Public Investment, Infrastructure Gap and Fiscal Policy: Evidence from OECD Countries*

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Abstract

A large body of literature has considered infrastructure investment to be a key factor in economic development and growth. However, widely recognized is its vulnerability to fiscal consolidation and fiscal rules. The aim of this paper is to study the process by which governments take decisions on public investment. In particular, I propose a simple model in which governments minimize a loss function depending on the difference between the actual infrastructure stock and a target level, and on the fiscal stance. Given an intertemporal budget constraint, equilibrium public investment is an increasing function of the infrastructure gap. By using data on OECD countries over the period 1980-2000 I find support for the view that public investment reacts not only to public finance and general economic conditions, but also to the infrastructure needs of countries.
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1. Introduction

Public investment is vulnerable to fiscal consolidation. It is indeed a commonly held view that during the 1990s public investment bore the brunt of fiscal retrenchment in many industrial countries; and particularly so in the European Union, where most countries were keen to fulfil the budgetary targets set by the Maastricht Treaty. Faced with the need for fiscal consolidation, policy-makers tended first to cut discretionary items such as public investment. In the Euro area alone, public investment fell by almost half a percentage point of GDP between the pre- and post-Maastricht periods. The recent international financial crisis has also imposed a dramatic burden in terms of public finance conditions, with a subsequent impact in terms of public investment and the need for new financial instruments to fund the so-called Trans-European Networks (De Grauwe and Moesen, 2008).

In general, in recent decades the GDP share of public investment has declined dramatically in many OECD countries, stabilizing their public capital spending at 4-4.5% of their GDP (Figure 1), a pattern similar to that of many emerging economies, especially in Latin America (Fedelino and Hemming, 2005)

[Figure 1]

Excessive reliance on public investment cuts raises two problems. First, it will depress growth, because depletion of the public capital stock will raise costs for the private sector. Second, as argued by Alesina and Perotti (1996), fiscal consolidation is typically less likely to be successful if it relies mainly on drastic cuts in public investment.

It has been recently argued that the contraction of public investment has been among the most important reasons for the widening infrastructure gap and consequent decrease in the average growth rate in certain regions (Calderon and Servén, 2003).

However, a decline in the ratio of public investment to GDP does not always negatively affect growth. Whilst poorer countries need to invest heavily in infrastructure, at higher income levels a lower amount of public investment is needed to meet infrastructure demand (IMF, 2004).

Yet, there may be a wholly different, and somewhat more benign, explanation of this trend. Public investment is not undertaken for its own sake but, more concretely, to meet the infrastructural needs of a growing economy. Intuitively, if the existing stock of infrastructures is grossly inadequate with respect to the needs of the economy, policy-makers will be pressed to maintain spending on public investment even in the face of budgetary restrictions. Otherwise, as may have happened in Europe for instance, the incentive to accumulate public capital stock will be far weaker. Surprisingly, however, the literature on public investment determinants has almost entirely ignored the extent to which the infrastructure gap influences public capital spending decisions.

In this paper, I propose a simple model of public investment decision-making in which a government faces a trade-off between the satisfaction of infrastructure demand and the maintenance of solid public balance conditions. Public investment is thus the result of the infrastructure needs and of the conditions of public finance. I have found support for the predictions of the model on considering 12 OECD countries over the period 1980-2001. In particular, I have estimated a standard fiscal policy reaction function (Galì and Perotti, 2002) in which public investment is regressed on fiscal variables and a measure of infrastructure gap. Depending on the infrastructure sector considered, I have found

that a 10% increase in the infrastructure gap induces a 3-6% increase in public investment.

The paper conducts a review of the literature in section two, while a simple and illustrative model is set out in section three. Section four proposes some empirical evidence, and section five concludes.

2. Public investment and infrastructure: a brief review of the literature

In both developing and industrialized countries, the provision of public capital is considered to be a strategic means with which to enhance economic growth. For more than twenty years, development professionals and scholars in the field have been involved, from their various practical and analytical viewpoints, in a discussion prompted by Aschauer's well-known work (1989).

Although the finding that infrastructure effectiveness is a decreasing function of capital stock furnishes empirical evidence for the prediction of the neoclassical growth model, other results are surprising and quite impressive. In fact, the magnitude of both elasticity and social rate of return estimates provide sound support for the thesis that there is still room for infrastructure investment, especially in developing countries.

Once infrastructures are in place, accessibility and service affordability are the channels through which they are able to enhance growth. In particular, access to water, sewage and energy directly affect the health and welfare of households (Calderon and Servén, 2003; Leipziger *et al.*, 2003). Moreover, the provision of infrastructure in transport and telecommunication sectors results in an increase in the productivity of firms and labor (see, for instance, Aschauer, 1989); finally, as demonstrated by cost function estimates, public capital may lower production costs (Morrison and Schwartz, 1996).

But if infrastructure investment has clear economic benefits, the reasons for its contraction over the last decades are controversial.[1] Easterly and Servén (2003) argue that, although infrastructure spending has high economic returns, governments do not benefit directly from those payoffs. Governments are often myopic and, when faced with severe budget constraints, they often prefer to cut public capital spending (which does not immediately affect voters' welfare), although this will have a negative fiscal impact in the long run (Easterly, 1999).

Calderon et al. (2003) convincingly argue that in Latin America the decline in public investment has been mainly due to restrictive fiscal policies throughout the 1980s and the 1990s. In fact, during that period, Latin America failed to deliver fiscal sustainability and credibility; and this failure, combined with rising debt levels and contingent liabilities in both the infrastructure and banking sectors, led the region to experience several financial and economic crises (Estache *et al.*, 2003). Calderon and Servén (2003) also show that the gap was developed during the 1980s and 1990s, so that fiscal adjustments in the region were largely carried out by decreasing public infrastructure investment: at least 50% of the changes in primary surplus as a share of GDP were due to the contraction of public investment in infrastructure in Argentina, Bolivia, Brazil, Chile and Ecuador.

A similar contraction in public investment seems to have occurred in recent decades in industrialized countries (Munnell, 1990). Gali and Perotti (2003) document a mild procyclicality of public investment, although they do not find a significant role of the Treaty of Maastricht in changing the behavior of government spending. Similar results

[1] It should be stated, however, that not all studies in the literature agree on the economic value of public spending (see, for example, Perotti, 2004), although Fedelino and Hemming (2005) find that the vast majority of the studies on this topic report a positive effect of infrastructure on the economy in a broad sense.

have been obtained by Valila and Mehrotra (2005), and by Turrini (2004), who finds that the Maastricht Treaty has had a positive effect on public balances which in turn has made room for public investment.

The recent macroeconomic literature has focused on the effect of public spending contraction, and it has put forward two alterative theories: the theory of asymmetric effects of public spending, and the theory of fiscal illusion.

In their seminal papers, Alesina and Perotti (1996) and Giavazzi and Pagano (1990; 1996) studied some episodes of fiscal adjustment driven by public expenditure contraction, where the consolidation of public deficit resulted in an unexpected increase in private consumption. Perotti (1999) has argued that in times of debt crisis ("bad times") the reaction of the economy to restrictive fiscal policies may change qualitatively: that is, the response of the private sector to fiscal shocks may exhibit a "keynesian" behavior during "good times", and a "non-keynesian" correlation during "bad times". Perotti (1999) and Alesina et al. (2002) find empirical evidence for the asymmetric effect of public spending for OECD countries, and explain it by considering the effect of credibility of fiscal policy. Consequently, this framework is not coherent with the structure of Latin American economies, where the lack of credibility is supposed to be a driving force behind the fiscal policy output, so that the consumption boom during the 1980s cannot be explained by the asymmetric effect of public expenditure contraction.

Easterly (2001) shows that, under certain conditions, a government will lower the conventional deficit while leaving its path of net worth unchanged, and that when required to lower its debt accumulation, the government will lower its asset accumulation or increase its hidden liability accumulation by an equal amount. In this

case, fiscal adjustment is an illusion, i.e. cutting public investments, operations and maintenance expenditure and other spending in "productive public capital" will affect the future path of economic growth and then the future situation of public finances (through tax base changes and assets revenues). It is consequently interesting to note that the current lack of competitiveness of Latin America with respect to other developing countries can be considered a clear result of the contraction of public investment during the 1970s and the 1980s.

Underlying a procyclical fiscal behavior was a tendency for governments to increase spending in response to a pick-up in growth, favourable terms of trade shocks, and surges in capital inflows, while cutting spending during downturns when financing dwindled. As a result, debt accumulated during periods of abundant capital inflows, exacerbating the procyclicity? of policies by increasing the magnitude of the adjustments that became necessary when conditions deteriorated (Alesina et al., 2008).

As for the determinants of public investment, Sturm (2001), on considering a large panel of developing countries, does not find a significant role played by political and institutional variables, while fiscal stance seems to be a key determinant in the investment decision. Similar results have been presented by Perée and Valila (2005), Valila and Mehrotra (2005), and Candelon et al. (2010) for European countries.

It appears from the aforementioned literature that public investment is a negative function of public debt and deficit, and that it is positively associated with the unmet infrastructure demand (the infrastructure gap). In the following section I present a formal, though simple, model of public investment decision-making.

3. An illustrative model[2]

The economic impact of public investment has been a much debated topic in the literature. Here, I take a very simple approach and assume that there exists an "optimal" level of public capital stock that policy-makers want to achieve. Governments, however, cannot simply set the level of public investment so as to close the infrastructural gap; they must also allow for the potentially undesired fiscal effects of higher public spending. Formally, I assume that policy-makers face a standard intertemporal budget constraint:

$$B_{t+1} = (1+r)B_t - PS_t + I_t \tag{1}$$

where B_t indicates the stock of public debt at time t, r is the interest rate, I_t denotes public investment, and PS_t is the current primary surplus (i.e. the primary surplus excluding I_t). I also assume that policy-makers seek to minimize the gap between K_t and its target level K^* and that they dislike higher future debt (B_{t+1}) insofar as it may constrain their future choices or place an undue burden on future generations. Hence, the policy-maker minimizes the following loss function:

$$L_t = \sum_{t=0}^{\infty}\left(\frac{1}{(1+r)}\right)^t\left(\frac{\alpha}{2}(I_t - I^*)^2 + \frac{1}{2}B_{t+1}^2\right) \tag{2}$$

[2] This section draws on Faini and Percoco (2007).

where α is the weight on K_t in the policy-maker's preferences and $I_t^* = K_t^* - K_{t-1}$ is the level of public investment needed to close the infrastructural gap.[3] Maximizing the objective function subject to the budget constraint yields:

$$I_t = \frac{1}{1+\alpha}\left(PS_t - (1+r)B_t\right) + \frac{\alpha}{1+\alpha} I^* \tag{3}$$

In this set-up, investment spending is treated as a discretionary item and, accordingly, as relatively more vulnerable to changes in budgetary conditions. Typically, policy-makers faced with budgetary difficulties will first cut discretionary spending items such as public investment, and then earmarked expenditure. Equation (3) shows that either a fall in the primary surplus, PS_t, or a rise in the outstanding public debt stock will depress public investment. Conversely, a strengthening in the fiscal position should boost I_t. Public investment, however, will also respond to the infrastructural gap: the larger is I^*, the greater will be the government's incentive to spend on public capital. In sum, in setting the level of public investment policy-makers will have to address the trade-off between closing the infrastructural gap and preserving fiscal stability.

Interestingly, the responsiveness of public investment to the fiscal situation and the infrastructural gap will be a function of α, i.e. the weight of K in the policy-maker's utility function. The effect will work in opposite directions, however. While a larger value of α should be associated with a greater rigidity of I and, as a result, a more

[3] For the sake of simplicity, although without any loss of generality, I assume k_t^* to be exogenously given. However, as will be clear in the empirical part of the paper, k_t^* can be conceived as being determined in a first step, given the features of the economy, as in Fay and Yepes (2003).

limited responsiveness to changes in the budgetary conditions, it should strengthen the response of public investment to the infrastructural gap.

Equation (3) is easy to estimate once a measure of the infrastructure gap is at hand, an issue that is the subject of the following section.

4. Estimating the infrastructure gap

Before proceeding with the estimation of the investment policy rule in equation (3), it is necessary to propose a measure of infrastructural gap and then to estimate it. Most of the literature proposes the estimation of infrastructure demand functions, and by projecting its determinants over the long run, uses the difference between the actual stock and what is needed in the future as a measure of investment needs (OECD, 2008). In this paper I take a different approach because I consider as a measure of infrastructure gap the distance between the actual level of infrastructure stock and a sort of current optimal level of public investment provision. I assume that the optimal level of infrastructure provision can be estimated through a simple demand function, as in Fay and Yepes (2003).

It should be noted that this approach differs from the aforementioned literature in that it does not consider forward-looking agents; rather, it assumes that decision-makers face the infrastructure gap year-by-year.

In estimating a sort of infrastructure demand function, the variable that I consider is the stock of infrastructure, rather than the flow of services that will be produced from it. To the extent that services are proportional to the physical stock (though intensity of use may vary), this function can be easily understood as demand for physical stocks of infrastructure (Fay and Yepes, 2003; Sturm, 2001).

Turning to the methodology, I estimate a function of the type:

$$g_{it} = \alpha_i + \gamma_t + \beta X_{it} + \varepsilon_{it} \quad (4)$$

where g_{it} is the *per capita* provision of a given typology of infrastructure stock at time t in country i; X_{it} is the vector of explanatory variables and ε_{it} is an iid error term. α_i and γ_t are country-specific and time-specific effects respectively. All variables are taken in logarithms.

As dependent variables I use kilometers of paved roads (ROAD), kilometers of railways (RAIL), megawatts of electricity produced (ENERGY) and number of telephone mainlines (TCOM).[4] All these variables are in per capita terms. The source of data for the infrastructure variables is the World Infrastructure dataset of the World Bank.

As explanatory variables I use the density of population and the percentage of urban population. Most studies explaining government size include the so-called structural variables to test for Wagner's law, especially in the version that stresses the transformation of traditional society into industrialized society with its shift from the family to public-sector services like education and health care (Lybeck, 1988). The inclusion of the rate of urbanization can be interpreted in such a way that we may expect a positive sign especially for the demand for energy and telecommunication.[5]. However, in the case of government capital spending there is another demand-side reason for

[4] I have also used the measures of infrastructure stock proposed by Kemps (2006) on the basis of the permanent inventory method. However, it turned out that the estimates of the infrastructure demand were always unsatisfactory.

[5] Indeed, one may argue that the more the population is spatially concentrated, the less telecommunication services are needed. However, this contention is not supported by the evidence because in my dataset the correlation coefficient between urban population and telephone mainlines is positive and large (0.78). This, in turn, means that there is an income effect driven by the fact that the degree of urbanization produces an increase in the output of, and then in the demand for, telecommunication services.

including the degree of urbanization. Most public capital spending concerns infrastructure, and rural areas are in relatively more need of it. Hence, in the case of roads and railways, I hypothesize that a larger degree of urbanization will lead to less demand for infrastructure.

Further explanatory variables are the gross domestic product *per capita* (GDPCAP), and two variables meant to describe the structure of the national production, namely the percentage of the value added produced by the manufacturing sector (MAN) and by the agriculture (AGR) respectively.

The data I use for the explanatory variables are from the World Development Indicators and relative to a sample of twelve OECD countries, namely Australia, Belgium, Canada, Denmark, France, Germany, Ireland, Italy, Norway, Sweden, United Kingdom, United States of America over the period 1979-2000. Table 1 provides summary statistics for the main variables.

The estimation of equation (4) poses serious problems of reverse causality and ultimately of endogeneity. To overcome this problem, Table 2 reports estimates of regression coefficients computed through an instrumental variable procedure in which all explanatory variables were treated as endogenous and where the instruments were the one-year lagged values of the variables themselves. Table 2 shows that the higher the GDP per capita, the larger the stock of infrastructure supplied, with the sole exception of the energy sector, which seems to react significantly only to the country's urbanization rate. Counter-intuitive results are those associated with the estimated coefficients for the urbanization rate and population density. In both cases, in fact, the coefficient is significant and positive, a result that does not support the view that the

reduction of distance between firms and consumers may result in the reduced importance of infrastructure (Friedman, 2005).

[Insert table 2 and figure 2 about here]

Let us now turn to measurement of the infrastructure gap. In particular, let us define the infrastructure gap for infrastructure type k (with k = ROAD, RAIL, ENERGY, TCOM) of a given country i at a given time t as:

$$(kg\_gap)^k_{it} = \hat{g}_{it} - g_{it} \tag{5}$$

That is, my measure of infrastructure gap is the difference between the predicted value of the dependent variables in equation (4), i.e. the theoretical level of infrastructure stock (given the characteristics of country i at time t), and the actual provision of public capital. In other words, I assume that the infrastructure gap is simply the residual? of equation (4) taken with the negative sign. According to the measure in (5), a country in which for a given year the infrastructure gap is positive has a demand ($\hat{g}_{it}$) which exceeds supply (g_{it}), whereas a negative infrastructure gap denotes an excess in the infrastructure stock.

Figure 2 reports some descriptive evidence on the pattern of infrastructure gap in the countries in my sample. As shown by the figure, most of the countries exhibit an over-provision of road infrastructure stock, whereas, surprisingly, Australia, Canada, Italy and the USA have an under-provision of telephone mainlines. It should be pointed out that this result is in contrast with the findings of Kemps (2005), who found an over-

provision of public capital in most of the European countries. However, it should be noted that my measure of the gap is simply a measure of the distance between supply and demand, not of the growth-maximizing stock of infrastructure.

With the indicator of the infrastructure gap and its estimates at hand, in the following section I present the results of the investment function.

5. Public investment, fiscal policy and infrastructure gap

In the previous section I proposed a measure of the infrastructure gap; in this section, I propose estimates of the reaction of public investment to fiscal policy and infrastructure gap as yielded by the formal model outlined in section 3. Accordingly, public investment (*pub_inv*) is assumed to be a function of the fiscal policy stance, as measured by the net lending (d_{it}) and the gross debt (b_{it}). All variables are normalized by GDP (y_t). Additionally, I consider the measure of the infrastructure gap as described in the previous section for a given sector k ($kg\_gap_{it}^{k}$) and the output gap as a ratio to potential output (y_gap_{it}) in order to capture the impact of unexpected output shocks?. In other words, I aim to estimate the following regression:

$$pub\_inv_{it} = \alpha_t + a_i + \beta_1 d_t + \beta_2 b_{it} + \beta_3 kg\_gap_{it-1}^{k} + \beta_4 y\_gap_{it} + \varepsilon_{it} \quad (6)$$

I expect $\beta_1<0$ as a larger deficit indicates a weaker fiscal position and hence will depress public investment, $\beta_2<0$ because a larger debt stock will force policy-makers to cut discretionary spending. In addition, I expect β_3 to be positive, because the larger the need for infrastructure, the larger the public investment. Finally, β_4 may have either sign since a positive output shock may not necessarily lead to higher spending. Note

that equation (3) predicts $\beta_1 = \beta_2$, an easily testable assumption. Finally coefficients α_t and a_i stand for a full set of time and country-specific fixed effects.

Data on public investment are from the International Finance Statistics, while the dependent variables are from the World Development Indicators.

I estimated equation (6) over the period 1980-2000. To reduce the heterogeneity in the propensity of countries to invest in public capital, I made use of a fixed effect framework that allowed for different intercepts among countries. However, as noted above, countries may also differ in the responsiveness of public investment to budgetary conditions. I tried to control for this possibility by introducing the policy-maker's political orientation among the explanatory variables and, in addition, checked whether interaction effects with fiscal indicators were significant. Finally, in a further attempt to reduce heterogeneity, I also considered European countries separately, my purpose being also to identify the impact of the Stability and Growth Pact.

To tackle the endogeneity issue, I followed Gali and Perotti (2003) and estimated equation (6) by using an instrumental variable estimator where the lagged values of all explanatory variables were used as instruments.

The baseline results of the econometric analysis are set out in table 3. Models 1-4 indicate that gross debt is a significant determinant of public investment, with a non-negligible effect, whereas the net lending does not have a significant effect. As expected from the illustrative model, the infrastructure gap always has a positive sign, implying that the larger the need for infrastructure, the larger the public investment is across all

the sectors considered.[6]. In models 5-8 I tested whether the coefficient of the gross debt and of net lending are the same.

[Insert table 3 about here]

Table 4 shows the results of a test on the relevance of the fiscal rules imposed by the Treaty of Maastricht, as in Gali and Perotti (2003) and Turrini (2004). In particular, I assessed whether the link between fiscal policy and public investment has changed since the adoption of nondiscretionary fiscal policy rules. To this end, I introduced among the regressors a dummy variable, *D92*, that took value 1 after 1992 for European countries and zero otherwise, and interacted it with fiscal policy and the infrastructure gap. All results in general are confirmed, although the impact of the fiscal stance is not significantly stronger in the 1990s, as shown by the significance of the coefficient for the interaction between public finance and *D92*, indicating an insignificant role played by the Treaty of Maastricht in the contraction of public investment.

Equation (3) also shows that the actual level of public investment is a function of the policy-maker's preference as expressed by the parameters in the loss function (1). Indeed, governments different in terms of political orientation may weigh public investment differently. Hence, a government's political orientation may affect the level of public investment via two main two channels: through its impact either on *pub_inv* (a level effect) or on the policy maker's preference parameter, or through both effects. To assess whether the slope effect is at work, I shall estimate an equation where the responsiveness of public investment to budgetary conditions is a function of the

[6] The measures of the infrastructure gap are extremely collinear. Hence no significant results were obtained when more than one indicator was used in the regression.

government's political orientation ($polity_t$). Putting all together, I also rely on the following, relatively more general, specification:

$$(7) \qquad pub\_inv_{it} = \alpha_i + a_t + \beta_1 polity_{it} + \beta_2 fiscalrule_{it} + \beta_3 polity_{it} \cdot fiscalrule_{it} + \\ + \beta_4 kg\_gap_{it-1} + \beta_5 y\_gap_{it} + \varepsilon_{it}$$

In equation (7), β_1 is meant to capture the impact of the government's political orientation on the level of public investment, while β_3 reflects the influence of *polity* on the policy-maker's preference parameter.

Data on government's political orientation are from work at the Fondazione Enrico Mattei (FEEM, 2005). The index ranges from 1 to 10, with a larger value being associated with a more conservative government.

[Insert tables 3, 4, 5 about here]

The estimation results of equation (7) are reported in table 5. The fiscal policy stance maintains its role as a key determinant of public investment. Secondly, as expected, a more conservative political orientation is associated with a lower volume of public investment, but this effect is not significant at conventional statistical levels. Even when I interact the fiscal policy stance with the political orientation variable, the latter is not statistically significant.

6. Conclusions

The role of governments in promoting economic development is a much debated topic in the economics literature, and it has received renewed interest because of the recent financial crisis. Among public policy actions, investments to increase the infrastructure stock are of particular importance and public interest.

In this paper I have proposed a simple model in which policy-makers minimize a quadratic loss function whose arguments consider both the fiscal stance of the country and an infrastructure gap, measured as the distance between the demand and supply of public capital. The solution of the minimization problem results in a public investment decision rule as a function of the structural debt, of the primary surplus (net lending), and of infrastructure gap. I estimated this decision rule on a set of 12 OECD countries over the period 1980-2000 and found that public investment reacts to such an infrastructure gap and that the Maastricht Treaty has not significantly affected the decision rule.

Finally, it should be pointed out that my theoretical and empirical model predicts that public investment increases not only as a response to higher demand but also in the case of positive public finance conditions, although these estimates must be treated with considerable caution. Nevertheless, they provide a benchmark against which to assess the effectiveness of alternative strategies to boost infrastructure spending, because even if we neglect the direct effect of a fiscal deterioration on the propensity of governments to undertake public capital spending, the indirect effect working through the stock of debt may be quite large, and it may easily more than wipe out the initial gains stemming from a more favourable fiscal treatment of infrastructure investment. This, in turn,

implies that an increase in public investment can be obtained though a rigorous approach to fiscal policy.

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Table 1: Summary statistics

Variable	Mean	Std. Dev.	Min	Max
Public Invesment	2.770	0.690	1.278	4.711
Roads	0.011	0.004	0.005	0.023
Rail	0.0009	0.0009	0.0002	0.004
Energy	0.002	0.001	0.0008	0.006
Telephone	0.502	0.114	0.230	0.758
Gross debt	67.411	28.007	21.884	140.669
Structural balance	-2.592	11.450	-51.890	11.288

Table 2: Estimates of infrastructure demand (IV estimates)

	(1) Road	(2) Rail	(3) Energy	(4) Telephone lines
GDP per capita	0.327***	0.230*	0.025	1.055***
	(0.096)	(0.123)	(0.082)	(0.061)
Manufacturing (%)	-0.077*	-0.025	-0.008	0.072***
	(0.0417)	(0.053)	(0.035)	(0.026)
Agriculture (%)	-0.0357	-0.064**	-0.007	0.078***
	(0.0248)	(0.031)	(0.021)	(0.015)
Urbanization	-1.621*	-2.636**	-1.724**	0.154
	(0.860)	(1.100)	(0.735)	(0.551)
Population density	-1.069**	0.240	0.699	1.879***
	(0.514)	(0.657)	(0.439)	(0.329)
Observations	252	252	252	252
Number of Countries	12	12	12	12
R^2	0.682	0.661	0.563	0.784

Notes: Dependent variables are in per capita terms. All variables are in logarithms. Fixed effect estimates with a full set of country-specific and year fixed effects. Instrumental variable estimates, where instruments are the lagged values of the explanatory variables. Robust standard errors are in parenthesis. Levels of significance: ***:p<0.01; **: p<0.05; *: p<0.1.

Table 3: Public investment and infrastructure gap (IV estimates)

	(1) Road	(2) Rail	(3) Energy	(4) Telephone lines	(5) Road	(6) Rail	(7) Energy	(8) Telephone lines
Output gap	2.991***	2.250***	2.824***	2.895***	2.533**	1.978**	2.318**	2.391**
	(0.737)	(0.653)	(0.780)	(0.662)	(0.945)	(0.771)	(0.963)	(0.858)
Gross debt	-0.009**	-0.009**	-0.010**	-0.011**				
	(-0.003)	(-0.003)	(-0.004)	(-0.003)				
Primary deficit	-0.005	-0.001	-0.006	-0.004				
	(0.004)	(0.005)	(0.005)	(0.004)				
Infrastructure gap	0.637***	0.593***	0.403***	0.296***	0.596***	0.663***	0.360***	0.269***
	(0.128)	(0.128)	(0.109)	(0.085)	(0.166)	(0.127)	(0.073)	(0.097)
Fiscal policy					-0.008**	-0.005**	-0.005**	-0.006**
					(-0.002)	(-0.002)	(-0.002)	(-0.002)
Number of countries	12	12	12	12	12	12	12	12
Observations	240	240	240	240	240	240	240	240
R-squared	0.879	0.883	0.869	0.866	0.851	0.864	0.839	0.838

Notes: Fixed effect estimates with a full set of country-specific and year fixed effects. Instrumental variable estimates, where instruments are the lagged values of the explanatory variable. A constant is always included though not reported in the table. Fiscal policy= Gross debt + Primary deficit. Robust standard errors are in parenthesis. Levels of significance: ***:p<0.01; **: p<0.05; *: p<0.1.

Table 4: Public investment and infrastructure gap – The role of the Maastricht Treaty

	(1) Road	(2) Rail	(3) Energy	(4) Telephone lines
Output gap	2.119***	2.994***	2.200***	2.103***
	(0.886)	(0.783)	(0.808)	(0.894)
D92	1.352***	1.050***	1.092**	1.196***
	(0.381)	(0.230)	(0.351)	(0.215)
Fiscal policy (t-1)	-0.006**	-0.006***	-0.008	-0.005***
	(0.002)	(0.002)	(0.003)	(0.002)
D92*Fiscal policy	-0.003	-0.003	-0.003	-0.002
(t-1)	(0.985)	(0.820)*	(0.665)	(0.666)
Infrastructure gap	0.595**	0.585**	0.495**	0.243**
	(0.273)	(0.288)	(0.331)	(0.114)
Number of countries	12	12	12	12
Observations	240	240	240	240
R^2	0.879	0.885	0.894	0.898

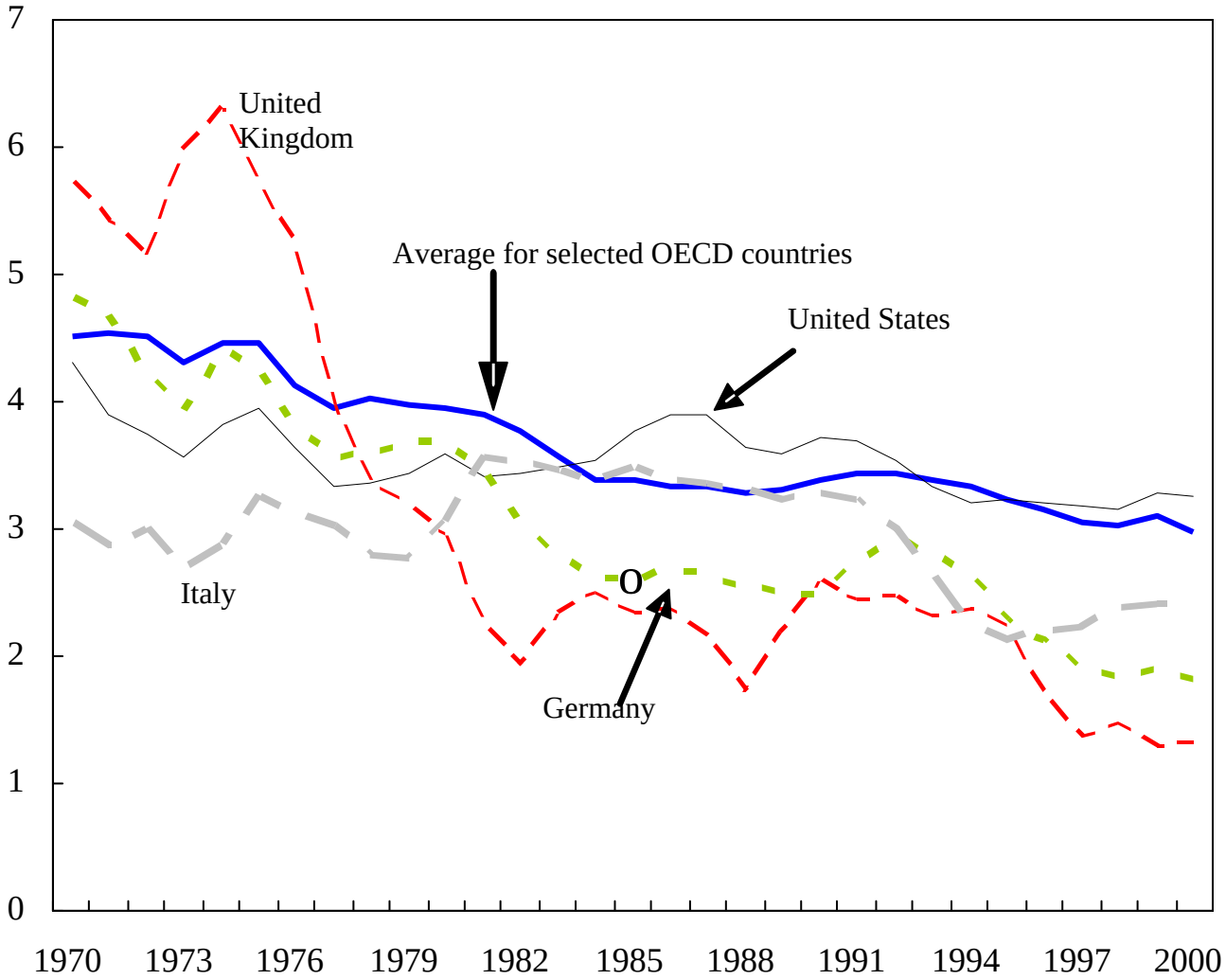
Notes: Fixed effect estimates with a full set of country-specific and year fixed effects. A constant is always included though not reported in the table. Fiscal policy= Gross debt + Primary deficit. . Instrumental variable estimates, where instruments are the lagged values of the explanatory variable. The dummy variable D92 is not instrumented. The variable D92*Fiscal policy is instrumented with the same set of instruments as other variables interacted with D92. Robust standard errors are in parenthesis. Levels of significance: ***:p<0.01; **: p<0.05; *: p<0.1.

Table 5: Public investment, infrastructure gap and political orientation

	1 Road	2 Rail	3 Energy	4 Telephone lines
Output gap	2.344*** (0.751)*	2.425*** (0.611)	2.070*** (0.780)	2.290*** (0.728)
Fiscal policy (t-1)	-0.024 (-6.010)***	-0.020 (-5.411)***	-0.025 (-6.265)***	-0.031 (-5.233)***
Polity (t-1)	-0.001 (-0.045)	0.009 (0.435)	0.003 (0.134)	-0.062 (-1.340)
Polity(t-1)*Fiscal policy (t-1)	0.002 (0.553)	0.002 (0.911)	0.003 (0.452)	0.001 (0.544)
Infrastructure gap	0.683** (0.326)	0.580** (0.249)	0.277** (0.125)	0.327** (0.151)
Number of countries	12	12	12	12
Observations	240	240	240	240
R^2	0.866	0.892	0.862	0.868

Notes: Fixed effect estimates with a full set of country-specific and year fixed effects. A constant is always included though not reported in the table. Fiscal policy= Gross debt + Primary deficit. Instrumental variable estimates, where instruments are the lagged values of the explanatory variable. The variable Polity*Fiscal policy is instrumented with the same set of instruments as other variables interacted with Polity Robust standard errors are in parenthesis. Levels of significance: ***:$p<0.01$; **: $p<0.05$; *: $p<0.1$.

Figure 1: Public Investment in OECD countries



Note: OECD average is the unweighted average for Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.

Source: Fedelino and Hemming (2005).

Figures 2: Infrastructure gap across sectors and countries