbae et al. (2009)	100	100
λ	utility of public good	public consumption/GDP	0.118	0.000001
γ	elasticity of labor supply	Corbae et al. (2009)	0.3	0.3
		Production		
α	Production Function	Corbae et al. (2009)	0.33	0.33
		Government		
C_g	baseline public Good	expenditure/GDP	0.136	0.136
		Inequality		
μ_a	average log asset holdings	average log asset holdings	normalization	1
σ_a	variance of log asset holdings	variance of non-labor income	0.714	0.714
μ_ϵ	average of log salaries	average of log salaries	normalization	1
σ_ϵ	variance of log salaries	variance of log salaries	1.021	1.021
		Turnout		
$\mu_{turnout}$	average probability of voting	probit regression		0.059
$\beta_{turnout}$	correlation of income and turnout	probit regression		0.214

6 Numerical Results

6.1 Public Goods Provision and the Economy

An increase in the public goods provision increases GDP and consumption, according to figure 1. If the government supplies more public goods, the marginal utility of consumption increases because of the complementarity between public goods and consumption, which leads to an increase in the labor supply, GDP, and consumption. But, as the government increases its supply of public goods, the marginal tax rate also increases, which has a negative effect on labor supply and consumption. This is why, for large values of C_G, GDP and consumption decrease with C_G.

Figure 1: **Public Goods, GDP, and Consumption**

(a) **GDP** (b) **Consumption**

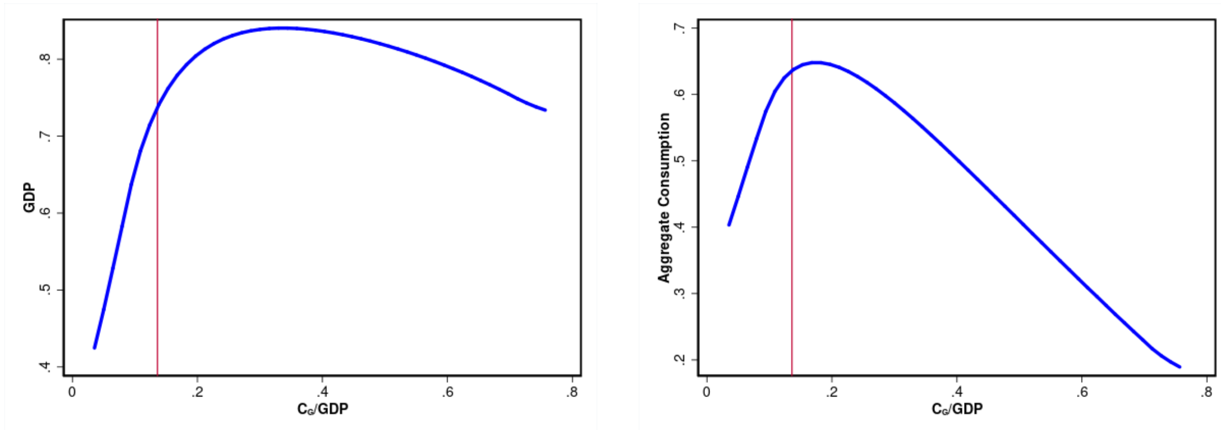
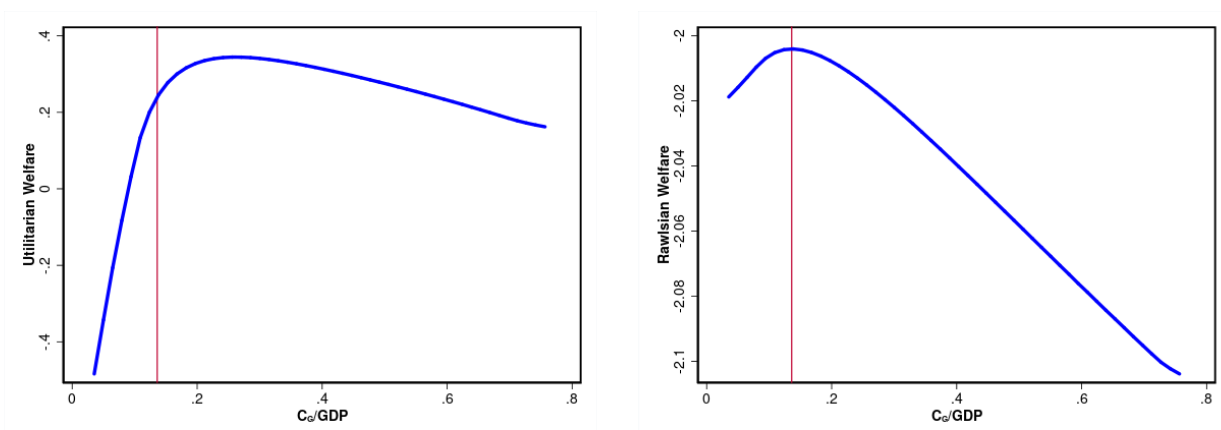


Figure 2 shows that an increase in the public goods provision can be welfare improving. The figure shows the utilitarian and the Rawlsian welfare functions for different values of public good. On average, agents would be better off with an increase in the provision of public goods but the smallest welfare in the economy, plot on figure 2b, would decrease.

Figure 2: **Public Goods and Welfare**

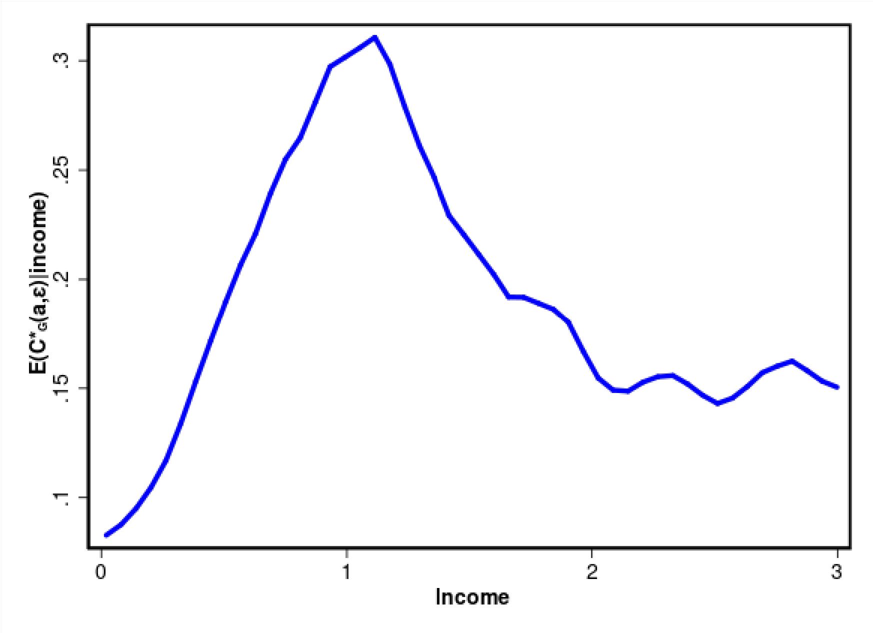
(a) **Utilitarian Welfare** (b) **Rawlsian Welfare**



6.2 Preferences for Public Goods Provision

Figure 3 shows that the income taxes and the complementarity in the utility function generate a non-linear relation between the preferences for government size and income. Because public goods and consumption are complements, low income individuals support small governments and the preference for public goods is increasing with income. For large income agents, the burden caused by high taxes dominates the utility gain of more public goods, and their preferred government size decreases with income.

Figure 3: **Preferences for Public Goods Provision by Income**



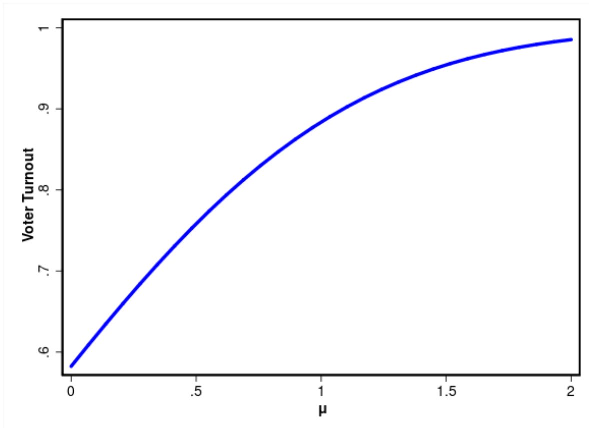
6.3 Effect of Compulsory Voting

What would happen if the government implemented a policy inducing higher turnout? To answer this question, figure 4 plots the equilibrium outcome under different values of $\mu_{turnout}$, i.e. the average unconditional probability of voting.

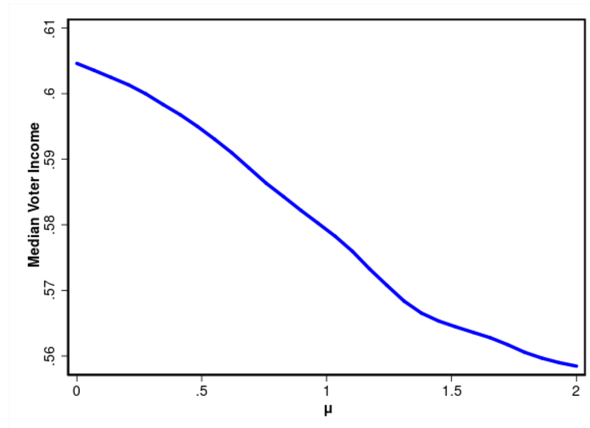
An increase in $\mu_{turnout}$ leads to a higher turnout and a decrease in the income of the median voter, as depicted in figures 4a and 4b. Because low-income voters value public good less, there is a decrease in the equilibrium public good provision. Because the provision of public goods is already sub-optimal, a decrease in public good provision reduces welfare. Therefore, a compulsory voting policy would reduce the government size and welfare.

Figure 4: **Public Goods and Welfare**

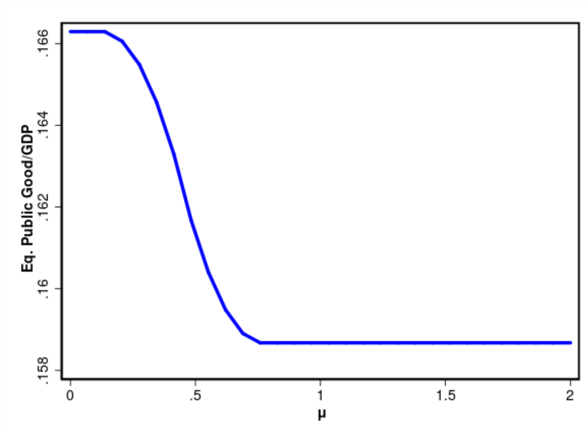
(a) **Turnout**



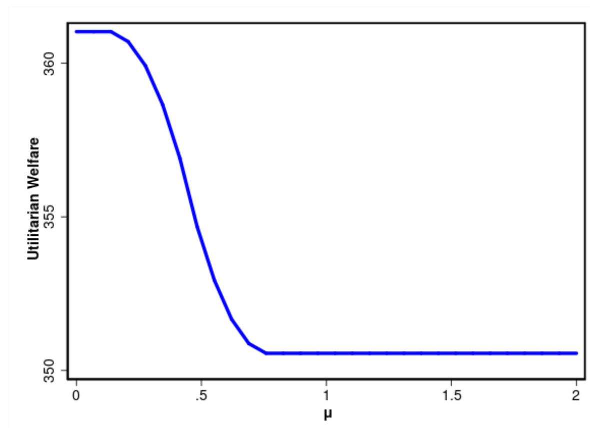
(b) **Median Voter Income**



(c) **Public Good**



(d) **Utilitarian Welfare**



7 Conclusion

I show that rainfall on the election day affects the composition of voters and future fiscal policy. When it is raining during state and local elections, high-income voters increase their turnout while low-income voters decrease it. As a consequence, the income of voters goes up. The change in the income of voters caused by rainfall on the election day has long-lasting consequences for fiscal policy. In the 2 years following the election, the expenditure on safety increases without any change in revenue or welfare programs.

I propose a model that explains the empirical results with complementarity between consumption and public goods. If public goods and consumption are complements, high-income people stand to benefit more from an increase in the public goods provision than low-income people. Therefore, when the rainfall causes high-income people to be overrepresented, the fiscal policy shifts towards their favorite preference.

I calibrate the model to reproduce the micro-elasticities and use it to study the consequences of a compulsory voting policy. The complementarity between consumption and public goods is identified from the relation between median voter income and expenditure identified in the data. The model finds that a compulsory voting policy would decrease the government size by 7%. A compulsory voting policy is also welfare decreasing because voters are not taking the positive externality effect of public goods into account.

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Table 5: Rainfall, Turnout, and Median Voter Income

	(1)	(2)	(3)	(4)	(5)	(6)
	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$
rain	0.0148*	0.0197**	0.0135*	0.0216**	0.0218**	0.0227**
	(0.00749)	(0.00858)	(0.00772)	(0.00887)	(0.00921)	(0.00919)
	Turnout	*Turnout*	*Turnout*	*Turnout*	*Turnout*	*Turnout*
rain	-0.0128	0.0123	-0.0244**	0.000422	0.000955	0.00207
	(0.0116)	(0.00952)	(0.00940)	(0.00479)	(0.00448)	(0.00436)
State FE		X		X	X	X
Year FE			X	X	X	X
State Controls					X	X
Election Controls						X

This table presents the estimated parameters of the regression 1. *log_median_voter_inctot* is the log of median voter's relative income and *rain* is the population share in the state facing rain on the election day, 2. The state controls are the share of males, average age, the share of whites, the share of married and years of education. Election controls are a dummy for governor election, turnout, median voter relative years of education and median voter relative age. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income is from the CPS election supplement. This table uses data for every election between 1984 to 2012. p-values are in parentheses.

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A Empirical Appendix

A.1 Tables

A.2 Heterogeneous Effect of Rainfall on Voter Turnout

Figure 5 estimates this relation non-parametrically. The parameters of the following regression are presented:

$$I\_voted_{i,s,t} = \sum_{d'=1}^{1} 0\theta_d \times I\{d_{i,s,t} = d'\} \times rain_{s,t} + X'_{i,s,t}\beta + \mu_s + \mu_t + \tilde{\epsilon}_{s,t} \quad (8)$$

Table 6: Rain and Turnout

	(1)	(2)	(3)	(4)	(5)	(6)
	I_voted	I_voted	I_voted	I_voted	I_voted	I_voted
c.rain#c.log_inctot	-0.0000373	-0.00750***	0.00281**	0.00338**	0.00386***	
	(0.750)	(0.000)	(0.035)	(0.022)	(0.009)	
log_inctot		0.0701***	0.174***	0.127***	0.127***	0.129***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
rain		0.0683***	-0.0264**	-0.0315**	-0.0368***	-0.0000431
		(0.000)	(0.040)	(0.025)	(0.009)	(0.975)
State FE			X	X	X	X
Year FE			X	X	X	X
Indiv. Controls				X	X	X
State + Election Controls					X	X
N	1113951	1113951	1113951	858924	858924	858924
R^2	0.000	0.014	0.068	0.155	0.161	0.161

+ p<0.15, * p<0.10, ** p<0.05, *** p<0.010

This table presents the estimated parameters of regressing the share of individuals in rainy counties on the election day, *rain*, the log of income, *log_inctot*, and the interaction of these two variables on a dummy variable taking the value of one if the agent voted in the current election, *I_voted*. Individual controls are years of education, age, a dummy if white, and a dummy if male. State controls are the share of males, average age, the share of whites, the share of married and years of education. Election controls are a dummy for governor election, turnout, median voter relative years of education and median voter relative age. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. p-values are in parentheses.

where I_voted is a dummy variable taking the value of one if agent i voted in the election taking place in state s and year t, $I\{d_{i,s,t} = d'\}$ is a dummy taking the value of one if agent i is in income decile d'. The parameter θ_d captures the effect of the average weather condition in state s and time t on the turnout of agents in income decile d. Figure 5 shows that the turnout increases for income deciles above the median while those below it are not affected.

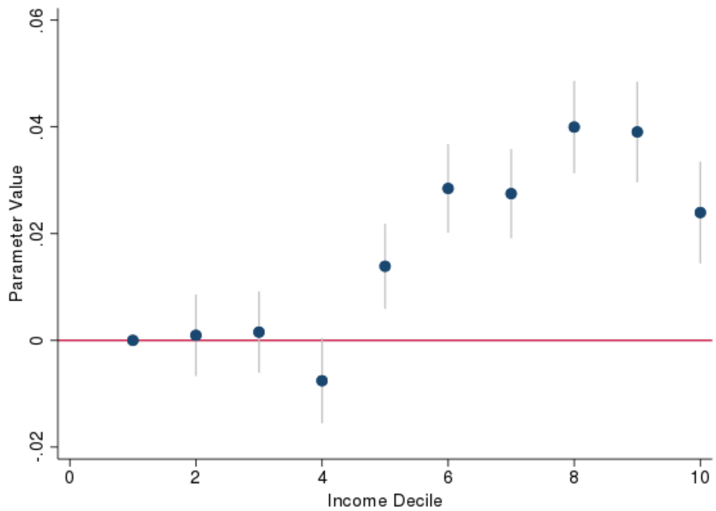
A.3 Other Fiscal Outcomes

Table 7: **Effect of Median Voter Income on Tax Structure**

	(1)	(2)	(3)	(4)	(5)
	$\log(TaxRevenue)$	$\log(IncomeTax)$	$\log(SalesTax)$	$\log(PropertyTax)$	$\log(CorporateTax)$
			Reduced Form		
rain	0.00639+	0.00369	0.0125**	0.0181**	0.0150
	(0.00440)	(0.0128)	(0.00574)	(0.00753)	(0.0264)
R^2	0.874	0.990	0.978	0.969	0.857
			2SLS		
$log\left(\frac{\text{Median Voter Income}}{Avg.Income}\right)$	0.254+	0.129	0.560+	0.836*	0.415
	(0.143)	(0.800)	(0.107)	(0.071)	(0.721)
R^2	0.857	0.990	0.965	0.944	0.855
N	493	437	493	493	462

This table shows the relation between rainfall on the election day, turnout, and the relative characteristics of the media voter. The first column contains voter turnout, i.e., the share of total voters participating in the election, the second column has the relative income of the median voter, the third column contains the relative labor income of the median voter, the fourth column contains the relative years of education, and the final column the relative age. Controls are the share of males, average age, the share of whites, the share married, average years of education, and a dummy for governor election. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors in parentheses. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010

Figure 5: Effect of Rain on Different Income Levels



This graph presents the estimated parameter $\{\theta_d\}_{d=1}^{1}0$ from equation 8. The x-axis contains the decile groups while the y-axis presents the estimated parameters. The 95% confidence intervals are around each dot. The controls are the share of males, average age, the share of whites, the share of married and years of education, a dummy for governor election, turnout, median voter relative years of education and median voter relative age. All control variables are in logs. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and turnout are from the CPS election supplement.

A.4 Robustness

Adding Controls Table 8 shows that the relation between rainfall on the election day, median voter income, and expenditure is stable even when adding a large set of controls.

Table 8: **Rainfall, Median Voter Income, and Expenditure**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$
	Reduced Form									
rain	0.0134**	0.0112*	0.0167***	0.0155***	0.0146***	0.0149***	0.0147***	0.0138**	0.0138**	0.0132**
	(0.00621)	(0.00592)	(0.00553)	(0.00538)	(0.00551)	(0.00548)	(0.00545)	(0.00558)	(0.00558)	(0.00528)
R^2	0.803	0.831	0.902	0.922	0.924	0.923	0.924	0.943	0.943	0.944
	2SLS									
$log\left(\frac{Median\ Voter\ Income}{Avg.Income}\right)$	0.946+	0.559	1.275*	0.698**	0.637**	0.639**	0.624**	0.608*	0.608*	0.581**
	(0.654)	(0.394)	(0.705)	(0.299)	(0.279)	(0.267)	(0.267)	(0.330)	(0.330)	(0.290)
R^2	0.494	0.726	0.510	0.819	0.840	0.839	0.843	0.879	0.879	0.885
State FE		X		X	X	X	X	X	X	X
Year FE			X	X	X	X	X	X	X	X
Demographic Controls					X	X	X	X	X	X
Economic Controls						X				X
Fiscal Policy							X			X
Linear Trend								X	X	X
Quadratic Trend									X	X
N	493	493	493	493	493	486	493	493	493	486

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy using specifications 3. *rain* is the share of population exposed to rainfall on the election day, $log(Expenditure)$ is the total state and local expenditure divided by GDP. The first panel shows the coefficient of equation 3 and the second panel the 2SLS estimate of using *rain* as an instrument for the relative median voter income. Demographic controls are the share of males, average age, the share of whites, the share married, average years of education, and a dummy if the election was for governor. Economic controls are average yearly salary and average income. The fiscal control is the lagged revenue. All specifications contain lagged total expenditure as the control. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors are clustered at the state level. Standard errors in parentheses. + $p<0.15$, * $p<0.10$, ** $p<0.05$, *** $p<0.010$

Extreme Weather Conditions If rainfall causes flooding and traffic jams, voters' perception could be affected. In this scenario, the identified results could be explained by a direct effect of rainfall on the election day instead of a change in the composition of voters. To test for that, Table 9 displays the coefficients of the main regressions but controlling for a large set of weather characteristics. Moreover, columns 3 and 4 drop the top 5% elections with the highest precipitation from the sample. The estimated coefficient is stable across specifications.

Table 9: **Rainfall, Median Voter Income, and Expenditure Controlling for Extreme Weather**

	(1)	(2)	(3)	(4)
	$log(Expenditure)$	$log(Safety)$	$log(Expenditure)$	$log(Safety)$
		Reduced Form		
rain	0.0120*	0.0184***	0.0342**	0.0354***
	(0.00614)	(0.00590)	(0.0135)	(0.0136)
R^2	0.925	0.923	0.911	0.911
		2SLS		
$log\left(\frac{Median\ Voter\ Income}{Avg.Income}\right)$	0.386**	0.646***	1.096**	1.239**
	(0.192)	(0.232)	(0.511)	(0.590)
R^2	0.893	0.840	0.810	0.788
Specification	Weather Control	Weather Control	Drop Extreme Weather	Drop Extreme Weather
N	486	486	459	459

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy using specification 3. Columns 1 and 2 control for measures of fog, snow, hail, thunder, temperature, average precipitation, average wind speed, and maximum wind speed. Columns 3 and 4 drop the top 5% elections with precipitation. *rain* is the share of the population exposed to rainfall on the election day, $log(Expenditure)$ is the of total state and local expenditure divided by GDP and $log(Safety)$ is the total of state and local expenditure on safety. The first panel shows the coefficient of equation 3 and the second panel shows the 2SLS estimate of using *rain* as an instrument for the relative median voter income. The controls are the share of males, average age, the share of whites, the share married, average years of education, a dummy if the election was for governor, lagged fiscal policy, year fixed effect, and state fixed effect. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors are clustered at the state level. Standard errors in parentheses. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010.

Eliminating Outliers Table 10 shows that the results are not being driven by outliers. It displays the estimated parameters, dropping the observations with the largest and the lowest change in expenditure from the sample.

Alternative Instruments Here I propose a second instrument inspired by the same natural experiment. I use the weather condition in rich regions[8] of a given state on the election day as an instrument for the median voter income. Because a higher (lower) turnout in rich

[8] I.e., regions with an average income above the average income in the state.

Table 10: **Rainfall, Median Voter Income, and Expenditure Dropping Outliers**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$	$log(Expenditure)$
					Reduced Form			
rain	0.0146***	0.0141***	0.0137***	0.0133**	0.0138***	0.0129***	0.0175***	0.0112+
	(0.00531)	(0.00509)	(0.00520)	(0.00539)	(0.00510)	(0.00483)	(0.00597)	(0.00710)
R^2	0.928	0.937	0.928	0.932	0.932	0.944	0.915	0.935
					2SLS			
$log\left(\frac{Median\ Voter\ Income}{Avg.Income}\right)$	0.634**	0.635**	0.610**	0.536**	0.612**	0.542**	0.786*	6.807
	(0.273)	(0.293)	(0.273)	(0.236)	(0.270)	(0.235)	(0.419)	(55.01)
R^2	0.844	0.857	0.853	0.876	0.855	0.890	0.784	.
Sample Dropped	Top 1% chg. exp.	Top 5% chg. exp.	Lowest 1% chg. exp.	Lowest 5% chg. exp.	Top and Lowest 1% chg. exp.	Top and Lowest 5% chg. exp.	Before 1990	Before 2000

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy using specification 3. In each column, a set of sample outliers is dropped. In column 1 the coefficient is estimated dropping the top 1% change in expenditure, in column 2 the top 5% is dropped, in column 3 the bottom 1% in the distribution of expenditure change is dropped, in column 4 the bottom 5% are dropped, in column 5 the bottom and top 1% are dropped, in column 6 the bottom and top 5% are dropped, in column 7 I use data only after 1990, and in column 8 I use data on elections after 2000. *rain* is the share of the population exposed to rainfall on the election day, $log(Expenditure)$ is the total state and local expenditure divided by GDP and $log(Safety)$ is the total of state and local expenditure on safety. The first panel shows the coefficient of equation 3 and the second panel the 2SLS estimate of using *rain* as an instrument for the relative median voter income. The controls are the share of males, average age, the share of whites, the share married, average years of education, a dummy if the election was for governor, lagged fiscal policy, year fixed effect, and state fixed effect. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors are clustered at the state level. Standard errors in parentheses. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010.

regions leads to a higher (lower) income of the median voter in that state in that election year, the weather generates an exogenous variation in the median voter income that allows us to identify its effects on the variables of interest.

$$rain\_rich_{s,t} = \sum_{i \in s_{\text{rich}}} I\{rain_{i,s,t}\} \tag{9}$$

where s_{rich} is the set of regions of state s that has an average income over the past 30 years above the average state income and $I\{rain_{i,s,t}\}$ is a dummy variable taking the value of one if it has rained in region i, in state s on the election day taking place in year t.

Two points are worth making about the choice of instrument 9 and the first stage in 1. Although income and the regional differences in income appear in the construction of the instrument 2, it is not a concern for exogeneity. The reason is that only persistent income differences are used, i.e. those that are constant over the full sample. Therefore, any spurious correlation of $rain\_rich_{s,t}$ and $y_{s,t+1}$ due to regional income differences is captured by the fixed effect μ_s.

Table 11 shows that rainfall in rich regions led to an increase in expenditure directed towards the safety budget.

Table 11: **Rainfall, Median Voter Income, and Expenditure Dropping Outliers**

	(2)	(3)	(4)	(5)	(6)	(7)
	$log(Expenditure)$	$log(Revenue)$	$log(PublicWelfare)$	$log(Education)$	$log(Health)$	$log(Safety)$
			Reduced Form			
$rain\_rich$	0.0127**	0.00652	0.00594	0.00911*	-0.0122	0.0238***
	(0.017)	(0.415)	(0.726)	(0.096)	(0.357)	(0.003)
R^2	0.923	0.876	0.922	0.923	0.905	0.943
			2SLS			
$log\left(\frac{Median\ Voter\ Income}{Avg.Income}\right)$	0.655**	0.289	0.301	0.482+	-0.557	1.262**
	(0.049)	(0.448)	(0.733)	(0.143)	(0.455)	(0.044)
R^2	0.835	0.859	0.913	0.885	0.893	0.802
N	486	486	486	486	486	486

This table shows the relation between rainfall on the election day, median voter income, and fiscal policy using specification 3. rain_rich is the share of population exposed to rainfall on the election day in rich countries. The first panel shows the coefficient of equation 3 and the second panel shows the 2SLS estimate of using *rain* as an instrument to the relative median voter income. Controls are the share of males, average age, the share of whites, the share married, average years of education, a dummy if the election was for governor, lagged fiscal policy, year fixed effect, and state fixed effect. The weather condition data is from the Global Summary of the Day (GSOD) dataset created by the National Centers for Environmental Information. Controls and median voter income are from the CPS election supplement. This table uses data for every election between 1984 to 2012. Standard errors are clustered at the state level. Standard errors in parentheses. + p<0.15, * p<0.10, ** p<0.05, *** p<0.010.