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ABSTRACT

The Contribution of Local Public Infrastructure to Private Productivity and its Political-Economy: Evidence from a Panel of Large German Cities

by Achim Kemmerling and Andreas Stephan

This paper proposes a simultaneous-equation approach to the estimation of the contribution of infrastructure accumulation to private production. A political economy model for the allocation of public infrastructure investment grants is formulated. Our empirical findings, using a panel of large German cities for the years 1980, 1986, and 1988, suggest that cities ruled by a council sharing the State ('Bundesland') government's current political affiliation were particularly successful in attracting infrastructure investment grants. With regard to the contribution of infrastructure accumulation to growth, we find that public capital is a significant factor in private production. Moreover, at least for the sample studied, we find that simultaneity between output and public capital is weak; thus, feedback effects from output to infrastructure are negligible.

Keywords: Local Infrastructure, Intergovernmental Grants, Productivity

JEL Classification: D72, D78, O40

ZUSAMMENFASSUNG

Der Beitrag lokaler öffentlicher Infrastruktur zur privaten Produktivität und seine politische Ökonomie: Empirische Evidenz von einem Paneldatensatz großer deutscher Städte

Dieses Papier verwendet ein simultanes Gleichungssystem zur Schätzung des Beitrags von Infrastrukturinvestitionen zu regionalem Wachstum. Ein polit-ökonomisches Modell der Al-lokation von Finanzzuweisungen für öffentliche Investitionen in Infrastruktur wird formuliert. Unsere empirischen Ergebnisse basierend auf einem Paneldatensatz für große deutsche Städte in den Jahren 1980, 1986 und 1988 deuten darauf hin, dass Städte, deren Mehrheit im Stadtrat die selbe politische `Couleur' wie die Landesregierung hatte, erfolgreicher bei der Zuteilung von Finanzzuweisungen waren. Im Hinblick auf den Beitrag der Infrastrukturakkumulation auf das Wachstum finden wir, dass öffentliches Kapital ein wichtiger Faktor für die private Produktion ist. Weiterhin, zumindest für den untersuchten Zeitraum, finden wir, dass die Si-multanität zwischen Output und öffentlichem Kapital gering ist; daher sind Feedback-Effekte von Output zur Infrastruktur vernachlässigbar.

1. Introduction

This paper examines the role of public capital in private production and provides empirical evidence on the politico-economic determinants of the allocation of public infrastructure investments. From this perspective, our study links the literature on the productivity effects of infrastructure with the literature on the political-economy of fiscal federalism.

Since Aschauer published an influential series of papers (1988, 1989a, 1989b, 1989c) about the effects of public infrastructure investment for long-run growth and productivity in the U.S. and other major countries, there has been an on-going debate about the role of public infrastructure in generating national welfare. Aschauer (1989a), for example, using a production function approach with aggregate time-series data for the U.S. from 1949 to 1985, found that the elasticity of output with respect to a broad measure of public infrastructure was significant and of a remarkable magnitude. At a time of widespread concern about the slowdown of U.S. productivity growth in the 1970s and 1980s, this finding suggested that the general decline in public infrastructure spending in the U.S. since the 1970s could at least partly explain the observed slowdown in productivity growth.

However, the magnitude of the estimated elasticity of infrastructure capital in Aschauer (1989a, 1989b, 1995) and other studies (Garcia-Milà and McGuire, 1992; Munnell, 1990a; Munnell, 1990b; Munnell, 1992; Munnell, 1993) is still a matter of discussion (for an overview, see Gramlich, 1994). The main focus of the so-called 'infrastructure' debate is on the interpretation of results and the appropriate empirical methodology (Aaron, 1990; Holtz-Eakin, 1994). For example, it is argued that the direction of causation is unclear, i.e., whether causality runs from infrastructure to output or from output to infrastructure (Tatom, 1991; Tatom, 1993). In order to address the problem of causality econometrically several studies have suggested simultaneous-equation-approaches with public infrastructure investment as an endogenous variable (e.g., Cadot et al., 1999; Duffy-Deno and Eberts, 1991; de Frutos and Pereira, 1993).

Similar to Duffy-Deno and Eberts (1991) or Crihfield and Pangebean (1995), our study estimates the contribution of public capital to private production at the local level. This approach seems to be justified by the fact that about 60 percent of public infrastructure is provided by local governments and not by the federal or state governments (Seitz, 1995).

Infrastructure investments at the municipal level in Germany usually consists of two parts: autonomous investment and matching investment grants from higher-tier governments. The increasing weight of investment grants for the realisation of local investment projects in Germany suggests to model both parts (grants and autonomous investments) separately within our simultaneous equation approach. Whereas the former is a matter of decision for the municipal councils, the latter is predominantly provided by the federal states ('Bundesländer').

The literature on the role of fiscal federalism for infrastructure policies so far has mainly discussed optimal rules for the provision of infrastructure at different levels of government (e.g., Hulten and Schwab, 1997). However, it remains an open question whether infrastructure policies are designed in reality according to such efficiency considerations. Therefore, the main contribution of our paper is that we empirically shed light on other potential determinants of infrastructure policies and test them against traditional efficiency arguments.

In this paper we adopt the approaches of Cadot et al. (1999) and Crain and Oakley (1995) in that we analyse the politics of infrastructure. What we suppose as politico-economic determinants of local infrastructure investment decisions are (i) 'pork-barrel' infrastructure policies due to the influence of firms on the allocation of investments (ii) distortions in allocation of intergovernmental infrastructure investment grants due to the political affiliation of governments at different levels or (iii) distortions in allocation of investment grants due to the strategical advantage of heavily contested constituencies ('swing voter' approach). All in all, these potential influences may give rise to outcomes of local infrastructure investment decisions that might differ substantially from an optimal allocation as a result of maximising social welfare.

With our empirical model we test these different ideas on a panel data set consisting of 87 German cities for the years 1980, 1986 and 1988. We use a simultaneous-equations approach to estimate the relationship between infrastructure investments, investment grants, local manufacturing output, policy and lobbying variables. The main findings of our analysis are (i) the contribution of local public capital to private production in cities is positive and significant (ii) political affiliation, measured by the coincidence of party colour between state and local government, is decisive in explaining the distribution of investment grants across cities (iii) cities with a prevalence of 'marginal voters' neither spend more on public infrastructure nor receive more investment grants from higher-tier governments (v) the larger the majority of government in city council the higher the local infrastructure spending (vi) investment grants do not induce higher autonomous infrastructure spending of cities, i.e. there is no evidence of a complementary relationship between matching investment grants and infrastructure spending (vii) efficiency considerations do not seem to determine the observed intergovernmental grant allocation across cities whereas redistributive concerns of higher-tier governments matter.

The remainder of this paper is organised as follows. Section 2 discusses the determinants of local infrastructure policies in Germany. Section 3 elaborates the hypotheses and presents the structure of the empirical model. Section 4 describes the empirical implementation and reports estimation results. Section 5 provides conclusions.

2. Local infrastructure policies in the context of German Fiscal Federalism

German federalism is constitutionally obliged to balance local autonomy and the uniformity of living conditions throughout the German territory. Humplick and Moini-Araghi (1996) argue that this often results in a less efficient provision of public infrastructure. As they put it 'the equity objective overrides the efficiency objective' (Humplick and Moini-Araghi, 1996: 32). These obligations of German federalism create the need for a network of horizontal and vertical bargaining institutions that coordinate the interests of the different governmental levels. Moreover, the German system of federalism differs from e.g. the U.S. system inasmuch as it fuses spheres of competence and control as well as the financing of investment. Because of this feature Germany has been called a 'unitary federal state' and the way how political bargaining is done has been characterised as 'intertwined politics' (Scharpf, 1988; Scharpf, 1999). In the following, we discuss the mechanism of fiscal transfers and its concomitant political bargaining process for the case of local infrastructure investments.

The resources for infrastructure investments in Germany usually consist of mixed financing between two or more levels of German government. There are two different financial sources for infrastructure investments: autonomous investments by municipalities, and investment grants provided by other institutions, the central government ('Bund'), the states ('Bundesländer'), the ERP, or horizontal fiscal exchange mechanisms. However, the overwhelming part of these funds are administered by the state governments. The latter usually allocate funds to local communities, monitor the implementation process and, where necessary, report to the central government or the ERP.[1] This justifies, in our view, to concentrate on the politico-economic process of allocating infrastructure investment that takes place between state and local governments and ignore other levels of fiscal federalism in Germany.

The majority of investment grants from states to municipalities takes the form of matching funds. Nevertheless, fixed matching ratios between state level grants and local investments are rarely found, as a result of planning problems and changing investment costs (Statistisches Bundesamt, 1986).

The procedure of starting a new infrastructure investment project is a complex arrangement between the local government, which makes proposal in the first stage of the project planning, and the federal state administration that grants an investment subsidy. Because of the growing fiscal tension in the local budgets (e.g. Pohlan, 1997), the role of investment subsidies in Germany has risen throughout the 1980s.[2]

The ratio between investment subsidies from various levels of higher-tier governments and total local investment in transport infrastructure rose from around 24 per cent in 1980 to 46 per cent in 1988. The municipalities' dependency on investment grants also makes it difficult for them to plan investment projects autonomously. One reason for this is the overall increase of insecurity in the planning process, as local decision-makers cannot anticipate the correct amount of future transfer payments (Statistisches Bundesamt, 1986: 913).

From a normative perspective, conditional mixed financing of local infrastructure project is usually justified as a means of internalising positive externalities ('spillovers') from infrastructure projects (e.g., Oates, 1999). On the other hand, the political cost of mixed financing of infrastructure projects is that local political autonomy is undermined. An example might illustrate this point: Schmals and Siewert (1982) elaborate a case study about public transportation in Munich in the 1970s.

Two alternative plans to improve public transportation existed. The first plan proposed the construction of a network of underground railways to alleviate inner-city traffic. The majority of city council members favoured this project. The construction and improvement of a municipal railway system, the second proposal, was backed by the Bavarian government. Because the Bavarian state government linked an investment grant with the realisation of the second project, the city council had to give in. Thus, in this case investment grant prospects had a decisive impact on the bargaining power between the two governmental levels.

The amount of investment subsidies granted to local infrastructure projects formally depends on external factors e.g. as length of the existing road infrastructure, expected impacts on the local economy, environmental effects, etc. But as Garlichs (1986) shows for the case of infrastructure funds for highways, the actual amount of money is a matter of intense bargaining between all lower level governments and the higher level. An iron quotas system, which in German politics is frequently the result of bargaining processes or of even legally settled principles such as unanimity, is likely to create further distortions for both efficiency and equity targets.

In our political-economy framework we explicitly test a set of political variables that might influence the allocation of investment subsidies. Given the complexity of the German federal system we are going to test several distinct sets of hypotheses that might explain the simultaneous development of both autonomous investments and grants. This makes it necessary to treat some of the variables as exogeneous – e.g. demand measures such as the number of cars or the amount of tax revenues – but narrows the research question down to the triple of efficiency, equity and political economy arguments of local infrastructure investments in Germany.

3. Hypotheses and structure of the model

Our simultaneous equation model is based on 3 equations, which we label as (i) production function $Q_{it} = f()$, (ii) infrastructure investment function $INV_{it} = f()$ and (iii) grant allocation function $GRANT_{it} = f()$.

3.1. Production function

To begin with the specification of the production function, we assume that production Q_{it} of the manufacturing sector can be described as

$$Q_{it} = f(t, K_{it}, L_{it}, G_{it}), \qquad i = 1 \dots N, \qquad t = 1 \dots T, \tag{1}$$

where t denotes time, Q_{it} output, K_{it} private capital, L_{it} labour input and G_{it} denotes the infrastructure stock in city i. In addition, city i's infrastructure stock G_{it} is defined as

$$G_{it} = (1 - \gamma)G_{i,t-1} + INV_{it} + GRANT_{it}, \tag{2}$$

where γ denotes the depreciation rate of public capital, INV_{it} denotes infrastructure investment, and $GRANT_{it}$ denotes infrastructure investment grants given to city i from higher-tier governments. Therefore, total infrastructure investment in city i is defined as $INV_{it} + GRANT_{it}$.

Assuming a Cobb-Douglas functional form for the manufacturing sector's production function in city i at time t we get

$$Q_{it} = A_0 \exp(\alpha_t t)\, L_{it}^{\alpha_L} K_{it}^{\alpha_K} G_{it}^{\alpha_G}, \tag{3}$$

where α_X denotes the elasticity of output Q with respect to input X, and $X \in \{L, K, G\}$. Dividing by L_{it}, (3) becomes

$$q_{it} = A_0 \exp(\alpha_t t)\, k_{it}^{\alpha_K} g_{it}^{\alpha_G} L_{it}^{\tilde{\alpha}_L}, \tag{4}$$

where lower-case capitals denote variables in terms of the labour input L and $\tilde{\alpha}_L$ is defined as $\tilde{\alpha}_L = \alpha_L + \alpha_K + \alpha_G - 1$.

Note that $\tilde{\alpha}_L$ will equal zero if returns to scale are constant with respect to *all* inputs, i.e., L, K and G; and $\tilde{\alpha}_L - \alpha_G$ will equal zero if returns to scale are constant with respect to private inputs L and K.

3.2. Infrastructure investment function

The increasing importance of investment grants for the realisation of infrastructure projects suggests to model both parts (grants and autonomous investments) separately within our simultaneous equation approach. Accordingly, to describe the simultaneous determination of investments and grants properly, our model is based on two additional equations besides the local production function: one which describes autonomous investment decisions of the cities and one which describes the level of investment grants the cities receive from higher-tier governments. Furthermore, autonomous investments enter the grants equation and, vice versa, grants enter the investment equation.

Our hypotheses regarding the determinants of a city's autonomous infrastructure spending can be summarised as follows. The first hypothesis we are able to test with our model is about the relationship between grants and autonomous investments. Though the majority of grants a city in Germany receives are matching funds, it nevertheless is an open question whether these matching grants have a complementary, substitutive or neutral relation to the autonomously financed infrastructure investments of cities.

The reason is that even in the case of matching grants, the relationship between grants and investment is not necessarily positive and therefore complementary, since the local government can reduce its own efforts on financing infrastructure projects by taking into account the amount of grants it will receive for a project from higher-tier governments.

Accordingly, grants and autonomous infrastructure spending are only complementary if grants do not lead to a reduction of financing efforts by local governments. Therefore, if the relationship between grants and investments is complementary, a local government which receives grants will *autonomously* finance more infrastructure projects than a government which does not receive any grants.

On the other hand, if local governments plan their infrastructure projects irrespective on the amount of future matching grants, then the relationship between autonomous spending and grants can be labelled as neutral. This implies that the local government will neither reduce nor increase its own financing efforts when anticipating the matching grants it receives. Consequently, the local government's own financing efforts are independent of the amount of matching grants.

The second hypothesis we test with our framework is that local infrastructure spending should also reflect the preferences of a city's residents. For instance, cities with a relatively large number of cars are likely to spend more on transport infrastructure.

The third hypothesis we test is whether a local government's spending on infrastructure is more responsive to increases in intergovernmental grant receipts than it is to increases in the city's own tax revenues. The usual finding of various previous studies on this topic, that local government's spending is more responsive to intergovernmental grant receipts, has been dubbed in literature as the 'flypaper effect' – money sticks where it hits (e.g. Oates, 1999; Oulasvirta, 1997).

Moreover, following an idea proposed by Cadot et al. (1999), we test the hypothesis that the number of manufacturing firms is decisive for local infrastructure spending. The main motivation for this presumption is that particularly manufacturing firms have sunk investments and therefore a vested interest in the quality and maintenance of the infrastructure where their production is located. Local politicians—on the other hand—are assumed to be sensitive to the lobbying efforts by business, for instance in anticipation of potential campaign contributions from firms, or in anticipation of the expected loss of trade tax revenues and/or employment opportunities for their city if firms move to another location.

The fifth hypothesis regarding determinants of local infrastructure investment is the role of the stability of the government majority in the city council. If local governments want to buy the support of the local swing voters, one would expect that the smaller its majority in the city council the larger its spending on local infrastructure projects.

Finally, the sixth hypothesis we test is the presumption that local governments might take the expected productivity effects of infrastructure spending on the local industry into account. Because of this, if local politicians indeed care about the efficiency of infrastructure projects we would observe a positive effect from the expected productivity effect of these infrastructure projects on actual the amount of infrastructure spending. Hence if the expected productivity effect is higher in a given city, spending of the local government should be higher as well.

3.3. Grant allocation function

The first hypothesis we can test with our model is the empirical relevance of the traditional main topic on intergovernmental grant allocation, i.e. the question of whether or not grant allocation polices are based on efficiency and/or equity criteria. Accordingly, we include in our model both a measure for expected productivity effects from infrastructure projects (efficiency) as well as income as a measure for redistributive concerns (equity).

However, a recent strand of literature discusses alternative politico-economic influences on intergovernmental grant distribution (e.g. Worthington and Dollery, 1998). For instance, Grossman (1994) hypothesizes that the distribution of grants is driven by the self-interest of grant-givers. The assumption is that politicians from higher-level governments are likely to allocate grants for the purpose of enhancing their reelection chances. In the words of Grossman, higher governmental level politicians uses grants to 'purchase political capital' to be used to influence the voting decisions of the local residents.

Accordingly, the second hypothesis we test with our model is that party affiliation between higher and lower-tier governments matters for the outcome of grant allocation. Grossman (1994) states that the political capital is of higher value to grant-givers if the party affiliation with grant-receivers is the same. However, in the specific case of German cities, our interpretation why party affiliation matters for grant-givers is that the identity of political colour shortcuts the bargaining process between lower and higher-tier governments because it lowers the lobbying cost for a city government if it has established party contacts to the state government. In short party affiliation favours certain municipalities by means of party loyalty.

Recently, it has also been suggested in the literature that grants are used as tactical (electoral politics) instruments for buying support of marginal voters ('swing voter' approach, e.g. Dixit and Londregan, 1998; Johansson, 1999). Using this framework, the third hypothesis we test is that cities will receive more grants if they are politically powerful, i.e. if there is a large number of voters who are indifferent between the two parties and therefore potentially could be influenced by pork barrel politics. Following Johansson we proxy political powerfulness as closeness between the major two blocs, Social Democrats (SPD) and Christian Democratic Union (CDU), in the last election for the city council. Hence, we expect that if there is evidence of political powerfulness as a determinant for the distribution of grants, the closer the last election results between the two major blocs, the larger the amount of grants a city receives from higher-tier governments.

Finally, the fourth hypothesis we test is that the number of manufacturing firms is decisive for grant-givers when allocating grants across regions. The reason is

Table I. Variable Description and Cities

Variable	Description
Q	Value added, manufacturing sector, million 1980 DM
L	Hours worked in manufacturing sector, million hours
K	Capital stock in manufacturing, million 1980 DM (from Deitmar, 1993)
G	Public infrastructure stock, million 1980 DM, (from Seitz, 1995)
INV	Public infrastructure investment, million 1980 DM
$GRANT$	Infrastructure investment grants, million 1980 DM
$DEBT$	Total debt of city, million 1980 DM
TAX	Trade tax ('Gewerbesteuer') revenues of city i, million 1980 DM
$CARS$	Number of registered motor verhicles (business and private)
$NFIRMS$	Number of manufacturing firms in city i
$DMIN$	Dummy variable equal to 1 when mining industry is present in city i
$PARTISAN$	Percentage of members in city council with the same political affiliation as the federal state ('Bundesland') government
$MAJORITY$	Percentage difference of the 2 large parties SPD (Social Democrats) and CDU (Christian Democratic Union) in last city council election, values rank transformed from 1 (largest) to 261 (smallest difference)

again the expectation that also higher-tier governments are sensitive to business interests. If business interests do indeed matter for the outcome of infrastructure policies, then a priori it is not clear at which level of government lobbying by firms or business associations takes place. For this reason, the number of manufacturing firms is included both in the investment and the grant allocation function.

4. Empirical implementation

4.1. Data

We use a panel data set consisting of 87 German cities and three years (1980, 1986, 1988). Table 4.1 provides a brief overview of the variables used in the analysis.

Most of the data is taken from the 'Statistical Yearbook of German Cities and Municipalities'.[3] For reasons of data availability, only 87 large cities are included in

Table II. Cities in Panel

Cities in Panel		
1 Aachen	30 Hamm	59 Neustadt/Weinstraße
2 Amberg	31 Hannover	60 Nürnberg
3 Ansbach	32 Heidelberg	61 Oberhausen
4 Aschaffenburg	33 Heilbronn	62 Offenbach/Main
5 Augsburg	34 Herne	63 Oldenburg
6 Baden-Baden	35 Hof	64 Osnabrück
7 Bamberg	36 Ingolstadt	65 Passau
8 Bayreuth	37 Kaiserslautern	66 Pforzheim
9 Bielefeld	38 Karlsruhe	67 Pirmasens
10 Bochum	39 Kassel	68 Regensburg
11 Bonn	40 Kaufbeuren	69 Remscheid
12 Bottrop	41 Kempten/Allgäu	70 Rosenheim
13 Braunschweig	42 Kiel	71 Saarbrücken
14 Coburg	43 Koblenz	72 Salzgitter
15 Darmstadt	44 Köln	73 Schwabach
16 Delmenhorst	45 Krefeld	74 Schweinfurt
17 Dortmund	46 Landau/Pfalz	75 Solingen
18 Duisburg	47 Landshut	76 Speyer
19 Düsseldorf	48 Leverkusen	77 Straubing
20 Erlangen	49 Lübeck	78 Stuttgart
21 Essen	50 Ludwigshafen	79 Trier
22 Flensburg	51 Mainz	80 Ulm
23 Frankenthal/Pfalz	52 Mannheim	81 Weiden/Oberpfalz
24 Frankfurt/Main	53 Memmingen	82 Wiesbaden
25 Freiburg/Breisgau	54 Mönchengladbach	83 Wilhelmshaven
26 Fürth	55 Mülheim/Ruhr	84 Worms
27 Gelsenkirchen	56 München	85 Wuppertal
28 Göttingen	57 Münster/Westfalen	86 Würzburg
29 Hagen	58 Neumünster	87 Zweibrücken

the sample. All of these cities are predominantly self-administered (autonomous) at the local level ('kreisfreie Städte'). Thus, these cities are highly comparable from a perspective of fiscal federalism. Table 3 displays the names of cities in our sample.

Output (Q), measured as gross value added of a city's manufacturing sector,[4] is taken from a joint publication of several German federal states' statistical offices.[5] These data are not available for each year, so that our sample is restricted to three years, 1980, 1986, and 1988.

The private capital stock (K) of the manufacturing sector is taken from Deitmar (1993). It is measured in 1980 prices and has been corrected for the territorial reforms that occurred in the 1970s in Germany.[6] The infrastructure capital stock (G), which includes investments both for construction and equipment, is taken from Seitz (1994) and is also measured in 1980 prices. Transport infrastructure is the largest part (about 30 percent) of local infrastructure investments (Bach et al., 1994).

Annual investment in infrastructure (INV) has been obtained from the statistical yearbook mentioned above. From the same source we also have the following variables: labour input (L), operationalised by the number of working hours in the manufacturing sector; special grant-in-aid ('Finanzzuweisungen') for investments ($GRANT$) from 'Bundesländer', 'Bund' or ERP; several measures of the financial situation of a city like the cumulated debt ($DEBT$) or trade taxes revenues (TAX) which are levied at the local level of cities, the number of (four-wheel) motor vehicles (private and business) ($CARS$), and the number of manufacturing firms ($NFIRMS$) in a city.

Furthermore, we constructed a political variable denoted as $PARTISAN$ to measure the congruence between the local city government and the state ('Bundesland') government. It gives the percentage of seats in the city council with the same political affiliation as the 'Bundesland' government where the city is located. All cities had at least one city council election during the period 1980 to 1987, some cities had also 2 city council elections in this period.

In a first step, the variable $MAJORITY$ was constructed as percentage difference of the 2 major parties, which are the parties SPD and CDU in Germany, from the results of last city council election. In a second step, in order to smooth the highly skewed distribution of this variable and also to make it less correlated with the variable $PARTISAN$ [7], a simple monotonic rank transformation has been performed which assigns the variable $MAJORITY$ rank numbers from 1 for the observation with the smallest difference in majority to number 261 for the observation with the largest.

Table 7 displays descriptive statistics of the variables. Note, for instance that grants are on average about one-third of autonomous investments. Annual infrastructure investment undertaken by cities is on average about 3.8 percent of the existing infrastructure capital stock. The mining industry is present in about 13

Table III. Descriptive Statistics of Variables

Variable	Mean	Std.Dev.	C.V.	Minimum	Maximum
Q	2099.1	2500.3	119.1	144.3	15718.8
G	2468.8	2834.5	114.8	302.5	18176.1
K	4087.7	5007.6	122.5	252.0	25714.9
L	30.74	29.08	94.6	2.4	168.2
INV	93.6	123.8	132.3	8.1	1040.4
$GRANT$	32.8	44.7	136.3	0.8	266.1
$DEBT$	407.9	509.1	124.8	14.3	3066.7
TAX	135.6	210.4	155.2	7.1	1314.6
$CARS$	88921	91046	102.4	14845	635888
$NFIRMS$	124.0	101.1	81.5	21	637
$DMINING$	0.126	0.333	263.4	0	1
$PARTISAN$	45.9	8.0	17.5	29.0	68.2
$MAJORITY$	131	75.5	57.6	1	258.5
Total number of observations: 261					

percent of cities in our sample. The partisan variable is on average 45.9 percent, with a minimum of 29.0 and a maximum of 68.2 percent.

Our simultaneous model is based on the following 3 equations for city i, $i = 1, \ldots, N,$ in year t, $t = 1980, 1986, 1988$.

Production function (5)

$$\begin{aligned} \ln Q_{it}/L_{it} &= \alpha_0 + \alpha_{BL} + \alpha_t \ (+) \ \alpha_{\mathrm{G}} \ln((G_{i,t-1} + INV_{it} + GRANT_{it})/L_{it}) \\ &\quad (+) \ \alpha_{\mathrm{K}} \ln(K_{it}/L_{it}) + \tilde{\alpha}_{\mathrm{L}} \ln(L_{it}) + \alpha_{\mathrm{MINING}} DMIN_i + u_{1it}, \end{aligned}$$

Local autonomous investment function (6)

$$\begin{aligned} INV_{it}/L_{it} &= \beta_0 + \beta_{BL} + \beta_t + \beta_{\mathrm{GRANT}} GRANT_{it}/L_{it} + \beta_{\mathrm{NFIRMS}} NFIRMS_{it} \\ &\quad (+) \ \beta_{\mathrm{MAJOR}} MAJORITY_{it} \ (+) \ \beta_{\mathrm{CARS/L}} CARS_{it}/L_{it} \\ &\quad + \beta_{\mathrm{G/L}} G_{i,t-1}/L_{it} (+) \beta_{\mathrm{PROD}} \alpha_{\mathrm{G}} Q_{it}/G_{i,t-1} \ (-) \ \beta_{\mathrm{DEBT/L}} DEBT_{it}/L_{it} \\ &\quad (+) \ \beta_{\mathrm{TAX/L}} TAX_{it}/L_{it} + \beta_{\mathrm{INCOME}} Q_{it}/L_{it} + \beta_{\mathrm{MINING}} DMIN_i + u_{2it}, \end{aligned}$$

Grant allocation function (7)

$$\begin{aligned} GRANT_{it}/L_{it} &= \gamma_0 + \gamma_{BL} + \gamma_t + \gamma_{\mathrm{INV/L}} INV_{it}/L_{it} \ (+) \ \gamma_{\mathrm{SWINGV}} MAJORITY_{it} \\ &\quad (+) \ \gamma_{\mathrm{PARTISAN}} PARTISAN_{it} \ (-) \ \gamma_{\mathrm{REDISTRIB}} Q_{it}/L_{it} \\ &\quad (-) \ \beta_{\mathrm{G/L}} G_{i,t-1}/L_{it} \ (+) \ \gamma_{\mathrm{PROD}} \alpha_{\mathrm{G}} Q_{it}/G_{i,t-1} \\ &\quad (+) \ \gamma_{\mathrm{NFIRMS}} NFIRMS_{it} + \gamma_{\mathrm{MINING}} DMIN_i + u_{3it}. \end{aligned}$$

Equation (5) refers to the production function of the manufacturing sector in city i described in section 3.1. Equation (6) is derived from the hypothesis discussed in section 3.2 and describes the autonomous infrastructure investments undertaken by city i. Equation (7) corresponds to the hypotheses discussed in section 3.3 and describes investment grants from higher-tier governments which city i receives. We add a dummy variable $DMIN$ to all equations indicating whether or not the mining industry is present in city. If a coefficient has an expected sign it is displayed in parentheses.

From the Cobb-Douglas production function, marginal productivity of infrastructure capital is defined as $\partial Q_{it}/\partial G_{it} = \alpha_G Q_{it}/G_{it}$. We include this measure of the expected productivity effects of infrastructure both in the investment and the grant allocation function. Since G_{it} also contains current investment INV_{it}, we replaced it with its lagged value $G_{i,t-1}$.

Parameters α_{BL}, β_{BL} and γ_{BL}, $BL = 1, \ldots, 8$, refer to fixed effects for the states ('Bundesländer') and α_t, β_t and γ_t, $t = 1, 2, 3$, refer to fixed effects for years.

For disturbances we assume a one-way error-component model with $u_{kit} = \mu_{ki} + v_{kit}$ for equation $k = 1, 2, 3$, where $\mu_{ki} \backsim IID(0, \sigma^2_{k\mu})$ reflects random individual effects of cities and $v_{kit} \backsim IID(0, \sigma^2_{kv})$ residual errors (Krishnakumar, 1995).

4.2. Results

The results of the estimations are presented in Table 7. Unobserved heterogeneity of cities is modelled as random error components (EC) for each equation. By modelling the individual effects as random, it is possible to add fixed effects for states and mining industry to the equations.[8] In addition, the endogeneity of Q_{it}, INV_{it} and $GRANT_{it}$ as right-hand side variables as well as the correlation of errors across equations is taken into account by using Full-Maximum-Likelihood (FIML) for the estimation of the simultaneous system.

Column 1 of Table 7 reports the results for the single equation estimation with Error Components Generalised Least Squares (EC GLS) (e.g., Baltagi, 1995). Columns 2 and 3 contain the results of simultaneous system estimations with Error Components FIML.[9] The specification of column 3 differ from column 2 in that $NFIRMS$ is

Table IV. Estimation Results

Nonlinear	**EC GLS**(a)		**EC FIML**(b)		**EC FIML**(b)	
Production function: $\ln(Q/L)_{it}$						
α_{BL}	Fixed effects***		Fixed effects***		Fixed effects***	
α_t	Fixed effects		Fixed effects**		Fixed effects**	
α_0	0.784	(3.06)	0.828	(4.58)	0.829	(4.59)
α_G	0.169	(3.23)	0.170	(4.63)	0.169	(4.60)
α_K	0.569	(10.68)	0.555	(14.91)	0.558	(14.95)
$\tilde{\alpha}_L$	0.044	(1.55)	0.045	(2.25)	0.043	(2.16)
α_{MINING}	-0.497	(-7.12)	-0.494	(-10.01)	-0.495	(-10.01)
$R^{2(c)}$	0.814		0.811		0.814	
Infrastructure investment function: $(INV/L)_{it}$						
β_{BL}	Fixed effects***		Fixed effects***		Fixed effects***	
β_t	Fixed effects***		Fixed effects***		Fixed effects***	
β_0	-10.77	(-4.40)	-9.77	(-5.10)	-10.88	(-5.25)
$\beta_{GRANT/L}$	0.530	(5.38)	-0.344	(-0.58)	-0.422	(-0.96)
β_{NFIRMS}	-0.262	(-0.38)	0.223	(0.37)	—	(—)
β_{MAJOR}	-0.002	(-2.00)	-0.004	(-2.60)	-0.004	(-4.27)
$\beta_{CARS/L}$	1.646	(5.36)	1.594	(6.67)	1.733	(6.52)
$\beta_{G/L}$	0.014	(4.01)	0.025	(3.41)	0.025	(4.43)
$\beta^{(d)}_{PROD}$	3.081	(1.81)	2.252	(1.80)	2.475	(1.94)
$\beta_{DEBT/L}$	-0.048	(-4.04)	-0.046	(-5.11)	-0.047	(-4.91)
$\beta_{TAX/L}$	0.025	(1.67)	0.026	(2.34)	0.029	(2.42)
β_{INCOME}	-6.199	(-1.76)	-12.31	(-3.34)	-12.80	(-3.73)
β_{MINING}	-1.643	(-7.29)	-1.61	(-7.86)	-1.55	(-7.00)
$R^{2(c)}$	0.811		0.753		0.743	
Grant allocation function: $(GRANT/L)_{it}$						
γ_{BL}	Fixed effects***		Fixed effects***		Fixed effects***	
γ_t	Fixed effects		Fixed effects*		Fixed effects*	
γ_0	-0.709	(-1.62)	-0.247	(-0.66)	-1.047	(-3.44)
$\gamma_{INV/L}$	0.171	(5.24)	0.018	(0.27)	0.133	(2.23)
γ_{SWINGV}	-0.001	(-2.30)	-0.002	(-3.83)	—	(—)
$\gamma_{PARTISAN}$	0.014	(2.34)	0.013	(2.91)	0.020	(5.13)
$\gamma_{REDISTRIB}$	-3.758	(-1.95)	-4.707	(-2.97)	-5.321	(-3.52)
$\gamma_{G/L}$	0.009	(6.25)	0.013	(7.29)	0.011	(6.73)
$\gamma^{(d)}_{PROD}$	0.236	(0.33)	-0.121	(-0.22)	0.317	(0.61)
$\gamma^{(d)}_{NFIRMS}$	0.498	(1.25)	0.388	(1.28)	0.273	(0.97)
γ_{MINING}	0.293	(2.00)	0.064	(0.46)	0.281	(2.28)
$R^{2(c)}$	0.738		0.715		0.730	

Notes: t-values in parentheses, ***10 %, **5 %, *** 1 % significant.
EC=Error Components Model, (a) Single Equation, (b) Simultaneous System.
(c) Based on GLS residuals, not bounded [0,1],(d) [10^{-3}].

excluded from the investment equation and $MAJORITY$ is excluded from the grant equation.

Overall, the fit of the 3 equations is remarkable high with R^2 ranging between 0.71 and 0.81. Turning first to the results for the production function, we find that local public capital is a productive input for local manufacturing. The estimated coefficient which is the elasticity of output with respect to infrastructure is positive and statistically significant with a value of about 0.17. This coefficient is remarkably stable with respect to the different estimation methods and specifications. As the estimates for the infrastructure coefficient do not vary much between single equation and simultaneous equation estimation, the econometric evidence for an endogeneity of infrastructure capital in the production function is weak. This can be attributed to the fact that infrastructure investment is relatively small compared to the infrastructure stock, thus replacing investment with predicted values from instrumental variables therefore has only a small impact on the estimated parameter for G_{it}. The ratio of output to public infrastructure stock is on average about 0.95, which implies a rate of return of infrastructure of about 16 percent.

In addition, private capital is significant with a value of about 0.55. The ratio of output to private capital stock is on average about 0.6, which implies a rate of return of private manufacturing capital of about 33 percent. From the value of t-statistic for labour input L, it can be infered that for the single-equation estimation, constant returns are not rejected at a 10 percent level, whereas for the simultaneous equation estimations constant returns to scale are rejected at a 5 percent level. Cities where mining industry is located have a lower expected output.

Turning second to the results for the infrastructure investment function, we find that from the positive and significant coefficient for $GRANT/L$ in the first column it appears as if grants and local public investments are *complementary*, i.e. grants stimulate further infrastructure projects. However, if the endogeneity of grants is taken into account by applying simultaneous system estimation methods, it turns out that the relationship between grants and local public investments appear to be *neutral*. Thus, the receipt of future grants is not taken into account by local governments when fixing their amount of autonomous spending. Assessing this result, the 'good news' is that cities do not reduce their own efforts in anticipating the receipt of future matching grants from higher-tier governments. The 'bad news' from this result is that cities do not increase their own spending efforts even with the prospect of matching grants for infrastructure projects. Thus, the incentive created by grants for expanding cities' own infrastructure investments is rather low.

With regard to the second hypothesis that local infrastructure spending should also reflect preferences and demand of cities' residents and business, we find that the coefficient of $CARS/L$, which is measured as number of (four-wheel) motor vehicles (business and private) per labour, is positive and highly significant. Thus, cities with a high intensity of cars do indeed invest more in infrastructure.

Turning to the economic factors that might determine a city's infrastructure spending, we find that the higher the debt ($DEBT/L$) of a city, the lower its infrastructure spending. This corroborates our initial presumption that the financial room to manoeuvre is decisive for local infrastructure investments. On the other hand, local infrastructure spending is higher the higher the trade tax revenues of a city. Thus, in our case there is no evidence of the 'flypaper' effect described above.

Furthermore, we find that labour productivity (Q/L) from the manufacturing sector is negatively related to infrastructure spending. Thus, cities where labour productivity of manufacturing is lower spend more on infrastructure. This evidence turns out to be even stronger if the endogeneity of output Q and $GRANTS$ is taken into account in columns 2 and 3. At a first glance, this finding suggests some kind of catching-up in infrastructure spending of economically underdeveloped cities. We also conclude from this finding that the argument of reverse causality, meaning in our case that more prosperous cities are likely to spend more on infrastructure, is empirically not supported.

However, we also find that the coefficient for infrastructure endowment (G/L) is positive and significant. This does not support the expectation of catching-up of economically weak cities, because cities which already have a good infrastructure endowment spend more than cities with a poor infrastructure endowment. Hence, at least for our sample, no convergence of cities' infrastructure endowments can be expected in the long-run.

In addition, expected productivity effects from infrastructure (β_{PROD}) appear to matter for local investments. However, the statistical reliability of this result is relatively weak at a 10 percent significance level.

Finally, turning to the political-economy determinants of infrastructure investment we find that the number of manufacturing firms (β_{NFIRMS}) is not decisive for local infrastructure spending. However, this result should not be interpreted as evidence of non-existence of lobbying efforts of business at the local level.[10] The reason is the difficulty to find plausible and observable measures for the lobbying efforts of firms. For instance, it can be argued that the number of manufacturing firms is not an adequate proxy for potential lobbying strength of business, since one dominating big firm might have a stronger influence on policy decisions than many small firms. For this reason, we also tried a dummy variable in our regressions indicating whether one or more headquarters of large stock companies are located in a city. However, this alternative measure of potential lobbying power turned out to be insignificant as well.

On the other hand, we find that the size of government majority of the government in the city council is decisive for infrastructure spending. However, since the coefficient β_{MAJOR} is negative, it implies that spending is higher the bigger the majority of the local government. As a consequence, this evidence does not support the hypothesis that local governments spend more on infrastructure if the majority is more unstable. One explanation for the positive coefficient β_{MAJOR} is that controversial infrastructure projects are likely to be prevented by the opposition in city council if the majority of the government is small. Furthermore, the larger $MAJORITY$ the less likely it is that a city's government is formed on the basis of a party coalition.

A similar finding holds also for the grant equation. The coefficient γ_{SWINGV} is negative and significant but as before, for the support of the swing voter hypothesis a positive coefficient is expected. This result means that cities where the majority of local government is small (i.e. more unstable) receive less grants whereas the swing voter hypothesis predicts that these cities will receive more grants in order to buy the support of swing voters. Thus, the negative coefficient for γ_{SWINGV} corresponds to the findings for β_{MAJOR} in the investment equation that cities where the government majority is more stable spend more on infrastructure and receive more grants.

Moreover, the estimate for the partisan variable ($PARTISAN$) is significant, which means that the expected level of grants is higher the larger the correspondence of political affiliation between the local city council and the state ('Bundesland') government. At the mean data points, one percentage point increase in political affiliation correspondence between the city and the state government gives on average 1.25 percent more investment grants. This is a considerable amount with regard to the fact that political affiliation in our sample varies from 29.0 to 68.2 percent. This finding is as an indication that self-interests of grant-givers do indeed matter for the allocation of grants. Local governments which have a higher 'political capital' (in terms of votes) to sell, are rewarded 'with a larger slice of the cake'. Thus, party affiliation of government is used as a shortcut for ideology, which allows politicians to target grants to those cities with the highest payoff.

Turning to the determinants of grant distribution that are not tactically but benevolently motivated, the negative and significant coefficient $\gamma_{\text{REDISTRIB}}$ indicates that redistributive concerns are important. Hence, the lower the labour productivity (Q/L) of manufacturing in a city (i.e. the more economically underdeveloped it is) the more grants it gets. On the other hand in contrast to what is expected, cities which already have a good endowment with infrastructure (i.e. a high infrastructure intensity G/L) get more grants. If infrastructure intensity G/L is also related to the economic development of a city, we would expect a negative sign.

Expected productivity effects (γ_{PROD}) of infrastructure investment appear not to matter for the allocation of investment grants. This can be explained by the fact that because investment grant decisions of state governments in Germany are based on consensus with all local level governments, this approach is prone to produce decisions that carefully skirt all areas of conflict. In terms of economic efficiency, the bargaining process will often lead to outcomes which are from a welfare perspective not optimal, so there is no guarantee that the money is being put to its most productive use.

Finally, for the specification in column 3 of Table 7 we find that investments have a positive impact on grants. The question arises whether this contradicts the finding for the investment function where no effect of grants on investments is found. Our explanation for this evidence is that local governments on the one hand are not responsive to changes in the amount of grants from higher-tier governments when fixing their level of autonomous investment spending, but higher-tier governments on the other hand are responsive to increased autonomous investment spending. This probably simply reflects the fact that the relation between local investments and matching grants is relatively fixed, i.e. if autonomous spending increases, grants increase as well. The underlying mechanism is that autonomous investments determine the amount of grants, but grants do not determine the amount of autonomous investment spending. In addition, it is also interesting to note that the coefficient $\gamma_{INV/L}$ with a value of 0.133 is significantly lower than one could expect from the average relation between matching grants and investments in our sample of 0.333. Once other factors that explain the distribution of grants are taken into account, the coefficient of investments decreases significantly. Finally, cities where mining industry is present spend less on infrastructure investment but receive on average more grants.

5. Summary and Conclusions

In this study we estimated a system of equations comprising a production function, an infrastructure investment function and an investment grant function using a panel data set of large German cities. Overall, our empirical results highlight the significance of political factors both for local infrastructure spending and for the intergovernmental distribution of grants.

Several key empirical findings emerge from our analysis (i) public capital is a significant input for local production (ii) cities where the city council's majority has the same political affiliation as the state ('Bundesland') government receive more grants (iii) cities where 'marginal voters' are decisive for the outcome of city council elections neither spend more on public infrastructure nor receive more investment grants from higher level governments, but the larger the government majority the higher the spending (iv) redistributive concerns of higher-tier governments matter for the allocation of grants, whereas efficiency considerations (i.e. putting the money to its most productive use) appear to be less important.

From a normative perspective our findings support the view that pork barrel politics are indeed important determinants for intergovernmental grant allocation which might give rise to policy outcomes that depart substantially from optimal policies that maximise social welfare.

Since politics is an important factor for the allocation of infrastructure investments, a few tentative conclusions about the peculiarities of German fiscal federalism arise. Firstly, in comparison with both France (Cadot et al., 1999) and the U.S. (Grossman, 1994) the political influence of interest groups is less visible in Germany.

Current models of political economy seem to have both theoretical and empirical shortcomings in explaining the German case. Secondly, the fact that inspite of empirical evidence for equity targets there seems to be no trend toward long-term convergence suggests a trade-off in the institutional system between the consensus principle on the one hand, and the constitutional commitment toward uniformity of living conditions. Furthermore, the fact that the swing voter prediction performs rather poorly in our empirical model whereas party affiliation has some explanatory power may imply that grants are more of a means of state governments to reward their political constituencies than a tactical instrument to gain elections in heavily contested areas. This is corroborated by the positive relationship between stability of local governments and the amount of grants they receive.

Finally, many studies on the productivity effects of public capital have treated infrastructure as an exogenous factor of production and neglected the politico-economic factors that shape infrastructure policy. However, the good news from our study is that evidence of an endogeneity bias of infrastructure capital estimates in a production function framework as well as evidence of reverse causality running from output to infrastructure investments is weak.

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Notes

[1] A good point in case are the so-called GVFG-funds of the central government. Although the central government formally exercises the task of allocating resources to projects, over 80 percent of the allocation is decided by the federal states. The latter are also in charge of the implementation and monitoring of projects.

[2] There are alternative views that state that the growing dependence on investment grants might be due to endogenous institutional change (Inman, 1988: 56). But in the German case 'the rules of the game' have been relatively stable throughout the 80s.

[3] Original title: 'Statistisches Jahrbuch der Städte und Gemeinden'.

[4] This includes also the mining industries.

[5] 'Volkswirtschaftliche Gesamtrechnung der Länder, Bruttowertschöpfung der kreisfreien Städte, der Landkreise und der Arbeitsmarktregionen in der Bundesrepublik Deutschland', Heft 26, Statistisches Landesamt Baden-Württemberg, 1995.

[6] For further details, see Deitmar (1993).

[7] The correlation between $MAJORITY$ without and $MAJORITY$ with rank transformation is -0.97. The correlation between $MAJORITY$ without rank transformation and $PARTY$ is 0.47, the correlation between $MAJORITY$ with rank transformation and $PARTY$ is -0.40.

[8] This would not be possible if the error components were modelled as fixed. The main reason, however, why we model unobserved heterogeneity of cities as random is that (i) the random effects model is more parsimonious in parameters (ii) more importantly, our sample does not have sufficient 'within' variation, which is due to the fact that there are only 3 distinct years of observation for each city.

[9] The estimations have been carried out using the PROC MODEL procedure in SAS V8.

[10] Numerous anecdotal evidence on this can be found in newspapers.

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