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Geographical redistribution with disproportional representation: a politico-economic model of Norwegian road projects

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Abstract Politicians bias public policies to favor particular election districts. According to the traditional common pool model, districts facing low tax shares should receive relatively large government projects. We suggest a swing-voter model where the number of voters on the ideological cut point, lack of party identification and number of district representatives per voter determine project sizes. We analyze the allocation of state road investments in Norway from 1973–1997 exploiting unique data on characteristics of voters, legislative representation and tax prices in 19 election districts. Geographical representation to parliament is biased, mostly due to an ancient constitution. Shares of swing voters and legislative over-representation lead to higher levels of road investments, while high levels of party identification reduce investments.

Keywords Distributive politics · Proportional representation · Game theory · Party competition · Infrastructure investments

1 Introduction

It is often observed that elected politicians bias public policies in favor of particular election districts. The district demand model is the conventional explanation: politicians representing particular districts demand nationally financed projects in order to win votes in their home district. District demand becomes a function of tax prices, and since the tax price of a district only covers a fraction of project costs, aggregate public spending becomes too high (Baqir 2002; Inman and Fitts 1990; Weingast et al. 1981).

The swing-voter model offers an alternative to this story (Dixit and Londregan 1996; Lindbeck and Weibull 1987). In this model two competing parties, or blocs of parties, maximize national vote support by offering different levels of spending to the election districts. The model has three main implications. First, spending increases with the number of district voters that are ideologically indifferent between the competitors (the number of "cut point

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voters"). Second, spending decreases with the fraction of district voters having strong party identifications (low voter mobility). Lastly, in equilibrium the competitors offer identical project vectors. In the current paper, we present a version of the swing-voter model that also accounts for disproportional geographical representation in the national assembly. This is of particular relevance to the Norwegian setting.

The Norwegian Constitution is the oldest written constitution in Europe. The founding fathers of 1814 invoked a radically democratic constitution: enfranchising about 2/5 of the adult men. The election system was designed to produce over-representation of urban election districts. As a safety precaution, therefore, the constitution imposed a cap on urban representation. Cities could not occupy more than 1/3 of the seats in the national legislature, even though the cities had only about 1/10 of the inhabitants. The next 200 years generated a population influx to cities unthinkable in 1814. Before long, the constraint that 2/3 of the representatives should come from rural districts became a constitutional instrument for maintaining rural over-representation in parliament.

A constitutional amendment in 1859 formally instituted a 2:1 ratio of urban to rural representation. Subsequent amendments introduced direct elections (in 1906) and proportional representation (in 1921). The ballot became a closed list system, with representatives from political parties as candidates. The over-representation of rural election districts has survived all reforms! This in striking contrast to the United States, where Supreme Court rulings in the 1960s imposed the principle of one man, one vote.

We analyze the allocation of nationally funded road projects in Norway from 1973 to 1997. The analysis utilizes data on the political clout of district electorates, districts' representation in the national parliament, and tax prices in 19 election districts. Consistent with our model, density at the ideological cut point, party identification and geographical representation affect levels of road investments. We also observe that district tax prices continue to affect road investments after control for swing-voter variables, suggesting that common pool politics cannot be completely discarded.

2 Existing research

A large body of work in political economy addresses the determinants of the geographical distribution of centrally financed public spending. We review three strands of research: assessments of the district demand model; distributional consequences of geographical misrepresentation; and empirical analysis of the swing-voter model.

Empirical analysis suggests that district spending is a decreasing function of the tax price, with a price-elasticity in the range of $-.5$ to -1.8 (Inman and Fitts 1990; Del Rossi and Inman 1999; Del Rossi 1995). This indicates the presence of a common pool problem in fiscal policy.

The district demand model receives fairly strong empirical support where policies are geographically targetable in a strict sense. Typical examples are allocation of military bases, highways, water projects and education facilities (Gilligan and Matsusaka 2001, 1995, Del Rossi 1995; Del Rossi and Inman 1999; Hird 1991). Spending is negatively related to cost-benefit ratios for US water projects, indicating that the suboptimality bias implied by the district demand model may be real (Hird 1991). Similar conclusions have been reached for centrally funded road expenditures in Norwegian counties (Elvik 1995).

A number of institutional factors seem to constrain district demand. This holds for strong US presidents (Del Rossi 1995; Inman and Fitts 1990), centralized committee structures (Inman and Fitts 1990), long-lived one party majority governments, and parliaments with an un-fragmented party structure (Borge and Rattsø 2002, 1997).

Since it is relatively inexpensive to "purchase" seats from election districts that are well represented in the national legislature, over-representation should pay off. A few empirical studies present evidence in favor of such a conjecture. The classical study of Wright (1974) demonstrates a strong positive effect of electoral votes per capita on federal new deal spending in US states, while Horiuchi and Saito (2003) find a strong positive effect of parliamentary seats per capita on central transfers to Japanese municipalities in the 1990s. Atlas et al. (1995) find a significantly positive effect of senators per capita and representatives per capita with respect to federal spending on states over the period 1972–1990. The effect of senators per capita is markedly stronger for defence spending than for spending on entitlements.

Ansolabere et al. (2002) and Lee (1998) study the effects of a series of US legal rulings in the early 1960s that challenged geographical biases in representation. Ansolabere et al. show that geographical over-representation leads to significantly higher per capita shares of total transfers among 3,022 counties in the period 1960–1980. Lee (1998) documents the effects of proportionality on per capita federal distributive and redistributive programs in a pooled time-series with 48 US states 1984–1990. Somewhat surprisingly, the spending bias is especially pronounced for non-discretionary programs.

McCubbins and Schwartz (1988) construct an index for metropolitan representation (based on an instrumental variable approach). This index increases with increased metropolitan representation and shows a strong positive effect on congressional appropriations of metropolitan programs, and a strong negative effect on appropriations of traditional farm programs, in a data set covering fiscal years 1948–1979.

Testing the swing-voter model requires data about voter characteristics at the constituency level. Empirical research based on swing-voter models is in its infancy, and most of the literature relies on quite crude indicators. For example, Dixit and Londregan (1996) show that an average concentration of apparel workers is statistically associated with below-average vote margins in presidential elections on a state-by-state basis 1974–1984. It is noted that industry size is not a significant predictor of tariff protection in empirical investigations. The explanation offered is the association between concentration of apparel workers and vote margins.

More systematic studies are found in Johansson (2003), Dahlberg and Johansson (2002), Case (2001) and Strömberg (1998). Johansson (2003) investigates distribution of grants over 255 Swedish municipalities in the periods 1981–1995 and 1990–1995 (3,825 and 1,020 municipality years respectively). She finds density at the ideological cut point of the municipalities to be positively related to grants per capita.

Dahlberg and Johansson conduct a nested test of the swing-voter model and the "core supporter" model (Cox and McCubbins 1986). Their dataset contains 115 Swedish municipalities applying for discretionary grants prior to the 1998 national election. The core supporter conjecture is rejected, while the swing voter conjecture is supported in their data.

Strömberg (1998) studies (the log of cumulative) federal unemployment relief to US communities in the New Deal era. He includes the standard deviation of the democratic vote share in previous elections as an independent variable. Strömberg's interpretation of this measure is somewhat odd, however, as it is said to capture "marginal voter density". Such an interpretation is clearly at odds with the meaning of "cut point density" in the models of Lindbeck and Weibull and Dixit and Londregan. Lastly, Case (2001) studies the allocation of total social assistance funding from central to community level in Albania in the mid 1990s. Her empirical indicators, however, have very weak relations to the theoretical concepts in the swing-voter model.

To sum up: Centrally financed district spending is: (i) negatively related to district tax prices, (ii) positively related to district seats per capita in the national assembly, and (iii) positively related to cut point densities of district voting populations.

3 Modeling geographical allocation

We present a formal model of geographical allocations in Appendix. The basic assumptions of the model are spelled out there in (1)–(3). In line with most existing models, we assume that citizens live in different election districts, and their preferences are defined over a local public good (roads) and private consumption. The local public good is financed by national taxation, and the financing system is exogenously given (i.e., unrelated to geographical distribution policy).

We use the district demand model as a benchmark. In this model the demand of a representative voter (usually the median voter on a net expenditure dimension) and her elected politician is taken as the point of departure. Since local projects are financed by national taxation, quantity demanded is a decreasing function of the tax price. The elected politician maximizes the welfare of the representative voter in her home district, subject to individual and government budget constraints, and taking the demand of other districts as given. The equilibrium concept is Nash in a simultaneous move J-district game. The canonical formulation is due to Weingast et al. (1981). A more recent formulation can be found in Baqir (2002).[1] Equation (4) presents the equilibrium solution. The essential implication is:

H1: *Public road expenditures per capita decrease with the tax share of the district.*

The details in our modified swing-voter model likewise are specified in Appendix.[2] Citizens are characterized by ideological preferences as well as a preference for consumption (5). Similar to the district demand model, a local public good is financed by a national income tax ((6) and (7)). Two competing parties offer citizens in various districts a level of spending on local public goods. Parties occupy fixed policy positions on an ideological dimension. Each district elects a fixed number of representatives to the national assembly, and districts' share of seats may deviate from its share of district voters. The political parties have probabilistic beliefs about the ideological preferences of district voters. Political parties maximize seats in the national assembly, not votes per se ((9) and (10)).

The swing-voter equilibrium is presented in Appendix (11). In equilibrium, the parties internalize tax costs and eliminate the common pool problem. In particular, each party takes into account that higher spending in one district implies higher taxes in all other districts, and that higher taxes lead to fewer votes and fewer party representatives from these districts. For a given number of mandates, a political party will find it less expensive to buy a seat from a district with a small electorate than from a district with a large electorate. Hence, the supply of local public goods is greater in districts with a higher ratios of parliamentary seats to votes.

[1] Since no district commands a majority in the national legislature, the district demand model must be supplemented by some kind of micro political underpinning. The most commonly cited underpinning is the, so-called "legislative norm of universalism" (Weingast 1979; Weingast et al. 1981, and reappearing as a conditional statement in Baron and Ferejohn 1989, Baron 1993, Proposition 1). These underpinnings are criticized by, amongst others, Wittman (1995, pp. 65–79) and Drazen (2000, pp. 327–331). If the one-shot game is replaced by an infinite horizon, the usual folk theorems apply and universalism (along with almost any other pattern of behavior) can be rationalized for high enough discount factors (Chari and Cole 1995).

[2] In addition to the seminal papers by Lindbeck and Weibull (1987) and Dixit and Londregan (1996), our model formulation draws on Persson and Tabellini (2000, particularly Chap. 7.4).

H2: *Public road expenditures per capita increase with the ratio of district seats to district votes.*

Voters weigh ideological positions against public goods consumption. Voters who attach great importance to the party's ideological stand (high degree of party identification) are hard to swing, while voters who primarily value political parties for the consumption opportunities they provide are more attractive political prey (low degree of party identification).

H3: *Public road expenditures per capita decrease with the share of district voters having strong party identification.*

Finally, districts are characterized by different voter distributions on the ideological dimension. Electorates with high densities at the ideological cut point are politically attractive, since a more generous budget will shift a larger fraction of voters towards the responsible party. This constitutes the core implication of the swing-voter model.

H4: *Public road expenditures per capita increase with the cut-point density of the district.*

Summing up, the provision of a nationally financed local public good should be influenced by four variables: district tax shares, the ratio of seats to votes, party identification and cut-point density.

4 Design and descriptive statistics

We use data on Norwegian road expenditures to test the hypotheses presented. The full dataset covers the 19 election districts (counties) over the period 1970–2000. The dependent variable is centrally funded roads per capita (1990 NOK). Three sets of independent variables are analyzed: district demand variables, swing-voter variables, and controls. The district demand variables are tax prices (H1); income per capita; and degree of urbanization (as a proxy for rivalry in consumption of the local public good). There are five swing-voter variables: the ratio of the district's share of national seats to the district's share of national votes (H2); the share of district voters with strong party identification (H3); and the density of district voters on the ideological cut point between the left and right party blocs. In addition, the swing voter model, like the district demand model, includes the degree of urbanization and income per capita (compare (4) and (11) in Appendix). We use two control variables: the area of the county in square kilometers, and the level of unemployment at the county level (as registered by the directorate of jobs). These data allow us to estimate versions of the following regression model, where subscript j denotes a county and subscript t denotes year:

$$\begin{aligned}&\log(\textit{Public road expenditures per capita})_{jt}\\&\quad=\textit{Constant}+\log(\textit{District demand variables})_{jt}+\log(\textit{Swing voter variables})_{jt}\\&\qquad+\log(\textit{Controls})_{jt}+\textit{Residual}_{jt}\end{aligned}$$

The dependent variable has been calculated as a moving average over time since we are dealing with investment projects. A typical project requires modest funding in the first year or two, peak funding a few years after that, followed by a gradual decline in funding until the project is finished. Projects are hardly ever aborted once underway. Smoothing takes out some of the variation caused by the dynamics inherent in these decisions. Letting the moving average cover three time points on each side of the time point in question secures

some smoothing over electoral periods as well, implying that ongoing projects continue while new projects are started up. Since our data cover the period 1970–2000, the moving average formulation cuts the data down to the period 1973–1997.[3]

The tax price is the core variable in the district demand model. Tax prices can be defined as share of total taxes paid by each district. Geographical differences in tax rates, however, may reflect distributional policy aims, causing tax shares to be endogenous. We therefore use the share of total taxable income (wages and capital) as our tax price variable. Voter demand for public consumption is also a function of income. We therefore include mean taxable income, measured per capita in 1990 prices.

The demand for publicly provided goods usually depends on the degree of rivalry in consumption of such goods, on a continuum from purely public to purely private goods. We capture the degree of rivalry by the degree of urbanization, measured by the fraction of county population dwelling in urban areas. The underlying assumption is that roads are local public goods and that increased urbanization will increase congestion, and thereby the degree of rivalry in consumption of the good. Data are interpolated from observations of urbanization in 1970, 1980 and 1990.

Our analysis includes a broader set of swing-voter variables than considered in previous empirical studies (Johansson 2003; Dahlberg and Johansson 2002 and Case 2001). The cut-point density of the district electorate is the core theoretical variable, and also the test statistic of existing empirical studies. In contrast to previous studies, we estimate the cut point directly. Data are taken from Norwegian election surveys where left-right self-placement has been measured. Respondents were asked: "In politics people sometimes talk of left (radical) and right (conservative). Where would you place yourself on a scale from 1 to 9 where 1 means the left and 9 means the right?" Election surveys have been available from 1973 onwards. These data allow us to estimate district-specific means and standard deviations for the left-right axis. Ideological preferences are assumed to follow district-specific normal distributions.[4]

Like Johansson (2003) and Dahlberg and Johansson (2002), we define the cut-point voter as the voter who is indifferent between the socialist party bloc and the non-socialist party bloc.[5] We consider the Center Party voter the most leftist party in the non-socialist bloc, and

[3] A natural suspicion is that our dependent variable follows an AR(1) process. Inspecting the dynamics of the variable in the aggregate (the county means per year), we obtain an autocorrelation coefficient of −.29. The corresponding Durbin-Watson h-statistics is −1.85. Thus for the 24 observations 1973–1997 we can reject the null hypothesis of significant autocorrelation at the 5% level. We note that about the same results as presented in the paper are obtained by running our regressions on the county year's share of total annual funding as the dependent variable. No aggregate time trends are present in that case.

[4] There is some variation over time in the instruments used for tapping the ideological left-right scale in the Norwegian election surveys. In the surveys of 1973, '77 and '81 the respondents were asked to place themselves on a scale according to radicalism/conservatism. In the survey of '73 the scale had 7 points, in '77 it had 10 points and in '81 it had 9 points (with minimum value 'extreme radical' and maximum value 'extreme conservative'). In the surveys of '85, '89, '93 and '97 the respondents were asked to place themselves on a scale according to the left-right of politics. In the surveys of '85, '89 and '93 a 10-point scale was used, while in '97 an 11-point scale was employed (with minimum value 'extreme left' and maximum value 'extreme right'). Due to nuances in the wording of the question used, variations in the number of points on the scale and low N in some county years, the identification of the cut-point, and the corresponding cut-point density, are bound to exhibit some errors of measurement. This notwithstanding, all survey responses where re-scaled on a 10-point scale (0–9) with higher values indicating more rightist ideological leanings.

[5] Except for the first conservative government of Willoch (October '81 to June '83) all non-socialist governments in the period 1973–1997 included the Center Party. Willoch's first government was transformed to his second government by the inclusion of the Center Party and the Christian Democratic Party in June '83 (which lasted until May 1986). All socialist governments of the period consisted of the Labor Party alone.

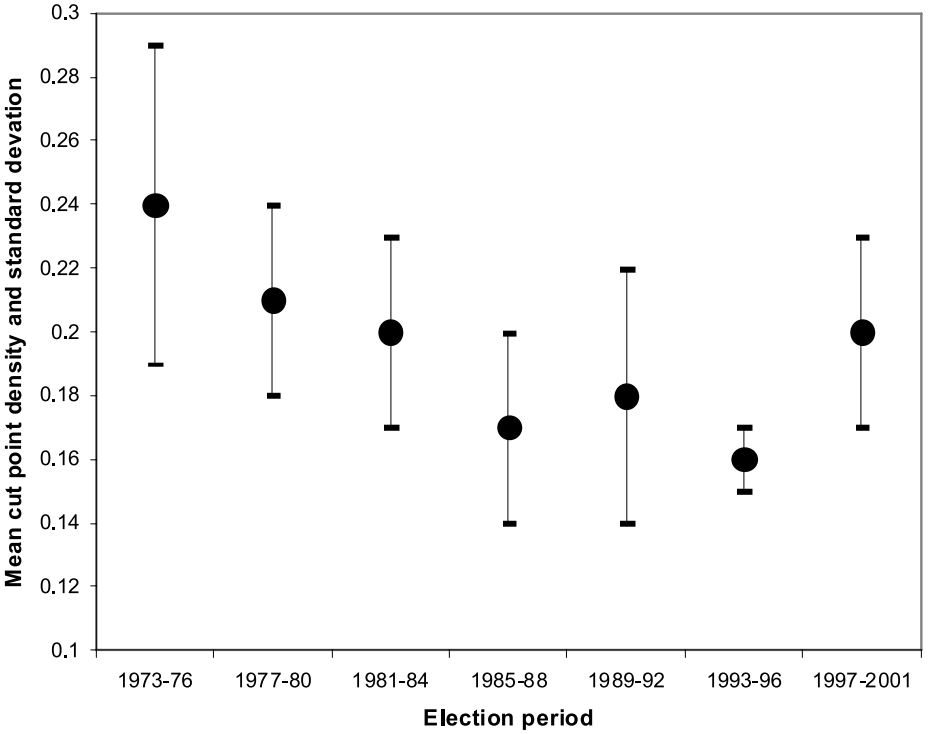

Fig. 1 Density at the cut point of the left-right axis: mean (*discs*) and standard deviation (*lines*)

the Labor Party is the most rightist party in the socialist bloc. The election surveys allow us to identify where these party voters are located on the left-right axis in each election district. The cut-point voter is defined as the median in the group of respondents stating they voted for either the Center party or the Labor party. Combining cut-points and normal distributions provides us with the cut-point density for each election district.

Figure 1 describes statistics for cut-point densities. With the exception of the election period 1993–1996, variations in cut-point densities are generally quite large.

The swing-voter model assumes that consumption and ideology affects party choice. A so-called "greed parameter" (Dixit and Londregan 1996) captures the impact of consumption levels relative to ideological predisposition. We use party identification to measure a "lack of greed". Ideologically oriented citizens have an enduring tendency to support a particular political party. Party identification starts to develop during one's formative years (when psychological orientations towards the parties are passed down from family members to children). A major shift in allocation of public expenditures per capita is needed to swing these voters in favor of the other bloc. Respondents in the Norwegian Election Studies were asked: "Do you feel particularly attached to one particular political party?" Party identification has fluctuated in the post-war period: 72% answered yes in the mid 1960s; 62% in 1973, 71% in 1981, and then a gradual decline to 42% in 2001. These data suggest that the importance of swing-voting should increase in the latter part of the sample period.

Our last variable is the district share of seats in the parliament relative to the district share of the eligible voters. If the ratio is larger than one, the district is overrepresented in parliament. Table 1 presents descriptive statistics for the relevant variables.

Table 1 Descriptive statistics

Variable	*N*	Min	Max	Mean	STD
Road expenditures per capita	475	290	3.600	1.119	644
Cut point density (l-r scale)	463	.07	.35	.19	.04
Party identification (pct)	468	.31	.88	.64	.10
Seat shares	475	0.04	.20	.08	.02
Vote shares	475	.02	.10	.05	.02
Seat shares on vote shares	475	.71	1.41	1.05	.16
Tax price	475	.01	.18	.05	.04
Income per capita (1.000 1990 NOK)	475	43	196	79	19
Urbanization (pct)	475	.34	.95	.67	.14
Area (1.000 sq km)	475	426	45.757	16.014	11.442
Unemployment (dept. of jobs)	475	.00	.05	.02	.01

STD: Standard deviation

Table 2 Preliminary evidence of associations. Average values 1973–1997

District	Road expenditures per capita	Seat share on vote share	Cut point density	Party identification	Tax price
Østfold	532	.91	.20	.61	.05
Akershus	841	.81	.17	.61	.11
Oslo	503	.88	.16	.60	.16
Hedemark	705	1.15	.20	.68	.04
Oppland	1.022	1.01	.22	.65	.04
Buskerud	815	.85	.19	.64	.05
Vestfold	757	.96	.18	.63	.05
Telemark	977	1.02	.20	.61	.04
Aust-Agder	1.052	1.12	.16	.52	.03
Vest-Agder	762	.93	.18	.60	.03
Rogaland	541	.87	.19	.57	.08
Hordaland	1.116	1.00	.21	.53	.09
Sogn & Fjord.	2.435	1.24	.22	.50	.02
Møre & Romsd.	1.051	1.11	.21	.59	.05
Sør Trønd.	759	1.05	.19	.60	.05
Nord. Trønd.	1.303	1.25	.24	.56	.02
Nordland	1.836	1.30	.20	.61	.05
Troms	1.437	1.07	.21	.59	.03
Finmark	2.807	1.36	.19	.59	.02

Table 2 provides preliminary evidence on the relationship between public road expenditures per capita, swing-voter variables, and the district demand variables. The table reports information about public road expenditures per capita, seat shares on vote shares, cut-point density, party identification and tax prices. All variables are presented as county averages over the period 1973–1997.

Per capita expenditures are very low in urban areas, and significantly higher in peripheral election districts, particularly in Northern Norway. Consider the political situation of the capital of Oslo and the surrounding election district of Akershus. These districts face the highest tax shares (due to large workforces and high wage levels), which may induce them to curb demand for local public goods. Relatively low cut point densities characterize these election districts.

Furthermore, urban election districts are also significantly underrepresented in parliament. Though their voters do not deviate in terms of party identification, party competition should lead to low levels of public road expenditures per capita in these districts. This is exactly what we observe in Table 2.

5 Empirical testing

Table 3 presents our regression estimates. All variables are in logs, and regressions are estimated with controls for county land area and level of country unemployment. Reported p-values for coefficients are based on robust standard errors.

Table 3 OLS (robust standard errors). All variables in log. Dependent: log of road expenditures per capita, 3 year moving average. Significance levels: ***: 1%; **: 5%; *:10%

	District demand	Swing voting	District demand and swing voting
Constant	−2.93***	−3.74***	−4.13***
	(.694)	(.607)	(0.595)
Tax price	−.28***		−.10***
	(.039)		(.030)
Income per capita	−.07	−.08*	−.06
	(.045)	(.045)	(.047)
Urbanization	−.05	.25**	.29*
	(.122)	(.112)	(.107)
Cut point density		.31***	.30***
		(.082)	(.080)
Party identification		−.40***	−.39***
		(.092)	(.093)
Seat−share on vote−share		1.98***	1.85***
		(.147)	(.143)
Unemployment	−.05	−.10**	−.12***
	(.033)	(.032)	(.033)
Area	.20***	.15***	.14***
	(.024)	(.018)	(.019)
Adjusted R^2	.51	.62	.63
N	463	463	463

Before we turn to the results, we briefly justify our choice of controls. The time-series variation in the main independent variables does not allow for a fixed effects estimation.[6] In Norway the degree of disproportionality is positively correlated with county area. At the same time, a county's area can be expected to impact systematically on its need for infrastructure investments. To account for this, we include county area as a control in our regressions.[7] The level of unemployment at the county level is included as a control for the use of infrastructure investments in macroeconomic stabilization policies.[8]

In the first regression ("district demand"), the equilibrium allocation of public road expenditures is characterized by three variables; tax prices, income per capita and urbanization. The main argument is related to the effect of tax prices on road expenditures. In equilibrium one expects tax prices to be negatively related to spending (H1). The results in the first regression support this expectation, with a significantly negative coefficient. The elasticity of the tax price variable is somewhat smaller in absolute terms than that found in most other studies. Of less concern, the degree of urbanization has a negative and insignificant effect on road expenditures, in opposition to model predictions. Income per capita is negatively related to road expenditures, and close to conventional significance levels. The sign of this coefficient is in line with theoretical predictions, and the income elasticity is comparable in size to that found in other studies.

In the second regression ("swing-voting"), the equilibrium allocation of public road expenditures is characterized by five variables; seat share on vote share; party identification; cut point density; income per capita and urbanization. Our version of the swing-voter model fares very well in the data. The estimate of the ratio of seat shares on vote shares is greater than unity, so overrepresentation in parliament yields higher road investments per capita (H2). This effect is significantly different from zero. Furthermore, road expenditures decrease significantly with party identification (H3); and increase significantly with cut point densities (H4). In addition the effects of income per capita and urbanization have the signs predicted by the model, and are significantly different from zero at conventional levels.

In the last regression ("district demand and swing-voting") the district demand model and the swing-voter model are entered simultaneously. As can be seen, the elasticity of tax prices drops to one-third of its original level, after controlling for the swing-voter variables. This indicates that a sizeable amount of the districts' bargaining power (small tax shares) is offset by the electoral needs of seat-maximizing centralized parties. While both urbanization and income per capita have the signs predicted by the model, only urbanization is significantly different from zero at conventional levels. The effects of cut point density, seat shares on vote shares, and party identification show a remarkable stability after inclusion of tax prices.

In all of the regressions county unemployment level has a negative sign, indicating that central spending on road infrastructure is used pro-cyclically. In the district demand regression this effect is uncertain, while in the last two regressions it is highly significant. County

[6]The results remain qualitatively unchanged when year fixed effects are included.

[7]Urbanization is entered as a proxy for the degree of rivalry in consumption of the public good. This is justified by the formal model. However, urbanization may also function as a control for differing needs in terms of infrastructure investments over more and less densely populated counties.

[8]Qualitatively similar results as the ones reported are obtained by using the annual change in the level of unemployment, instead of the level.

Table 4 Partial effects based on fourth column, Table 3. 1990 NOK per capita

	Maximum to minimum value	One per cent increase from mean
Tax price	−219	−0.7
Cut point density	336	2.2
Party identification	−327	−2.9
Seat-share on vote-share	919	13.8

area is positively and significantly related to road expenditures per capita in all the regressions.[9]

To illustrate the economic significance of our findings, we present: (a) partial effects of an increase from minimal to maximal value in the tax price as well as in the main swing-voter variables, and (b) partial effects of a one percent increase from average values in these variables.

According to Table 4, a shift from minimal to maximal malapportionment carries a gain of 919 NOK per capita (in 1990 prices). This gain is almost three times larger than the one associated with a corresponding movement in cut-point density or party identification. In absolute numbers, going from minimal to maximal malapportionment has an effect more than four times stronger than that associated with a corresponding movement on tax prices.

Consider then the partial effect of increasing a variable by one percent above its mean, holding all other variables at their mean values. The marginal effect of tax prices turns out to be quite modest. Cut-point density and party identification has somewhat stronger effects, but they are still moderate compared to the partial effect of a one percent increase in geographical misrepresentation above its mean values.

For example, consider the overall effect of going from the capital of Oslo to the rural election district of Finmark in 1997. It turns that such a move carries a loss of 2.074 NOK per capita in public road expenditures (in 1990 prices). The main components explaining the loss is the simultaneous movement from minimal to maximal malapportionment, and from maximal to minimal tax price. The loss is dampened somewhat by a higher cut point density and higher degree of urbanization in Oslo. On the other hand, the loss is increased by a higher unemployment rate, a larger area, and a lower rate of party identification in Finmark.

6 Conclusions

The variation in centrally financed road expenditures can be explained by two different political mechanisms; one operating at the level of district representatives, the other at the level of national parties. To some extent, individual districts are able to get their desired projects approved by parliament. Low tax prices lead to higher district expenditures. But there is more to road investments than simple district demand. Empirical support for the swing-voter model suggests that national political parties coordinate districts' demands to win seats in parliamentary elections. National parties allocate more road expenditures to districts with many voters at the ideological cut point, low party identification, and a high return of district seats per vote to the parliament.

[9] Running a simple jack-knife test on the last regression reveals that the results remain qualitatively unchanged when one county is removed at a time; thus the results do not seem to be driven by a particular county. Running the last regression in a non-logged form produces qualitatively similar results as the log-log formulation reported; thus the results do not seem to be driven by the functional form chosen.

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Appendix

District demand

We define a utility function for citizen i in election district j over private and public consumption. Citizens in district j enjoy equal amounts of pre-tax income $y_{ij} = y_j$, private consumption $c_{ij} = c_j$, and public service consumption, $g_{ij} = g_j$. This yields the utility function for citizen $i \in (n_1, n_2, \ldots, n_J)$ in district $j = \{1, 2, \ldots, J\}$:

$$U_{ij} = c_{ij} + H(g_{ij}) \tag{1}$$

Utility is linear in private income, and we assume $H'(g_j) > 0$ and $H''(g_j) \leq 0$. Let $0 \leq \tau \leq 1$ be the national income tax rate. The private budget constraint becomes:

$$c_j = (1 - \tau) y_j \tag{2}$$

We assume that the government must prepare a balanced budget. The population share of district j can be written $\frac{n_j}{n} \equiv \alpha_j$. Let $0 \leq \gamma \leq 1$ define the degree of rivalry in public goods consumption. The adjusted population share of district j may then be written as $\frac{n_j^\gamma}{n} \equiv \alpha_j^*$. Keeping in mind that $y = \sum_{j \in J} \alpha_j y_j$, we may then define the government's budget constraint as follows:

$$\tau y = \sum_{j \in J} \alpha_j^* g_j \tag{3}$$

The indirect utility function is found by combining (1), (2) and (3). Suppose district j plays a one-shot, simultaneous move, game with the $J - 1$ other districts. The Nash equilibrium in pure strategies is found by maximizing district j's indirect utility function with respect to g_j, taking the choice of the $J - 1$ other districts as given. The equilibrium outcome is commonly denoted the universalism solution:

$$\frac{1}{H'(g_j)} = \frac{1}{\alpha_j^*(\frac{y_j}{y})} \tag{4}$$

Swing-voting

Assume that two exogenously given parties compete for seats in a national assembly. Citizens cast their votes in J separate election districts, each with a fixed number of seats. The parties are assumed to have fixed policy positions on an ideological dimension δ for the duration of the electoral campaign. Without loss of generality, we assume that party A takes the position $\delta^A = -\frac{1}{2}$ and party B takes the position $\delta^B = +\frac{1}{2}$. This yields the following individual utility functions:

$$U_{ij}^P = \kappa_j [c_j^P + H(g_j^P)] - \frac{1}{2}(\delta_{ij} - \delta^P)^2, \quad P = \{A, B\} \tag{5}$$

Note that κ_j measures the weight put on public and private consumption relative to ideology.

The individual's and the government's budget constraints are similar to those defined above.

$$c_j^P = (1 - \tau^P) y_j, \quad P = \{A, B\} \tag{6}$$

$$\tau^P y = \sum_{j \in J} \alpha_j^* g_j^P, \quad P = \{A, B\} \tag{7}$$

Substituting the budget constraints (6) and (7) into the utility function (5) yields the indirect utility functions. Voters are indifferent between parties A and B when $U_{ij}^A - U_{ij}^B = \kappa_j[c_j^A + H(g_j^A)] - \kappa_j[c_j^B + H(g_j^B)] - \delta_{ij}$. Note that voter i has "ideological" utility loss of $-\delta_{ij}$ irrespective of which party enters office. This leads us to the definition of cut point (where c_j, $P = \{A, B\}$ is defined by (6) and (7)):

$$\delta_{ij}^* = \kappa_j[c_j^A + H(g_j^A) - c_j^B - H(g_j^B)] \tag{8}$$

Voters' ideal points can be described by a cumulative distribution function $F_j(\delta_{ij})$, with corresponding probability density function $f_j(\delta_{ij})$. Let m_j denote the number of mandates allocated to district j, and let $\mathbf{g}^P = (g_1^P, g_2^P, \ldots, g_J^P)$, $P = \{A, B\}$. The parties share of mandates (m^P) can now be written:

$$m^A(\mathbf{g}^A, \mathbf{g}^B) = \sum_{j \in J} m_j F_j(\delta_{ij}) \tag{9}$$

$$m^B(\mathbf{g}^A, \mathbf{g}^B) = 1 - \sum_{j \in J} m_j F_j(\delta_{ij}) \tag{10}$$

Each of the parties maximizes seat shares for the whole country by allocating optimal shares of public spending to the J election districts, given the choice of allocations made by the opposing party. In the resulting equilibrium both parties promise the same vector of public expenditures per capita:[10]

$$\frac{1}{H'(g_j)} = \frac{m_j \kappa_j f_j(\delta_{ij}^*)}{\alpha_j^* \sum_{j \in J} m_j \kappa_j f_j(\delta_{ij}^*)(\frac{y_j}{y})} \tag{11}$$

We appreciate that in equilibrium the levels of per capita public spending in district j will increase with: (i) increasing share of district mandates from j, (ii) increasing weight on consumption relative to ideology in j, (iii) increasing density at the cut point in j, (iv) decreasing share of population in j, and (v) increasing rivalry in consumption of the publicly provided good in j.

In the swing-voter model the levels of public spending in individual districts is determined by the entire distribution of revenues. This in contrast to the district demand model, where the equilibrium levels of public spending is determined by $\frac{y_j}{y}$ in each of the J districts.

[10] Given the cdf over voters' ideal points on the ideological dimension, parties are uncertain of aggregate voting behavior. This, together with the assumption that utility is a quasi-concave function of own transfer vector and a continuous function of opponents transfer vector, secures the existence of an equilibrium. Details are given in Dixit and Londregan (1996).

The impact of taxable revenues is indeterminate in the swing-voter model. An increase in average revenue (y) for a given level of revenue in district j (y_j) will increase public consumption in district j. When a district has an infinitesimal small share of voters, an increase in taxable revenue does not affect average taxable revenue. In this case, higher revenues in district j leads to a decrease public consumption in that district. In the general case, an increase in taxable revenues in district j leads to a higher level of public consumption if the district is "politically unattractive", while it leads to a lower level of public consumption if the district is "attractive".

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