ERASMUS UNIVERSITEIT ROTTERDAM

An Empirical Test of Economic Theories of Democracy: The Decline of Public Association with Formal Politics and how Governments can Stem the Tide

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MSc International Economics – Master's Thesis

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Introduction

Abstract

In this paper we use quasi-experimental regression designs to estimate population effects on voter turnout based on theory, to try to explain the decline of voter turnout in the 20th century. Using municipal mergers in the Netherlands we provide causal estimates for population effects on turnout with a fixed number of seats. We then make a first empirical test of the game theoretic account put forward by Feddersen & Pesenderfer (1996) by comparing voter abstention rates with different levels of education, using reference categories. This is done to test an alternative, game-theoretic model from where population effects may also be derived. Here we show how rising inequality within geographical boundaries can lead to lower voter engagement in politics alongside loss of voter power caused by larger populations, proving that newer, game-theoretic models provide additional possibilities for identifying mechanisms that affect the vote.

It is vital that through research we are able to understand and explain behaviours in economic environments. However with voting behaviour, there is a tremendous disconnect between what theorists accept and what empirical researchers have dedicated resources to. In this particular school of study the first theories on voter behaviour are still not being applied universally in regression designs (Geys, 2006).

Voter turnout measured as vote share of the voting age population has been declining since the mid 20th century in established democracies across the world (Pintor & Gratschew, 2002). Some authors have put this decline down to the introduction of television (Gentzkow, 2006)[2] and increasingly aggregated news sources (George & Waldfogel, 2008)[2], negative campaigning (Ansolabehere et al.,

[2] Cited in Gerritsen et al. (2016)

1994)[2], a lack of trust in politicians (Putnam, 2000)[2] and the failure of the state (Mayntz, 1993). Over the same period of time populations have been growing. From figures I and II we can see that, in the U.S., the vote share as a percentage of the voting age population is declining, whilst population growth in terms of voting age population has been moving steadily in the opposite direction. We can also see the distraction effect of aggregated media in reducing turnout for midterms from the introduction of television and diffusion of more aggregated media sources since the 60s, since these elections have reduced coverage in mainstream media. However a large part of the variation in presidential elections remains unexplained to this day.

Several studies that have looked at the connection between population size and voter turnout and have found negative relationships that are in line with the theoretical models put forward by Downs (1957) and Riker & Odershook (1968), known as the calculus of voting. These models provide a simple explanation for this negative relationship; it is that a citizen will only vote when their reward outweighs the costs of voting. Since this reward also depends also on the probability of exercising a pivotal vote, then as the voting age population increases the expected benefits of voting will tend to zero and more people will abstain from voting.

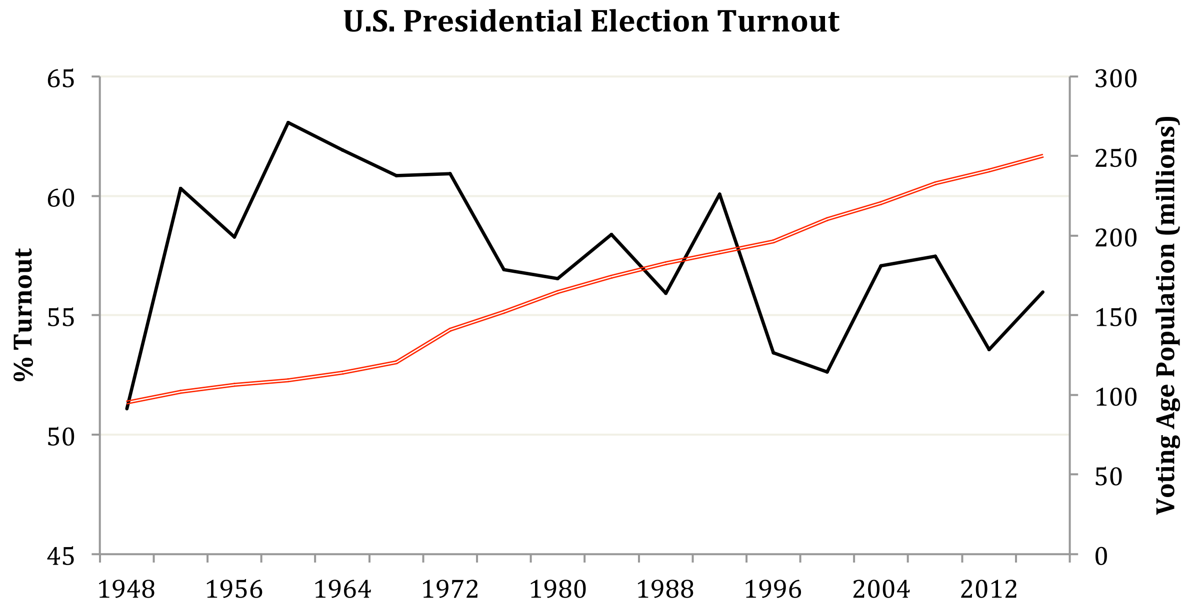
Although a large number of these studies have found significant results, causal interpretations are still lacking, since it is not clear by how much population growth leads to abstention. This is partly because most population growth is sluggish and thus it is difficult to establish concrete relationships[3]. Issues will often arise with time series because of endogeneity with population/voting age variables. For instance, growing communities may differ in their propensity to vote as compared with a shrinking community because modern cities that are attracting new people may create a more compelling political environment whilst a shrinking community may have deep rooted political partisanship that young voters feel that they cannot change. These forms of bias will lower significance levels and make inference tricky. Cross-sectional estimates will similarly be biased because of differing socioeconomic factors between rural areas and cities. Voting registration procedures and differing distances from voting booths in cities and rural areas can similarly compound bias (Gerritsen et al., 2016).

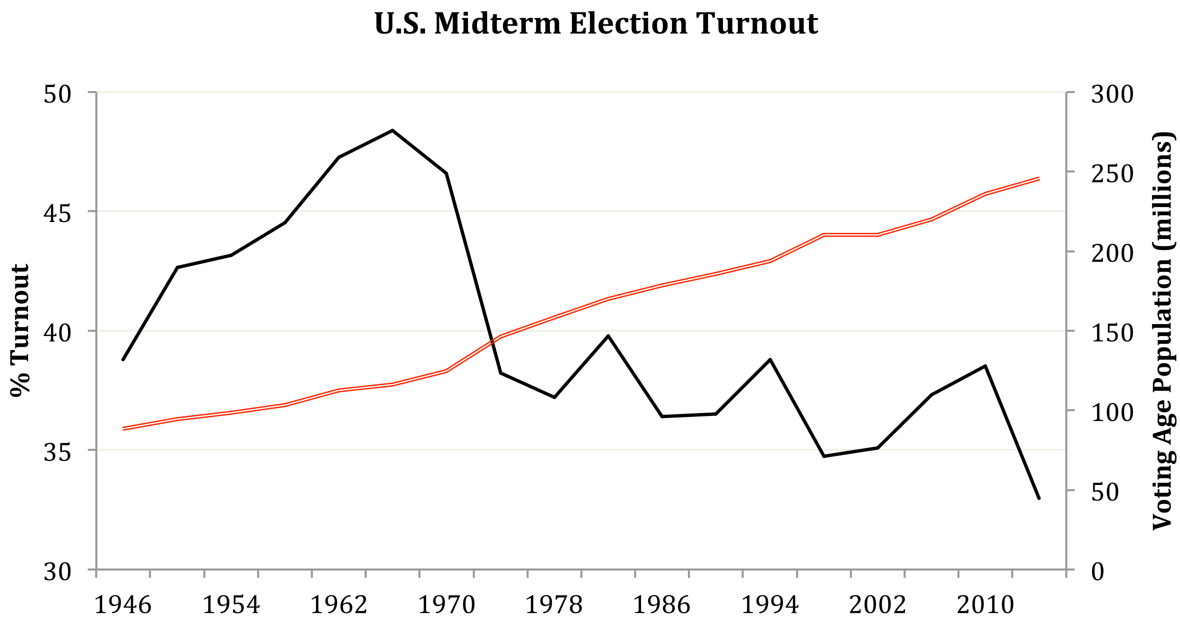
Other authors have attempted to tackle this issue using panel methods with varying success. In this paper we will be confronting these issues using a quasi-

[3] Using panel data for Norwegian local elections Hansen (1994) finds direct population effects on turnout as the number of people turning out to vote that are too large whilst Barzel & Silberg (1973), using data on Gubernatorial elections in the U.S., find t-ratios for the indirect effects of population that are below experimentally certain confidence intervals. We will take a novel approach in this study by controlling for both effects categorically in the same regression design.

experimental approach to see how an exogenous shock to voting age population, before and after municipal mergers in the Netherlands, leads to changes in voter turnout. By continuing the unpublished work of Gerritsen et al. (2016), this arguably remains one of the first studies of its kind (see also Kraaykamp, Dam, & Toonen, 2001; Ansolabehere & Konisky, 2006) and we hope one that will provide causal estimates of the marginal effect of population on turnout.

FIGURES I & II





Source: International Institute for Democracy and Electoral Assistance (IDEA). Turnout figures are the percentage vote share of the voting age population, shown on the left axis. Voting age population, represented by the double line, is on the right axis.

Since for parties to gain votes through their manifestos they must discover relationships between what they intend to do and what voters want to vote for

(Downs, 1957), behavioural aspects of voting must be understood for parties to approach elections with policies that appeal to the appropriate masses. An understanding of what constitutes an appropriate number of votes is the first step in understanding the efficacy of actions employed by participants. Furthermore, knowing what can incur additional constraints to the voter can also be suggested from this research since not unlike like population effects, voter costs will be incorporated in this study based also on the seminal works of the calculus of voting. Evidence and estimates of these effects will be crucial for future policy implications in election races, not least because elections are a means for creating social solidarity and legitimising action (Downs, 1957). If information is exclusive, less people will engage in what should be a universal civic endeavour.

Without academic agreement on economic theories of voter turnout it will be impossible for incumbent governments to understand how their policies are affecting civic engagement. By distinguishing root causes of voter abstention this paper will offer a window of opportunity for policymakers to assess damage caused to civic engagement by a lack of consistency with voter desires after controlling for relevant parameters made explicit by this study. This is a crucial step to safeguarding voter interest in formal political channels.

Second approach: an Empirical comparison of population estimates

Whilst the first economic theories on voting behaviour are substantiated by relevant empirical research, there is a focussed movement of theoretical efforts to explain voting behaviour beyond instrumental models based on Downsian theory. These models are based on game-theoretic theoretical accounts. Since it is well known that voters behave strategically, and since sequential choice models seem to be a plausible next step in explaining probability based voting decisions, we will add to the results of our initial foray into basic economic models of voter behaviour by assessing one such game-theoretic account put forward by Feddersen & Pesenderfer (1996). Ultimately from this endeavour we hope to fulfil our study objective, which is:

Are population on vote share effects part of larger more complex voting mechanisms and can we show that population estimates derived from simpler models of voting are nonetheless robust to omitted variable bias when considering strategic voting behaviour?

The game-theoretic account of voting suggested by Feddersen & Pesenderfer predicts the likelihood that individuals will vote as depending on information that they receive. It also suggests that, acting strategically; less informed voters would prefer to abstain in order to leave their vote to others that are more likely to have been informed in the first stage of the game. This form of behaviour is most notable in the distraction effects of television (Gentzkow, 2006) and aggregated media sources (George & Waldfogel, 2008), which show that in pulling the electorate away from local media sources, national media creates a dampening effect on local political engagement. Based on this we could assume individuals choose to abstain because they no longer receive the information they need to make a vote that they know will create a positive outcome.

What this tells us is that population effects may also be wrought from information costs, since bigger municipalities usually means that voters need to be informed about more candidates and their respective policies. This is not to say that voters in the Feddersen & Pesenderfer framework are not making probability decisions that will be affected by population size since pivotal vote probabilities are still an important factor in their account of voting behaviour. However we will show that when information costs are higher, the voter suffers from reduced rewards from going to the ballot (Hoffmann-Martinot, 1994). Observing the number of candidates will allow us to control for political fragmentation when testing other hypotheses of Feddersen & Pesenderfer's game-theoretic account.

We believe that by incorporating aspects of Feddersen and Pesenderfer's game theoretic accounts into our analysis we are making a first empirical foray using aggregated data in testing this particular account. Some tests have been conducted on another game-theoretic account initiated by Harsanyi (1977) and extended by Feddersen & Sandroni (2006) using liquor referenda to see how rule utilitarian behaviour affects turnout (see Coate & Conlin, 2004). We believe however that the account chosen by us will be simpler for policy makers to apply to real aggregate predictions. This is because not all elections necessarily require a rule utilitarian input. As such our simplistic approach provides a good starting point for policy makers looking to estimate vote share in elections and minimize attrition when deciding on policies that could cause concern to the voting public.

In this study we will make the assumption that levels of education will coincide with access to information that allows individuals to make a vote. Since Feddersen & Pesenderfer model the probability that an individual will be informed to vote before the individual decides whether or not to turnout, we will model turnout rates using access to education, which we will assume to be largely correlated with information absorption. Through our results we will provide an economic analysis that goes beyond socioeconomic status evaluations that higher levels of education typically achieve more voter engagement since most socioeconomic inputs are significant only in cross-sectional studies and not as economic theories of democracy over longer horizons.

Using reference categories in addition to our quasi-experimental design we will show that socioeconomic assumptions do not hold over time, as expected based on our economic viewpoint, whilst scholastic polarisations of the workforce are significant in decreasing turnout, even with increases in educational inputs, using aggregated panel data. We also show that population effects are robust to perhaps the most applicable omitted variable bias considerable from contemporary game-theoretic accounts.

Aims of this study

In this study we are providing causal estimates for population, which are otherwise impossible to find without similar data as we will explain leading to the so called "knowledge problem" i.e. deficient knowledge of causal relationships and the "governability problem" i.e. the impossibility to intervene in a goal directed manner because of limited instruments (Mayntz, 1993). Governments are unable to change electoral seats back after mergers. Without being able to increase the number of seats civic engagement is effectively doomed. This particular disappointment of the voting public will push individuals that do not see voting as an appropriate means of addressing discontent into less conventional forms of political engagement.

However in this study we hope to show ways that local governments can develop in a cohesive manner in order to minimize vote share decline so that the public maintains appropriate means by which to represent itself, thus allaying the decline in public civic engagement. We also suggest new avenues for future research into voter behaviour by showing how inequality within geographical boundaries inevitably leads to disillusionment in formal avenues available to the public to influence governments and their respective policies. This would also provide a direct way of managing the failure of political efforts to govern in the interests of the common voter (Mayntz, 1993).

It is now common knowledge that probability based voting behaviour is vital to understanding why people vote and because of this Geys (2006) points out that population estimates and measures of closeness must be used more in studies, whilst also emphasizing the importance of highlighting the measure of turnout used. We go one step further in this study by distinguishing between different population effects and taking them into account. This may be exactly why this disconnect exists and why authors have been sloth in the past, simply because population effects cannot be separated without novel regression designs. Our paper requires a literature foray that lays bare the lack of commitment to an important backbone of economic theories of voting. We hope that this will be repaired at least in part given that this paper may or may not ever be published and distributed into a school of study that is lacking in true *impact*[4] despite being at the centre of a media storm now, because of Trump and Brexit, and for many generations to come.

In the first section we will review the literature. In the second section we will discuss the approach of this paper. In the third section we will describe the two difference-in-difference models that will be used. In the fourth and fifth section we will discuss the results of each research question in turn and compare these results to our U.S. data before concluding.

Section I

The first models in the literature on voting behaviour begin by assuming that voters decide whether to vote based on a simple choice. This choice is determined instrumentally and this model is described as a rational choice model. A first such model, the calculus of voting, was developed by Downs (1957) and extended and tested using survey data by Riker & Odershook (1968). The idea behind it is that voters behave by calculating the benefits of voting by a simple set of principles based on a utility choice whereby the individual prefers outcomes with higher utility to those with lower utility.

From Riker & Odershook (1968):

$$R = PB - C + D \qquad 3.1$$

Where R is the reward from voting, PB is the probability that a pivotal winning vote is cast and the utility gain from the preferred candidate over a second choice: $B_i = E(U_{t+1}^1)_i - E(U_{t+1}^2)_i$ and always greater than zero. If $R \leq 0$ it is not reasonable to vote. C is the cost of voting and D is the utility gain from civic duty. This tells us is that voting is a decision that is calculated by each voter as a utility maximizing individual and the decision is unique to each actor or agent. This model may refer to a two-party choice, and given an incumbent, a negative utility differential between the current government and the opposition would usually result in a vote for change. Downs (1957) takes care to express that as rational individuals, some can derive benefit from change whilst others do not, making utility decisions incorporate individual character to some extent. Downs also points out that voters might be future oriented and in such a manner may vote for a party on the basis that they want the party to grow and in order to influence

[4] When we talk about *impact* we mean the ability that a scholarly publication has to change the way that people use academic research to make measurable changes to peoples lives.

other parties with their vote. These individuals will reflect these characteristics in their utilities.

Using Down's definition of utility differential and assuming that negative rewards means that an individual will abstain and thus derive zero utility, the reward expression can be rewritten as:

$$R = \begin{cases} P(U_1 - U_2) + D > C, \\ 0 \text{ otherwise.} \end{cases}$$

The contribution by Riker & Odershook (1968) was to include a D term, without which the reward from voting would often be negative, since the probability of one vote affecting the results in say, a general election, are so small implying an unfeasibly large utility gain in B. Individuals continuing to turnout to vote then could only be seen as behaving irrationally. This possibility is improved upon somewhat by adding a simple utility gain from seeing democracy continue, which if no one voted, would certainly fail. This is the most prominent specification for aggregate level studies of voting behaviour and one that has been tested empirically far more so than any other model.

Several authors in the past have noted that a problem arises with the calculus of voting, it is that the probability term here is infinitesimal meaning that 'civic duty' must be very large in order to remove all possibility of irrational voting behaviour. Therefore this instrumental model appears to yield a non-instrumental theory for voting that is more closely represented by consumption. This consumption ideal is supported by survey data (Blais, Young, & Lapp, 2000) but not by aggregate data (c.f. Blais, 2000), which supports instrumental choice ideals against all logic.

Said logic is based on the fact that there are just too many voters in most elections. Using derivations from Owen & Grofman (1984) we have that given N voters and assuming that a citizen votes for candidate 1 with probability p and votes for candidate 2 with probability *(1 – p),* the number of votes must be exactly equal to $\frac{n}{2}$ when n is even or $\frac{n-1}{2}$ when n is odd in order for a single individual to be able to influence the election by themselves. The subjective probability of this precise outcome is equal to:

$$p_e = \binom{N}{N/2} * p^{\frac{N}{2}} * (1-p)^{\frac{N}{2}} \qquad 3.2$$

When N is even (if N is odd one would need to subtract 1 from all N terms in the equation). By following a binomial distribution in the case of a yes or no vote referendum or a two party race we have that:

$$p_e = f(N,p) \approx \frac{2e^{-2(N-1)(p-\frac{1}{2})^2}}{\sqrt{2\pi(N-1)}} \quad 3.3$$

Where p_e represents the probability of having a pivotal vote. Hence the probability of a pivotal vote depends on the likelihood of a tie (p approaching 0.5) and population size N. As an example, using this formulation, with a constituency of one million people we have that $p_e \approx .0008$ when $p = \frac{1}{2}$. However when p (party preference) moves marginally, for example to $p = .6$, even with a population as small as one thousand people we have that $p_e \approx 0.0000000001$. Despite this empirical tests using aggregated data find p_e to be significant through closeness (Barzel & Silberberg, 1973; Blais, 2000; Settle & Abrams, 1976; Silberman & Durden, 1975) and population size (Baekgaard et al., 2014; Blais, 2000; Blais & Dobrzynska 1998; Kau & Rubin, 1976; Silberman & Durden, 1975).

In a similar manner, in the calculus of voting, for a voter to be making an instrumental voting decision, the utility gain term B would also have to surpass any reasonable number. Again, these utility gains and their interaction have been proven to influence willingness to vote after controlling for probabilities (Filer & Kenny, 1980; Hansen, 1994). Many critical authors often fail to point out at this stage that having a pivotal vote *is* extremely unlikely, but being the man to decide an election could be seen as equally incredible. Utility gains do therefore need to account for the gratitude of fellow voters and an immense feeling of empowerment, evidenced by the fact that people who are part of organisations are the most likely to vote (Wolfinger & Rosenstone, 1980), likely because of benefits to compatriots. As improbable as they are, elections won by a single vote have occurred in 1910 in the US for the House of Representatives and in the UK in the same year for a seat in the House of Commons, which is certainly something to bear in mind. It appears then that however unlikely, in the West lightning does strike twice.

Moreover, given this model of voting an inevitable paradox occurs. The paradox is that if the probability of voting is so small that no one votes, the subsequent choice to vote will provide, by and large, a certain probability of influencing the election and therefore a strong incentive to vote. This is the paradox of nonvoting characterised by the work of Fairjohn & Fiorina (1975) that subsequently led to the rise of alternative rational choice models (Fiorina, 1976; Crain et al. 1987). This was followed by game-theoretic accounts that sought to explain voter behaviour through the use of 'mixed strategies' whereby voters are strategic actors as oppose to simply utility maximizing individuals. Under the latter framework voters are left with a strategic choice between voting and not voting, and by assuming how other agents will act, would then subjectively assume their probability of being able to influence the vote. For those who had given up on a rational solution, process models were also considered (see Kramer, 1977).

It is also true that most voters are generally not able to correctly assess probabilities i.e. assume the true state of the world (Aldrich, 1993), largely also because of the difficulties brought about by this paradox. In order to compensate for this difficulty Ferejohn & Fiorina (1975) put forward the idea where a voter decided on the option that posed the least lost utility or "regret". The minimax regret model replaced a payoff matrix comparing utility gain from voter choices (vote for 1, vote for 2, abstain) with a regret matrix comparing utility opportunity costs from all voter choice scenarios. They found that by minimizing so-called maximum regret from each choice, an individual is much more likely to vote, typically for their preferred candidate, than someone who is simply a utility maximising individual.

Unfortunately a major drawback with the minimax regret solution, as shown mathematically by the authors, is that minimax regret voters will never vote for their second choice. In many real-life scenarios however, it is argued by the media that certain candidates are a "wasted vote" since they have no real chance of winning. The wasted vote logic of receiving this information is to vote for a second choice, as was the case for many voters in the Anderson, Carter, Reagan election race in the US in 1980 (Owen & Grofman, 1984). Similarly in the UK, the liberal democrats in the past have been ostracized by the media as a wasted vote by comparison with the other two major parties: Labour and the Conservatives in the lead up to general elections. Even Downs (1957) makes reference to wasted vote logic, implying that utility decisions alone are not enough when a utility maximising choice increases the probability of less favourable candidates winning.

In fact it is often the case that voters who make use of wasted vote logic do so in constituencies where their first choice has lower support, whilst areas where a wasted vote candidate has more support such as in home constituencies, votes are less affected by the national media. This is also how voters would react when making both expected utility calculations and their interaction with probability terms, at least in an Electoral College system. Under similar composite voting systems the smallest constituencies have the greatest voting advantage.

Smaller constituencies will therefore often have higher levels of turnout in municipal elections, giving evidence to the fact that the greater the chance of having a pivotal vote, the greater the turnout. Probabilities have also been shown to affect turnout positively through the closeness of elections, even though it is well known that many electoral candidates act strategically by spending more money when elections are closer. Cox & Munger (1989) show that even after controlling for elite-level response, some variation in turnout is still correlated with closeness, meaning that voters are indeed making instrumental calculations in their voting decisions despite difficulties with the calculus of voting. Filer & Kenny (1980) examine city-county consolidation referenda to find that turnout rises with mean gains, after controlling for closeness, population and the number of issues at the ballot[5], lending further support to an instrumental model.

Voting in elections is thus far accepted as being a complex decision and it is likely one requiring more than a partial equilibrium analysis. As Ledyard (1984) explains "somewhere between no one voting and everyone voting lies a situation in which some vote." What he means is that the paradox of voting requires a general equilibrium analysis, since more than one partial equilibrium exists. Game-theoretic models assume that voters take other voters' decisions into account when deciding whether or not to vote, therefore these types of models appear to be the logical progression in terms of understanding how turnout can be modelled effectively by view of looking at the voting population as a strategic actor. Moreover this new approach to modelling turnout has led to the creation of a great variation of game theoretic models, each with their own individual characteristics (see also Palfrey & Rosenthal, 1985; Feddersen & Sandroni 2006).

The game-theoretic model that we will be investigating in this paper in addition to affects of voting age population on turnout will be the model put forward by Feddersen and Pesenderfer (1996). This paper proposes one of the most intriguing models of voter participation that we have seen and one that offers a credible explanation for the behaviour of large set of voters not fully described by the calculus of voting. The voting decision making process here is explained using a sequential game. In the first stage of this game an individual can become informed about events that will influence their vote. Once this stage is over a voter may be fully informed or partially informed. One could assume that it is arduous for a voter to become "fully informed" given the distinction between the two states, because of this we assume that an individual would need to have access to and be able to interpret large amounts of information. In the second stage an individual chooses whether to vote or abstain based on what that person believes others will know. If that individual is partially informed it is assumed that they may abstain so as to leave their vote to fully informed voters.

Using these accounts we are be able to extend economic theories of voting and their usefulness in regression designs. This account is particularly interesting because it allows us to analyse compositions of the workforce, as we will explain.

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[5] In effect measuring the costs of voting relative to the fixed cost of going to the voting booth. The more issues on the ballot the less an election will cost since the cost is distributed over the issues at stake. The less issues being voted on the more expensive the vote will appear to be.

One way to assess this form of voter behaviour could be to use levels of education in the workforce. Begin by imagining an experiment of the kinds conducted by Wolfinger & Rosenstone (1980) in their book Who Votes. In these studies voters are observed individually en masse using logit and probit regressions. Despite the important social arguments put forth in this book however it is impossible to create an economic view of voting behaviour from these studies because socio-economic factors change over time. Two years of additional education will lose its marginal benefit as workforces create greater entry requirements. That being said it is of course important to include socioeconomic factors in some macro models, such as the number of university graduates in the workforce as done by Hansen (1994) previously.

For this very reason we will often find that socioeconomic indicators will not work with time series, largely because heteroscedasticity over time makes for insignificant estimates, but also because of exogenous shocks to educational achievement and changing social norms that make socioeconomic impacts difficult to estimate efficiently. Enter Feddersen & Pesenderfer's theory on the swing voter's curse and we now have a justifiable interpretation for including educational attainment in a macro model. In our regressions we expect this theory to be significant when observing polarisations in education whilst socioeconomic orientations of regression designs will likely be found to be insignificant. In return we would know that our analyses go beyond socioeconomic principles not suited to economic theories of voter behaviour. This particular distinction is important for this research to be credible.

Section II

In order to test economic theories of voting we will be using data on municipal mergers in the Netherlands since this will allow us to extract causal estimates by controlling for different population effects as we will explain. The Netherlands in particular provides ample cases for this sort of study. Kraaykamp et al. (2001) make note of the optimal environment that Holland has produced through agglomeration policy for this form of research. Over the last two centuries the Netherlands has been steadily merging small municipalities to form larger, more powerful local governments. The authors however fall short of offering any statistically worthy insight in their research.

In 1817 the Netherlands administered 1,236 municipalities, by 2009 this number had fallen to 441. Our dataset, which is dated up until 2010, contains 431 municipalities. We assume this slight attrition is due to mergers over the year between information that is sourced from an article in Demos by Erik Beekink and Peter Ekamper (1999) and our dataset becoming available, meaning that we have a near comprehensive sample. The dataset was obtained from the CPB, which translates to the Bureau for Economic Policy Analysis in English. In this dataset we have 3736 observations in total.

Dutch municipalities on 1st January 1940

Source: Beekink & Ekamper (1999)

Our dataset includes nine elections years from years 1978 up until 2010 and includes variables ranging from turnout, populations of municipalities (before and after mergers occur), populations of the local areas to be merged (to account for general population growth) as well as information on active participants and their vote shares.

Dutch municipalities on 1st January 2009

Source: Beekink & Ekamper (1999)

By and large most of the mergers in this dataset occur in rural areas of the Netherlands and as such some omitted variable bias may exist such as greater vote shares based on access to greater public debt and free rider incentives (Hinnerich, 2009) available to larger municipalities, since this might make people vote more. This also means that treatment in our dataset is negatively skewed, which will impact our estimated averages with diff-in-diff estimation.

Because of this we may find that long-term effects cannot easily be disentangled, given that treatment is not randomly assigned. Notwithstanding Gerritsen et al. (2016) have some success when the treatment municipalities are limited to larger ones, more closely representing the control group. Here they find that mergers reduce turnout for up to seven years after the agglomeration, unlike Kraaykamp, Dam, & Toonen (c.f. 2001) who find insignificant long term effects. This may also be because local democratic renewal, of the form described by Ashworth et al. (2004), is implementable with small municipalities. It would be surprising *not* to see small municipalities make an organised effort to repair voter declined after something as exceptional as a merger.

For our second set of regressions we will be constructing a similar dataset that combines the municipality data from the CPB with workforce and education statistics from the CBS, which translates to Statistics Netherlands. This dataset will be shortened down to 4 elections years 1998, 2002, 2006 and 2010, since the CBS only has these years available that coincide with CPB data covering the same election years. In order to match municipality datasets that are coherent we also suffer a minor loss of observations due to municipalities changing. What we mean by this is that they contrast in the datasets by occurring in 2011, which is as far as the CBS database goes. This is because CBS municipalities are already set to the most recent classification throughout the sample. The raw data before agglomerations was unfortunately not available. In this dataset we have 401 municipalities and 1526 observations.

By combining the two datasets we will be able to use all of the controls available in the first estimations whilst testing a game theoretical model, which by extension relies on many of the same assumptions of the first theories of voting. We will do no less than incorporate additional factors that are also believed to affect *strategic* choice in voter behaviour. This will work as both a robustness test of population effects to omitted variable bias as well as an identification of strategic behaviours using what we believe to be the most applicable contemporary, game-theoretic account of voter behaviour, helping us to achieve our study objective.

This newer dataset adds to the previous dataset by including total workforce numbers and the number of those individuals educated to primary, secondary and higher level in thousands relating to primary and secondary school and university education respectively. The database also contains figures for unknown level of educations, which will not be used in this study. Since we are using logarithms, the scale of the data will not matter for interpretation.

Independent Variable Choices and Interpretations

At this stage it is important to note that when measuring population effects on turnout there are different coefficient interpretations that can be found, depending on the independent variable used. If we were to use simply the logarithm of turnout, then population coefficients would explain additional individuals turning out to vote as they are added to the electoral register. Based on this, we expect coefficients to be *one-for-one* since each new person added to the electoral register would add up to one more vote after controlling for other factors that increase or decrease the vote share. For simplicity we will call these the "direct effects" of population on turnout.

What we will refer to in this paper as the "indirect effects" of population on turnout relating to theory, which we are interested in computing for the purpose of this study, can be measured using two different approaches. The first is if we were to use turnout as the percentage vote share of the population, our coefficient estimates would explain how increases in population affect turnout as a percentage of the voting age population. Since if an additional person did not affect the vote share of others, holding all else equal, the coefficient would not be different from zero, thus ignoring the additive effects of population on turnout. If an additional person *were* to affect the vote share of others, as theory predicts based on individuals' probabilities of a having pivotal vote, then we would see indirect effects reducing turnout ratios as the voting age populations grow and probabilities of pivotal votes tend to zero. These indirect population effects are found to be non-linear and negative (Owen & Grofman, 1984).

The second approach, one that we will be using in this study, is to include population growth effects on the logarithm of turnout in order to control for direct effects contemporaneously with exogenous shocks to the municipality population, in order to measure more accurate indirect effects. Assumptions of linearity will be improved upon since our independent variable will not be a function of population of a function of population, by using log-linearized specifications with the appropriate variables as oppose to a ratio as the independent variable. Our population variable in our ratio would also not have any specific seat restrictions, potentially confounding the results of a quasi-experimental regression design looking at fixed vs. non-fixed seat restrictions.

As Geys (2006) points out, an unreasonable number of studies fail to explicitly state which measure of turnout is being used and to what ends that measure will affect any form of coefficient interpretation. Furthermore as we know from our review of the literature discussed in section I, near to none of the studies mentioned interpret the difference between indirect effects related to theory and direct effects of population on turnout. This is where we believe this theoretical disconnect to have the most dampening effect on the *impact* of past studies of voting behaviour. Although contemporary game theoretic models begin to explain voting behaviours that go beyond the calculus of voting related to our indirect effects, these game-theoretic accounts still use the fundamental principles of the calculus of voting based on the probability of having a pivotal vote. This means that it is crucial that these effects are distinguished so that contributions to the fundamental theoretical basis of all voting behaviour can truly be appreciated. We also note fundamental failures of regression estimates with spurious regression problems that we will discuss in the next subsection and in section III.

The "spurious" omitted variable bias problem

What we found from experimenting with different population variables in this research was that population estimates are difficult to estimate even when using exogenous shocks. This is because of potential for finding biased results.

We have that:

$$Y_{it} = \alpha P_{it} \qquad 2.1$$

$$\alpha = 1 - \gamma \qquad 2.2$$

Where Y_{it} represents turnout, P_{it} represents population and α represents the vote share. Since each additional voter will add one vote, population coefficients are both γ and 1. Including just a trend will not be enough since population growth is known to follow an exponential trend. If we try to regress $Y = \alpha P + \delta t$ we will still find a slightly "spurious" regression in α, because the trend cannot account for all the effects of population growth. The resulting coefficient for population will be too large and significant whilst the trend term will attempt to compensate for population growth by changing sign. The trend also loses any solid interpretation since it is also biased. We cannot difference data since elections in our sample do not always happen every 4 years.

We use "spurious" in parenthesis because this is actually an omitted variable bias issue, which gives spuriously large, negative coefficients for alpha in our regressions.

If we could regress $Y = \gamma P_{it}^{A} + P_{it}^{B} + \delta t$ we could remove any biased results by effectively distinguishing covariances to OLS. A way to do this would be to include a population variable with fixed seats (municipality population) and a population variable where the seats are not fixed (population). OLS will only find a negative correlation in the prior variable since the fixed seat restriction reduces vote share considerably. Furthermore OLS will not find a negative correlation in the latter variable since turnout will not decline with population growth outside of fixed seat restrictions. In our regression estimation we will include both variables. For "spurious" regression results see appendix.

Our *population* variable will be the sum of the populations regardless of merger and will be used to track population growth, whilst our *municipality population* variable will be a weighted average of the populations before the merger and a true population of the combined municipality after the merger. Using log-linearized population variables will allow us to demean non-linear population effects not removed by a linear trend.

TABLE I: Municipality merger variables example

Variables	Year 1	Year 2	Merger year
Municipality 1	1,000	1,100	1,210
Municipality 2	4,000	4,400	4,840
Population	5,000	5,500	6,050
Municipality population	(1,000/5,000)*1,000+(4,000/5,000)*4,000 = 3,400	3,740	6,050

By using these two variables we are able to improve our results considerably by being able to change our independent variable. Our independent is no longer the ratio of vote shares used by most of the literature that we have studied. Seats are restricted in municipality population variable since the populations described by this series only have one municipality in which to vote. We expect this variable to approximate γ whilst our population variable will only find additive affects.

Graphical representations

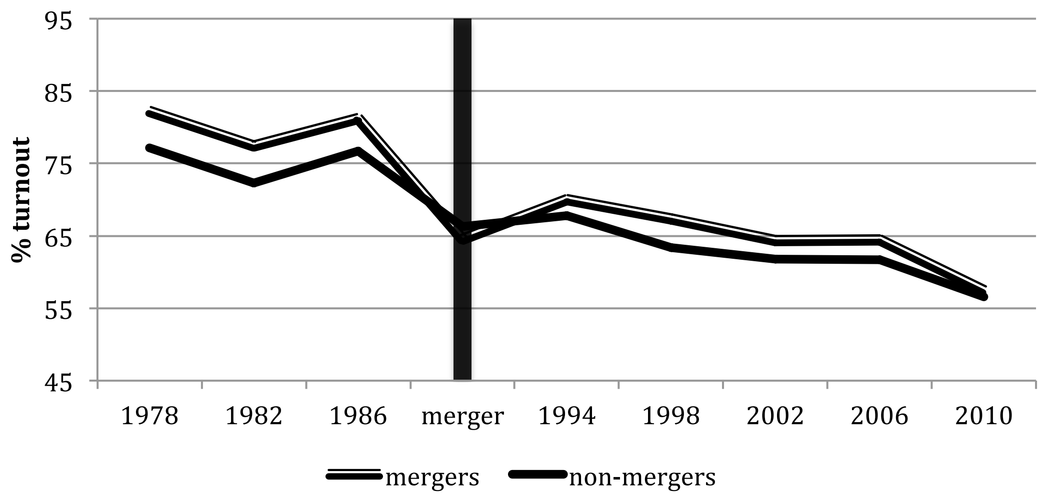
Our measure of turnout in the experiments conducted will be the logarithm of turnout, however for graphical representations we will use percentage turnout of individuals registered to vote in order to make indirect effects comparable across municipalities, as with have done with our U.S. data. The axis will be labelled and the most important thing to understand is the difference between the two interpretations. Since there are no registration requirements in the Netherlands and everyone that is a Dutch citizen of voting age is automatically registered to vote we will avoid issues of voting age population figures including individuals that are not able to vote, such as migrants and seasonal workers.

In order for a difference-in-difference framework to be viable we would have to test for common trend assumptions. We can see from figures III and IV, that for municipalities that merged in 1990 and 1998 the common trend assumptions hold. It is important to note that the gaps between elections in the dataset are connected in the graphs as such it is essential here to observe trends up until the last observation before the merger. For figure III this would be up until 1986 and for figure IV the common trend should be observed up until 1994.

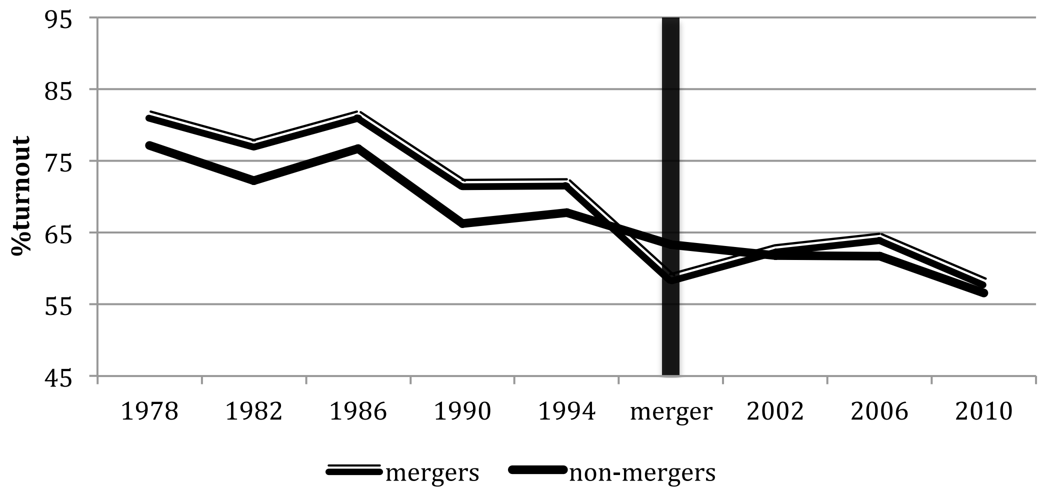
We can see that assumptions of a common trend are well represented by the composition of the dataset, however since we will be using a fixed effects model, a common trend assumption is not entirely necessary. It will however give greater support to linear estimates by giving credibility to conditional mean assumptions and homoscedastic errors. Model specifications will be discussed in the next section of this thesis.

FIGURES III & IV

Turnout municipalities merged in 1990 and non-mergers



Turnout municipalities merged in 1998 and non-mergers



Source: CPB

Section III

We will be addressing two research questions in this essay. The first will be asking whether we can prove that there exists a relationship between population size and voter turnout in elections based on theory and beyond additive effects. The second question will be asking what are the causal effects of population on turnout based on the calculus of voting. These estimates will be explored further using robustness checks and evaluation of strategic behaviour in voter choice.

Our fixed effects model specification will be:

$$Y_{it} = \beta_i + \beta_1 M_{it} + \beta_2 \mathbf{X}_{it} + \delta t + \varepsilon_{it} \qquad 4.1$$

Where Y_{it} represents the logarithm of voter turnout in municipality i in election year t, where M_{it} is a dummy variable that is equal to unity once a merger has occurred, β_i is a municipality intercept and δt is a trend term. By including municipality fixed effects we will be able to control for unobserved characteristics of municipalities, such as amenities. By using a trend term we will have a better control for declining time trends in voter turnout rates, avoiding the spurious regression problem that sometimes will occur with time series data. This is true in this case especially because voting behaviour is consistent. In many cases authors argue for the use of a lagged turnout variable, which we however cannot include in this study since we are using fixed effects. The $\mathbf{X}_{it}$ term here represents a vector of time varying covariates such as the logarithm of voting age population outside of the fixed seat restrictions, ex ante measures of closeness and the number of parties participating in the election. Since we are using logarithms, all variables can be interpreted as elasticities, apart from winning majority, which is already a ratio. Although we would have liked to leave the number of participants in its original nature so that the coefficient interpretation is simplified by keeping its constitution, i.e. how an increase of one additional participant affects the vote share, we find that population estimates are somewhat lower since participant effects need to be linearized. Given this fact we will offer some guidance for the interpretation of this variable.

The ex ante measures of closeness that we will use will include winning majority and a measure of entropy. Our winning majority variable will be the vote share of the winning party less the vote share of the party that takes second place:

$$D_{it} = S_{it}^1 - S_{it}^2 \qquad 4.2$$

Where D_{it} is the winning majority for municipality *i* at time *t* and S_{it}^{j} is the vote share for municipality *i* at time *t* that arrives in the *j^th^* place of the race i.e. first or second. Our alternative measure for closeness will be used to account for 'three horse race' situations as suggested by authors Kirchgässner & Schimmelpfennig (1992). The variable is defined as:

$$a_j = \frac{S_{it}^{j}}{(S_{it}^{1} + S_{it}^{2} + S_{it}^{3})} \qquad 4.3$$

$$ENT_{it} = -\sum_{j=1}^{3} a_j \log a_j \qquad 4.4$$

Where a_j represents the vote share of coming in j^{th} place, divided by the total vote share of the first three candidates. ENT_{it} is our measure of entropy for municipality *i* in election year *t*.

The higher the winning majority or the lower the level of entropy, the greater the distance between the winning party and its competitors, with a winning majority equal unity being the highest and zero being the lowest and a degree of entropy equal to zero being the lowest and values above one being highly contested between the three main parties. We would expect closeness to be negatively related to turnout since probabilities of having a pivotal vote will be lower, the greater the winning party's margin whilst entropy should be positively related to turnout under the same logic. Another measure of closeness we could use is the winning party's vote share (see Crain & Deaton, 1977) however to avoid compromising a fixed effects model by using a variable that is somewhat similar to a lagged independent variable, this variable was not included.

In this study we are using ex ante measures of closeness even though we do not have access to the kind of information that a voter might use to assess election candidates, such as opinion polls and newspaper reports. Previous election results are available and may be enough to make an informed closeness calculation. Drawbacks to this view are wrought from the fact that elected parties can, and sometimes do disappoint, leading to disenfranchisement and thus a change in the vote. This performance rating[6] effect is something that we cannot predict given our data.

[6] Performance ratings can be measured as $\left[\frac{U_t^i}{U_t^a}\right]$ (Downs, 1957), where U_t^i is utility gained from the incumbent government for individual i at time t, whilst U_t^a is the utility opportunity cost of the other party not being in power. Both utility calculations should also account for the power of the opposition to influence actions of the governing party. Other measures can be used, such as approval ratings. These ratings could improve results in national election studies.

For this same reason ex post measures of closeness are used more often than not in the literature (Geys, 2006). This however implicitly assumes that voters have completely rational expectations concerning outcomes (Mueller, 2003), which is a risky assumption to make given that individuals are notoriously bad at judging probabilities (Aldrich, 2006). Not immune to the same bad judgement, we will however be satisfied with lagged closeness results. Voters at the relative points in time may be better informed than we could hope to be ourselves using historical accounts, because as we know, especially of late given Trump and Brexit in 2016, that opinion polls can also be wrong, and that such municipality level information is also often very difficult to find, particularly for rural areas where opinion polls do not exist or are too costly to introduce. However we also believe that in guessing probabilities, previous election results will be much harder to out-predict even for a well-informed voter in many cases, especially on a municipality level where performance ratings are scarce and where utility effects are more complex.

If we were to use only a difference-in-differences regression design, since treatment happens on different years, we would need to include a treatment group dummy and a dummy for treatment. I.e. there is no need for an interaction term since the treatment term already identifies the treatment group after treatment given differing treatment dates. However our regressions includes an intercept for each municipality in the form of fixed effects therefore there is much less need for a treatment group dummy. Once we choose to use a fixed effects specification we cannot use a dummy for the treatment group thereafter since we are not able to apply a random effects. The reason being that treatment is not independent of our dependent variables, most notably population, which is our main variable of interest.

Because of this fact, unobserved characteristics for the treatment group may be different to that of our control and may vary wildly since treatment is not randomly assigned in our data. The majority of the merger municipalities that are part of the treatment group are smaller in size however the specific criteria for mergers was in fact to overhaul municipalities that were considered to have weak or inefficient administrations. In such a case a municipality fixed effect may do a better job of separating variance to obtain more efficient estimates than a simple difference-in-differences model since every municipality is different in some way. These municipalities may also have been selected for mergers because of very specific reasons including public willingness to vote. Eventually municipalities were given the power to merge by themselves, which might make a treatment dummy even less effective at singling out individual biases as compared with individual municipality intercepts. Based on these concerns we will be more rather than less satisfied with a fixed effects specification.

Finally, to reduce bias from using a dummy treatment variable, we will see how municipality population affect turnout in our model by conducting a two stage least squares (2SLS) regression with fixed effects.

1st stage regression: $$Q_{it} = \gamma_i + \gamma_1 M_{it} + \gamma_2 \mathbf{X}_{it} + \delta t + \varepsilon_t \quad 4.5$$

2nd stage regression: $$Y_{it} = \rho_i + \rho_1 \hat{Q}_{it} + \rho_2 \mathbf{X}_{it} + \delta t + \varepsilon_{it} \quad 4.6$$

Where Q_{it} represents the municipality population, instrumented by treatment.

We believe the IV with fixed effects approach will provide more consistent estimates since treatment, being binary, will include other effects that occur because of the merger, such as greater access to public spending money and free-riding debt incentives (Hinnerich, 2009). In effect by instrumenting changes in municipality population with treatment we will find a 2SLS method may categorically exclude the most of this bias through homoscedastic error assumptions and linear predictions, making an instrumental model with fixed effects a better linear unbiased estimator.

We also believe the IV with fixed effects approach will provide more consistent estimates since treatment, being binary, is weighted by the sample. Instead 2SLS will give weighted average by population figures in the observation, giving more accurate average treatment effects, rather than providing only local average treatment affects, which will be negatively skewed given the larger number of small municipalities that merge in the sample. The result of which will be to have more applicable estimates for the sake of policy analysis.

Testing Feddersen & Pesenderfer

In order to test probability voting's resilience to omitted variable bias we will conduct a second set of 2SLS regressions. In principle we are comparing our previous model with additional factors that may also give evidence for contemporary theories of voting. Our regression specification will be as follows:

$$Q_{it} = \gamma_i + \gamma_1 M_{it} + \gamma_2 \mathbf{X}_{it} + \delta t + \varepsilon_t \quad 4.7$$

$$Y_{it} = \beta_i + \beta_1 \hat{Q}_{it} + \beta_2 \mathbf{X}_{it} + \beta_3 T_{it} + \beta_A W_{it}^A + \beta_B W_{it}^B + \delta t + \varepsilon_{it} \quad 4.8$$

As before we are instrumenting the municipality population using the treatment dummy. We know that through instrumentation we are improving our treatment effects and in this case we will not conduct both regression formats. In this model Y_{it} remains the logarithm of voter turnout in municipality *i* in election year *t.* Furthermore under this framework the same vector of time-varying factors are included under $\mathbf{X}_{it}$, for reference these include voting age population size, ex ante measures of closeness and the number of parties participating in the election. Once again fixed effects β_i are included for each of the 401 municipalities. Similarly we are still including a time trend to account for declining voter behaviour, which is behaviourally consistent.

Now however we are including T_{it} representing the size of the total workforce in municipality *i* at time *t* as well as W_{it}^A and W_{it}^B, which represent two out of a set of three categorical variables generating three unique regression specifications. The set of categorical variables refers to workforce educated to primary, secondary and higher level where higher represents university educated workers. Since including all three groups would lead to multicollinearity, i.e. that the workforce variable T_{it} could be estimated by summing the three educational tiers, one must be omitted and used as a reference category. Using this formulation we now have three regressions where coefficient interpretations of the educational tiers are interpreted as the elasticity of changes to one educational tier from the [omitted] reference category. For example, by moving from secondary educated to higher educated workforce distribution, what are the marginal benefits/losses to vote share caused by aggregate voter behaviours.

Because this study uses panel data over several years, we would not expect any education variables to be significant since socioeconomic requirements in workforces change over time. Notwithstanding however if we are able to interpret significant coefficients when using specific reference categories, namely secondary education, we could instinctively make comparisons with more economic theories of voting behaviour particularly that of Feddersen & Pesenderfer. If we find that these polarisations are negative either way, even for increases in educational attainment, then we would be able to surmise abstention effects. These abstention effects, as predicted by Feddersen & Pesenderfer would be that partially informed voters are more likely to abstain given the higher probability that there are other individuals in fully informed states.

The results presented in the fifth section of the thesis give evidence of this particular form of abstention whilst adhering to our assumptions of heteroscedasticity, and therefore insignificant estimates, in socioeconomic arrangements of our regression specification, i.e. not using secondary education as a reference category.

Our workforce variable T_{it} present in equation 4.8 will allow us to improve on previous estimates regarding additive population effects. By combining coefficients we will have a more informed representation of how growing populations can lead to higher vote shares, as we will explain. The inclusion of this variable is also helpful in conducting our robustness checks since rural mergers might be in less employed areas of the Netherlands and subject to bias. These effects will largely be controlled for with a fixed effects specification. Notwithstanding changes in the composition of the workforce over time on a country level could also affect turnout estimates, which is what we may observe in our population estimates in this set of specifications compared with the prior. A large shift in estimated coefficients for population will be a significant case for omitted variable bias.

Section IV

Below we present the results of our regressions. These regressions relate to equations 4.1 in columns 1 and 2, and 4.5 and 4.6 in columns 3 and 4 of table II.

TABLE II: Fixed effects and 2SLS regression estimates

	Dependent variable: ln (voter turnout)			
	(1) FE	(2) FE	(1) IV	(2) IV
Constant	17.2215*** (.2280)	17.1498*** (.2301)	17.0456*** (.2381)	16.9748*** (.2402)
Treatment/Municipality Population[IV]	-.0392*** (.0038)	-.0396*** (.0038)	-.0543*** (.0053)	-.0547*** (.0053)
Ln (Voting age population)	.9724*** (.0085)	.9723*** (.0088)	1.0164*** (.0093)	1.0163*** (.0096)
Ln (Participants)	-.0100** (.0048)	-.0121** (.0049)	-.0086* (.0048)	-.0106** (.0049)
Winning majority$_{t-1}$	-.0249* (.0130)		-.0235* (.0130)	
Ln (Entropy$_{t-1}$)		.0066 (.0078)		.0058 (.0078)
Election year (trend)	-.0087*** (.0001)	-.0086*** (.0001)	-.0086*** (.0001)	-.0085*** (0001)
R-squared	.9855	.9856	.9870	.9870

The reported intercept is the average value of the municipality fixed effects. Standard errors are in brackets.
*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

From these results we can observe that through a merger the average reduction in turnout is 3.92%, which corresponds to the local average treatment effect of our dataset. Using 2SLS we find that by doubling population size turnout falls by between 5.43% and 5.47% relating to average treatment effect of our dataset.

The difference here is somewhat idiosyncratic and largely due to the fact that mergers in our sample occur in smaller municipalities, skewing estimated averages.

In U.S. presidential elections the voting age population doubled from 109 million in 1960 to 220 million in 2004. Over this period turnout declined from 63% to 57%, marginally more than our estimates would predict. From a Downsian view of economic theories of voting this would make sense, since little else would be needed for a utility decision to be calculated. We are inclined to believe this since closeness has a central tendency and in most democracies trust comes and goes.

However U.S. midterm participation has fallen by 10% over the same period, by comparison, there we only explain half of the variation in turnout using population estimates alone. Since midterms have developed less media coverage than presidential elections we might assume that some of the reduction in turnout in U.S. midterm elections may also be due to rising information costs to the voter, as local information from aggregated channels becomes less dispersed (Gentzkow, 2006; George & Waldfogel, 2008).

From our regression estimates we can see that the more candidates running in a race the more participants that the voting public must be informed about and the more the public will choose to abstain because of the information costs associated with making a rational decision. It becomes cumbersome to get informed about several candidates, even if the greater number of candidates makes for a more represented political spectrum. For example increasing the number of candidates from four to five would lead to between a .215% and a .265% fall in voter turnout. American midterm elections however require voters to be informed about candidates and the incumbent president's intentions, given the strategic nature of midterms and the incentive voters have to block/push representatives in order to manage party politics in congress and the senate where legislation suggested by government is contested.

The negative coefficient for participants also lends support to Feddersen & Pesenderfer's game theoretic account that assumes that informed voters make votes therefore if it is more costly to become informed about all candidates, less people should turnout to vote. In the next section we will assess if Feddersen & Pesenderfer's account could work in practice and how population estimates are affected under a more complex model of voting behaviour.

With the instrumental models we can see the effects that a growing population has on turnout since each voter adds more than his one vote, which gives evidence to the endogeneity that we predicted was a cause of issues surrounding population effects and growth patterns in previous research. It is that growing populations add more than a one-for-one effect given the characteristics of growing cities and political motivation. However since our municipality size variable is instrumented by treatment in this quasi-experimental approach, we are able to isolate direct effects related to theory.

In support of the calculus of voting we have a final stroke of luck in one of our ex ante measures of closeness through winning majority, which is found to reduce vote shares considerably. Not being an elasticity we would interpret this coefficient as being a certain win leading to a 2.49% reduction in turnout. Entropy although insignificant has the correct symbol and using a certain winning majority in a three-horse-race we find that turnout would decline by .66% using a one hundred per cent elasticity.

We also find that after controlling for all variables, voter engagement is in fact falling. This may be due to other factors such a declining trust in politicians as described by Putnam (2000). Our model is an excellent fit, providing ample context for analysis post-hoc. We will return to these coefficient estimates later.

Section V

In the previous section we have contributed evidence in favour of the existence of probability based voting through population sizes and one ex-ante measure of closeness whilst also providing evidence for cost based decisions that could impact voter behaviour as described by the calculus of voting.

Our next move would be to ascertain the causality of estimates and one particular way we can do so is by testing extensions of the calculus of voting using Feddersen & Pesenderfer's game theoretic account. In this particular account we will be contributing to the literature by assessing how educational achievement can affect voter turnout through abstention. From this regression design we will also develop solutions to reduce voter abstention caused by growing populations and subsequent losses of voter power. In table III we show our results.

Despite the lack of significance in the latter two regression specifications, the results are somewhat promising. The reason being that only the first model, which has secondary education as a reference category finds significant estimates in all workforce categories. With significant theoretical reasoning, this can be looked at positively in view of the Feddersen & Pesenderfer model and economic theories of voting. In showing that polarisations of the workforce are always detrimental to voter turnout and significant we are supporting the economic model. At the same time we show that although increasing educational attainment is always positive, it is insignificant because of changing socioeconomic factors over time. This way our analysis goes one step beyond socioeconomic impetus into the economic realm provided by the game-theoretic account in the discipline. This is not to say that increasing levels of education is not beneficial to voter engagement however as we will explain later, there is significant negative effects caused by not following cohesive local policies.

TABLE III: 2SLS regression estimates

	Dependent variable: ln (voter turnout)		
	IV (3)	IV (4)	IV (5)
Constant	14.2338*** (1.1959)	16.1408*** (1.0437)	13.9845*** (1.0854)
Ln (Municipality population)	-.0535*** (.0136)	-.0497*** (.0129)	-.0539*** (.0133)
Instrument treatment			
Ln (Voting age population)	.9620*** (.0255)	.9634*** (.0248)	.9626*** (.0250)
Ln (Labour force)	.1358*** (.0359)	.0677 (.0446)	.0082 (.0428)
Ln (Lower education)	-.0629*** (.0183)	-.0441** (.0177)	
Ln (Secondary education)		-.0067 (.0283)	.0248 (0.0277)
Ln (Higher education)	-.0380** (.0193)		.0026 (.0178)
Ln(Participants)	-.0139 (.0128)	-.0109 (.0116)	-.0144 (.0117)
Winning $majority_{t-1}$	-.0390 (.0313)	-.0427 (.0277)	-.0197 (.0300)
Election year (trend)	-.0071*** (.0006)	-.0080*** (.0006)	-.0069*** (.0006)
R-squared	.9794	.9793	.9798

The reported intercept is the average value of the municipality fixed effects. Standard errors are in brackets.
*** Significant at the 1% level
** Significant at the 5% level
* Significant at the 10% level

Notwithstanding being higher educated could lead to better management of information that might encourage a less informed individual to vote whilst not creating any incentives for knowledgeable voters. One such theory leading to systemic loss of votes with greater information would be correlation neglect as noted by authors Levy and Razin (2015). However with a large enough sample our results should stand unless media bias is consistent throughout the data, giving support to a new critical but overlooked reason for the decline in civic duty, which is inequality within geographical boundaries.

As educational achievement moves either way away from secondary education, be that higher or lower, we still observe greater abstention, so long as these changes are within the same municipality. Despite the fact that many other authors emphasise returns to education are positive, which we do not disagree with on an individual level, we do believe that a lack of cohesive development within fixed seat restrictions can also be a cause of voter attrition.

Certainly, workforce decline in education levels always leads to abstention and is significant when low skilled workers replace higher educated individuals. Furthermore increases in education appear at least to always be positive. But when higher educated workers replace middle educated workers, abstention occurs theoretically because lower educated individuals that do not have access to the information required to make a rational vote effectively give up on formal civic engagement because they know there are others who conversely are fully informed. We support this idea with the fact that more education creates greater incentives to vote on an individual level in cross-sectional regression designs often without compromise (Wolfinger & Rosenstone, 1980) however we now know that on a more aggregate level, over time, there are greater forces at play.

From our model we see that the endogeneity of growing populations making a more interesting voting environment are no longer certain since our population growth coefficient is marginally below a one-for-one effect. Instead we have that people who are added to the electoral register and are part of the labour force add approximately 1.1 votes each holding other variables constant. This tells us that for interesting political environments to emerge, individuals need to be of voting age *and* young enough to work. If however these individuals are higher or lower educated, as oppose to having graduated from secondary school, vote shares will only increase by 1.06 and 1.03 respectively, holding other effects constant. These differences are marginal but considerable if you reflect that when offering access to higher education to 10,000 individuals that were previously secondary educated, in a single municipality, theory would predict that this would lead to a loss of 400 votes from lower educated individuals, who could already be marginalised and underrepresented.

The future for civic duty appears to be ill-fated not only for the masses through population effects, but also to lower educated individuals who become left behind by a society that is developing beyond their means to have access to appropriate levels of education, which is a very sobering fact indeed.

Our indirect population effects remain stable after the addition of these new parameters. We find after considering the two models with the best goodness of fit that our probability effects of population remain -5.4% for a doubling of the population. We observe these coefficients to be the causal effect of population on turnout since they are robust, our model is comprehensive and the population shocks are exogenous. We find that our trend term is slightly smaller at around -.007 when observing the same two models. We believe that this is due to the fact that inequality is increasing in line with our trend. What we are left with is a more accurate depiction of falling civic duty due to growing mistrust in government (Putnam, 2000) and possibly the failure of the state (Mayntz, 1993).

The importance of this second regression design becomes apparent in how it offers an avenue for stopping the steady decline of disinterest caused by losses of voter power. As something that has been a sort of axiom of European Union policy for the past few years: Cohesive development is an honest solution and one that can be applied with a relatively independent regulative framework within which municipalities operate. We will conclude, after this section with how this policy could work, in practice by encouraging municipalities to operate under equal more distributions of education.

Taking the results of these regressions and comparing these estimates with our data on U.S. Presidential elections described in figure I we find that our results are in line with American voter decline over the past half century. The population of the U.S. doubled from 1960 to 2004, over this period turnout as a ratio of voting age population declined by 6%. This tells use that population effects account for 90% of the decline in turnout. Our trend, i.e. mistrust (Putnam, 2000) and failures of the state to adhere to voter preferences (Mayntz, 1993), accounts for 0.31% or 5.2% of the decline. After that and we are left with 0.28%, which we would attribute to rising inequality.

If we were to compare our estimates with U.S. midterm election turnout we would find that our estimates account for only 54% of the variation in turnout, however we know that the distraction effects of television (Gentzkow, 2006) and more aggregated news sources (George & Waldfogel, 2008) have played a part in reducing information channels for less publicised political events.

We believe that relationships between population size and voter turnout are proven in this study to be significant in all cases. We also find that strategic behaviour with regards to information is also a prevailing factor in determining voter behaviour. This stands as evidence to newer theories of voting based on voter power and strategic behaviours in voting.

Conclusions

Feddersen and Pesenderfer (1996) note that it is impossible for a population of individuals to go out and vote and the ensuing result not to be an optimal outcome. What we conclude from this research is that as populations grow more people become less compelled to vote because of their lack of power, i.e. their utility benefits are not large enough given the probability of their vote counting, to outweigh their costs. Furthermore we know that by being marginalised, individuals will be pushed into informational states that compel them to leave their votes to other individuals. This gradual decline will only result in less people voting and thus having their opinion taken into consideration. This inevitable decline will continue to affect poorer people with less to lose. Because of this, optimal outcomes will reflect only the welfare of those with more vested interests, esp. people who have more capital at stake. This is because probabilities and utility benefits are considered in tandem, someone who has a lot of money at stake will find it easy to outweigh the costs of going to the ballot, which are often small and often based around access to resources that wealthy individuals find easier to obtain, such as access to information and distance to the voting booth.

This steady decline in voting is something that cannot be stopped by changing municipality policy because even without mergers (seat reductions), populations will continue to grow, minimizing voter power. This fact is cemented by our research and the research of countless others that have continued to include population variables in their regressions.

From our regression we can prove that turnout is negatively correlated with population size and that our estimates are robust to omitted variable bias but how do we prove that these individuals are acting strategically in the way that Owen & Grofman (1984) and thereafter Aldrich (1993) suggested, i.e. that voting becomes a decision based on how many people are expected to abstain. Are less people voting because the probability is getting smaller or is the lower probability causing more voters to abstain strategically? The two things are very similar but very hard to separate. In effect people who abstain could be doing so because they know their vote will be influenced elsewhere however this is difficult to believe given that population effects reduce turnout so much. From this study we are still not able to pick apart the fundamental way that people manage voting decisions.

We can however distinguish how voters behave in different educational environments. If there is a change in educational levels away from an acceptable, standardized level we know based on theory that there will always be less educated individuals willing to relinquish their votes. This tells us that there is more to voting than simple economic theories suggest, since costs alone would not explain the abstention that we have found with a polarised workforce. Thus it is believed that in behaving this way individuals are making complex, strategic decisions based on what they perceive the remainder of the workforce knows.

The estimates for population provided by our first model based the calculus of voting are robust to a more complex model of voting behaviour based on informational states. This was concluded by adding more variables that are closely related to population effects without any significant differences in the indirect population effects that were the focus of this research. Even assuming that voting is a utility maximizing decision based on Downsian models of voting then we can also conclude that educational differences will only exacerbate an existing issue already causing the decline of the poor man's vote.

Advice for policymakers

Using estimates for population effects in this study, variations in turnout above and beyond these parameters will be useful to understand where disenchantment with incumbent governments has lead to lower turnout figures. Looking back at our results for U.S. elections we can see that turnout has fluctuated a lot and after compensating for population effects with a fixed number of seats and inequality in education attainment, a participating party could make a distinction between a situation where even the most frivolous electoral campaign will not change already permeated voter interest and one where there is scope to win fresh support with new politics.

We have also shown with precision how mergers can negatively affect turnout through population size repairing the so called "knowledge problem" but leaving us with yet another "governability problem", described by Mayntz (1993). The problem here is that the only way to create greater civic engagement is to increase the number of seats per capita in order to increase probabilities with higher voter numbers. Governments are however incapable of changing the number of seats since they are set by institutions that make up the foundations of society. Even reversing mergers would not provide an efficient solution since many conglomerated for efficiency reasons with regards to governance, therefore disappointment in civic duty appears to be a side effect of more efficient management.

"Prevention is better than a cure" - Desiderius Erasmus

What we propose as the very best solution to stemming the decline in civic engagement with regards to mergers and more so in general good governance practices is to ensure cohesive management. This would mean training a municipality population collectively and hence minimize inequalities. It would also mean merging only the municipalities that are similar in educational attainment in order to minimize abstention of individuals who are likely to feel left behind.

Avenues for future research

We believe that it is always important to include both a trend in future regressions as well as fully detrending the population variable, which involved adding variables that represent population growth outside of seat restrictions. This could be the logarithm of country population at time t in a panel regression with the population in each college area. Estimates will be much more efficient that way.

A key point from this research is that perfect regression designs are almost impossible to construct without such a database as the one used in this study. This is because population effects cannot be properly separated giving rise to spurious results. We do believe that because of this, logit and probit studies might be the best avenue for studying economic theories of voter behaviour since under these frameworks only indirect effects of population on turnout will be estimated. We would expect logit and probit specifications to perform better than using ratio of vote shares since the largest effects will be not be biased and hard to disentangle. This would however require obtaining information on individual voters for a long time, i.e. an extended version of the research conducted by Wolfinger and Rosenstone (1980). This is costly but worthwhile if policymakers want to understand what makes people tick boxes at the ballot.

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[9] dr. Bas ter Weel - CPB Netherlands Bureaucracy for Economic Policy Analysis.

Bibliography

Aldrich, J. H. (1993). Rational Choice and Turnout. *American Journal of Political Science , 37* (1), pp. 246-278.

Ansolabehere, S., & Konisky, D. M. (2006). The Introduction of Voter Registration and Its Effect on Turnout. *Political Analysis , 14* (1), pp. 83-100.

Ansolabehere, S., Iyengar, S., Simon, A., & Valentino, N. (1994). Does Attack Advertising Demobilize the Electorate? *The American Political Science Review , 88* (4), pp. 829-838.

Ashworth, R., Copus, C., & Coulson, A. (2004). Local Democratic Renewal: An Introduction. *Local Government Studies , 30* (4), pp. 459-466.

Baekgaard, M., Jensen, C., Mortensen, P. B., & Serritzlew, S. (2014). Local News Media and Voter Turnout. *Local Government Studies , 40* (4), pp. 518-532.

Barzel, Y., & Silberg, E. (1973). Is the Act of Voting Rational? *Public Choice , 16*, pp. 51-58.

Beekink, E., & Ekamper, P. (1999, June 28). De grenzen verlegd; twee eeuwen herindeling Nederlandse gemeenten. *Demos, bulletin over bevolking en samenleving , 15* (6), pp. pp. 41-44.

Blais, A. (2000). *To Vote or Not to Vote: The Merits and Limits of Rational Choice Theory.* Pittsburg, Pennsylvania: University of Pittsburg Press, pp. 25-31.

Blais, A., & Dobrzynska, A. (1998). Turnout in electoral democracies. *European Journal of Political Research , 33* (2), pp. 239-261.

Blais, A., Young, R., & Lapp, M. (2000). The calculus of voting: An empirical test. *European Journal of Political Research , 37* (2), pp. 181-201.

Cox, G. W., & Munger, M. C. (1989). Closeness, Expenditures and Turnout in the 1982 U.S. House Elections. *The American Political Science Review , 83* (1), pp. 217-231.

Coate, S., & Conlin, M. (2004). A Group Rule–Utilitarian Approach to Voter Turnout: Theory and Evidence. *The American Economic Review , 94* (5), pp. 1476-1509.

Crain, W. M., Leavens, D. R., & Abbot, L. (1987). Voting and not voting at the same time. *Public Choice , 53* (3), pp. 221-229.

Crain, M. W., & Deaton, T. H. (1977). A Note on Political Participation as Consumption Behaviour. *Public Choice , 32* (1), pp. 131-135.

Downs, A. (1957). *An Economic Theory of Democracy.* New York: Harper & Row, pp. 36-50.

Feddersen, T. J., & Pesendorfer, W. (1996). The Swing Voter's Curse. *The American Economic Review , 86* (3), pp. 408-424.

Feddersen, T., & Sandroni, A. (2006). A Theory of Participation in Elections. *The American Economic Review , 96* (4), pp. 1271-1287.

Ferejohn, J. A., & Fiorina, M. P. (1974). The Paradox of Not Voting: A Decision Theoretic Analysis. *The American Political Science Review , 68* (2), pp. 525-536.

Filer, J. E., & Kenny, L. W. (1980). Voter Turnout and the Benefits of Voting. *Public Choice , 35* (5), pp. 575-585.

Fiorina, M. P. (1976). The Voting Decision: Instrumental and Expressive Aspects . *The Journal of Politics , 38* (2), pp. 390-413.

Geys, B. (2006). Explaining voter turnout: A review of aggregate-level research. *Electoral Studies* (25), pp. 637-663.

Gentzkow, M. (2006). Television and Voter Turnout. *Quarterly Journal of Economics , 121* (3), pp. 931-971.

George, L. M., & Waldfogel, J. (2008). National Media and Local Political Participation: The Case of the New York Times. In R. Islam, *Information and Public Choice: From Media Markets to Policy Making* (pp. pp. 33-48). Washington, D.C.: The World Bank.

Gerritsen, S., Webbink, D., & Weel, B. t. (2016). Testing the economic theory of democracy More potential voters - less voting? *Unpublished*.

Hansen, T. (1994). Local Elections and Local Government Performance. *Scandinavian Political Studies , 17* (1), pp 1-30.

Harsanyi, J. C. (1977). Morality and the Theory of Rational Behavior. *Social Choice , 44* (4), pp. 623-656.

Hinnerich, B. T. (2009). Do merging local governments free ride on their counterparts when facing boundary reform? *Journal of Public Economics , 93* (5-6).

Hoffmann-Martinot, V. (1994). Voter turnout in French municipal elections. *Local elections in Europe* , pp. 13-42.

Kau, J. B., & Rubin, P. H. (1976). The Electoral College and the Rational Vote. *Public Choice , 27* (1), pp. 101-107.

Kirchgässner, G., & Schimmelpfennig, J. (1992). Closeness Counts if It Matters for Electoral Victory: Some Empirical Results for the United Kingdom and the Federal Republic of Germany. *Public Choice , 73* (3), pp. 283-299.

Kraaykamp, G., Dam, M. v., & Toonen, T. (2001). Institutional Change and Political Participation: the Effects of Municipal Amalgamation on Local Electoral Turnout in the Netherlands. *Acta Politica , 36* (4), pp. 402-418.

Kramer, G. H. (1977). A Dynamical Model of Political Equilibrium. *Journal of Economic Theory , 16* (2), pp. 310-334.

Levy, G., & Razin, R. (2015). Correlation Neglect, Voting Behaviour and Information Aggregation. *American Economic Review , 105* (4), pp. 1634-1645.

Mayntz, R. (1993). Governing Failures and the Problem of Governability: Some Comments on a Theoretical Paradigm. In J. Kooiman, *Modern Governance* (pp. 9-20). London: SAGE Publications.

Owen, G., & Grofman, B. (1984). To vote or not to vote: The paradox of nonvoting. *Public Choice , 42* (3), pp. 311-325.

Putnam, R. (2000). Bowling Alone: America's Declining Social Capital. In L. C. Crothers L., *Culture and Politics* (pp. 223-234). New York: Palgrave Macmillan.

Pintor, R. L., & Gratschew, M. (2002). *Voter Turnout since 1945 A Global Report.* Institute for Democracy and Electoral Assistance. Stockholm, Sweden: International IDEA.

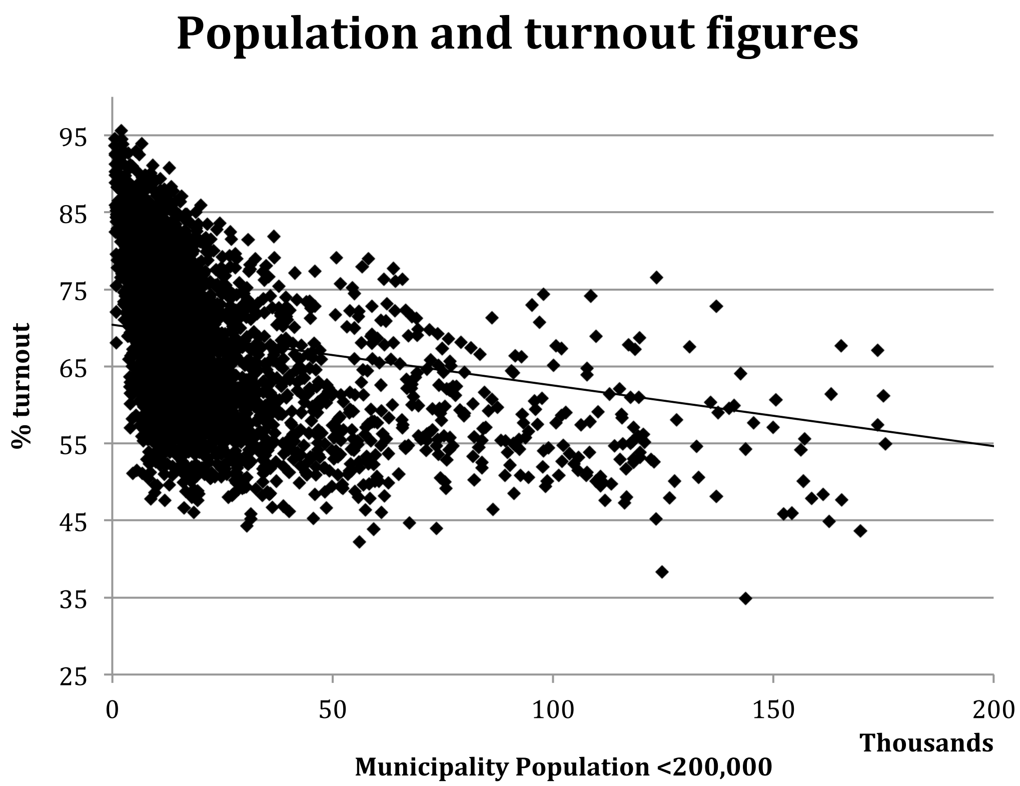
Settle, R. F., & Abrams, B. A. (1976). The Determinants of Voter Participation: A More General Model. *Public Choice , 27*, pp. 81-89.

Silberman, J., & Durden, G. (1975). The Rational Behaviour Theory of Voter Participation: The Evidence from Congressional Elections. *Public Choice , 23*, pp. 101-108.

Riker, W. H., & Odershook, P. C. (1968). A Theory of the Calculus of Voting. *The American Political Science Review , 62* (1), 25-42.

Wolfinger, R. E., & Rosenstone, S. J. (1980). *Who Votes?* New Haven & London: Yale University Press, pp. 13-26, 27-34.

Appendix



Source: CPB

Regression estimates

Fixed effects regression (1)

```
. xtreg ltu lvap treatment lpart lwm Electionyear, fe

Fixed-effects (within) regression               Number of obs      =      3694
Group variable: gem2010                         Number of groups   =       428

R-sq:  within  = 0.8065                         Obs per group: min =         6
       between = 0.9898                                        avg =       8.6
       overall = 0.9855                                        max =         9

                                                F(5,3261)          =   2718.55
corr(u_i, Xb)  = -0.4647                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lvap |   .9723918   .0084686   114.82   0.000     .9557876     .988996
   treatment |  -.0392003   .0037725   -10.39   0.000    -.0465969   -.0318036
       lpart |  -.0100041   .0048159    -2.08   0.038    -.0194466   -.0005616
         lwm |  -.0249094   .0129756    -1.92   0.055    -.0503505    .0005317
Electionyear |  -.0086857   .0001362   -63.79   0.000    -.0089527   -.0084187
       _cons |   17.22152   .2279971    75.53   0.000     16.77449    17.66855
-------------+----------------------------------------------------------------
     sigma_u |   .0851081
     sigma_e |  .05528323
         rho |  .70326725   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(427, 3261) =    14.72           Prob > F = 0.0000
```

Fixed effects regression (2)

```
. xtreg ltu lvap treatment lpart llen Electionyear, fe

Fixed-effects (within) regression               Number of obs      =      3632
Group variable: gem2010                         Number of groups   =       427

R-sq:  within  = 0.7974                         Obs per group: min =         1
       between = 0.9898                                        avg =       8.5
       overall = 0.9856                                        max =         9

                                                F(5,3200)          =   2518.99
corr(u_i, Xb)  = -0.4609                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lvap |   .9722583   .0087903   110.61   0.000      .955023    .9894936
   treatment |  -.0396317   .0038279   -10.35   0.000    -.0471371   -.0321262
       lpart |  -.0120668   .0049167    -2.45   0.014     -.021707   -.0024266
        llen |   .0065902   .0077637     0.85   0.396    -.0086322    .0218126
Electionyear |  -.0086494   .0001384   -62.48   0.000    -.0089209    -.008378
       _cons |   17.14979   .2301259    74.52   0.000     16.69858      17.601
-------------+----------------------------------------------------------------
     sigma_u |  .08460948
     sigma_e |  .05542715
         rho |   .6997176   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(426, 3200) =    14.42           Prob > F = 0.0000
```

IV regression (1) with fixed effects

```
. xtivreg ltu lvap lpart lwm Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression          Number of obs      =      3694
Group variable: gem2010                       Number of groups   =       428

R-sq:  within  = 0.8043                       Obs per group: min =         6
       between = 0.9915                                      avg =       8.6
       overall = 0.9870                                      max =         9

                                              Wald chi2(5)       =  1.05e+08
corr(u_i, Xb)  = -0.4085                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |   -.054256   .0052516   -10.33   0.000    -.0645489    -.043963
        lvap |   1.016373   .0092972   109.32   0.000     .9981509    1.034595
       lpart |  -.0086029   .0048412    -1.78   0.076    -.0180915    .0008857
         lwm |  -.0234894   .0130492    -1.80   0.072    -.0490653    .0020865
Electionyear |  -.0085567   .0001428   -59.93   0.000    -.0088365   -.0082768
       _cons |   17.04563   .2380607    71.60   0.000     16.57904    17.51222
-------------+----------------------------------------------------------------
     sigma_u |  .07561593
     sigma_e |  .05560345
         rho |  .64904487   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(427,3261) =    12.88        Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lvap lpart lwm Electionyear treatment
------------------------------------------------------------------------------
```

IV regression (2) with fixed effects

```
. xtivreg ltu lvap lpart llen Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression          Number of obs      =      3632
Group variable: gem2010                       Number of groups   =       427

R-sq:  within  = 0.7951                       Obs per group: min =         1
       between = 0.9915                                      avg =       8.5
       overall = 0.9871                                      max =         9

                                              Wald chi2(5)       =  1.03e+08
corr(u_i, Xb)  = -0.4004                      Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |  -.0547081   .0053141   -10.29   0.000    -.0651236   -.0442927
        lvap |   1.016341   .0095949   105.93   0.000     .9975352    1.035146
       lpart |   -.010578   .0049419    -2.14   0.032     -.020264    -.000892
        llen |   .0057845   .0078084     0.74   0.459    -.0095197    .0210888
Electionyear |  -.0085191   .0001451   -58.70   0.000    -.0088035   -.0082346
       _cons |   16.97475   .2402124    70.67   0.000     16.50394    17.44556
-------------+----------------------------------------------------------------
     sigma_u |  .07510008
     sigma_e |  .05574136
         rho |  .64478606   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(426,3200) =    12.54        Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lvap lpart llen Electionyear treatment
------------------------------------------------------------------------------
```

IV regression (3) with fixed effects

```
. xtivreg ltu lvap lpart lwm ltlf lle lhe Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression         Number of obs      =       1057
Group variable: gem2010                      Number of groups   =        323

R-sq:  within  = 0.7111                      Obs per group: min =          1
       between = 0.9833                                     avg =        3.3
       overall = 0.9794                                     max =          4

                                             Wald chi2(8)       =   3.49e+07
corr(u_i, Xb)  = -0.1759                     Prob > chi2        =     0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |  -.0535463   .0136392    -3.93   0.000    -.0802786   -.026814
        lvap |   .9620308    .025461    37.78   0.000     .9121282   1.011933
       lpart |  -.0138678   .0127508    -1.09   0.277    -.0388588   .0111233
         lwm |  -.0390316   .0313095    -1.25   0.213     -.100397   .0223338
        ltlf |   .1357688   .0358585     3.79   0.000     .0654874   .2060503
         lle |  -.0628772   .0183205    -3.43   0.001    -.0987846  -.0269698
         lhe |  -.0379928   .0193077    -1.97   0.049    -.0758352  -.0001505
Electionyear |  -.0071249   .0006149   -11.59   0.000      -.00833  -.0059197
       _cons |    14.2338   1.195881    11.90   0.000     11.88992   16.57768
-------------+----------------------------------------------------------------
     sigma_u |  .08346048
     sigma_e |  .05346644
         rho |  .70902185   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(322,726) =     6.89         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lvap lpart lwm ltlf lle lhe Electionyear treatment
------------------------------------------------------------------------------
```

IV regression (4) with fixed effects

```
. xtivreg ltu lvap lpart lwm ltlf lle lse Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression         Number of obs      =      1216
Group variable: gem2010                      Number of groups   =       351

R-sq:  within  = 0.6876                      Obs per group: min =         1
       between = 0.9840                                     avg =       3.5
       overall = 0.9793                                     max =         4

                                             Wald chi2(8)       =  4.04e+07
corr(u_i, Xb)  = -0.1503                     Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |  -.0496724   .0128668    -3.86   0.000    -.0748909   -.0244539
        lvap |   .9633762   .0247904    38.86   0.000     .9147879    1.011964
       lpart |  -.0108767   .0116101    -0.94   0.349    -.0336321    .0118786
         lwm |  -.0427158    .027714    -1.54   0.123    -.0970344    .0116027
        ltlf |   .0676987   .0446188     1.52   0.129    -.0197525    .1551499
         lle |  -.0441324   .0176727    -2.50   0.013    -.0787703   -.0094944
         lse |  -.0067362   .0282587    -0.24   0.812    -.0621222    .0486498
Electionyear |  -.0079787   .0005566   -14.33   0.000    -.0090697   -.0068877
       _cons |   16.14079   1.043687    15.47   0.000      14.0952    18.18638
-------------+----------------------------------------------------------------
     sigma_u |  .08388351
     sigma_e |  .05277622
         rho |  .71641273   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(350,857) =     8.30         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lvap lpart lwm ltlf lle lse Electionyear treatment
------------------------------------------------------------------------------
```

IV regression (5) with fixed effects

```
. xtivreg ltu lvap lpart lwm ltlf lse lhe Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression         Number of obs      =       1144
Group variable: gem2010                      Number of groups   =        342

R-sq:  within  = 0.6982                      Obs per group: min =          1
       between = 0.9840                                     avg =        3.3
       overall = 0.9798                                     max =          4

                                             Wald chi2(8)       =   3.81e+07
corr(u_i, Xb)  = -0.2117                     Prob > chi2        =     0.0000
```

ltu	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lvapgem	-.0539072	.0133484	-4.04	0.000	-.0800697	-.0277447
lvap	.9626181	.0250084	38.49	0.000	.9136026	1.011634
lpart	-.0143559	.0116588	-1.23	0.218	-.0372068	.008495
lwm	-.0196945	.0299984	-0.66	0.511	-.0784903	.0391012
ltlf	.008243	.0428201	0.19	0.847	-.0756829	.0921689
lse	.0248197	.0277153	0.90	0.371	-.0295012	.0791406
lhe	.0026103	.0177765	0.15	0.883	-.032231	.0374516
Electionyear	-.0069241	.0005557	-12.46	0.000	-.0080133	-.0058349
_cons	13.98447	1.085376	12.88	0.000	11.85717	16.11177
sigma_u	.08352653					
sigma_e	.05294817					
rho	.71334826	(fraction of variance due to u_i)				

```
F  test that all u_i=0:     F(341,794) =     7.23          Prob > F    = 0.0000

Instrumented:   lvapgem
Instruments:    lvap lpart lwm ltlf lse lhe Electionyear treatment
```

<u>"Spurious" regression results</u>

```
. xtreg ltu lvap treatment lpart lwm Electionyear, fe

Fixed-effects (within) regression               Number of obs      =      3694
Group variable: gem2010                         Number of groups   =       428

R-sq:  within  = 0.8065                         Obs per group: min =         6
       between = 0.9898                                        avg =       8.6
       overall = 0.9855                                        max =         9

                                                F(5,3261)          =   2718.55
corr(u_i, Xb)  = -0.4647                        Prob > F           =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lvap |   .9723918   .0084686   114.82   0.000     .9557876     .988996
   treatment |  -.0392003   .0037725   -10.39   0.000    -.0465969   -.0318036
       lpart |  -.0100041   .0048159    -2.08   0.038    -.0194466   -.0005616
         lwm |  -.0249094   .0129756    -1.92   0.055    -.0503505    .0005317
Electionyear |  -.0086857   .0001362   -63.79   0.000    -.0089527   -.0084187
       _cons |   17.22152   .2279971    75.53   0.000     16.77449    17.66855
-------------+----------------------------------------------------------------
     sigma_u |   .0851081
     sigma_e |  .05528323
         rho |  .70326725   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(427, 3261) =    14.72           Prob > F = 0.0000

. xtreg ltu treatment lpart lwm Electionyear, fe

Fixed-effects (within) regression               Number of obs      =      3694
Group variable: gem2010                         Number of groups   =       428

R-sq:  within  = 0.0242                         Obs per group: min =         6
       between = 0.1157                                        avg =       8.6
       overall = 0.0787                                        max =         9

                                                F(4,3262)          =     20.25
corr(u_i, Xb)  = 0.2464                         Prob > F           =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
   treatment |   -.064499    .008456    -7.63   0.000    -.0810786   -.0479194
       lpart |    .044573   .0107605     4.14   0.000     .0234749     .065671
         lwm |  -.0069313   .0291324    -0.24   0.812    -.0640509    .0501883
Electionyear |   .0011713   .0002373     4.94   0.000      .000706    .0016366
       _cons |   7.001868   .4713129    14.86   0.000     6.077769    7.925967
-------------+----------------------------------------------------------------
     sigma_u |  .73763247
     sigma_e |  .12412944
         rho |   .9724614   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F test that all u_i=0:     F(427, 3262) =   255.68           Prob > F = 0.0000
```

```
. xtivreg ltu lvap lpart lwm Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression           Number of obs      =      3694
Group variable: gem2010                        Number of groups   =       428

R-sq:  within  = 0.8043                        Obs per group: min =         6
       between = 0.9915                                       avg =       8.6
       overall = 0.9870                                       max =         9

                                               Wald chi2(5)       =  1.05e+08
corr(u_i, Xb)  = -0.4085                       Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |   -.054256   .0052516   -10.33   0.000    -.0645489    -.043963
        lvap |   1.016373   .0092972   109.32   0.000     .9981509    1.034595
       lpart |  -.0086029   .0048412    -1.78   0.076    -.0180915    .0008857
         lwm |  -.0234894   .0130492    -1.80   0.072    -.0490653    .0020865
Electionyear |  -.0085567   .0001428   -59.93   0.000    -.0088365   -.0082768
       _cons |   17.04563   .2380607    71.60   0.000     16.57904    17.51222
-------------+----------------------------------------------------------------
     sigma_u |  .07561593
     sigma_e |  .05560345
         rho |  .64904487   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(427,3261) =    12.88         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lvap lpart lwm Electionyear treatment
------------------------------------------------------------------------------
. xtivreg ltu lpart lwm Electionyear (lvapgem=treatment), fe

Fixed-effects (within) IV regression           Number of obs      =      3694
Group variable: gem2010                        Number of groups   =       428

R-sq:  within  =      .                        Obs per group: min =         6
       between = 0.8229                                       avg =       8.6
       overall = 0.7485                                       max =         9

                                               Wald chi2(4)       =  1.86e+07
corr(u_i, Xb)  = -0.8802                       Prob > chi2        =    0.0000

------------------------------------------------------------------------------
         ltu |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     lvapgem |  -.0919554   .0128428    -7.16   0.000    -.1171268    -.066784
       lpart |   .0511316   .0114639     4.46   0.000     .0286628    .0736004
         lwm |  -.0031465     .03103    -0.10   0.919    -.0639643    .0576713
Electionyear |   .0021456   .0003425     6.26   0.000     .0014742    .0028169
       _cons |    5.92034   .5927769     9.99   0.000     4.758519    7.082161
-------------+----------------------------------------------------------------
     sigma_u |   .8089468
     sigma_e |  .13223471
         rho |  .97397453   (fraction of variance due to u_i)
------------------------------------------------------------------------------
F  test that all u_i=0:     F(427,3262) =    47.29         Prob > F    = 0.0000
------------------------------------------------------------------------------
Instrumented:   lvapgem
Instruments:    lpart lwm Electionyear treatment
------------------------------------------------------------------------------
```