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JEL Codes: D6; D72; D78; R42

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The allocation of transport infrastructure in Swedish municipalities: Welfare maximization, political economy or both?

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1 Introduction

A growing literature views economic-policy decisions as resulting from the maximization by incumbent politicians of objective functions that are not necessarily correlated with social welfare. In addition to resource constraints, the politico-institutional structure and the wish of politicians to be re-elected in order to implement their respective policy agendas are suggested as candidates for understanding the priorities in actual decision-making. Using information about investment in transport infrastructure in France, Cadot et al., (2006) is one example of this literature. Other political economy studies of transport infrastructure investments include Fridstrøm and Elvik (1997), Helland and Sørensen (2009), both of whom study the allocation of road-project funding in Norway, and Knight (2004), who examines the allocation of transport projects in the US.

A related literature studies decision-makers' prioritization of infrastructure projects from a welfare perspective. The point of departure in Nilsson (1991) was the government's formal directive to take the maximization of social welfare into account when establishing an investment program for national road infrastructure in Sweden.[1] No relationship between social welfare and actual priorities could be established, and no other rationale for priorities was found. Policies in Sweden have subsequently been adjusted, primarily by shifting the ultimate control over project prioritization from the sector agency to the government itself. Later

[1] The means for meeting this target was to rank projects based on the results of a Cost Benefit Analysis (CBA), summarized in terms of Net Present Value (*NPV=B-C*), *B* and *C* representing the present value of benefits and costs over the expected lifetime of a project. Because of budget constraints, projects with a higher *NPV* ratio (=*NPV/C*) were to be prioritized over less beneficial projects.

research still indicates that the results of a CBA in Sweden at best provide a partial explanation of project prioritization; cf. Eliasson and Lundberg (2011) and Jussila Hammes (2013). Similar observations have been made in Norway (Odeck (1996), Fridstrøm and Elvik (1997), Welde et al. (2013)), Estonia (Kõrbe Kaare & Koppel, 2012), Mexico (Ramírez Soberanis, 2010), France (Quinet, 2010) and the United Kingdom (Mackie, 2010).

A third strand of literature studies the strategic interaction that emanates from “benefit spill-overs” (Brueckner, 2003) between tiers of government The main thrust of this literature, some of which is briefly surveyed in the next section, has been in estimating the size of the spillover effects across municipalities and regions.

It is difficult to provide a single comprehensive explanation for what drives this type of prioritization, at least in an international perspective. This paper combines the three strands of literature: political economy modelling, assessment of the impact of welfare considerations on project choice, and implications of spillover effects from investment in one region on its neighbors, in order to shed some light on what, specifically, drives policy decisions as manifested in three national transport infrastructure investment programs in Sweden. The first program was established by a center-left government, and the other two by a center-right government; this also provides an opportunity to test whether or not infrastructure projects are void of political preferences per se.

The paper is organized as follows: The next section briefly summarizes some relevant literature and provides a background, whereafter the theoretical background and the hypotheses are presented. Section 4 describes the data, section 5 contains the regression results and section 6 concludes the paper with a discussion.

2 Background

Political economics offers several explanations for the preferences that guide the provision of public services. In this paper, we examine three of these. The district demand model starts by noting that spending on public goods, here transport infrastructure, provides benefits that primarily are geographically concentrated, while costs are paid by taxpayers at large. This separation between the benefits and costs of projects may create an incentive for political parties to increase spending in electoral districts or municipalities that predominately vote for them. Since each district pays only a small share of the associated costs, but enjoys most of the benefits, new infrastructure may be seen as a prize won by the political majority for their constituency. In addition, and in order to avoid overspending, parties have reason to restrain spending in other districts (Knight, 2004).

The swing-voter theory provides a second explanation. Rather than focusing on the stock of loyal voters, this assumes that two competing (blocks of) parties maximize their national vote by offering different levels of spending to election districts depending on the propensity of the voters in each district to "swing" their vote (Helland & Sørensen, 2009). Districts that ex ante are believed to be affected in their choice on polling day by projects "given by benevolent decision-makers" are therefore rewarded with new infrastructure. A third candidate explanation is that local interest groups seek to convince parliamentary decision makers to allocate infrastructure funds to their home district. This is relevant if a district's electorate is not very volatile, that is, given that the above-described electoral concerns are not very strong (Cadot et al., 2006).

While voting by well-informed citizens reveals the voters' preferences, the three political economy models do not yield a definite weighing between considerations of social welfare, on the one hand, and electoral considerations and lobbying on the other. The weighing of social welfare against lobbying has been modeled by Grossman and Helpman (1994; 2001). Their model does not include voting, however.[2]

Although most benefits from an infrastructure project accrue to those living closest to it, it is also feasible that residents in neighboring municipalities or electoral districts may benefit (Brueckner, 2003). An early paper addressing the spillover effects from infrastructure investments is by Case, et al. (1993), who formalize and test the notion that (US) state expenditure depends on the spending of neighboring states. They show that an increase in the expenditure of a state's neighbors increases its own expenditure. Related to this, Ihara (2008) shows how geography can influence the provision of local public goods. Of special interest are falling transport costs, which can change the provision status of local public goods from under-provision to over-provision. Gutiérrez, et al., (2010) use accessibility indicators to measure and monetize the spatial spillovers of transport infrastructure investments. Their analysis separates direct investments (what is actually invested in a region) from real investments (the benefits

[2] Grossman and Helpman (1996) consider voting, but exclude the social welfare aspect by concentrating on informed and uninformed voters and the incentives of politicians to receive campaign contributions in order to influence the latter voters.

accruing to a region from all investments). Dembour and Wauthy (2009) study the impact that infrastructure spillovers have on tax competition between regions. Rather than looking at the transport infrastructure, Guriev, et al. (2010) examine the spatial distribution of interest groups within a federation and show how this influences firms' performance.

In this paper we argue that accounting for spillover effects may provide an additional explanation for any discrepancy between the 'socially optimal' and observed provision of public goods. This is based on the numerous examples of large infrastructure projects that benefit the residents in a whole region, not only those of the municipality where the project is built.

Using spending on national-level transport infrastructure projects and information on the projects and the municipalities where they are built, this paper examines how these models fare in explaining observed priorities. We test the basic model, which explains investment spending in a municipality with social welfare, against two alternative political economic models, i.e. the district demand model, and the swing-voter model including the impact of lobbying. We also test all models including a spatial aspect to account for the spillover effects.

Helland and Sørensen (2009) make a comprehensive survey of the results of previous tests of both district demand and swing-voter models. Therefore, for the purposes of this paper, it is necessary only to highlight the results of a few previous transport or Sweden-related analyses. Knight (2004) finds empirical support for his hypothesis about common pool incentives from an analysis of 1998 US Congressional votes on transportation project funding. Thus, the probability of a political representative supporting funding for projects is increasing in a legislator's own-district spending and decreasing in the tax burden associated with aggregate spending.

Helland and Sørensen (2009) find no support for the district demand model in their analysis of road investments in Norway for the period 1973 to 1997, but the swing voter model rationalized observed priorities. They also note that high levels of party identification – a measure of voter's resistance to being 'bribed' by central allocations of funds – reduce investments. A panel of French regions, used by Cadot et al. (2006) to examine the determinants of transport infrastructure investments over the period 1985-1992, also indicates that electoral concerns and influence activities (lobbying) were significant in explaining the cross-regional allocation of investments. Johansson (2003) tests the swing voter model by using another type of good for which incentives are similar to infrastructure investment, namely intergovernmental grants in Sweden between 1981 and 1995. She also finds support for the swing voter model.

3 Hypotheses

In this section we reproduce, with some modifications, the models for district demand (Helland & Sørensen, 2009) and swing voters with lobbying (Cadot et al. 2006; Helland and Sørensen, 2009). The models generate six hypotheses.

3.1 District demand

A utility function over private and public consumption is defined for citizen i in municipality $j \in J$. Citizens enjoy equal amounts of pre-tax income $y_{ij} = y_j$, private consumption $c_{ij} = c_j$, and public service consumption, $g_{ij} + \rho \sum_{k \neq j} g_{ik} = s_j$. The second term in this expression is due to the fact that municipality j has $k = \{1, \dots, q\}$ neighbors, and if $\rho > 0$, the neighbors' level of public service provision also affects the consumption of individuals residing in municipality j. The aggregate supply of public services sums over municipalities so that $\sum_{j \in J} g_j = g$. For tractability, all municipalities are assumed to have an equal number of neighbors. The utility function for citizen $i \in (n_1, n_2, \ldots, n_I)$ in municipality $j = \{1, 2, \ldots, J\}$ is then:

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

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

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

Substituting (2) into (1) gives the indirect utility function for a representative citizen in municipality *j*

$$V_j(\tau, y_j, s_j) = (1 - \tau)y_j + H(s_j) \tag{3}$$

The national income is $y = \sum_{j \in J} y_j$, and since the government is assumed to balance the budget, the government's budget constraint can be written as:

$$\tau y = \sum_{j \in J} g_j = g. \tag{4}$$

Substituting (4) into (3) yields

$$v_j(y_j, s_j) = \left(1 - \frac{\sum_{j \in J} g_j}{y}\right) y_j + H(s_j). \tag{5}$$

The socially optimal supply of public services is established by solving $\max_{g_j} \sum_{j \in J} v_j$. Assuming that $H'(s_j) = H'(s_k)\ \ \forall j, k, j \neq k$ the FOC from (5) is

$$H'(s_j^*) = (1 + g\rho)^{-1}. \tag{6}$$

Because of the concavity of $H(s_j)$, higher marginal benefits imply that the optimal supply of public services (s_j) is lower; cf. Figure 1. $H'(g_j^*) = 1$ represents the social optimum without spillovers, and the social optimum with spillovers exceeds this level. The spillover from public service consumption in municipality j to the neighboring municipalities k thus generates a socially optimal provision of public services at a higher level than when only municipality j benefits from the service.

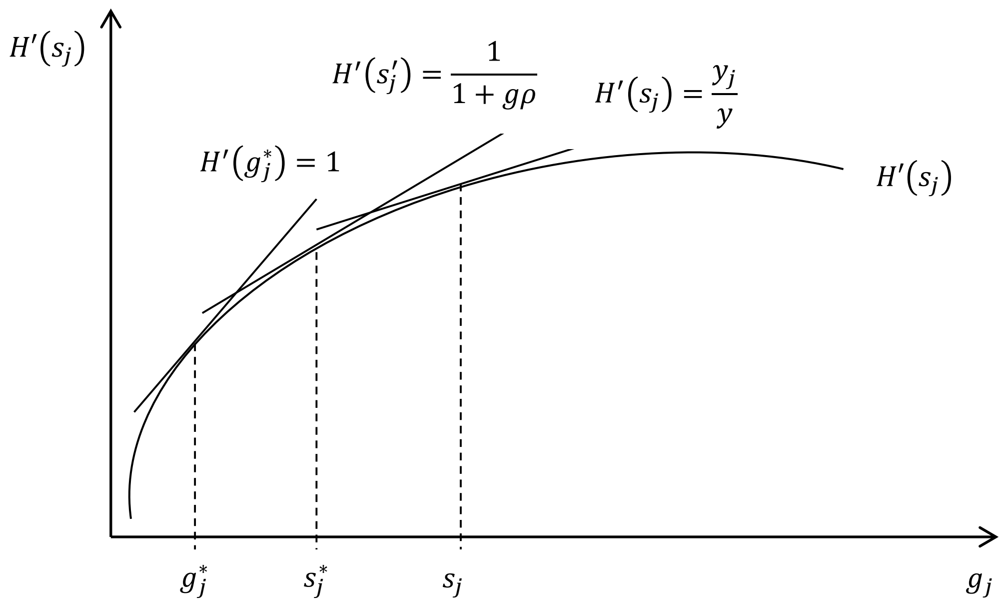

Figure 1. Three optima. The socially optimal level of infrastructure provision in the absence of spill-over effects is given by the point where $\boldsymbol{H'(g_j^*) = 1}$, yielding infrastructure investment at $\boldsymbol{g_j^*}$. With spill-over effects the social optimum moves to $\boldsymbol{H'(s_j^*) = (1 + g\rho)^{-1}}$, with

infrastructure investment $\boldsymbol{s_j^*}$. The politically optimal provision according to the district demand model is $\boldsymbol{H'(s_j) = y_j/y}$, which yields infrastructure investment $\boldsymbol{s_j}$.

Suppose municipality j's representative in the national parliament plays a one-shot, simultaneous move game with the representatives of the $J-1$ other municipalities. The Nash equilibrium in pure strategies is found by maximizing municipality j's indirect utility function with respect to g_j, taking the choice of the $J-1$ other municipalities as given. The equilibrium outcome is:

(7)
$$H'(s_j) = \frac{y_j}{y}.$$

Since $y_j/y < 1$, the Nash equilibrium indicates that the left-hand side is sub-optimal; $H'(s_j) < H'(g_j^*)$. As a result, the supply of the public good exceeds the optimal level (see Figure 1). This holds even with spillovers as long as municipality j's share of national income is low enough, i.e. as long as $y > y_j(1 + q\rho)$. A representative therefore endeavors to persuade the central government to allocate more funds to her municipality/electoral district than is socially optimal.

Using Equation (4) to express (7) in terms of tax revenue yields $H'(s_j) = \tau y_j/g$, where τ and g are given. This yields a testable hypothesis:

Hypothesis 1: National funding of transport infrastructure in a municipality decreases as the tax share of the district increases.

The district demand model is the "conventional explanation" for the observation that elected politicians bias the allocation of public services, in this case infrastructure projects, in order to favor their own election districts to win votes. But the larger the share of this investment that the municipality has to pay for itself, i.e. the closer y_j is to y, the closer to the narrowly defined optimum the representative wants to be. And if $y_j = y$ the representative would strive for $H'(s_j) = 1$ and there would be under investment from the perspective of spillover effects.

3.2 Swing voters with lobbying

The originators of the swing voter model are Lindbeck and Weibull (1987) and Dixit and Lodregan (1996). We complement this with lobbying á la Cadot et al. (2006). The basic model implies that voters not only have preferences over (public and private) consumption, but also over ideological positions. Individuals who attach great importance to a party's ideological stand have an enduring tendency to support that particular political party, and are therefore hard to swing, while voters who primarily value political parties for the consumption opportunities they provide are more attractive political prey. A major shift in the allocation of public expenditure per capita is needed to swing the ideologically oriented voters towards the other block (Helland & Sørensen, 2009, pp. 9, 11).

More specifically, 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 proportional to the population in each district. Let $g_j^P, P = \{A, B\}$ be the amount of public good in district j announced before an election by party $P = \{A, B\}$.

Candidates maximize an expected rent based on the number of mandates obtained and a rent from being in office, itself made up of two components. The one is an exogenous term δ

reflecting utility from ideology.[3] δ^P is assumed to be fixed for the duration of the electoral campaign, and is without loss of generality assumed to be $\delta^A = -\frac{1}{2}$ and $\delta^B = \frac{1}{2}$. The other component $R(g_j^P)$ is endogenous, and is interpreted as a post-political life reward (position on a board or so) offered by a lobby interested in g_j^P and conditioned on the policy promised and implemented. Thus, $R(g_j^P)$ can only be earned if party P's candidate wins the election. The candidate's utility is therefore summarized by (8).

$$v^P = \begin{cases} |\delta^P| + R(g_j^P) & \text{if the candidate from party } P \text{ is elected} \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

Let $m^P(g_j^A, g_j^B)$ be the share of mandates going to party P given platforms g_j^A and g_j^B. A party's problem is thus

$$\max_{g_j} m_j^P(g_j^A, g_j^B)[|\delta^P| + R(g_j^P)]$$

Voter i in the electoral district j gets utility both from consumption and from ideology:

$$U_{ij}^P = \kappa_j[c_j^P + H(s_j^P)] - \frac{1}{2}(\delta_{ij} - \delta^P)^2, \qquad P = \{A, B\}.$$

κ_j measures the weight put on (public and private) consumption relative to ideology and δ_{ij} denotes voter i's ideal position.

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

$$c_j^P = (1 - \tau^P)y_j, \qquad P = \{A, B\} \tag{9}$$

[3] In Cadot, et al. (2006) this is a rent from being in office, which is different from utility from ideology.

$$\tau^P y = \sum_{j \in J} g_j^P, \qquad P = \{A, B\}. \tag{10}$$

Voters are indifferent between parties A and B when $U_{ij}^A - U_{ij}^B = 0 \Leftrightarrow \kappa_j\left[c_j^A + H\left(s_j^A\right) - c_j^B - H\left(s_j^B\right)\right] - \delta_{ij} = 0$. Voter i has an 'ideological' utility loss of $-\delta_{ij}$ irrespective of which party enters office. This leads to the definition of a cut point; that is, the point where the voter is indifferent between parties *A* and *B*. Using $c_j^P, P = \{A, B\}$ as defined by (9) and (10):

$$\delta_{ij} = \kappa_j\left[c_j^A + H\left(s_j^A\right) - c_j^B - H\left(s_j^B\right)\right]. \tag{11}$$

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

$$m^A(\boldsymbol{g}^A, \boldsymbol{g}^B) = \sum_{j \in J} m_j F_j\left(\delta_{ij}\right) \tag{12}$$

$$m^B(\boldsymbol{g}^A, \boldsymbol{g}^B) = 1 - \sum_{j \in J} m_j F_j\left(\delta_{ij}\right) \tag{13}$$

The parties' problem is to maximize the expected power rent; that is, to solve

$$\max_{g_j^A} \; m^A(\boldsymbol{g}^A, \boldsymbol{g}^B)\left[|\delta^A| + R\left(g_j^A\right)\right] \tag{14}$$

$$\max_{g_J^B} \; [1 - m^A(\boldsymbol{g}^A, \boldsymbol{g}^B)]\left[|\delta^B| + R\left(g_j^B\right)\right] \tag{15}$$

It is apparent from equations (12) - (15) that in equilibrium both parties offer the same platform, $\boldsymbol{g}^A = \boldsymbol{g}^B$, and that the mandates are divided equally between the parties, $m^A = m^B$. As in Cadot et al. (2006), identical platforms arise from the fact that both candidates cater to the wishes of the same lobby, here balanced by the (symmetrical) utility from ideology. If each party had a favored lobby and the lobbies had extreme positions, platforms would be pulled in opposite directions, in the same way as when candidates are partisan.

Given the symmetry of the equilibrium, we analyze party A's platform only. Taking the first order condition of (14), using (12), where δ_{ij} is given by (11), substituting in (9) and (10) for c_j yields:

(16)
$$\phi'(g_j^A) \equiv m_j f_j(\delta_{ij}^*)\kappa_j \left[H'(s_j^A)(1+\rho q) - \sum_{j\in J} \frac{y_i}{y} \right] \left[|\delta^A| + R(g_j^A) \right]$$
$$+ m^A(\boldsymbol{g}^A, \boldsymbol{g}^B) R'(g_j^A) = 0.$$

Rearranging (16) yields:

(17)
$$H'(s_j^A) = \frac{\sum_{j\in J} m_j f_j(\delta_{ij}^*)\kappa_j \frac{y_j}{y}}{m_j f_j(\delta_{ij}^*)\kappa_j(1+\rho q)} - \frac{m^A(\boldsymbol{g}^A, \boldsymbol{g}^B) R'(g_j^A)}{\left[|\delta^A| + R(g_j^A) \right] m_j f_j(\delta_{ij}^*)\kappa_j(1+\rho q)}.$$

If lobbying does not matter ($R'(g_j^A) = 0$), the model boils down to the one in Helland and Sørensen (2009), with the addition of a spatial dimension. Thus, in equilibrium without lobbying the level of public spending in district j will increase with a greater share of mandates in that district (m_j), increasing density at the cut point in j ($f_j(\delta_{ij}^*)$), increased weight on consumption relative to ideology in j (κ_j), and increasing spillovers to neighboring districts (ρ and q). The model thus yields the following two hypotheses that can be empirically tested:

Hypothesis 2: National transport infrastructure expenditure in an electoral district decreases as the share of district voters having strong party identification increases ($\boldsymbol{\kappa_j}$ falls).

Hypothesis 3: National transport infrastructure expenditure in an electoral district increases as the cut-point density ($\boldsymbol{f_j(\delta_{ij}^*)}$) of the district increases.

Hypothesis 3 is based on the distribution of voters' ideological preferences and the density of the ideological distribution function at the ideological cut point. Since districts are characterized by different ideological voter distributions, 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 party promising this carrot (Helland & Sørensen, 2009, p. 9).

In order to shift focus to the lobbying aspect, the electoral incentives are neutralized by setting $\frac{\sum_{j\in J} m_j f_j\left(\delta_{ij}^*\right)\kappa_j \frac{y_j}{y}}{m_j f_j\left(\delta_{ij}^*\right)\kappa_j(1+\rho q)} = \frac{1}{1+\rho q}$. Equation (17) then simplifies to

(18)
$$H'\left(s_j^A\right) = \frac{1}{1+\rho q}\left\{1 - \frac{m^A(\boldsymbol{g}^A, \boldsymbol{g}^B)R'\left(g_j^A\right)}{\left[|\delta^A| + R\left(g_j^A\right)\right]m_j f_j\left(\delta_{ij}^*\right)\kappa_j}\right\}.$$

An (expected) increase in party A's total share of votes, m^A raises the lobbying term, which in turn reduces the left-hand side (LHS) of Equation (18). The concavity of $H\left(s_j\right)$ therefore implies a higher level of infrastructure investment in district j. Likewise, a higher marginal lobbying effort, $R'\left(g_j^A\right)$, reduces the RHS, thus raising the level of investment. An increase in the electoral considerations (an increase in m_j, $f_j\left(\delta_{ij}^*\right)$ or κ_j) also lower the lobbying term, thus reducing the lobbies' clout and moving the optimum closer to the social optimum. This suggests a test of the strength of lobbying influences:

Hypothesis 4. If the volatility of a region's electorate leads, in equilibrium, to more of the public good being provided to that region, then lobbying influences will not be "so strong".

The corollary of Hypothesis 4 is that if a region's electorate is not very volatile, that is, if the swing-voter theory has a low degree of explanatory power as to the amount of investments going to a region, lobby groups may – ceteris paribus – have a large influence on the investment decision.

3.3 Social welfare and spillover effects

Two more hypotheses arise from the exclusion of electoral considerations and the consideration of spillover effects from an investment. The latter effects have been included in both the district demand and the swing voter models, and the following hypothesis derives from the observations made from these models:

Hypothesis 5. National transport infrastructure expenditure in an electoral district increases when there are benefits that accrue to neighboring municipalities from its provision.

The corollary of Hypothesis 5 is that when a spatial lag in the provision of the public good is included in the model, the explanatory power of the political variables should fall. This provides the third alternative explanation for the distribution of public goods: that the conventional econometric methods, which do not account for the benefits accruing to the neighboring areas, underestimate the optimal level of investment and overestimate the impact from other explanatory variables.

The final hypothesis can be derived both from the district demand and the swing voter models by eliminating the electoral considerations. We consider the model implied by Hypothesis 6 as the base case against which the other hypotheses are tested:

Hypothesis 6. National funding of transport infrastructure in a municipality is determined by the welfare consequences of that investment. That is, municipalities with projects having a positive net present value are given priority.

4 Data

Sweden's central government finances all national-level transport infrastructure projects. The only exception is the "voluntary co-financing" by municipalities, regions or private enterprises that was first introduced in conjunction with the 2010-2021 National Transport Infrastructure Plan.[4] Since the government's budget constraint does not allow all proposed projects to be approved, the choice is expected to follow the recommendations from cost-benefit analyses (CBA), so that projects with the highest NPV ratio will be given priority, and projects with a negative net present value will not be built at all.

We use data from the National Transport Infrastructure Plans for 2004-2015, for 2010-2021, and for 2014-2025. For the first of these, only information about approved projects is available, but the 2010-2021 and the 2014-2025 data also include information about some projects that were ultimately not included in the Plan. The "counterfactuals" for the 2014-2025 Plan are

[4] Some co-financing was already secured for the National Transport Infrastructure Plan for 2004-2015, but it was very little. After an evaluation of co-financing undertaken after the Plan for 2010-2021 was approved (Swedish National Audit Office, 2011), the parliamentary Committee on Transport and Communications demanded a revision of the practice of co-financing. For example, the committee does not want co-financing to influence the choice of infrastructure projects (Parliamentary Committee on Transport and Communications, 2014). The practice concerning co-financing is therefore not quite clear at the time of writing.

found among those projects evaluated for the 2010-2021 Plan but not included in either of the two plans. The counterfactuals for 2014-2025 are determined by matching the included projects against the counterfactuals for 2010-2021. No new counterfactuals have been calculated in conjunction with the Plan for 2014-2025. The Plans are available from the Swedish Transport Administration, and the remaining data mainly comes from Statistics Sweden. The political variables, *Cut point density* and *Party attachment*, which are used to test the swing voter theory, are from the Swedish National Data Service (SSD).[5]

Summary statistics for the dependent variable are shown in Table 1 for a panel combining the three plans, and for cross sectional data for each respective Plan separately. The dependent variable is the investment cost (IC) of transport infrastructure per municipality in millions SEK (in 2008 prices), as planned in the National Transport Infrastructure Plans for 2004-2015, 2010-2021 and 2014-2025.[6] The total IC, and IC for road and rail investments separately, are used. The investment cost per municipality statistic is constructed by identifying in which municipality (municipalities) a given object is to be built, and then allocating the total cost of the object to the municipality (-ies) getting part of it in relation to population. Finally, the shares of IC allocated to a municipality are added up. Based on results from a Box-Cox regression, which is used to determine the choice between logarithms or levels, we use the natural logarithm of the

[5]The material was originally collected by Sören Holmberg and Henrik Oscarsson at the University of Gothenburg. Neither the SSD nor Holmberg and Oscarsson bear any responsibility for the analyses and interpretations in this paper.

[6] The average exchange rate in 2008 was 9.6 SEK/EUR and 6.6 SEK/USD.

resulting IC, the dependent variable thus being *Ln(IC)*. In order not to have to drop municipalities with zero IC from the sample, we add 1 SEK to the IC for all municipalities.

Table 1. Summary statistics for the dependent variables in mSEK (2008 terms) and in natural logarithms.

Variable	Obs.	Mean	Std. Dev.	Min	Max
IC mSEK	870	544.66	3448.94	0	66544.30
IC mSEK on roads	870	208.59	1750.44	0	32903.01
IC mSEK on rail	870	334.47	1901.73	0	32581.93
Ln(IC) mSEK	870	-4.44	9.49	-13.82	11.11
Ln(IC roads) mSEK	870	-9.48	8.05	-13.82	10.40
Ln(IC rail) mSEK	870	-6.61	9.07	-13.82	10.39
IC mSEK 2004	290	479.80	2372.88	0	35195.84
IC mSEK 2010	290	428.94	2634.65	0	38105.50
IC mSEK 2014	290	725.23	4810.98	0	66544.30
IC mSEK roads 2004	290	172.27	1426.09	0	23724.32
IC mSEK roads 2010	290	201.00	1595.02	0	26218.01
IC mSEK roads 2014	290	252.49	2152.26	0	32903.01
IC mSEK rail 2004	290	307.54	1223.52	0	11651.18
IC mSEK rail 2010	290	227.94	1294.54	0	17249.45
IC mSEK rail 2014	290	467.95	2769.82	0	32581.93
Ln(IC) mSEK 2004	290	-2.03	8.97	-13.82	10.47
Ln(IC) mSEK 2010	290	-5.21	9.41	-13.82	10.55
Ln(IC) mSEK 2014	290	-6.07	9.63	-13.82	11.11
Ln(IC roads) mSEK 2004	290	-9.38	8.14	-13.82	10.40
Ln(IC roads) mSEK 2010	290	-9.46	8.08	-13.82	10.17
Ln(IC roads) mSEK 2014	290	-9.38	8.14	-13.82	10.40
Ln(IC rail) mSEK 2004	290	-3.39	9.03	-13.82	9.36

Ln(IC rail) mSEK 2010	290	-7.42	8.79	-13.82	9.76
Ln(IC rail) mSEK 2014	290	-9.04	8.46	-13.82	10.39

The National Transport Infrastructure Plans provide information about planned but not necessarily actual expenditure. Moreover, some objects that were included in the Plan for 2004-2015 may have been discarded in the 2010-2021 Plan (for example the Norrbottniabanan railway link). Finally, projects that were already in the construction stage when the Plans were approved have been removed, since they typically do not represent an actual choice but rather a formality with respect to signaling the allocation of money.

IC varies considerably between municipalities. A large number of municipalities in all three Plans have no IC at all, since no national projects were/are to be built there. The maximum IC in all the Plans is in Stockholm (35,200 mSEK in 2004, 38,100 mSEK in 2010 and 66,500 mSEK in 2014), followed by the two next largest cities, Gothenburg and Malmö.

The independent variables used in the panel data models and the cross-sectional models are summarized in Table 2 and Table 3, respectively. The variable used to test the district demand model (Hypothesis 1) is a municipality's share of total state income tax paid on earned income and capital, measured by the natural logarithm of *Tax share*. Tax income in 2002 is used for the 2004-2015 Plan, in 2008 for the 2010-2021 Plan, and in 2012 for the 2014-2025 Plan, all in 2008 prices. This measure does not include taxes to the municipalities and the county boards, and also excludes the state wealth tax and the state tax on real estate. The rate of state income tax does not vary between the regions. The tax receipts are, however, a function of income in the respective municipality, since no tax is paid at low levels of income, and the marginal tax rate varies depending on income.[7]

Table 2. Summary statistics for the independent variables, panel data.

Variable	Obs	Mean	Std. Dev.	Min	Max
Cut-point density (CPD)	870	0.46	0.12	0.26	1.36
Ln(CPD)	870	-0.80	0.21	-1.34	0.31
Party attachment	870	0.34	0.09	0.08	0.56
Ln(Party attachment)	870	-1.11	0.26	-2.48	-0.58
Firms > 500 employees	870	2.99	13.02	0	222
Tax share of municipality	870	0.00	0.02	0.00	0.31
Ln(Tax share)	870	-6.85	1.26	-9.52	-1.17
Indicator NPV positive	870	0.38	0.49	0	1
Indicator NPV on road projects positive	870	0.20	0.40	0	1
Indicator NPV on rail projects positive	870	0.25	0.43	0	1
Indicator NPV negative	870	0.13	0.33	0	1
Indicator NPV on road negative	870	0.06	0.24	0	1
Indicator NPV on rail negative	870	0.09	0.28	0	1
Indicator co-financing	870	0.08	0.27	0	1
Share of rail projects	870	0.35	0.43	0	1
Share of road projects	869	0.26	0.39	0	1
Population density per km^2	870	129.37	438.93	0.20	4504.30
Ln(Population density)	870	3.33	1.63	-1.61	8.41

[7] In 2012, individuals earning less than 401,100 SEK/year (about 46,000 EUR; 60,000 USD) did not pay any state income tax, but only paid municipal and county-board taxes. For incomes between 401 100 and 574 300 SEK/year, the state income tax rate is 20 per cent of the taxable earned income. For incomes above 574,300 SEK/year (about 66,000 EUR; 86,000 USD), the state income tax on earned income is 25 per cent. (Skatteverket, 2014).

Table 3. Summary statistics for the independent cross sectional variables.

Variable	Obs.	Mean	Std. Dev.	Min	Max
Cut-point density, election in 2002	290	0.42	0.06	0.26	0.50
Cut-point density, election in 2006	290	0.49	0.12	0.29	0.88
Cut-point density, election in 2010	290	0.47	0.16	0.33	1.36
Ln(CPD) 2002	290	-0.89	0.15	-1.34	-0.69
Ln(CPD) 2006	290	-0.73	0.21	-1.25	-0.13
Ln(CPD) 2010	290	-0.80	0.22	-1.10	0.31
Party attachment, election in 2002	290	0.41	0.08	0.30	0.56
Party attachment, election in 2006	290	0.32	0.06	0.08	0.47
Party attachment, election in 2010	290	0.30	0.08	0.08	0.50
Ln(Party attachment) 2002	290	-0.91	0.19	-1.21	-0.58
Ln(Party attachment) 2006	290	-1.16	0.21	-2.48	-0.75
Ln(Party attachment) 2010	290	-1.25	0.26	-2.48	-0.69
Firms > 500 employees, 2002	290	2.92	13.31	0	220
Firms > 500 employees, 2008	290	2.96	13.42	0	222
Firms > 500 employees, 2012	290	3.09	12.35	0	193
Tax share of municipality in 2002	290	0.003	0.02	0.00009	0.30
Tax share of municipality in 2008	290	0.003	0.02	0.00008	0.27
Tax share of municipality in 2012	290	0.003	0.02	0.00007	0.31
Ln(Tax share) 2002	290	-6.82	1.24	-9.29	-1.20
Ln(Tax share) 2008	290	-6.81	1.26	-9.46	-1.30
Ln(Tax share) 2012	290	-6.92	1.29	-9.52	-1.17
Indicator NPV positive 2004	290	0.44	0.50	0	1
Indicator NPV positive 2010	290	0.36	0.48	0	1
Indicator NPV positive 2014	290	0.35	0.48	0	1

Indicator NPV on road projects positive 2004	290	0.20	0.40		0	1
Indicator NPV on road projects positive 2010	290	0.20	0.40		0	1
Indicator NPV on road projects positive 2014	290	0.21	0.41		0	1
Indicator NPV on rail projects positive 2004	290	0.33	0.47		0	1
Indicator NPV on rail projects positive 2010	290	0.22	0.41		0	1
Indicator NPV on rail projects positive 2014	290	0.19	0.39		0	1
Indicator NPV negative 2004	290	0.18	0.38	0	1	290
Indicator NPV negative 2010	290	0.12	0.33	0	1	290
Indicator NPV negative 2014	290	0.00	0.06	0	1	290
Indicator NPV on road negative 2004	290	0.10	0.31	0	1	290
Indicator NPV on road negative 2010	290	0.08	0.28	0	1	290
Indicator NPV on road negative 2014	290	0.11	0.31	0	1	290
Indicator NPV on rail negative 2004	290	0.10	0.30	0	1	290
Indicator NPV on rail negative 2010	290	0.04	0.21	0	1	290
Indicator NPV on rail negative 2014	290	0.18	0.38	0	1	290
Indicator co-financing 2004	290	0.03	0.16		0	1
Indicator co-financing 2010	290	0.17	0.37		0	1
Indicator co-financing 2014	290	0.04	0.19		0	1
Share of rail projects 2004	290	0.51	0.46		0	1
Share of rail projects 2010	290	0.33	0.41		0	1
Share of rail projects 2014	290	0.22	0.36		0	1
Share of road projects 2004	290	0.47	0.46		0	1
Share of road projects 2010	290	0.35	0.41		0	1

Share of road projects 2014	290	0.37	0.44	0	1
Population density per km^2 2000	290	123.84	415.15	0.30	3997.20
Population density per km^2 2005	290	127.42	427.34	0.20	4106.90
Population density per km^2 2010	290	136.85	473.55	0.20	4504.30
Ln(Population density) 2000	290	3.33	1.60	-1.20	8.29

After each election, respondents to the Swedish Election Survey are asked whether they are attached to one particular political party. This is used to test the first part of the swing voter hypothesis, Hypothesis 2; the share of positive answers to this question in the respective electoral district (2002) and county (2006, 2010) is used as a proxy for party attachment. In order to avoid taking a logarithm of a number lower than 1, we multiply the share of positive respondents by 100 and use a natural logarithm of the share of positive respondents to *Party attachment*. The share of individuals indicating particular attachment to one political party fell from about 41 per cent in 2002 to 32 per cent in 2006 and to 30 per cent in 2010.

Again, using the answers from Swedish Election Surveys for 2002, 2006 and 2010, Hypothesis 3 is tested following the approach described by Helland and Sørensen (2009) to estimate the cut-point densities (CPD). The respondents are asked to place themselves on a left-right scale between 0 (extreme left) and 10 (extreme right), where 5 signifies neither left nor right. The densities of the ideological distribution function at the values of 4, 5 and 6 for the respective electoral district (for 2002) and county (for 2006 and 2010) are observed, added together and multiplied by 100 to obtain a measure of the CPD.[8] The natural logarithm of the obtained measure is used in the analysis. Since data is only available for the electoral districts and counties, this does not yield municipality-specific cut point densities (Johansson, 2003).

Following Cadot et al. (2006), the impact of lobbying on investment cost per municipality (Hypothesis 4) is tested by including the number of large firms located in a given municipality in 2002, 2008 and 2012. Firms with 500 or more employees are defined as 'large'.

In addition to lobbying by large firms, it is also possible that the municipalities themselves lobby the central government. This might be reflected in their willingness to co-finance infrastructure projects. We therefore include an indicator variable taking the value of 1 if the municipality where a project is to be built offers co-financing. Jussila Hammes (2013) demonstrated that co-financing influenced the probability of a project being included in the Plan for 2010-2021. This variable is of questionable quality for 2004 and for 2014, since only eight municipalities have positive values for the 2004-2015 Plan, and only 11 for the 2014-2025 Plan. The figures for the latter Plan are uncertain because of the above-discussed complications by the Parliamentary Committee for Transport and Communications (2014). For 2010 the data is much richer.

[8] Only three data points exist for Gotland in 2010, which makes the estimation of the density function for that county impossible. Hence, for Gotland in 2010, we use the *Party attachment* and *CPD* measures estimated from the 2006 Election Survey data .

The impact of the spillover effects (Hypothesis 5) is tested by estimating the model with the help of a spatial weight matrix. Rook-contiguity, defining neighbors as municipalities that share borders, is used.[9] The specification of the spatial model is described in the next section.

Finally, the impact of welfare considerations (Hypothesis 6) is tested by including two indicator variables, one that takes a value of 1 if the sum of the net present values (NPV) for all investments in a municipality, per Plan, is positive, and zero otherwise, and another that takes a value of 1 if the sum of the NPVs is negative, and zero otherwise.[10] Information is not available about the NPV for all projects included in a Plan, however.

Besides its projects, the 2010-2021 Plan also includes 'counterfactuals', that is, the NPV of projects that were studied but not included in the final Plan. For municipalities with no projects included in the 2010-2021 or the 2014-2025 Plans, but where there is information of such projects, the NPV for the non-included projects is used to construct the indicator variables *NPV positive* and *NPV negative*. This yields counterfactual information for 63 municipalities in 2010 and 60 municipalities in 2014. For those municipalities with both included and non-included projects, we only consider the sum of the NPVs for the included projects.

[9] Due to limitations in Stata's ability to run spatial analyses, the tests of spatial autocorrelation have been run with a spatial weight matrix that defines neighbors as municipalities lying within 100 kilometers from the centroid of the respective municipality.

[10] Grossman and Helpman (1994) and the large literature following that article construct a theoretical model that examines how politicians weigh general welfare against lobbying.

The base case for NPV is therefore the one where there is no NPV measure for a municipality. In some rare cases it may be possible that the sum of NPVs for a municipality equals zero, but this is unlikely. *Ind NPV positive* and *Ind NPV negative* (for road, rail) have a correlation coefficient of -0.30 (-0.13, -0.17), so multicollinearity should not be a problem.

Two control variables are used. To control for the possible impact of congestion arising from higher population densities on decisions, we include population density per square kilometer for 2000, 2005 and 2010. [11]

Jussila Hammes (2013) shows that rail investments, ceteris paribus, have a greater probability of being included in the Plan for 2010-2021 than road projects. In order to control for this, the share of rail investments out of all investments in a municipality is used as a control variable.[12]

5 Regression results

The statistical tests are run using Stata. The spatial weight matrix is constructed using OpenGeoDa.

We start by testing Hypotheses 1-4 and 6 without a spatial aspect. To this end, we pool the data and run a fixed-effects panel regression in order to control for municipality-specific constant

[11] The municipality of Knivsta separated from Uppsala in 2004. To handle this, population in the municipality and state income tax data for this municipality have been extrapolated from 2000 to 2003.

[12] Jussila Hammes (2012) further shows that the mean number of rail projects included in the 2004-2015 Plan exceeds that for the 2010-2021 Plan in a statistically significant manner. This indicates that rail projects may have had a greater probability of being included in the 2004-2015 Plan than road projects.

effects. We run the model using both the natural logarithm of total IC and IC for road and rail investments as dependent variables. Using a random effects estimator would be inappropriate, since we are studying a specific set of objects, namely the 290 municipalities in Sweden and, consequently, the individuals cannot be considered as drawn randomly from a large population (Baltagi, 2008).

We run three regression models to test the five hypotheses. We start by testing Hypothesis 6 by itself. To this end we include variables *Indicator positive NPV* and *Indicator negative NPV*. As control variables we use $\boldsymbol{x} =$ *(Rail share, Urban share)*. The regression model is of the form:

(19)
$$Ln\left(IC_{jt}\right) = \alpha + \beta_1 Ind\ pos\ NPV_{jt} + \beta_2 Ind\ neg\ NPV_{jt} + \sum_{i=1}^{2} \gamma_i x_{ijt} + \epsilon_{jt},$$

for respective municipality *j*, control variable i and at time $t = (2004, 2010, 2014)$, and with the error term taking the form appropriate for the type of estimator used. The results from estimating this model are shown in Table 4, columns (1), (4) and (7). Column (1) uses the natural logarithm of total IC as the dependent variable, while column (4) contains only the natural logarithm of IC for road projects and column (7) contains only the natural logarithm of IC for rail projects. To save space, we report the coefficients and *t*-values for *Indicator positive/negative NPV of road/rail* on the same line as the corresponding variables for the total model.

Table 4. Results from a fixed-effects panel regression.

	(1) Ln(IC) mSEK	(2) Ln(IC) mSEK	(3) Ln(IC) mSEK	(4) Ln(IC road) mSEK	(5) Ln(IC road) mSEK	(6) Ln(IC road) mSEK	(7) Ln(IC rail) mSEK	(8) Ln(IC rail) mSEK	(9) Ln(IC rail) mSEK
Ind positive	3.424***	3.396***	3.696***	12.48***	12.48***	12.15***	2.190**	2.203**	2.410***
NPV	(4.78)	(4.73)	(5.28)	(17.58)	(17.57)	(17.71)	(3.17)	(3.18)	(3.51)
Ind negative	0.172	0.118	0.570	3.036**	3.043**	2.818**	2.624**	2.656**	2.792**
NPV	(0.19)	(0.13)	(0.64)	(3.06)	(3.07)	(2.89)	(2.96)	(2.98)	(3.14)
Share rail	11.60***	11.64***	10.53***	-0.724	-0.729	-1.496*	15.05***	15.02***	14.22***
	(14.89)	(14.88)	(12.97)	(-1.21)	(-1.21)	(-2.44)	(20.59)	(20.48)	(18.72)
Ln(Population	-4.748	-4.443	-5.832	-3.071	-3.150	-3.860	-3.966	-4.180	-5.648
density)	(-0.84)	(-0.79)	(-1.04)	(-0.64)	(-0.65)	(-0.81)	(-0.86)	(-0.91)	(-1.21)
Ln(Tax share)		-0.752	-1.271		0.199	-0.250		0.509	0.118
		(-0.64)	(-1.09)		(0.20)	(-0.26)		(0.54)	(0.12)
Ln(Cut-point			-2.572*			-1.873*			-1.960*
density)			(-2.36)			(-2.03)			(-2.18)
Ln(Attachment)			2.307*			1.560+			1.712*
			(2.23)			(1.79)			(2.00)
Firms > 500			0.0488			-0.00424			0.0258
employees			(0.38)			(-0.04)			(0.24)
Indicator co-			5.176***			5.107***			2.861***
financing			(5.78)			(6.73)			(3.85)
Constant	5.969	-0.190	1.035	-1.707	-0.0839	-0.604	0.532	4.736	7.186
	(0.32)	(-0.01)	(0.05)	(-0.11)	(-0.00)	(-0.03)	(0.03)	(0.28)	(0.42)
Observations	870	870	870	870	870	870	870	870	870
R^2	0.405	0.406	0.445	0.359	0.359	0.410	0.605	0.606	0.620
Adjusted R^2	0.103	0.102	0.155	0.032	0.031	0.102	0.405	0.404	0.422
AIC	5140.2	5141.5	5090.1	4857.0	4858.9	4794.6	4782.3	4783.9	4759.5
BIC	5164.0	5170.1	5137.8	4880.8	4887.5	4842.3	4806.2	4812.5	4807.2

t statistics in parentheses

+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

The model provides some support for Hypothesis 6. Thus, the existence of a positive NPV in a municipality increases the rate of total investment costs in that municipality by a factor of 3.4 (column (1) of Table 4), road investment costs by a factor of 12.5 (column (4)), and rail investment costs by a factor of 2.2 (column (7)).

The coefficient for *Indicator negative NPV* is also significant at 1 % level and positive for road and rail investments. Since we expected a negative NPV to lower investment in those municipalities, it seems that the mere existence of a NPV measure is sufficient to explain the investment costs of a municipality – whether the measure is positive or negative does not matter. It is nevertheless worth noting that the coefficient in column (1), for the total IC model, is insignificant, and the impact of a negative NPV is much smaller on road investments than the impact of a positive NPV – a negative NPV raises investment in roads by a factor of about 3.0, while a positive NPV raises it by a factor of 12.5. For rail investments (column (7)) the impact is higher for the negative NPV measure, however. F-tests of equal coefficients indicate that the coefficient for *Indicator positive NPV on road* exceeds the coefficient for *Indicator negative NPV on road* in a statistically significant manner, but that the coefficients for *Indicator positive NPV on rail* and *Indicator negative NPV on rail* are equal to one another.

The second model to test is the district-demand hypothesis (Hypothesis 1). We run the following model:

(20) $$Ln\left(IC_{jt}\right) = \alpha + \beta_1 Ind\ pos\ NPV_{jt} + \beta_2 Ind\ neg\ NPV_{jt} + \delta_1 Ln(Tax\ share_{jt}) + \sum_{i=1}^{2} \gamma_i x_{ijt} + \epsilon_{jt},$$

The results from the model estimation are shown in columns (2), (5) and (8) in Table 4. The coefficient of *Ln(Tax share)* is insignificant both for the total IC model and for IC in road and rail. We therefore reject Hypothesis 1.

In order to test the swing-voter with lobbying model we run the following:

$$\text{(21)} \quad Ln\left(IC_{jt}\right) = \alpha + \beta_1 Ind\ pos\ NPV_{jt} + \beta_2 Ind\ neg\ NPV_{jt} + \delta_1 Ln\left(Tax\ share_{jt}\right) + \theta_1 Ln\left(CPD_{jt}\right) + \theta_2 Ln\left(Attachment_{jt}\right) + \theta_3 Firms500\ employees_{jt} + \theta_4 Ind\ cofin_{jt} + \sum_{i=1}^{2} \gamma_i x_{ijt} + \epsilon_{jt}.$$

The results are shown in columns (3), (6) and (9) of Table 4. The swing voter model cannot predict the sign for *Ln(Tax share)*. The coefficient of *Ln(Attachment)*, used to test Hypothesis 2, gets a coefficient that is significant at least at 10 % level of significance in all three models, but it has the “wrong” sign; that is, the coefficient is positive and not negative as conjectured. We therefore reject Hypothesis 2. A similar observation applies to *Ln(Cut-point density)*, which gets a significant sign at 5 % level in all three models, but with a negative sign and not a positive sign as expected. We reject Hypothesis 3 as well.

As explained above, we test Hypothesis 4, which is about the influence of interest groups, by including two variables. One is a measure of the number of firms large enough to have resources for lobbying, namely more than 500 employees. The coefficient for this variable is insignificant in all three models. The other variable measures lobbying mainly by the municipalities themselves, namely co-financing. The coefficient for the indicator variable is significant at 0.1 % level of significance and takes the expected positive sign in all three models.

Thus, the rate of total IC in a municipality increases by a factor of 5.2 in those municipalities that offer co-financing as compared to municipalities that do not co-finance. The impact on IC on road is an increase by a factor of about 5.1, and on IC on rail by a factor of about 2.9.

Finally, the measures of fit, AIC and BIC, indicate that the district demand model (columns (2), (5) and (8)) offers the worst fit, while the swing-voter with lobbying model (columns (3), (6) and (9)) offers the best fit. The adjusted R^2 measures support this finding.

In order to test Hypothesis 5, that spillover effects to neighboring municipalities may explain the investment cost in a municipality, we use cross sections of the data for the respective plans, 2004-15, 2010-21 and 2014-25. Neither Stata nor OpenGeoDa can test spatial correlation in panel data. We estimate the following types of models testing both the district demand model and the swing voter model against the influence of "welfare only":

$$(22)\quad Ln(IC_{jt}) = \alpha + \rho \boldsymbol{W} Ln(IC_{jt}) + \beta_1 Ind\ pos\ NPV_{jt} + \beta_2 Ind\ neg\ NPV_{jt} + \delta_1 Ln(Tax\ share_{jt}) + \theta_1 Ln(CPD_{jt}) + \theta_2 Ln(Attachment_{jt}) + \theta_3 Firm > 500\ employees_{jt} + \theta_4 Ind\ cofin_{jt} + \sum_{i=1}^{2} \gamma_i x_{ijt} + \epsilon_{jt}.$$

$$\epsilon_{jt} = \lambda \boldsymbol{W} \epsilon_{jt} + \mu$$

We start by examining whether the cross sectional data exhibits either heteroscedasticity or spatial autocorrelation. In order to do this, we estimate Equations (19) to (21) using an ordinary least squares (OLS) estimator. We do not show the results in this paper. The Breusch-Pagan test does not indicate heteroscedasticity for total *Ln(IC)* in 2004, but the models for 2010 and for 2014 are heteroscedastic. The ICs for road and rail regressions are heteroscedastic. The global measures for spatial autocorrelation, Moran's I, indicates spatial autocorrelation for the models for *Ln(IC on road)* in 2010 and in 2014, and for *Ln(IC on rail)* in 2010, at least at 5 % level of significance, both excluding and including the swing-voter variables. Including the swing voter with lobbying variables, the test indicates spatial autocorrelation for total *Ln(IC)* in 2010 at 5 % level, and for 2004 at 10 % level.

We estimate model (22) using an estimator that corrects for a spatial lag in the dependent variable. We do not present models with spatially correlated error terms, or Durbin models controlling for both aspects of spatial dependency, because the coefficient for spatially autocorrelated errors in these models is insignificant.

The results for the welfare model (Hypothesis 6, similar to Equation (19)) complemented with the spatial weight matrix) are shown in Table 5. The results with regard to the impact of social welfare (positive NPV) do not change compared to the panel model shown in Table 4. Thus, the impact of welfare considerations is positive for all three plans. It is strongest for road investments and less so for rail investments.

The results with regard to *Indicator negative NPV* are similar to the panel model, too, except that the coefficient of the variable is also significant for the total IC model. The above conclusions hold but Hypothesis 6 cannot be confirmed as it is. Rather than welfare concerns driving the results, it is the mere existence of CBA results that seems to explain project choice.

Table 5. Investment cost per municipality and infrastructure plan explained by concern for social welfare (CBA results), controlling for a spatially lagged dependent variable. The coefficient $\boldsymbol{\rho}$ is included to control for a spatially lagged dependent variable

	(1) Ln(IC) mSEK 2004-2015	(2) Ln(IC) mSEK 2010-2021	(3) Ln(IC) mSEK 2014-2025	(4) Ln(IC road) mSEK 2004-2015	(5) Ln(IC road) mSEK 2010-2021	(6) Ln(IC road) mSEK 2014-2025	(7) Ln(IC rail) mSEK 2004-2015	(8) Ln(IC rail) mSEK 2010-2021	(9) Ln(IC rail) mSEK 2014-2025
Ind positive NPV	9.403***	6.167***	8.471***	18.37***	12.67***	12.05***	4.949***	5.890***	5.942***
	(16.55)	(5.60)	(7.88)	(42.97)	(13.67)	(13.07)	(9.23)	(5.11)	(4.74)
Ind negative NPV	7.733***	3.475**	1.980	19.73***	5.552***	3.457**	6.078***	7.452***	2.843
	(7.89)	(2.78)	(1.42)	(7.25)	(4.75)	(2.59)	(8.84)	(5.11)	(1.62)
Share rail	9.551***	8.086***	6.005***	-0.461	0.0929	-0.445	13.86***	8.973***	10.36***
	(15.60)	(6.63)	(4.36)	(-1.28)	(0.10)	(-0.42)	(26.01)	(7.30)	(7.44)
Ln(Population density)	0.599**	0.995**	1.235***	0.0794	0.897***	0.727**	0.575***	0.526*	0.883***
	(3.24)	(3.28)	(4.08)	(0.64)	(3.70)	(2.75)	(4.30)	(2.01)	(3.39)
Constant	-13.70***	-14.09***	-14.80***	-13.29***	-15.62***	-14.69***	-14.79***	-14.19***	-15.74***
	(-18.70)	(-12.14)	(-12.80)	(-27.92)	(-17.27)	(-14.71)	(-27.66)	(-14.36)	(-15.47)
rho									
Constant	0.0741***	0.0255	0.0337+	0.0506**	0.0254	0.0439*	0.0547**	0.0460**	0.0734***
	(4.67)	(1.35)	(1.84)	(2.67)	(1.37)	(2.51)	(3.26)	(2.69)	(4.61)
sigma2									
Constant	14.47***	55.11***	54.91***	7.423***	34.03***	37.41***	8.635***	34.47***	30.53***
	(11.88)	(12.02)	(12.01)	(11.95)	(12.02)	(11.99)	(11.96)	(11.98)	(11.88)
Observations	290	290	290	290	290	290	290	290	290
AIC	1620.4	2000.6	2000.3	1422.1	1860.8	1890.2	1466.7	1866.7	1836.8
BIC	1646.1	2026.3	2026.0	1447.8	1886.5	1915.9	1492.3	1892.4	1862.5

t statistics in parentheses
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Spatial spillovers also fare fairly well in explaining the pattern of investment. The ρ-coefficient is significant at least at 10 % level for total IC in 2004 and 2014, for road investment in 2004 and 2014, and for rail investment in all three plans. We conclude that spatial spillovers, at least when only controlling for the welfare aspects of project choice, are a significant explanation for the IC in a municipality, and that we cannot reject Hypothesis 5.

The results from testing the district demand model (Hypothesis 1, similar to Equation (20) with the spatial weight matrix included) are shown in Table 6. The coefficient of *Ln(Tax share)* is significant in most models but takes the wrong sign. We conclude that we find no support for the district demand model.

Finally, the results from testing the swing voter model with lobbying (Hypotheses 2-4, the entire model in Equation (22)), including a spatial aspect, are shown in Table 7. The two swing voter variables, *Ln(Attachment)* and *Ln(CPD)* either get insignificant coefficients at 5 % level in all nine models, or the coefficient takes the 'wrong' sign (column (7)). We thus reject hypotheses 2 and 3 and conclude that when a spatial aspect is added to the list of explanations for infrastructure investment in municipalities, neither political economic hypothesis has explanatory power with regard to the investment volume.

Table 6. The district-demand model tested with an estimator controlling for a spatially lagged dependent variable

	(1) Ln(IC) mSEK 2004-2015	(2) Ln(IC) mSEK 2010-2021	(3) Ln(IC) mSEK 2014-2025	(4) Ln(IC road) mSEK 2004-2015	(5) Ln(IC road) mSEK 2010-2021	(6) Ln(IC road) mSEK 2014-2025	(7) Ln(IC rail) mSEK 2004-2015	(8) Ln(IC rail) mSEK 2010-2021	(9) Ln(IC rail) mSEK 2014-2025
Ln(Tax share) 2002	0.945***	2.683***	1.225*	0.0656	2.096***	0.832*	1.097***	1.871***	1.048**
	(3.38)	(5.31)	(2.41)	(0.32)	(5.22)	(1.98)	(5.36)	(4.64)	(2.74)
Ind positive NPV	8.919***	4.916***	7.782***	18.32***	11.48***	11.59***	4.543***	5.000***	5.182***
	(15.51)	(4.56)	(7.05)	(40.72)	(12.52)	(12.27)	(8.85)	(4.44)	(4.09)
Ind negative NPV	7.485***	2.683*	1.524	19.68***	5.321***	3.424**	5.594***	6.321***	1.634
	(7.76)	(2.23)	(1.10)	(7.22)	(4.77)	(2.59)	(8.43)	(4.41)	(0.92)
Share rail	9.575***	8.235***	5.981***	-0.480	-0.421	-0.791	13.91***	9.393***	10.69***
	(15.93)	(7.04)	(4.37)	(-1.32)	(-0.48)	(-0.74)	(27.37)	(7.91)	(7.75)
Ln(Population	0.0231	-0.499	0.559	0.0429	-0.238	0.273	-0.0797	-0.546	0.274
density)	(0.09)	(-1.23)	(1.35)	(0.25)	(-0.73)	(0.78)	(-0.45)	(-1.56)	(0.80)
Constant	-5.017+	9.759*	-3.731	-12.70***	2.894	-7.203+	-4.889*	2.416	-6.233+
	(-1.89)	(2.10)	(-0.79)	(-6.60)	(0.79)	(-1.84)	(-2.55)	(0.65)	(-1.72)
rho									
Constant	0.0732***	0.0298	0.0358*	0.0512**	0.0340+	0.0440*	0.0579***	0.0551***	0.0785***
	(4.52)	(1.59)	(1.97)	(2.71)	(1.85)	(2.50)	(3.53)	(3.31)	(5.11)
sigma2									
Constant	13.93***	50.18***	53.80***	7.418***	31.04***	36.91***	7.842***	31.95***	29.64***
	(11.88)	(12.01)	(12.00)	(11.95)	(12.01)	(11.98)	(11.95)	(11.96)	(11.87)
Observations	290	290	290	290	290	290	290	290	290
AIC	1611.1	1975.8	1996.6	1424.0	1836.9	1888.3	1441.3	1848.1	1831.5
BIC	1640.4	2005.1	2025.9	1453.4	1866.2	1917.6	1470.6	1877.5	1860.9

t statistics in parentheses
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

Table 7. The swing voter with lobbying model tested with an estimator controlling for a spatially lagged dependent variable

	(1) Ln(IC) mSEK 2004-2015	(2) Ln(IC) mSEK 2010-2021	(3) Ln(IC) mSEK 2014-2025	(4) Ln(IC road) mSEK 2004-2015	(5) Ln(IC road) mSEK 2010-2021	(6) Ln(IC road) mSEK 2014-2025	(7) Ln(IC rail) mSEK 2004-2015	(8) Ln(IC rail) mSEK 2010-2021	(9) Ln(IC rail) mSEK 2014-2025
Ln(Party	3.179+	0.601	1.369	0.899	-1.734	-0.693	2.789*	0.641	0.475
attachment)	(1.74)	(0.26)	(0.74)	(0.71)	(-0.95)	(-0.44)	(2.18)	(0.32)	(0.30)
Ln(Cut-point	1.058	1.130	0.932	0.552	-0.581	-1.117	3.036+	0.636	0.512
density)	(0.47)	(0.50)	(0.41)	(0.35)	(-0.32)	(-0.56)	(1.95)	(0.32)	(0.26)
Firms > 500	-0.00828	0.0273	-0.0427	0.0267+	0.0279	-0.0128	0.00275	0.0351	0.0211
employees	(-0.42)	(0.87)	(-1.04)	(1.85)	(1.11)	(-0.38)	(0.19)	(1.37)	(0.65)
Ind co-financing	1.728	8.359***	9.693***	0.0220	5.600***	8.444***	3.013*	5.352***	5.691**
	(1.08)	(7.46)	(3.86)	(0.02)	(6.13)	(4.05)	(2.54)	(5.75)	(3.02)
Ln(Tax share) 2002	0.869**	1.955***	1.115*	-0.0704	1.692***	0.766+	0.945***	1.316**	0.831*
	(2.99)	(3.93)	(2.12)	(-0.33)	(4.22)	(1.78)	(4.48)	(3.20)	(2.07)
Ind positive NPV	8.907***	5.156***	7.496***	18.24***	10.89***	11.45***	4.361***	5.379***	5.171***
	(15.45)	(5.09)	(6.93)	(39.78)	(12.31)	(12.32)	(8.61)	(5.00)	(4.15)
Ind negative NPV	7.514***	3.212**	1.288	19.85***	4.888***	2.816*	5.506***	7.025***	1.318
	(7.79)	(2.85)	(0.94)	(7.22)	(4.61)	(2.16)	(8.48)	(5.09)	(0.73)
Share rail	9.467***	6.732***	6.281***	-0.508	-1.459+	-0.863	14.00***	8.158***	10.78***
	(15.63)	(6.17)	(4.66)	(-1.38)	(-1.71)	(-0.83)	(27.73)	(7.12)	(7.92)
Ln(Population	0.158	-0.482	0.562	0.105	-0.385	0.0394	-0.0422	-0.515	0.273
density)	(0.59)	(-1.14)	(1.29)	(0.57)	(-1.12)	(0.11)	(-0.22)	(-1.39)	(0.75)
Constant	-21.63	-2.750	-12.82	-19.25*	8.332	-0.465	-27.71**	-6.812	-11.54
	(-1.59)	(-0.18)	(-1.01)	(-2.04)	(0.67)	(-0.04)	(-2.93)	(-0.51)	(-1.05)
rho									
Constant	0.0675***	0.0249	0.0294	0.0525**	0.0254	0.0430*	0.0508**	0.0503**	0.0752***
	(4.03)	(1.31)	(1.54)	(2.78)	(1.36)	(2.38)	(2.98)	(2.94)	(4.65)
sigma2									
Constant	13.78***	42.12***	51.10***	7.288***	27.44***	34.76***	7.517***	28.69***	28.47***
	(11.90)	(12.02)	(12.01)	(11.94)	(12.02)	(11.98)	(11.97)	(11.97)	(11.87)
Observations	290	290	290	290	290	290	290	290	290
AIC	1614.8	1932.6	1989.0	1427.1	1808.4	1878.7	1435.8	1824.1	1827.0

BIC	1658.8	1976.7	2033.1	1471.1	1852.4	1922.8	1479.8	1868.1	1871.0

t statistics in parentheses
+ p<0.1, * p<0.05, ** p<0.01, *** p<0.001

The lobbying variables *Firms > 500 employees* and *Ind co-financing* show an interesting pattern. Thus, the only significant coefficient for the former (at 10 % level) is for road investments in 2004 – a period when co-financing does not seem to have influenced the volume of road investment. Otherwise, it is the coefficient for co-financing which is significant. All the significant coefficients take the expected positive sign. We conclude that we cannot reject Hypothesis 4.

Finally, the ρ-coefficient measuring the spatial lag in the dependent variable is significant for the total IC model (column (1) of Table 7), for IC in road in 2004 and 2014 (columns (4) and (6), and for IC in rail in all three Plans. As above, we conclude that we cannot reject Hypothesis 5.

The impact of the two control variables varies between the models. In Table 5, both *Share rail* and *Ln(Population density)* get significant coefficients in most of the models, the notable exception for *Share rail* being the model for *Ln(IC on road)*. Thus, municipalities with a larger share of rail investments out of all investments get more total investment funds and rail investment funds than municipalities with a lower share of rail investments. Municipalities with higher population density also get more investment funds. This effect disappears in Table 7, however. An explanation for this might be that population density in some way functions as a proxy for co-financing, for instance if municipalities with higher population densities are more prone to co-finance projects. Nevertheless, the two variables are not highly correlated with each other, the correlation coefficient being 0.34 in 2004, 0.25 in 2010 and 0.25 in 2014.

6 Summary and conclusions

The results in this paper indicate that the allocation of transport infrastructure funds in Sweden can be explained with three factors: the existence of a CBA, which may, but does not necessarily, indicate considerations of social welfare, the spillover effects from investment in one municipality on its neighbors, and municipality lobbying measured by the presence of co-financing. The two political economic models relating to "vote buying", namely the district demand and the swing voter models, have to be rejected, however. Hence, a municipality's tax share, the voters' strength of party attachment, and an electoral district's cut point density cannot be used to explain the investment decisions. The number of large firms in a municipality is a borderline significant explanation for road investment in only one of the Plans.

An additional variable with explanatory power is the share of rail investments out of the total stock of investments – rail investment may be preferred over road investment, but the choice of rail projects is influenced to a lesser degree by the societal benefits arising from these investments. The explanation for preferring rail over road is probably the 'warm glow' effect on politicians investing in a transport mode considered environmentally friendly.[13]

[13] Cadot et al., (2006) motivate the use of infrastructure investment as a test-bed to assess alternative hypotheses as explanations forpolitical priorities by maintaining that this type of decision is not driven by ideological aspects. They claim that this not only makes this particular class of decision fit for testing hypotheses that relate to choices made by office-motivated politicians in conjunction with probabilistic voting, but influences activities as well. Still, the results in this paper indicate that there is indeed a political dimension in prioritizing infrastructure construction.

Our results contrast somewhat with the existing literature. Thus, Knight (2004), examining the behavior of individual legislators in the US Congress, demonstrates that the district demand model fits well in explaining the allocation of transport infrastructure funds. Helland and Sørensen (2009) reject the district demand model for Norwegian data, but find support for the swing voter model. Johansson (2003), who studies intergovernmental grants in Sweden, finds support for the swing voter model. Finally, Cadot et al. (2006) find that electoral considerations and lobbying have affected the allocation of infrastructure funds in France. This variety of results not only highlights the importance of taking the institutional and cultural context of decision-making into consideration, but also indicates that different political strategies can be used within different areas of policy.

Several of the transport related references do not include measures of social welfare in their analysis. Rather than CBA results, Knight uses proxies for demand, such as the area of the Congressional district, percent of urban population and commuting time. He furthermore includes information on the percentage of firms in four different industries. Helland and Sørensen use data on income per capita, urbanization (percent), area of the region and unemployment. Finally, Cadot et al. do not seem to include any measures of more general welfare in their analysis. The models therefore cannot determine whether estimated societal benefits or political economics explain investment volume.

This study is, to our knowledge, the first to use spatial analysis to explain the allocation of infrastructure funds in municipalities or in electoral districts. Previous studies have examined the impact of investment in neighboring areas on investment in the study area, instead of explaining the need for higher investment in the study area by the benefits arising from the neighboring areas.

The only previous study to have considered co-financing as an explanation for infrastructure project choice, which we are aware of, is Jussila Hammes (2013). While both that study and this paper find empirical support for the influence of this variable on project choice in Sweden in 2010, neither builds a formal explanation for either the motives of the financiers, or why the factor may have an impact on project choice. Instead, we have to rely on conjecture.

Mellin et al. (2012) show that most of the funds used for co-financing in 2010 were either recycled state funds, or came from the municipalities concerned. Jussila Hammes (2013) argues that local authorities indeed have an incentive to co-finance a project up to the point where the (local) marginal cost of co-financing equals the (local) marginal benefit. If the probability of a project being undertaken is an increasing function of co-financing, this creates the possibility of using co-financing as a means for lobbying. Building a model that explains these incentives in a formalized manner is left for future research.

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