Economic and Financial Report 2005/01

Evolution and Determinants of Public Investment in Europe

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JEL Classification codes: E62, H54, C23.

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Evolution and Determinants of Public Investment in Europe

Abstract

We examine the evolution of public investment and public capital stocks in Europe during the past three decades. Against this background, we employ an array of econometric techniques to assess the macroeconomic determinants of public investment, with a special focus on its long-term trend. We find that public investment has been determined by national income, the stance of budgetary policies, and fiscal sustainability considerations. Neither the cost of financing nor the fiscal rules embodied in EMU have had a systemic impact on public investment. The significant downtrend that characterises the evolution of public investment, measured in relation to GDP, in non-cohesion countries is chiefly determined by drawn-out episodes of fiscal consolidation, unrelated to EMU.

CONTENTS

1. INTRODUCTION

It is regarded as accepted wisdom by now that public investment has been on a trend decline in most industrial countries since the 1970s. Indeed, gross fixed capital formation by the general government in the 15 countries constituting the pre-enlargement EU has halved from well over 4 percent of GDP in the early years of the 1970s to just over 2 percent of GDP in recent years. In the US the decline has been less pronounced from 3.5 percent of GDP in the early 1970s to 3 percent of GDP now.

Several hypotheses have been put forward to explain the downtrend in public investment. They include, most notably, extensive privatisation and the drive toward a smaller economic role for the state in the past two-three decades; the emergence of alternative ways to finance infrastructure investment, such as public-private partnerships; the impact of EMU's fiscal rules; and a decreasing need for additional infrastructure.

Some of these hypotheses can be refuted up-front. Privatisation, for one, is unlikely to have affected public investment—let alone to have accounted for its long-term downtrend—as any investment undertaken by public enterprises is recorded in national accounts statistics as investment of the enterprise sector. Only investment recorded in and financed from the budget of the national or a subnational government qualifies as public. Consequently, privatisation per se would not affect public investment at all.[1] Furthermore, it is unlikely that any political drive toward a smaller economic role for the state has been very important; after all, if measured in terms of tax revenue to GDP ratios, it would seem that governments have not become smaller in recent decades. Finally, public-private partnerships remain a recent phenomenon and account for a visible share of infrastructure investment in only a few countries.

Only a handful of studies contain analyses providing insights into what factors determine public investment and, consequently, into the validity of the other hypotheses. De Haan et al. (1996) and Sturm (1998) focus on politico-economic factors affecting public investment, estimating a range of model specifications using

[1] However, privatisation may well affect other items in the budget, such as capital transfers.

panel data for 22 OECD countries for the period 1980-1992. They conclude that episodes of "fiscal stringency" and frequent changes of government tend to be associated with lower public investment, and that movements in public investment tend to follow those in private investment.

In a more recent study Galí and Perotti (2003) analyse, among other things, the determinants of public investment in EMU countries, with a special focus on whether or not EMU has changed the cyclical behaviour of public investment. Their explanatory variables include only the expected output gap and public debt, both of which are statistically significant. They find the behaviour of public investment "mildly procyclical", with a one percentage point change in the expected output gap moving public investment (in relation to potential GDP) by 0.04 percentage points. EMU has reportedly not caused any statistically significant change in this relationship.

Finally, European Commission (2003) and Turrini (2004) offer panel data analyses of the determinants of public investment in the EU (before enlargement). Both include a range of general economic and fiscal variables among the regressors (real per capital GDP or trend GDP; output gap; real long-term interest rates; cyclically adjusted budget balance; public debt; total revenue or current expenditure of the general government; EMU dummy). They find that public investment (in percent of GDP) tends to decline with GDP growth (in real per capita terms in the study by European Commission and per capita trend GDP in the study by Turrini); with a deterioration in the cyclically adjusted budget balance (primary balance in the case of Turrini); and with increasing public debt. Both find also that EMU has had a significant and positive impact on public investment, both directly and through its interaction with the budget balance variable.

Against this background, it would appear that there remain gaps in our understanding of the determinants of public investment, especially as regards its long-term downtrend. To fill at least some of the gaps, this paper aims to assess what economic factors have been driving public investment in Europe over the past three decades. In doing so, the following innovations compared to the earlier studies quoted above are introduced:

- While public investment, in percent of GDP, has indeed declined in most EU countries, the magnitude of the decline has varied greatly between countries, and in the cohesion countries (Greece, Ireland, Portugal, and Spain) public investment has actually increased. Consequently, any analysis lumping all EU (or EMU) countries together, as the studies mentioned above have done, will hide significant differences between countries and have only limited explanatory power. Therefore, we perform separate estimations for a panel of those EU countries where public investment has declined, and for a panel of those where it has increased (control group). Moreover, we perform single-equation estimation for each country where public investment has declined.

- The panel data and single-equation analyses inform us about the determinants of public investment, but without explicitly distinguishing between the short-term (cyclical) and long-term (trend) developments. As the long-term trend decline is the most striking feature of public investment in non-cohesion countries, the determinants of the long-terms trends are examined by means of a cointegration analysis.

In addition, we report the results of a preliminary cross-section analysis aimed at assessing the validity of the hypothesis that the demand for public capital (infrastructure) has already been saturated. To our knowledge, there has not been any attempt so far to link the level of public investment to the size of the public capital stocks in the European context.

Chapter 2 provides a description of how public investment flows and public capital stocks have evolved over the past three decades in the pre-enlargement EU. Against this background, Chapter 3 presents panel data and single equation analyses of the macroeconomic determinants of public investment, as well as a brief discussion of the cross-section analysis of the link between public capital and public investment. The determinants of the long-term trend developments in public investment are the topic of Chapter 4. To conclude, all results are interpreted from a macroeconomic perspective in Chapter 5.

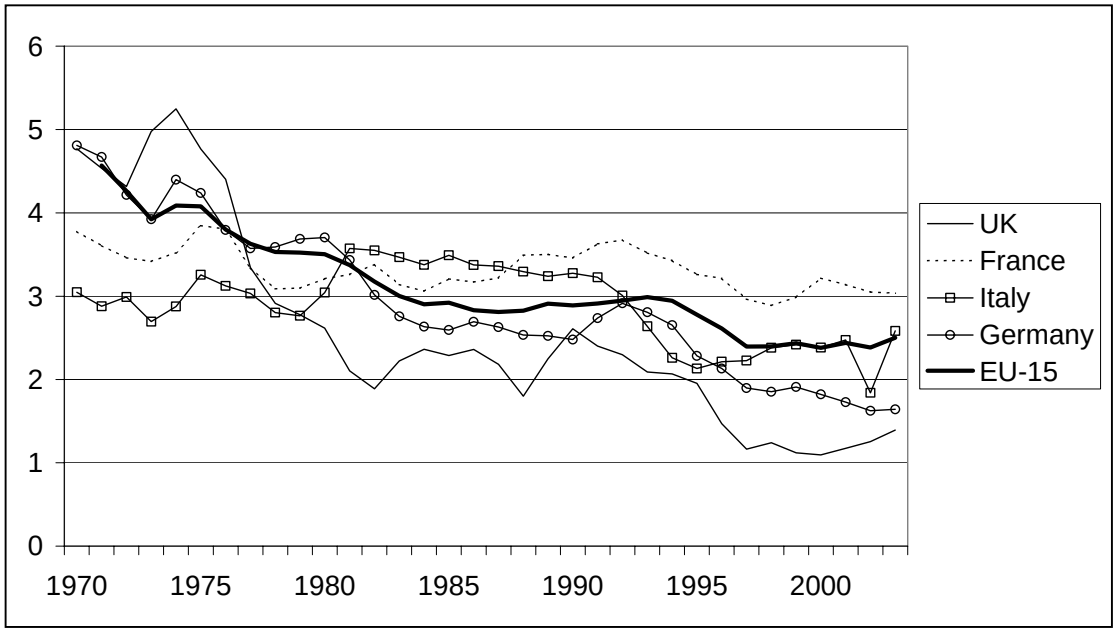
2. EVOLUTION OF PUBLIC INVESTMENT AND PUBLIC CAPITAL STOCKS

2.1. Evolution of public investment flows

To start with, a note on terminology is warranted. There is often confusion about the terms "infrastructure investment" and "public investment". While it is true that the bulk of public investment is infrastructure investment—financing the construction, operation, and maintenance of roads, bridges, tunnels, schools, hospitals, prisons and the like—the reverse does not hold. That is, there is a whole lot of infrastructure investment that is undertaken by commercial entities (be they public sector corporations or private sector ones) that is often mistakenly believed to be public investment. Examples include investment by energy companies in generation capacity; telecoms companies in networks; or rail companies in rolling stock or rail infrastructure. In all these cases the investment is financed and undertaken by commercially run enterprises and therefore recorded as investment of the enterprise sector in national accounts statistics—regardless of the ownership structure of that enterprise. Only investment that is directly financed from the budget of the government—be it at the central or subnational level—qualifies as public investment.

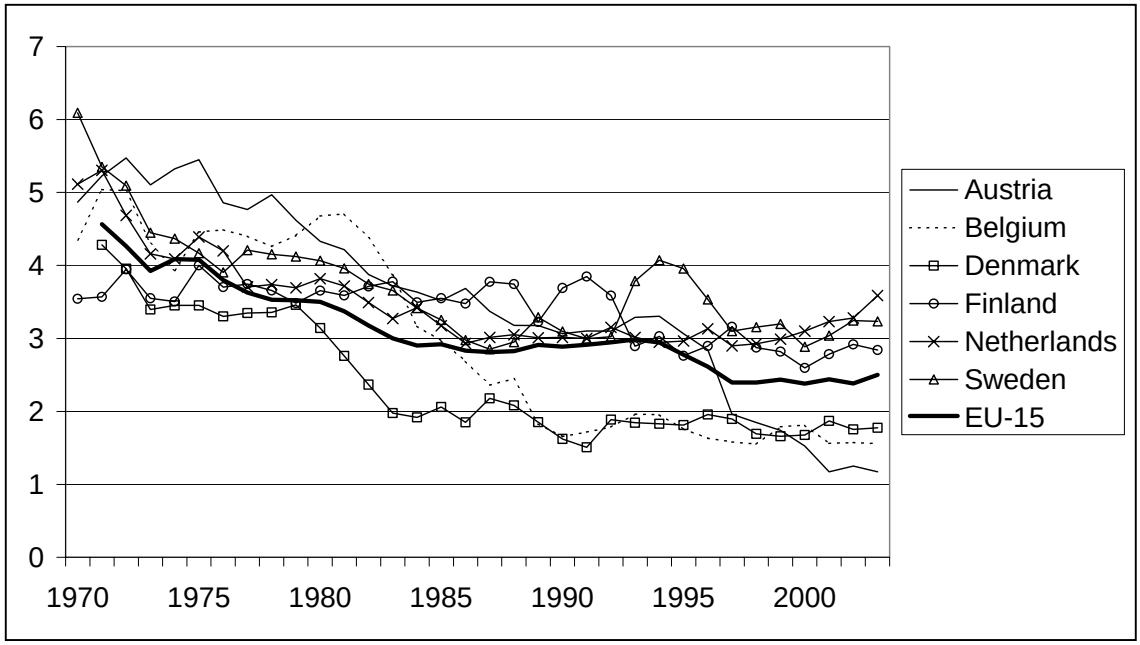
While the general trend in public investment thus defined, in percent of GDP, has indeed pointed down in the pre-enlargement EU, there has been considerable variation across individual countries, as illustrated by the figures below. In the group of large countries (France, Germany, Italy, and the UK) public investment fell on average from 4 percent of GDP in the early 1970s to 2.2 percent of GDP in recent years. The fall has been particularly pronounced in the UK, where public investment peaked at 5 percent of GDP in the early 1970s; fell to some 2 percent of GDP by the early 1980s where it hovered for a decade, only to continue sliding thereafter toward 1 percent of GDP.

Figure 1. Gross fixed capital formation by the general government in large EU countries (in percent of GDP), 1970—2003.



Source: OECD.

Figure 2. Gross fixed capital formation by the general government in smaller non-cohesion countries (**in percent of GDP**), **1970—2003.**

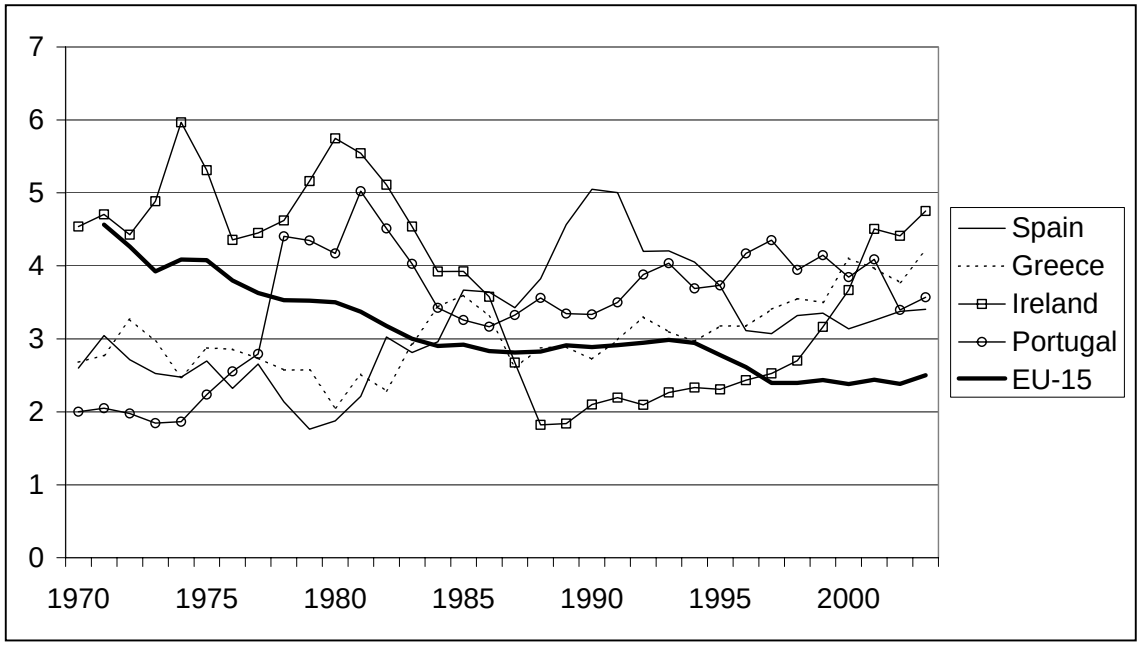


Source: OECD.

The fall in public investment was quite pronounced also in the group of smaller non-cohesion countries (Austria, Belgium, Denmark, Finland, the Netherlands, and Sweden), where average public investment more than halved from almost 5 to 2.4 percent of GDP. Austria and Belgium experienced the biggest declines, from 5 percent of GDP in early 1970s to just over 1 percent of GDP in recent years. In contrast, Finland's public investment has declined by less than one percentage point of GDP during the past three decades.

The cohesion countries (Greece, Ireland, Portugal, and Spain) have been less homogenous as a group; nevertheless, there has been a tendency for public investment to trend up rather than down within that group, the average increasing from 3 to 4 percent of GDP. Ireland, representing an extreme, has seen public investment drop from the peak of 6 percent of GDP in the 1970s to below 2 percent of GDP in the late 1980s, with a subsequent bounce back to nearly 5 percent of GDP more recently.

Figure 3. Gross fixed capital formation by the general government in cohesion countries (**in percent of GDP**), **1970—2003.**



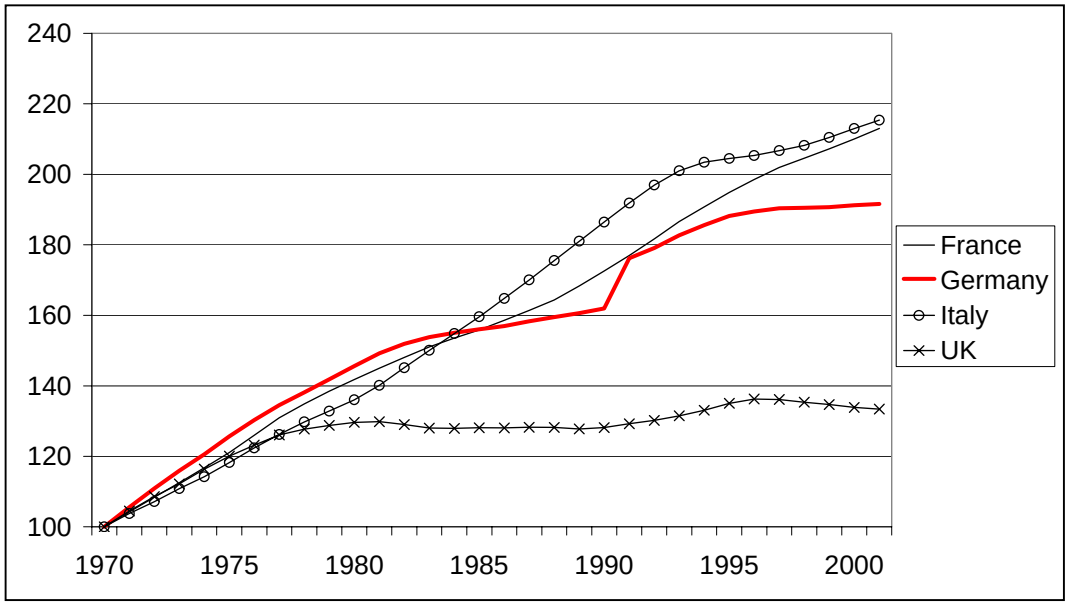
Source: OECD.

2.2. Evolution of public capital stocks

Having depicted the evolution of public investment flows, it is of interest to examine how public capital stocks have evolved as a result of mostly falling flows—at least if measured in relation to GDP. A new set of estimates on public capital stocks in 22 OECD countries enables such an examination (Kamps (2004)). The estimates for the pre-enlargement EU member states are presented below in relation to the size of the public capital stock in 1970 in each country and also in a cross-country comparison.[2]

The first figure below shows that public capital stocks have roughly doubled since 1970 in all large EU countries except in the UK, where the cumulative growth has been below 40 percent. Moreover, the public capital stock in the UK has remained rather flat since the late 1970s.

Figure 4. Public capital stock in large EU countries (1970 = 100), 1970—2003.

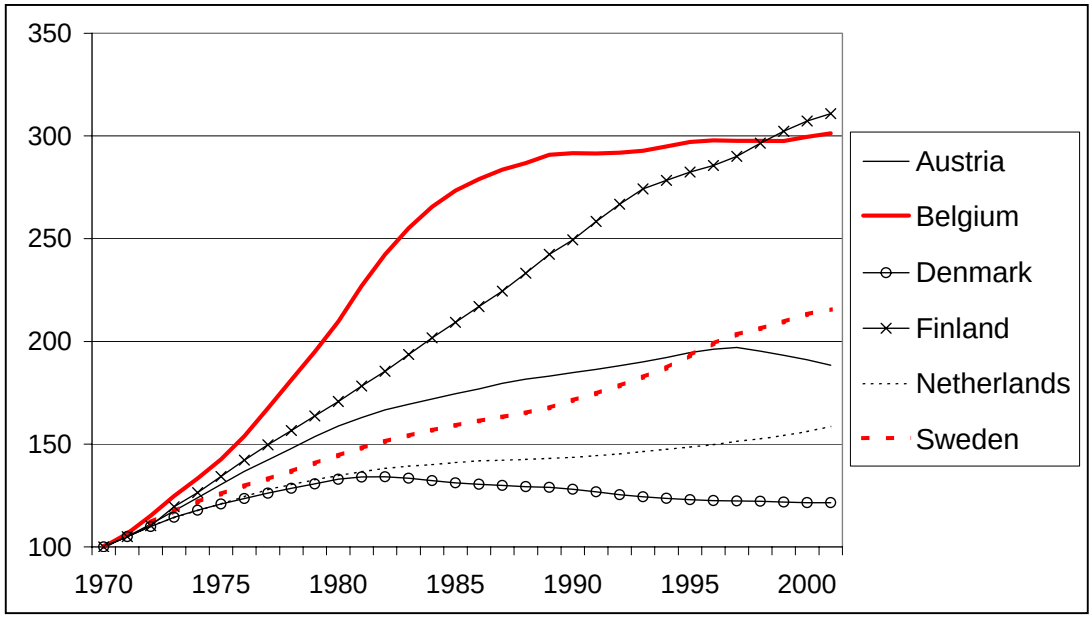


Source: Kamps (2004).

[2] The estimates for the public capital stocks depicted below are calculated using the so-called perpetual inventory method. The capital stock in any given period is calculated as the sum of the stock in the previous period plus gross investment flow in the current period less depreciation. The initial capital stock is estimated assuming that the capital stock in year 1860 equalled zero, and that gross investment grew during 1860-1960 at a constant rate of 4 percent, to reach the actually observed level in 1960. The rate of depreciation is assumed constant for any given year but variable across years during 1960-2001. It is assumed to have been constant at 2.5 percent during 1860-1960, while increasing gradually from 2.5 percent in 1960 to 4 percent in 2001. The constant depreciation rate implies that the capital put in place in any given year will never be fully depreciated, it just converges toward zero over a very long time.

Among smaller non-cohesion countries net public capital stocks have trebled in Belgium and Finland, doubled in Austria and Sweden, while growing more modestly in the Netherlands and Denmark. The growth took place as early as the 1970s in Austria, Belgium, and Denmark; since the 1980s, these countries' public capital stocks have been almost unchanged.

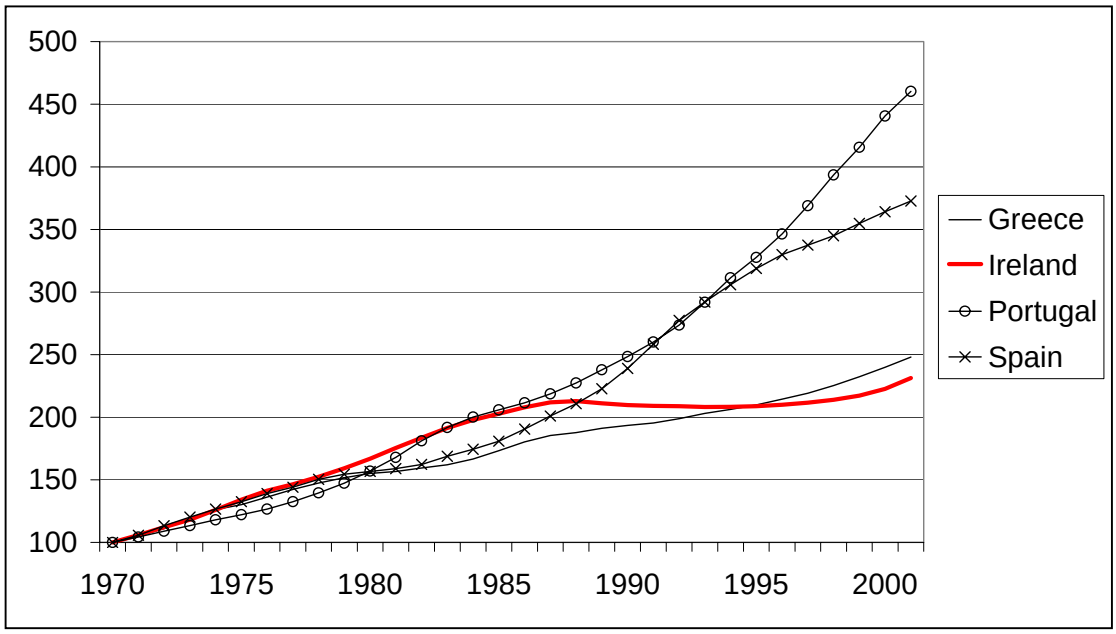
Figure 5. Public capital stock in smaller non-cohesion countries (1970 = 100), 1970—2003.



Source: Kamps (2004).

As regards the cohesion countries, the net public capital stock has grown almost fivefold in Portugal, fourfold in Spain, and more than doubled in Greece and Ireland.

Figure 6. Public capital stock in cohesion countries (1970 = 100), 1970—2003.



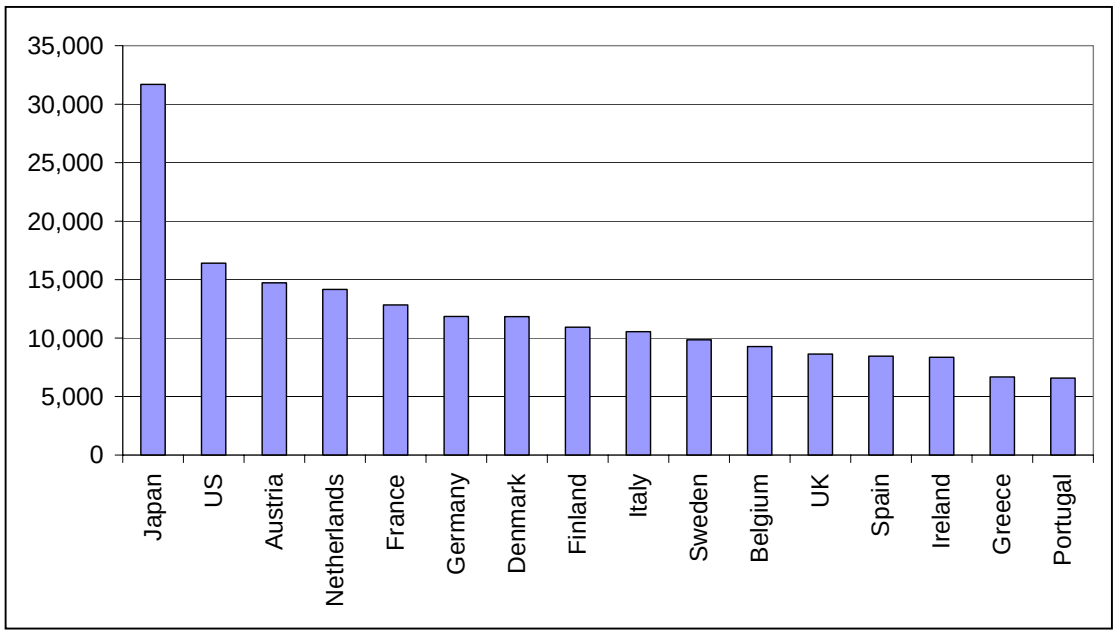
Source: Kamps (2004).

While the increases in public capital stocks reported above seem large at the outset, one needs to recognise that they have occurred over more than three decades. Over such a long period of time average annual growth rate of no more than 2.3 percent is sufficient to double the initial stock.

Nevertheless, the important observation above is that public capital stocks have been growing in real terms in all but three sample countries. This implies that the downtrend in the ratio of public investment to GDP has not been so steep as to cause public investment to fall below the level of depreciation; on the contrary, in most old EU member countries public investment continues to cover depreciation and allow for a further expansion of public capital stocks. The downtrend in investment flows has, however, led to a slowdown in the rate of growth of public capital stocks, but it has not reversed that growth.

Let us then compare the size of public capital stocks across countries. This is done in the figure below, converting the estimates in national currency units for the year 2000 into US dollars at purchasing power parity. Moreover, the stocks are expressed in per capita terms to abstract from the differences in country sizes.

Figure 7. Public capital stock per capital at purchasing power parity in 2000 USD.



Source: Kamps (2004).

Among the old EU member states, Austria has the largest net public capital stock at about USD15,000 per capita. This is less than half of Japan and some 10 percent less than the US. At USD6,600 per capita, Portugal's net public capital stock is smallest in the sample.

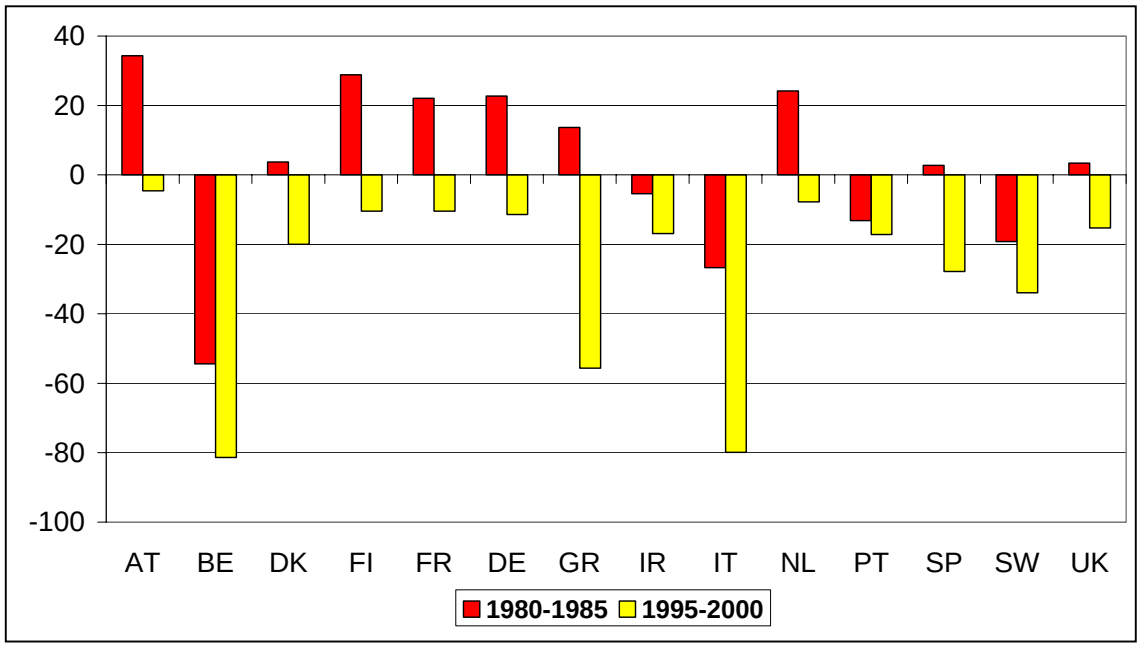
The differences between public capital stocks in especially non-cohesion countries are striking. Consider Austria, Belgium, Denmark, and the UK, all of which have had virtually flat public capital stocks since the 1980s. The Austrian public capital stock per capita is almost double that in Belgium and the UK, with Denmark in the middle.

Some of the dispersion is likely to reflect statistical differences related to the institutional set-up for providing infrastructure and public services.[3] Furthermore, geography and demography can explain away some of the differences: it is more expensive to construct roads in mountains than on plains, and it is more expensive to provide public services in countries with relatively old populations.

[3] An infrastructure or public service may be financed and provided by a public corporation in one country (thus showing up as investment of the enterprise sector in national accounts statistics), while in another country it is financed directly from, e.g., local budgets (thus showing up as public investment).

The estimates for public capital stocks can be compared with the amount of public debt, thus providing a very rough measure of governments' net worth. This is done in the figure below, with the following caveats. First, the ratio of public capital to GDP is expressed in real terms, so it is fully comparable with the debt-to-GDP ratio only under the assumption that the GDP deflator can also be used to deflate public investment. Second, public debt is measured in terms of gross outstanding debt, thus excluding any contingent liabilities etc. Finally, the comparison above is purely mechanical and does not take into account how productive public capital is, i.e., what is the true value of governments' fixed assets.

Figure 8. Public capital less public debt, in percent of GDP.



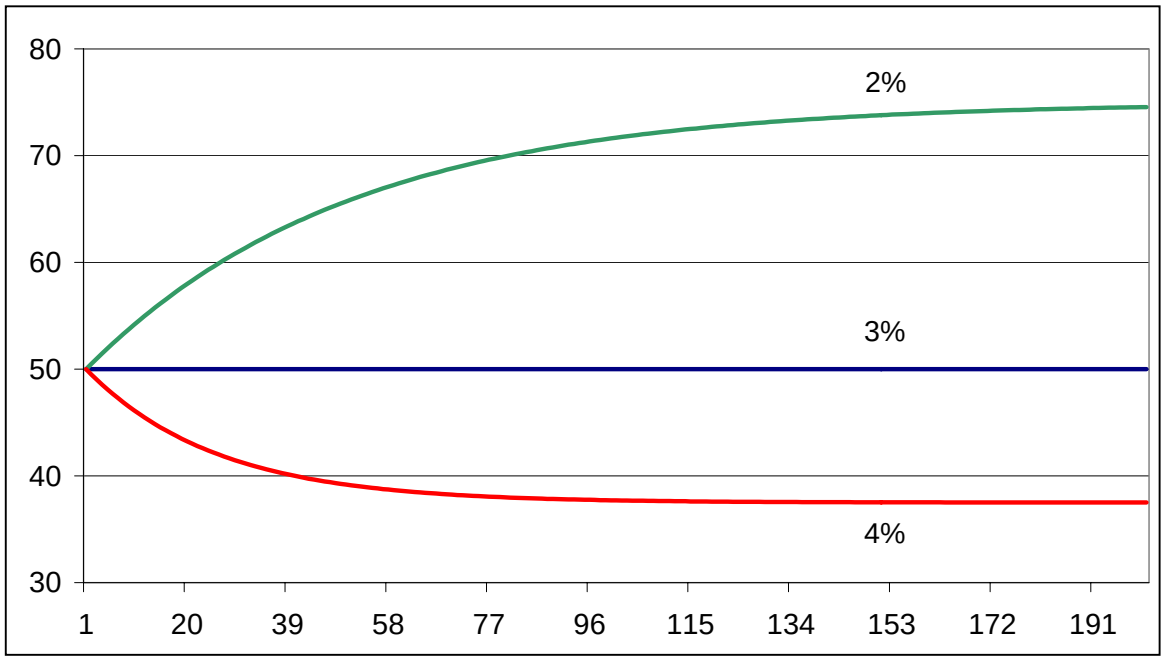
Sources: Kamps (2004), OECD.

With the caveats in mind, our crude measure of net worth would seem to have turned negative in all pre-enlargement EU countries by the mid-1990s. Two decades ago public debt was more than fully backed by public capital in the majority of the countries. However, in the second half of the 1990s that was no longer the case in any single country, with the gap above 15 percentage points of GDP in 9 out of the 14 countries.

Having described the evolution of public investment and public capital stocks during the past 30 years, let us conclude by taking a glimpse forward in time. Specifically, let us see how public capital stocks would evolve in the very long term on current trends.

On average, public capital stocks in non-cohesion countries amount currently to some 50 percent of GDP. Assuming that annual public investment stays at 1.5 percent of GDP (as it is in the five countries where the drop has been steepest), the figure below shows how the ratio of public capital to GDP would evolve over a 200-year horizon under three different assumptions about the depreciation rate (2, 3, and 4 percent, respectively).

Figure 9. Projected evolution of public capital stock over 200 years (in percent of GDP) with different depreciation rates.



Source: Authors' calculations.

That is, the public capital stock would remain unchanged relative to GDP with a 3 percent depreciation rate, while it would converge to just below 40 percent of GDP if the depreciation rate were 4 percent. With a 2 percent depreciation rate the public capital stock would, in turn, converge to 75 percent of GDP.

In sum, even if the current—allegedly low—level of public investment prevailed, public capital stocks would not whither away even in the very long run.

3. DETERMINANTS OF PUBLIC INVESTMENT: PANEL DATA AND SINGLE-EQUATION ANALYSES

3.1. Model specification

The dependent variable in the analysis is gross fixed capital formation of the general government (in percent of trend GDP).[4] As regards the explanatory variables to be employed, Turrini (2004) suggests a set of general economic and fiscal variables based on a theoretical model of public investment determination. In that model, the level of public investment is determined by the government's objective to reach the possibly mutually inconsistent targets for output, public debt, and the budgetary balance. The resulting explanatory variables include trend output, output gap, primary fiscal balance (total revenues less non-interest spending)[5], public debt, and the long-term real interest rate. In addition, to capture the possible impact on public investment that EMU may have had through the fiscal constraints that it imposes, membership in EMU is added as another explanatory variable.

Drawing on the above, we can spell out a number of possible model specifications for the panel data analysis. In the simplest specification, we regress the gross fixed capital formation of the general government (*gfcf*) on the lagged level of real output (*y*); on lagged real long-term interest rates (*r*); on lagged public debt (*debt*)[6]; and on a dummy variable to account for the participation of the respective economy in EMU (*emu*). Excluding country-specific constants and time trends this specification becomes:

$$gfcf_{it} = \alpha + \beta_1 y_{it-1} + \beta_2 r_{it-1} + \beta_3 debt_{it-1} + \beta_4 emu_{it} + u_{it} \qquad (1)$$

[4] "Gross fixed capital formation of the general government" is abbreviated GFCF, and it is used interchangeably with "public investment" in the text.

[5] This explanatory variables includes thus public investment (the dependent variable), which may be problematic for the empirical analysis.

[6] As regards the timing of fiscal decisions, we adopt the assumption in Turrini (2004) that the fiscal authority takes the budgetary decisions for period *t* in period *t-1*, on the basis of the values for prevailing interest rates and the level of debt at time *t-1*.

This is also the model for the single-equation country-by-country estimations, due to the relatively short sample period.

In the second panel specification, we add the lagged net lending (overall surplus) of the general government:

$$gfcf_{it} = \alpha + \beta_1 y_{it-1} + \beta_2 r_{it-1} + \beta_3 debt_{it-1} + \beta_4 emu_{it} + \beta_5 lend_{it-1} + u_{it} \quad (2)$$

Dividing net lending into current receipts (*currec*) and current disbursements[7] (*curdis*) gives us a third and final panel specification:

$$gfcf_{it} = \alpha + \beta_1 y_{it-1} + \beta_2 r_{it-1} + \beta_3 debt_{it-1} + \beta_4 emu_{it} + \beta_6 currec_{it-1} + \beta_7 curdis_{it-1} + u_{it} \quad (3)$$

As regards the expected signs for the coefficients, it is not clear a priori which sign β_1 should assume. A positive sign results if public investment moves in unison with GDP—either because infrastructure demand rises with the level of income or because public investment behaves procyclically—otherwise the coefficient assumes a negative sign.

The inclusion of the interest rate is straightforward, as the real long-term interest rate can be expected to influence investment decisions as an opportunity cost variable. Higher interest rates increase the cost of debt service, implying a negative coefficient on β_2. Fiscal sustainability considerations are captured by including the level of government debt in the estimation, with an expected negative coefficient on β_3. It is conceivable that the coefficient is larger (in absolute value terms) for high-debt economies than for low-debt economies. Net lending is added to include shorter-term budgetary considerations, with the sign of β_5 ambiguous a priori.

[7] According to the OECD data structure, net lending can be disaggregated into current receipts, less current disbursements (excluding gross interest payments), less net capital outlays. In our case, capital outlays are the dependent variable. Current receipts include direct and indirect taxes, social security contributions, other current receipts and property income paid by government. Government current disbursements include government final consumption expenditure, property income paid by government, subsidies, social security benefits paid by government, and other current payments paid by government.

The EMU dummy obtains the value one for EMU countries from 1993 to-date and zero otherwise. The year 1993 could be seen to start the post-Maastricht era, characterised by the fiscal rules embodied in the convergence criteria.[8] The effect of EMU's fiscal rules on public investment is unclear a priori, so we cannot specify the expected sign of β_4.

The signs of the coefficients β_6 and β_7 on current receipts and disbursements are also not clear a priori. Revenue-based fiscal consolidation or expansion need not necessarily imply any changes in public investment; however, if public investment is used to support tax-based fiscal tightening or loosening, β_6 would obtain a negative value. Expenditure-based fiscal consolidation or expansion, in turn, can be implemented across-the-board, with both current and capital spending moving in unison (implying a positive value for β_7) or by changing the composition of public spending, with the two spending categories moving in opposite directions (implying a negative value for β_7). The latter is particularly the case if political economy considerations regarding the relative ease of cutting public investment are predominant.

3.2. About the data and estimation methodology

We use annual data from 1970 to 2003 for the ten EU member states where public investment has declined during the sample period: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Sweden and the United Kingdom (henceforth EU-10). Similar data are used for the cohesion countries Greece, Ireland, Portugal and Spain that are used as the control group in the panel estimation. Luxembourg is excluded from the analysis due to inadequate data availability. Unless otherwise indicated, the data originate from the OECD Economic Outlook Database No. 75.

The models are estimated considering the dependent variable as well as all fiscal variables (public debt; net lending of the general government; current receipts; and

[8] The Maastricht treaty was signed in February 1992. In the study by Gali and Perotti (2003), the post-Maastricht period is assumed to start in 1992. Alternatively, the approach by the European Commission (2003) and Turrini (2004) could be used, where the dummy obtains a value of one only from 1994 onwards, corresponding to the start of the second phase of the EMU.

current disbursements) as ratios to trend GDP, the latter calculated by a Hodrick-Prescott filter[9]. The estimation period starts in 1972 in order to limit the end-of-sample bias caused by filtering in the beginning of our estimation period. Possible autocorrelation of public investment decisions is accounted for by including the lagged dependent variable as a regressor, but only in the single equation estimations as it could cause estimator bias in the fixed effects panel estimation.

The choice of the explanatory output variable (*y*) in the model specifications presented in the previous section warrants a comment as it contrasts with earlier literature on two accounts. First, instead of using both trend output and output gap as explanatory variables, we only use cyclically unadjusted output (in logs). [10] This reduces both the risk of spurious correlation between the dependent and explanatory variables and the risk of multicollinearity, as both public investment and all fiscal variables are measured in relation to trend GDP. Second, instead of relating the output variable to the size of population, as in European Commission (2003) and Turrini (2004), we use the level of real GDP so as to focus on movements in aggregate output and so as to abstract from volatility caused by demographic changes alone. [11]

To tackle the possible endogeneity problem between public investment and output, we use lagged output in both panel and single-equation OLS estimations. As explained in footnote 7, this is consistent with the fiscal authority deciding the level of public investment for period *t* on the basis of information about the period *t-1* outcome of the explanatory variables.

Finally, a few remarks on the transformation of the fiscal variables. First, we use cyclically adjusted fiscal data throughout to allow us to focus solely on the impact of discretionary fiscal measures on public investment. This will also serve to reduce the correlation between the fiscal and the output variables. Second, the inclusion of both

[9] Estimations with the series expressed in relation to potential GDP are performed as robustness tests, with the potential output series provided as such by the OECD.
[10] As an extension to the basic analysis, we estimate the models with the output gap (calculated by the OECD), but without including trend GDP as a separate explanatory variable. The OECD output gap is expressed as the difference of actual GDP from potential GDP in percent of potential GDP.
[11] The German data for real GDP is adjusted for unification by taking the difference between West German and German series for 1991 and using this difference to adjust the West German series (the level) before 1991. The German GDP data are from Eurostat.

debt and deficit variables in model specification (2) does not appear to be a significant problem in our sample. The average correlation coefficient between these two variables is –0.19, with the maximum value at 0.50 (for Germany) and the minimum value at –0.69 (for the Netherlands). Finally, the (lagged) net lending variable appearing in that model specification includes the lagged dependent variable, which could be a source of estimator inconsistency, as pointed out above.

Turning to the time-series properties of the data, two different panel unit root tests are conducted for the EU-10 subsample. As the cross-sectional dimension of the panel is not large, a panel unit root test by Levin, Lin and Chu (LLC henceforth, see Levin *et al*., 2002, for details) was considered. The model allows for fixed effects and unit-specific time trends, whereas the coefficient on the lagged dependent variable is restricted to be homogeneous across all units of the panel. In contrast, the Im, Pesaran and Chin (IPS henceforth, see Im *et al*., 1997) test allows for individual unit root processes, letting the coefficient on the lagged dependent variable to vary across cross sections. While the alternative hypothesis to the null of unit root in the LLC test is that all series are stationary, the alternative in the IPS framework is that some cross-sections are without unit root. Both Akaike and Schwarz information criteria were used in order to determine the lag length of the tests.

The results from the LLC panel unit tests for the EU-10 member states suggest predominantly that the series are stationary or trend stationary (see Annex 1 for a complete listing of the test results). For most series we are able to reject the null hypothesis of integratedness at 5 percent significance level when Schwarz information criteria is used to determine the lag length, in both the LLC and IPS tests. The only exception is net lending to trend GDP, where the LLC test rejects the null hypothesis of stationarity. Using the Akaike information criteria, the finding of stationarity is somewhat weaker. In this case, stationarity is rejected at 5 percent level in the LLC test for real GDP, output gap and net lending to trend GDP. However, the IPS test still cannot reject stationarity in any of these three cases, suggesting that at least some of the series are without a unit root. Consequently, even with a small probability of integrated series (including the possibility of cointegration), all single equation and panel data models are estimated in levels as shares to trend GDP, with a time trend

included in the estimated model to capture the possible trend-stationarity of the dependent and explanatory variables.

3.3. Estimation results

3.3.1. Panel data estimation

Below we display the results from the panel estimation for the EU-10 member states where public investment declined during the sample period. We use fixed effects models, with country-specific constants and time trends. The model specifications are identical to the ones presented in section 3.1.

Table 1. Panel estimation results, OLS fixed effects, EU10 member states, 1972-2003.

	Model		
	(1)	(2)	(3)
y	**0.0489**	**0.0323**	**0.0378**
	(2.75)	(2.19)	(2.97)
r	**0.0266**	**0.0270**	0.0169
	(1.65)	(2.19)	(0.86)
debt	**-0.0099**	**-0.0182**	**-0.0193**
	(-1.68)	(-3.23)	(-3.57)
net lending		**-0.0438**	
		(-3.51)	
current receipts			0.0072
			(0.35)
current disbursements			0.0277
			(0.94)
EMU	0.0016	0.0017	0.0014
	(0.98)	(1.12)	(0.92)
adjusted R2	0.87	0.89	0.89
observations	301	285	285

Note: Dependent variable gross fixed capital formation of the general government, as a share of trend GDP. All explanatory variables are lagged by one period, with *t*-values in parentheses (significance at the 10% level is indicated in bold). White standard errors robust to heteroskedasticity and serial correlation were used. Country-specific time trends and constants are not displayed.

Output is a statistically significant explanatory variable in all models, obtaining a positive coefficient. This contrasts with the findings by European Commission (2003), who find a significant but negative coefficient for a comparable output variable.[12] Our estimation results suggest that a one percent change in real GDP leads to a change in the ratio of public investment to GDP of between 0.03 and 0.05 percentage points.[13] When real GDP is replaced by output gap as the (cyclical) indicator of output, the latter variable is significant and positive in all specifications, providing evidence of procyclical behaviour of public investment.[14] This result is in line with the finding of Galí and Perotti (2003) that the behaviour of public investment is "mildly procyclical" in EMU countries (see also footnote 17).

The estimated coefficients for the aggregated fiscal variables suggest that public investment tends to move in tandem with discretionary changes in fiscal policy but to smooth out movements in public debt. The coefficient for the (cyclically adjusted) net lending variable is significant and negative, so active fiscal consolidation efforts appear to have hit public investment, while public investment has increased during episodes of discretionary fiscal expansion. The debt variable is always significant and negative, as in other studies, implying that public investment acts so as to smooth out movements in public debt. The estimated coefficient implies, e.g., that a 10 percentage point increase in public debt (in percent of trend GDP) will lead to a 0.1—0.2 percentage point decline in public investment (in percent of trend GDP). The real long-term interest rate obtains a positive but only weakly significant coefficient, suggesting that financing cost considerations have not played an economically sensible role in determining public investment decisions.

The consideration of disaggregated budgetary variables does not add to the model's explanatory power in the case of non-cohesion countries, as their coefficients are not

[12] If time trends are omitted from our estimation, the coefficient for the real output variable becomes indeed significantly negative in all the three specifications at 5 percent level. Moreover, when time trends are included but not specified to be country-specific, the R-squared value for all three models falls below 0.75. This can be seen to confirm the existence of country-specific effects and to justify the inclusion of country-specific time trends in the panel estimation on the one hand and the use of single-equation models on the other hand.

[13] Note that changes in the GDP variable are relative as its values are expressed in logs while the changes in all other variables are absolute. This affects the interpretation of the estimated coefficients, as indicated in the text.

[14] The coefficients on other variables remain significant and relatively robust to a change in the output variable used.

significantly different from zero. Therefore, it does not appear that discretionary fiscal effort based only on either expenditure or revenue-side measures would have had a significant impact on public investment.

The EMU dummy (defined as a post-Maastricht dummy variable) obtains a positive sign in our estimations, but it is never individually significant. The same is true for the interaction terms between the EMU dummy and the net lending variable, and the dummy and the public debt variable, also in the models including the output gap variable (not reported in Table 1). These results suggest that EMU has not had any statistically significant impact on public investment in non-cohesion countries either directly or indirectly through its fiscal rules. We additionally tested for a dummy variable that obtains a value of one only from 1994 onwards, in line with the European Commission (2003) and Turrini (2004), but the dummy variable was not individually significant in this specification either.[15]

When the series with respect to potential GDP were considered, the main results do not change. Output still obtains a highly significant positive coefficient, and it is of a similar magnitude. This is also the case for the coefficient on the negative debt variable. The main difference is that the coefficient on current receipts turns significant and negative in specification (3), which would imply that public investment supports revenue-based fiscal effort by declining (increasing) when the fiscal stance is tightened (loosened) by raising (lowering) taxes.

Table 2 below replicates the panel data estimations of the previous table, now conducted for the cohesion countries Greece, Spain, Ireland and Portugal that constitute our control group to test the usefulness of the estimated model outside the main sample.

[15] However, in this case the inclusion of the interaction terms in model specifications 1 and 2 makes the dummy itself significant. The interaction terms would remain insignificant. In model specification 3 neither the dummy nor the interaction terms are significant.

Table 2. Panel estimation results, OLS fixed effects, cohesion countries, 1972-2003.

	Model		
	(1)	(2)	(3)
y	**0.0977**	**0.0913**	**0.0767**
	(2.32)	(7.33)	(6.92)
r	0.0391	0.0632	**0.0708**
	(0.72)	(1.59)	(2.23)
debt	0.0032	**-0.0194**	**-0.0453**
	(0.35)	(-3.85)	(-15.83)
net lending		**-0.0710**	
		(-1.92)	
current receipts			**0.0639**
			(3.16)
current disbursements			**0.0790**
			(3.38)
EMU	0.0005	0.0021	0.0005
	(0.11)	(0.47)	(0.10)
adjusted R2	0.46	0.66	0.71
observations	97	87	87

Note: Dependent variable gross fixed capital formation of the general government, as a share of trend GDP. All explanatory variables are lagged by one period, with *t*-values in parenthesis (significance at the 10% level is indicated in bold). White standard errors robust to heteroskedasticity and serial correlation were used. Country-specific time trends and constants are not displayed.

The overall R-squared value is lower than for the EU-10 member states, but the results are similar to the ones obtained in Table 1, suggesting that the model is a reasonable one for the assessment of public investment determination more generally. Output still obtains a significant positive coefficient, notably double the magnitude compared to the EU-10 member states, with a one percent change in GDP moving public investment (in percent of trend GDP) by as much as 0.1 percentage points.[16] The coefficient for the real interest rate variable is positive but significant only in the third specification. The government debt variable has a significant negative coefficient in two model specifications; similarly, the net lending variable obtains a

[16] When output gap is used instead, it is found to be significant in all the specifications at 1 percent level. Similarly to the case of the non-cohesion counties, its use increases the significance of the debt variable in the first specification, as it becomes negative and significant at 1 percent level. In contrast, neither net lending in the second nor real interest rate in the third specification are now significant at 10 percent level.

negative coefficient in the second specification. The coefficients for the revenue and expenditure variables are now both significant and positive, suggesting that public investment supports expenditure-based discretionary fiscal efforts but counteracts revenue-based efforts. The EMU dummy is insignificant also for the cohesion countries, both when included individually and when included together with the interaction terms with the fiscal variables. This insignificance is further confirmed by testing with the alternative dummy specification that only yields a value one starting in 1994; in this case, both the individually included dummies and interaction variables are insignificant for all the model specifications.

3.3.2. Single-equation estimation

The table below displays the results of the country-by-country single equation analysis, using an OLS estimation procedure.

Table 3. Single equation OLS estimates, 1972-2003.

	y	*r*	*debt*	*emu*	$gfcf_{t-1}$	*time*	*R2*
Austria	**0.0528**	-0.0804	0.0261	0.0021	**0.4124**	**-0.0026**	0.98
	(1.92)	(-1.28)	(1.39)	(0.87)	(1.87)	(-2.23)	
Belgium	**0.0412**	0.0158	**-0.0090**	0.0024	**0.6366**	**-0.0012**	0.97
	(1.76)	(0.50)	(-1.73)	(1.28)	(4.24)	(-2.18)	
Germany	**0.1000**	**-0.0700**	-0.0142	-0.0003	0.1553	**-0.0024**	0.98
	(6.67)	(-2.75)	(-1.63)	(-0.17)	(1.23)	(-5.97)	
Denmark	0.0246	0.0290	-0.0002		**0.4131**	-0.0005	0.71
	(1.41)	(0.78)	(-0.05)		(2.15)	(-1.54)	
Finland	**0.0374**	0.0132	0.0132	**-0.0071**	0.0797	**-0.0011**	0.88
	(2.51)	(0.92)	(1.44)	(-2.12)	(0.52)	(-2.11)	
France	0.0225	**0.0757**	**-0.0306**	-0.0004	0.0088	0.0001	0.90
	(1.21)	(3.58)	(-2.92)	(-0.36)	(0.05)	(0.10)	
Italy	**0.0357**	-0.0131	-0.0045	-0.0041	**0.5419**	-0.0005	0.84
	(1.96)	(-0.66)	(-0.95)	(-1.58)	(4.67)	(-1.14)	
Netherlands	0.0169	-0.0046	**-0.0114**	-0.0007	**0.4618**	-0.0004	0.93
	(1.21)	(-0.26)	(-2.61)	(-0.61)	(3.84)	(-1.13)	
Sweden	**-0.0629**	0.0237	**-0.0191**		**0.5304**	**0.0013**	0.89
	(-3.10)	(1.06)	(-3.43)		(6.36)	(3.11)	
UK	**0.04**	0.0261	-0.0112		**0.7283**	**-0.0013**	0.95
	(2.41)	(1.46)	(-1.54)		(6.99)	(-2.65)	

Note: Dependent variable gross fixed capital formation of the general government, as a share of trend GDP. t-values in parentheses (significance at the 10% level is indicated in bold).

The estimation results need to be taken with a pinch of salt due to the short sample period available. However, they do provide some further insights into differences across countries in the determination of public investment. Firstly, the coefficient on the level of real output obtains a positive sign in most countries, being significant for Austria, Belgium, Finland, Germany, Italy and the UK. The coefficient is significant but negative in the case of Sweden, suggesting that public investment has declined as national income has increased.[17]

Public debt obtains a negative coefficient in all countries except Finland and Austria, but the negative coefficients are significant at conventional levels for only four countries. Interestingly, however, we do not find evidence for the hypothesis that high debt countries would have actually reduced public investment the most: in France, the Netherlands and Sweden, where the debt variable is negative and significant, the average debt level in the period 1970-2003 was lower than the sample average.

The signs for the coefficients for the real long-term interest rates and the EMU dummy vary between countries, and are mostly insignificant. The EMU dummy was only found to be significant for Finland. Testing again for an alternative specification for the EMU dummy, giving it a value of one from 1994 onwards, makes it insignificant even for Finland.

We performed misspecification tests for the single country models, using Jarque-Bera tests for normality, the Breusch-Godfrey test for autocorrelation and an ARCH-LM test both with 1 and 4 lags, and the White heteroskedasticity test. The results from the tests are listed in Annex 2. The misspecification tests do not, for the most part, lead to a rejection of our estimated models. Nonnormality cannot be rejected for Italy, however, and there is some serial correlation in the residuals in the case of Belgium. Finally, for the U.K. we find some evidence of ARCH effects at 5 percent level.

[17] Output gap is insignificant for Austria, Belgium, Denmark, Italy and the Netherlands. Note that real GDP was also found to be insignificant for Denmark and the Netherlands. In contrast, output gap obtains a significant and positive coefficient for Finland, France, Germany and the United Kingdom. It obtains a significant and negative coefficient for Sweden, suggesting countercyclical behaviour of public investment there.

3.4. Cross-section analysis to test the saturation hypothesis

As mentioned in the Introduction, one hypothesis links the long-term trend decline in public investment to a reduction in the demand for additional infrastructure services. Underlying this hypothesis is the argument that developed countries' infrastructure networks are already so extensive that there is little, if any, need to expand them further. In economic terms this would imply that the marginal productivity of (public) investment in new infrastructure is converging to zero, with public capital stocks close to their optimal sizes.

To assess the validity of this hypothesis, one can test whether the level of public investment is determined by the size of the public capital stock. As the estimates for public capital stocks presented in section 2.2. have been compiled using data on public investment flows, the two variables are linked by construction. This precludes the use of methods of time-series analysis to assess the link between public investment and public capital.

We therefore ran cross-section regressions with model specification (1)—excluding the real interest rate variable and the EMU dummy that proved insignificant in the panel data analyses—augmented with the size of the public capital stock as another explanatory variable for EU-14 for the years 1980, 1990, and 2000. The public capital stock was measured both in terms of GDP and in terms of PPP-adjusted USD per capita.

The overall performance of the model was relatively weak, thus rendering the results speculative rather than conclusive.[18] Nevertheless, the coefficient for the public capital stock variable was consistently statistically insignificant. Additional analysis is obviously needed to test the link between public capital and public investment, with a special focus on model specification. As a first approximation, however, our evidence goes against the saturation hypothesis.

[18] The detailed results are available upon request.

4. DETERMINANTS OF PUBLIC INVESTMENT: COINTEGRATION ANALYSIS

While the results reported above allow us to conclude that fiscal factors unrelated to the institutional arrangements of EMU have had a negative impact on public investment, they do not allow us to distinguish between the short-term and long-term determinants of public investment.[19] However, as seen in section 2 and quantified in section 3.2., the long-term downtrend is the key characteristic of public investment in EU-10, so it is of special interest to focus on the long-term determinants of public investment.

To this end, we perform an analysis of the possible existence of common stochastic trends, i.e. cointegration relationships, among public investment, budgetary position, and public debt. More precisely, the variables included comprise gross fixed capital formation of the general government; net lending by the general government (overall surplus—excluding gross fixed capital formation); and public debt. [20] All variables were expressed in real terms and in logarithms, which is in contrast to the panel data analysis, where all variables except for real GDP were expressed in relation to trend GDP. While the numerical results from the panel data and cointegration analyses are therefore not directly comparable with one another, the two analyses will nevertheless give us a coherent overall picture of the determinants of public investment.

The country sample in this analysis is limited to six non-cohesion countries due to data availability. In order to get reasonably robust estimates, a sufficient number of observations are required in the cointegration testing. The cointegration analysis has therefore to be limited to those countries for which quarterly data are available (using the OECD database referred to above). The country sample includes (with the starting date of the sample in parenthesis) Austria (1970), Finland (1975), France (1977), Germany (1971), the Netherlands (1970), Sweden (1970) and the United Kingdom

[19] The estimations with the output gap can, however, be regarded as providing evidence of short-term (cyclical) determinants of public investment.

[20] All these variables were found to be I(1) in unit root tests (first differencing is needed to make the series stationary) and can therefore be used to study common stochastic trends. Note that the variables used in the panel data and single-equation analyses, which were expressed in relation to trend GDP, were found to be stationary or trend-stationary. Cointegration in its usual sense should not exist between stationary variables.

(1970). However, cointegration testing found no robust evidence for a cointegrating relationship in Sweden, and when a cointegration relation was nevertheless estimated, the stability tests provided evidence of an unsatisfactory model. For all other countries (Austria, Finland, France, Germany, and the Netherlands), the tests predominantly suggested a cointegration rank of one between all the three variables.[21]

The Johansen procedure was used in the estimation of the cointegration relationship, with the following order for the endogenous variables: investment, debt, deficit. The coefficient on the public investment variable was then normalised to one. The results are reported in Table 4.[22]

Table 4. Results of cointegration analyses

	Debt	Net lending
Austria	-0.386	**-1.651**
	(1.165)	(4.602)
Germany	**-0.254**	**0.307**
	(2.082)	(3.865)
Finland	-0.205	**-0.413**
	(0.959)	(3.840)
France	0.593	**-1.834**
	(0.492)	(4.818)
Netherlands	**-0.689**	**-0.262**
	(4.677)	(2.376)
UK	**3.147**	**-1.551**
	(7.103)	(5.983)

Note: t-values in parentheses (significance at the 10% level is indicated in bold). Time trends not reported.

[21] Cointegration tests were conducted by the Johansen test (see Johansen, 1995) for all countries except Germany. For Germany, the Saikkonen-Lütkepohl test was used (see Saikkonen and Lütkepohl, 2000) as the test allows for the inclusion of shift dummy variables. Such a variable was necessary to account for the structural shift during the German unification. Lag length for the models was determined on the basis of the size of the estimation sample, coupled with results from the misspecification tests, while the lag length for cointegration tests was determined by the Akaike, Hannan-Quinn and Schwarz information criteria. For the UK and Germany, results from bivariate tests did predominantly not indicate the existence of cointegrating relationships (similarly to Sweden). We nevertheless estimated a cointegrating relationship due to the rather strong finding of a cointegrating relation when all three variables were included in the estimation, and due to the satisfactory performance of the estimated system in the stability tests.

[22] For diagnostic checking of the estimated models, we used the Portmanteau and the Breusch-Godfrey tests for residual autocorrelation, the Jarque-Bera tests for nonnormality and the ARCH-LM tests for autoregressive conditional heteroskedasticity in the residuals (the latter two tests based on single equations of the system).

We can think of the cointegration relationship as a fiscal reaction function, where public investment is related to both public debt and the net lending position of the government. Then, a negative coefficient on government debt would imply that a long-term increase in public debt is associated with a downtrend in gross fixed capital formation of the government. Similarly, a negative coefficient on the net lending variable implies that trend fiscal consolidation (an increase in net lending) would be supported by a downtrend in public investment.

The fact that we observe negative coefficients for both variables in the results reported above should be interpreted so that long-term fiscal consolidation efforts aimed at reducing budget deficits and public debt have been associated with a trend decline in public investment. That fiscal positions have indeed remained in deficit means that public debt has still increased—thus the negative coefficient on the debt variable. The role of fiscal consolidation, including through a trend decline in public investment, would then have been to slow down the accumulation of public debt.

This is, indeed, what seems to characterise the Netherlands. Also in Austria and Finland the signs of the coefficients point to this explanation; however, the statistical insignificance of the coefficient on the debt variable suggests that the direct link between trends in public debt and public investment is weak. Also in France the debt variable is insignificant. In Germany the coefficient on the public debt variable is negative and significant—suggesting that the downtrend in public investment is linked to an uptrend in public debt—but the net lending variable assumes a positive and significant coefficient. This combination of signs would seem to suggest that the decline in public investment in Germany has been associated with trend increases in fiscal deficits and public debt. In other words, declining public investment has slowed down the widening of budget deficits, while other factors have kept it on an uptrend. Finally, in the UK trend fiscal consolidation has been associated with declining public investment; however, trends in public investment and public debt seem to move in unison. This result could arise if a golden rule had been in place; however, based on the results reported above one cannot go so far as to infer that an (implicit) golden rule would have been in operation.

As all variables in the cointegration analysis were expressed in real terms and in logs, the interpretation of the estimated coefficients is straight-forward. The coefficient for the public debt variable, which is negative and significant in Germany and the Netherlands, suggests that each one percent increase in real public debt is associated with a 0.03—0.07 percent real decline in public investment. Each one percent reduction in the budget deficit (again in real terms), in turn, tends to be associated with a 1.5 percent real decline in public investment, less so in Finland.

When considering the results of the cointegration analysis, one should be mindful of their interpretation and relation to the results of the panel data and single-equation analyses. As regards the results of the cointegration analysis, they inform us about long-term common trends among the variables included in the analysis. Therefore, one should interpret the estimated coefficients as expressing how, on average, the trends of two variables are related. Consequently, using the coefficient estimates quoted above, if public debt is on an uptrend, each 10 percent increase in it is associated with roughly 0.5 percent trend decline in real public investment.

As regards the comparability of the results from the cointegration analysis with those from the panel data and single-equation analyses, one can compare the signs of the estimated coefficients but not the coefficient estimates themselves. This is because the panel data and single-equation analyses used the variables of interest in relation to trend GDP, while the cointegration analysis had to be conducted using the variables in real level terms. Therefore, with a high level of budgetary deficit and a relatively speaking low level of public investment, for example, a small percentage decline in the former can conceivably be associated with a large percentage decline in the latter. This would imply a large absolute value for the estimated coefficient on the net lending variable in the cointegration analysis, as was indeed the case for a few countries. Such a result can be fully consistent with a small estimate for the coefficient on the net lending variable in the panel data analysis, where both public investment and net lending are measured in relation to trend GDP and where the coefficient estimate measure changes in terms of percentage points of trend GDP.

Against this background, the results of the cointegration analysis are consistent with the results of the panel data analysis reported in Table 1. While it is indeed difficult to

compare the magnitudes of the estimated coefficients due to the different ways to express the variables in the two analyses, it is clear that the signs are the same. The fact that the public debt variable appears more significant in the panel data analysis is related to the different country samples and different variable definitions in the two analyses.

The results are also broadly consistent with findings from the single equation estimations reported in Table 3. For Austria, where no other variables except for output and lagged investment were significant in the single equation analysis, only net lending was found to be significant in the cointegration relation. For Germany, we confirm the negative sign for the coefficient on public debt that has now become significant, in addition to finding the positive relationship between net lending and investment. For Finland, the coefficient on debt was found to be statistically insignificant both in the single equation and the cointegration framework. For France, debt is not significant in the cointegration relationship, in contrast to the finding from the single equation estimations. The results for the Netherlands are in line with the ones from single equation, as the significance and sign of debt is confirmed. Finally, for the UK we find that whereas debt was statistically insignificant in the single equation framework, it was actually significant in the cointegration relation.

5. ECONOMIC INTERPRETATION OF RESULTS

The econometric analyses reported above pinned down a set of macroeconomic variables that exert a statistically significant influence over the evolution of public investment in the pre-enlargement EU during the past three decades. Most notably, public investment has been determined by fiscal policy considerations, both short and long term, with the fiscal rules of the EMU, however, not playing any significant role. In addition, public capital (infrastructure) has characteristics of a luxury good (demand increasing with income), as suggested by the finding that higher levels of GDP tend to be associated with higher public investment in relation to trend GDP, *ceteris paribus*. Also, public investment was found to behave procyclically in a few sample countries. Neither the cost of financing nor the size of the existing public capital stock are statistically significant determinants of public investment.

This concluding section aims to provide an assessment of the macroeconomic, as opposed to statistical, significance of the results obtained and, moreover, to offer a unified and coherent qualitative interpretation of the results of the individual analyses. The discussion is focussed on the results pertaining to non-cohesion countries.

First, the results of the panel data analysis underlined the significance of the long-term downtrend of public investment in non-cohesion countries.[23] Recall that the estimated coefficients for EU-10 (Table 1) suggested that every one percent real GDP growth will increase public investment by 0.04 percentage points of GDP (or by 2 percent, if the initial level were 2 percent of GDP). On the other hand, public investment would decline by the same amount, ceteris paribus, with a discretionary fiscal contraction of 1 percentage point of GDP or with an increase in public debt by 2 percentage points of GDP. Consequently, real GDP growth alone would have increased public investment by some 5 percentage points of GDP in EU-10 during our entire sample period. However, this increase has been more than offset by the negative impact of fiscal consolidation, continued increase in public debt (as net lending has remained negative), and the downward sloping time trend. Based on the estimated coefficients, fiscal consolidation and the increase in public debt seem to have reduced public investment in EU-10 by some 3 percentage points of GDP. Given that public investment in EU-10 has declined by some 2 percentage points of GDP over the sample period, the time trend therefore accounts for a decline of 4 percentage points of GDP.

Second, the results of the single-equation and cointegration analyses (Tables 5 and 6) allow us to distinguish country groups that differ from one another in terms of what has been driving the long-term downtrend in public investment. In Germany and the Netherlands the evolution of public investment has been directly linked to fiscal sustainability concerns, with increasing public debt depressing public investment. In the Netherlands efforts to reign in budget deficits—obviously for the ultimate purpose of strengthening fiscal sustainability—have also had a direct negative impact on public investment, while in Germany the slowdown in public investment has just

[23] It is worth emphasising that the time trend included as an explanatory variable serves to capture the variables' trend stationarity and thus also possible differences between individual variables' time trends.

limited the widening of budget deficits. Notably, in neither country have the fiscal sustainability or budgetary consolidation considerations been related to EMU.

Another distinct group consists of those countries where the downtrend in public investment is directly related to prolonged episodes of budgetary consolidation only, with public debt considerations only indirectly responsible for the downtrend. This group includes Austria, Finland, France, and the UK. Again, the budgetary consolidation efforts have not been linked to EMU, with only Finland showing weak evidence that EMU may have had a direct negative, albeit miniscule, impact on the level of public investment.

The final group consists of those countries for which a cointegration analysis could not be conducted (Belgium, Denmark, Italy, and Sweden). Based on the single-equation analyses for the countries it can be inferred that the downtrend in public investment has been linked to fiscal sustainability concerns in Belgium and Sweden. In Italy and in Denmark the only other visible explanation for the behaviour of public investment has been autocorrelation, i.e., public investment decisions in any year are strongly dependent on the investment undertaken the year before.

Table A1: Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) panel unit root test for EU-10, 1972-2003

Series	Deterministic term	Information criteria for lag length	test	test statistic	p-value
Real GDP	*f, t*	AIC	LLC	1.352	0.912
			IPS	-2.871	0.002 ***
		SC	LLC	-1.800	0.036 **
			IPS	-3.689	0.000 ***
Output gap	*f*	AIC	LLC	-0.934	0.175
			IPS	-5.367	0.000 ***
		SC	LLC	-3.320	0.001 ***
			IPS	-5.778	0.000 ***
Real interest rate	*f*	AIC	LLC	-3.461	0.000 ***
			IPS	-3.688	0.000 ***
		SC	LLC	-2.723	0.003 ***
			IPS	-3.113	0.001 ***
	f, t	AIC	LLC	2.258	0.988
			IPS	0.698	0.758
		SC	LLC	0.806	0.790
			IPS	1.282	0.900
Debt to trend GDP	*f*	AIC	LLC	-2.831	0.002 ***
			IPS	-1.333	0.091 *
		SC	LLC	-3.619	0.000 ***
			IPS	-2.388	0.009 ***
	f, t	AIC	LLC	1.086	0.861
			IPS	-1.147	0.126
		SC	LLC	0.068	0.527
			IPS	-1.303	0.096 *
GFCF to trend GDP	*f*	AIC	LLC	-3.871	0.000 ***
			IPS	-3.496	0.000 ***
		SC	LLC	-4.145	0.000 ***
			IPS	-3.679	0.000 ***
	f, t	AIC	LLC	-1.280	0.100
			IPS	-2.322	0.010 **
		SC	LLC	-2.521	0.006 ***
			IPS	-2.369	0.009 ***
Net lending to trend GDP	*f*	AIC	LLC	-1.116	0.132
			IPS	-2.826	0.002 ***
		SC	LLC	-1.192	0.117
			IPS	-2.156	0.016 **
	f, t	AIC	LLC	-1.325	0.093 *
			IPS	-2.530	0.006 ***
		SC	LLC	-0.934	0.175
			IPS	-0.777	0.219
Current disbursements to trend GI	*f*	AIC	LLC	-5.242	0.000 ***
			IPS	-4.926	0.000 ***
		SC	LLC	-5.136	0.000 ***
			IPS	-4.368	0.000 ***
	f, t	AIC	LLC	-0.655	0.256
			IPS	-0.496	0.310
		SC	LLC	-0.899	0.184
			IPS	-0.020	0.492
Current receipts to trend GDP	*f*	AIC	LLC	-2.987	0.001 ***
			IPS	-2.386	0.009 ***
		SC	LLC	-2.581	0.005 ***
			IPS	-1.724	0.042 **
	f, t	AIC	LLC	-3.839	0.000 ***
			IPS	-3.280	0.001 ***
		SC	LLC	-3.441	0.000 ***
			IPS	-2.528	0.006 ***

Tests conducted according to the lag length indicated by Akaike (AIC) and Schwarz (SC) information criteria.
Asterisks ***, **, and * denote significance at 1%, 5% and 10% level, respectively.
f and *t* denote fixed effects and individual effects and trends, respectively

Table A2. Misspecification tests for the full model

	Jarque-Bera		*Breusch-Godfrey LM*				*ARCH-LM*				*White test*	
			1 lag		*4 lags*		*1 lag*		*4 lags*			
	test stat	*prob*	*test stat*	*prob*	*test stat*	*prob*	*test stat*	*prob*	*test stat*	*prob*	*test stat*	*prob*
Austria	0.82	0.67	0.60	0.45	1.62	0.21	0.20	0.65	0.83	0.52	1.59	0.18
Belgium	1.05	0.59	0.05	0.82	3.95	**0.02**	2.10	0.16	0.05	0.99	1.15	0.37
Germany	0.91	0.64	0.44	0.51	0.40	0.81	0.18	0.68	0.35	0.84	2.24	0.06
Denmark	0.96	0.62	0.13	0.72	0.89	0.50	0.71	0.41	0.67	0.63	2.10	0.11
Finland	0.94	0.62	0.03	0.88	1.82	0.17	0.54	0.47	0.45	0.77	1.09	0.42
France	0.95	0.62	0.36	0.56	1.20	0.35	0.07	0.80	0.45	0.77	1.24	0.34
Italy	22.33	**0**	0.04	0.84	1.05	0.40	1.82	0.19	0.53	0.71	1.64	0.17
Netherlands	0.06	0.97	0.11	0.75	1.25	0.32	0.39	0.54	2.08	0.12	0.80	0.62
Sweden	1.14	0.57	0.00	0.98	2.69	0.06	0.05	0.83	0.66	0.63	1.32	0.28
UK	0.36	0.84	0.01	0.93	0.73	0.58	0.08	0.78	3.46	**0.02**	1.67	0.16

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