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Article

Infrastructure finance in Europe: Composition, evolution and crisis impact

EIB Papers

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European Investment Bank (EIB), Luxembourg

Suggested Citation: Wagenvoort, Rien; de Nicola, Carlo; Kappeler, Andreas (2010) : Infrastructure finance in Europe: Composition, evolution and crisis impact, EIB Papers, ISSN 0257-7755, European Investment Bank (EIB), Luxembourg, Vol. 15, Iss. 1, pp. 16-39

ABSTRACT

This article is the first attempt to compile comprehensive data on infrastructure finance in Europe. *We decompose infrastructure finance by institutional sector (i.e. public versus private) into its main components, which consist of traditional public procurement, project finance and finance by the corporate sector, and analyse how the roles of the public and private sectors in financing infrastructure have evolved over time, especially during the recent economic and financial crisis. In contrast with government finance that is slightly up, private finance, in particular project finance through Public-Private Partnerships, has fallen substantially during the recent crisis, reversing, at least temporarily, the longer-term trend of more private and less public financing of infrastructure.*

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The authors would like to thank Hugh Goldsmith, Armin Riess, Hubert Strauss, and Timo Välilä for many valuable comments. The usual disclaimer applies.

Infrastructure finance in Europe: Composition, evolution and crisis impact

1. Introduction

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Long-term cycles of public and private ownership and investment in infrastructure can be seen across many European countries. Concession contracts can be traced back to the ancient Greeks, and were widely used by the Romans. They were given a modern form under the Napoleonic code, allowing most 18th and 19th century infrastructure (canals, railways, water systems *etc.*) to be built using private capital, frequently with implicit or explicit subsidies or other forms of government support. Many infrastructures were subsequently taken into public ownership. In the second half of the 20th century, infrastructure finance entered a new phase with privatization, new regulation models and, last but not least, new ways of cooperation under innovative legal frameworks for Public-Private Partnerships (PPPs).[1]

But, how important is private funding of infrastructure today from a macro-economic perspective? To the best of the authors' knowledge, a comprehensive empirical description of infrastructure finance in Europe has yet to be made.

The main objective of this article is to measure the relative importance of public and private sources of infrastructure finance in Europe. We present some concrete facts and figures on (a) the roles of public and private sectors in financing infrastructure as well as the different types of financial instruments used, and (b) how these roles have evolved over time, especially during the recent economic and financial crisis.

It is important to emphasise that this exercise should be seen as the first attempt to compile comprehensive data on infrastructure finance. As will be explained in more detail below, data availability in this area is unsatisfactory. The figures presented below can and should be further refined in a number of dimensions and should, therefore, be considered as indicative only at this stage.

The remainder of this article is organised as follows. In the next section, we first decompose infrastructure finance by institutional sector (*i.e.* public *versus* private) into its main components, including traditional public procurement, project finance, and finance by the corporate sector. Our task in Section 2 consists of detecting possible differences in this decomposition across sectors of activity (*i.e.* Education, Health, Transport and Utilities). We also examine the relative use of different financial instruments in project finance. Section 3 investigates the longer-term evolution of infrastructure finance, and its relative importance in the overall economy, by considering the evolution of its share in GDP. However, since GDP came down considerably in a number of EU countries in 2009, the crisis impact on infrastructure finance cannot be derived from GDP shares alone. Section 4, which zooms in on the crisis impact, therefore presents the recent evolution of the absolute volumes of infrastructure finance sources. Section 5 concludes.

1 Välilä (2005) provides an overview of the pros and cons of PPPs as compared to traditional public procurement. Riess (2005) analyses to what extent the PPP model is applicable across sectors.

2. Composition of infrastructure finance

Infrastructure has been understood to include many different things, and a universally accepted definition has remained elusive. One well-known attempt reads (Gramlich 1994, p. 1177):

"*The definition that makes the most sense from an economics standpoint consists of large capital intensive natural monopolies such as highways, other transport facilities, water and sewer lines, and communications*".

This description characterizes what is called *economic* infrastructure. It includes the physical structures from which goods and services are produced that enter directly as common inputs to many industries (Chan *et al.* 2009). They have primarily network characteristics.

A broad definition of infrastructure would include economic infrastructure (e.g. highways and water lines) and social infrastructure such as schools and hospitals.

A broader definition would also cover so-called *social* infrastructure, most notably infrastructure in the education and health sectors (*i.e.* schools and hospitals). Social infrastructures produce services that enter *indirectly* as common inputs to many industries. As is the case with economic infrastructure, investment in social infrastructure sectors is likely to be suboptimal in the absence of government intervention due to the presence of pervasive market failures.

Data on infrastructure investment, let alone its finance sources, are not available in any ready-to-use form. Infrastructure is not separately classified in national account statistics. The closest one can get is to consider Gross Fixed Capital Formation (*i.e.* investment) in the activity sectors commonly labelled as "infrastructure sectors": Education, Health, Transport, and Utilities.[2] "Transport" includes transport, storage and communication. "Utilities" includes energy, water supply, sewage, and waste management. It needs to be stressed that in what is to come, we refer to total investment by infrastructure sectors.

This entails two problems. The first major problem is that we overestimate true infrastructure investment, since the investment measure includes all fixed capital formation in the sectors covered, not just the creation of infrastructure assets. For example, trucks are included under transport investment. Furthermore, the definition of infrastructure sectors may be too large from a pure infrastructure services point of view. For instance, storage is included. On the other hand, the investment measure excludes some intangible assets that should arguably be included in a broad infrastructure concept. In Education, for example, we do not account for the services that lead to the creation of knowledge but only for the facilities.

The second problem with this breakdown is that the transport sector also includes storage and communication in the national accounts; no further breakdown is available. Lumping together investment in road and telecom networks makes the aggregate data obviously less useful and informative.

These *caveats* duly noted, let us now turn to describing the data used.

First, we use Eurostat national accounts data to get estimates of total and government infrastructure investment. Private investment follows as the residual:

$$\text{Private} = \text{Total} - \text{Government} \qquad (1)$$

2 The Congressional Budget Office follows the same approach in a recent study on public spending on transportation and water infrastructure in the US (CBO 2010).

The second data source is Projectware that allows us to distinguish between, on the one hand, investments made through Special Purpose Vehicles (*i.e.* projects) and, on the other hand, investment by corporations in the infrastructure sectors. SPVs are a way for investors to ring-fence their other assets. In other words, SPVs provide funding against the cashflows of one particular project. In contrast, when investing in corporations, investors expose themselves to all business activities of the firm, including the non-infrastructure related activities. The amount of corporate investment is computed as the difference between total private and private project investment:

$$\text{Corporate} = \text{Private} - \text{Private Project} \quad (2)$$

Investment by utilities classified as corporations is an example of what is included on the left side of Equation (2).

Finally, this article uses the same Public-Private Partnership (PPP) project data as described in a recent publication jointly produced by staff from the Economic and Financial Studies division and the European PPP Expertise Centre (EPEC) at the EIB (Kappeler and Nemoz 2010). Note that in most PPPs, finance is entirely private. The share of non-PPP projects in private project finance can thus be approximated by:

$$\text{Non-PPP Project} = \text{Private Project} - \text{PPP} \quad (3)$$

The resulting infrastructure finance[3] decomposition is summarized in Figure 1. On the upper branch, private finance consists of finance by the corporate sector, PPPs and private non-PPP project finance. Government budget finance consists of investment through traditional public procurement, and a few projects financed by public sources[4]. A typical example of the latter would be an SPV funded through a regional government.

Private finance consists of finance by the corporate sector, PPPs and private non-PPP project finance.

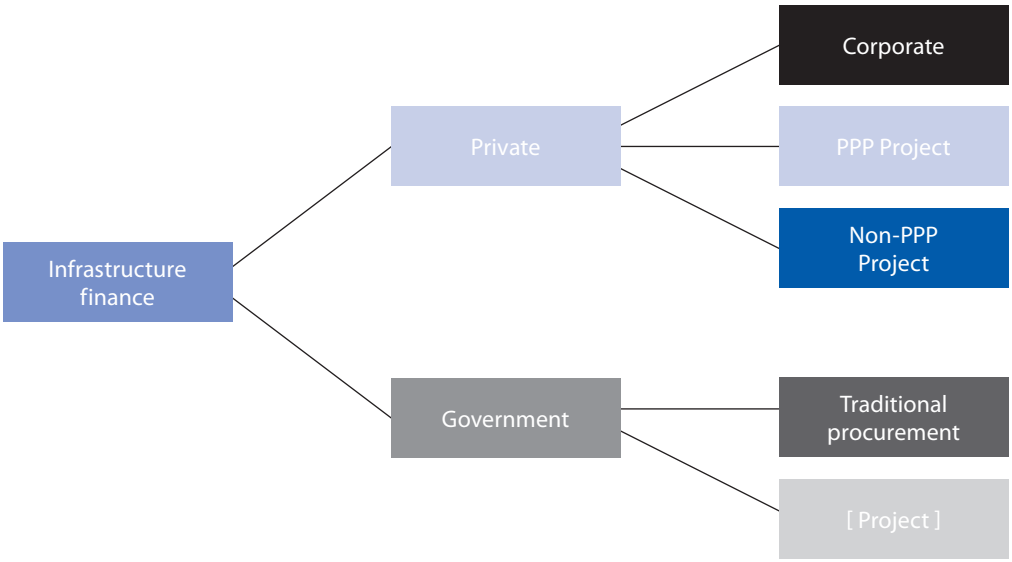
When it comes to the ultimate finance instruments, government finance consists predominantly of taxes and borrowing. Private finance is made up of loans, bonds, and equity. User fees can be used to reward these financial instruments once the infrastructure is up and running, but are not available during the construction phase. Therefore, we do not consider them here.

At this point, three further *caveats* warrant mention. First, the breakdown between public and private finance is blurred by the accounting treatment of government-owned corporations. Investment of government-owned corporations that are financed for 50 percent or more by market sales (*i.e.* revenues from pricing their services) is reported in the national accounts under (private) corporate investment, which tends to exaggerate the share of private infrastructure finance. For instance, investment in electricity networks by the French utility company EDF is counted under private finance although the French government is by far the largest shareholder.

3 In the remainder of this article, the terms "investment" and "finance" are used interchangeably.

4 These public projects are excluded from the project amount on the right side of Equations (2) and (3). The item public projects is put in brackets in Figure 1 as we do not show it separately in what follows.

Figure 1. Composition of infrastructure finance



Almost all project finance may be assumed to be private.

Second, the classification of project finance vehicles/PPPs across institutional sectors is not harmonized across Europe, and differs between Eurostat and Projectware. *De facto* this means that the exact share of private project finance remains unknown. Furthermore, government finance is possibly overestimated because it may contain more of PPPs than the part which is financed by public sources. According to Eurostat's rules, a PPP is on the government balance sheet if either the construction risk, or both the demand and the availability risk remain with the government, even when the project is financed entirely by the private sector. Almost all project finance may, however, be assumed to be private. For practical purposes, we therefore classify the full amount of all PPPs under private finance.

Third, Eurostat flow data on total and government investment show the amount of investment in a particular year, while the data on project finance/PPPs (from both Projectware and the EIB/EPEC paper) show the total capital value of the project. In order to make the data sets compatible, we convert the data on capital value (stocks) into annual investment flows by assuming that the average construction phase of a project is five years, and distribute the capital value proportionally over that period following the financial-close date.[5]

All these *caveats* imply that the breakdowns presented below need to be considered with due care. It is, however, important to notice that the way to compile the data presented above does not exclude any infrastructure finance (after all, we start from the "total" reported for the whole economy), nor do the breakdowns below contain any double-counting. Annex 1 provides further details on the construction of variables whereas Annex 2 contains a basic description of the data sources used.

As regards the statistical methodology adopted in this article, the recently developed Harmonic Weighted Mass (HWM) index test (Hinloopen *et al.* 2008) is applied in order to determine whether differences across categories, such as groups of countries or type of projects, are statistically significant. The HWM test is briefly explained in Box 1.

5 The five-year period is suggested by EIB project experts, though the actual investment period may vary considerably across sectors and projects. For more details, see Kappeler and Nemoz (2010).

Box 1. Comparing samples with the HWM test

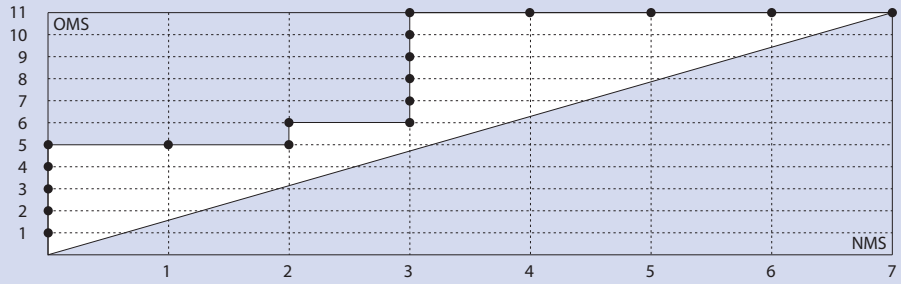
The HWM index is a non-parametric homogeneity test that is particularly suitable for small samples with outlying observations. In all cases below, we compare samples of individual country averages. For example, one sample may consist of 15 country average values for the older EU member states whereas the other sample may consist of 12 average values for the new member states. Samples can thus be unbalanced (*i.e.* have a different number of observations), and have ties (*i.e.* have identical observations) when the variable in question, such as the amount of PPP finance, is zero for more than one country.

To determine whether samples are drawn from the same distribution, Empirical Distribution Function (EDF) tests can be used if the underlying population distributions are not known. These non-parametric tests are especially attractive when samples are small and contain outlying observations, which is the case in this article. EDF tests quantify in one way or the other percentile-percentile (p-p) plots: the scatter plot of percentiles of two distributions for all entries of their joint support. Written as a function it reads as:

$$p \mapsto F_1(F_2^{-1}(p)),\ 0 \le p \le 1, \qquad \text{(B1)}$$

where F_1 and F_2 are the empirical distribution functions of the first and second sample respectively. To illustrate, Figure B1 contains the p-p plot which compares the sample of 11 old member states' ratios of total infrastructure investment to GDP with the sample of 7 corresponding ratios for new member states (see Table 1). In this case, the p-p plot line is above the diagonal, implying that at each domain value the cumulative density of the OMS sample on the vertical axis is larger than the cumulative density of the NMS sample on the horizontal axis. As a share of GDP, OMS thus tend to invest less in infrastructure than NMS. If, in contrast, OMS and NMS had identical investment shares, then the two cumulative distribution functions would be the same, and the p-p plot would coincide with the diagonal.

Figure B1. Comparing total infrastructure investment as a share of GDP in old and new EU member states with the p-p plot



Hinloopen *et al.* (2008) therefore propose the area between the diagonal and the p-p plot for hypothesis testing. The associated Harmonic Weighted Mass (HWM) index test has several advantages over other EDF tests. First, the HWM test has more power than any other EDF test when samples are close over their entire domain. Second, it has the unique feature that the exact critical values can be analytically derived for any number of balanced samples free of ties (Hinloopen and Wagenvoort 2010). Third, when there are ties, the HWM test provides a more robust statistic than the L_1-version of the well-known Fisz-Cramér-von Mises (FCvM) test in that the HWM statistic is invariant to the position of the tie in the sequence of order statistics. The FCvM test, which sums up over all distances between the two discrete cumulative density functions, does not possess this property.

2.1 Infrastructure finance composition by institutional sector

Relative to GDP, infrastructure investment is, on average, one third higher in the new member states than in the old due to a much higher government share.

Let's now turn to the results. Figure 2 shows the source decomposition of infrastructure finance by country separately for the old member states (OMS, left panels) and the new member states (NMS, right panels). The figures and tables in Section 2 are based on average values over the period 2006-2009, which reflects an average of the pre-crisis boom and the post-crisis investment slump. While there are substantial differences within each group of countries, infrastructure investment is, on average, significantly higher in the NMS than in the OMS. The average ratio of infrastructure investment to GDP in the NMS of 5.1 percent exceeds the corresponding ratio in the OMS of 3.9 percent by about one third (Table 1).

In the NMS, the public sector makes a significantly higher contribution to infrastructure finance than in the OMS. As a share of GDP, NMS governments spend more than double on infrastructure than their OMS counterparts. The same cannot be said for the private sector. The average ratio of private finance to GDP is slightly lower in the NMS (2.3 percent) than in the OMS (2.5 percent). Thus, higher total infrastructure investment ratios in the NMS are mainly explained by higher public contributions. The last column of Table 1 shows that the differences between the OMS and the NMS are significant for total and for government infrastructure finance but not significant for any of the sub-components of private finance at the 10-percent level.

The lower two panels of Figure 2 illustrate the relative importance of each funding source in total infrastructure finance for each country. In the OMS, the public sector accounts on average for about one-third of infrastructure finance. Finance by the corporate sector accounts for slightly more than half, and the remaining part of about one-tenth is distributed between PPPs (5 percent of the total) and non-PPP projects (4 percent of the total). In contrast, in the NMS, slightly more than half of all infrastructure investment is financed by the public sector. Furthermore, 38 percent is financed by the corporate sector, 3 percent by PPPs and another 3 percent by non-PPP projects. Project finance in the NMS is, however, restricted to a limited number of countries: projects are found in only five out of the eight countries for which data are available.

There are notable differences in the composition of infrastructure finance between individual member states. For example, the public sector share in Austria is only 14 percent whereas at the other end of the distribution Poland has a share of 76 percent. Some of the differences might stem from different classification systems in different European countries.

We next analyse the differences in the infrastructure finance composition across sectors of activity.

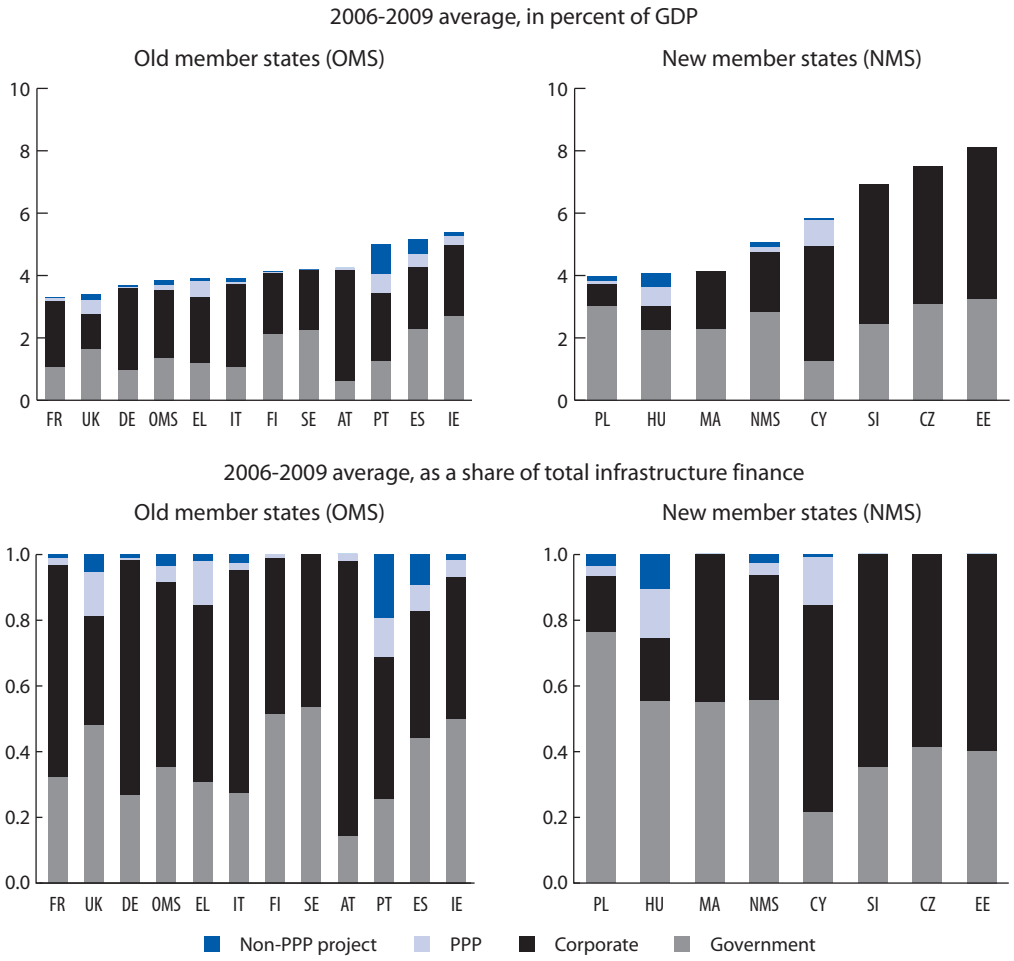
2.2 Infrastructure finance composition by sector of activity

For the EU as a whole, total infrastructure investment amounts to 3.9 percent of GDP, falling into 2.2 percent of GDP for Transport, 0.7 percent for Utilities, 0.6 percent for Health and 0.4 percent for Education.[6] The investment to GDP ratio is statistically significantly higher in the NMS than in the OMS for both the transport and utilities sectors (Table 2). In contrast, the OMS and the NMS spend about an equal share of GDP on infrastructure in Education and in Health.

Economic infrastructure accounts for about three quarters of total infrastructure investment in the EU, social infrastructure for one quarter. As is known from previous research (Alegre *et al.* 2008), Transport is the single largest infrastructure sector by investment. We find that it accounts for more than half of total infrastructure investment in Europe (Figure 3). Utilities (*i.e.* energy, water, waste and sewage) come second. The NMS spend a considerably larger fraction (27 percent) of total infrastructure investment on utilities than the OMS (17 percent). As for social infrastructure, the OMS spend more in the health than in the education sector, the exceptions being Ireland and the UK. In the NMS as a group, social infrastructure investment falls into equal shares for Education and Health.

6 The ratios of total investment to GDP are lower in Table 2 than in Table 1 for both OMS and NMS because more countries are available for the sector analysis than for the institutional breakdown.

Figure 2. Composition of infrastructure finance across institutional sectors



Source: Eurostat, Projectware, EIB/EPEC

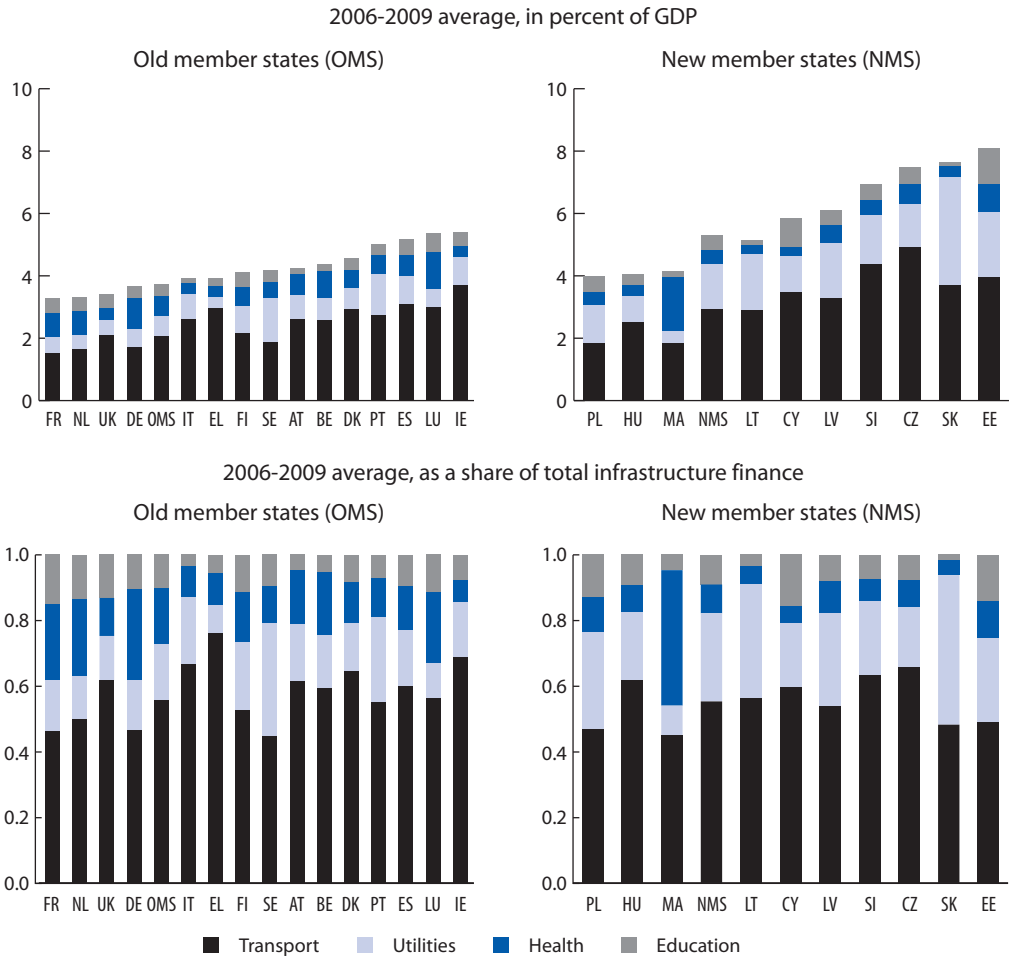
Table 1. Average infrastructure finance to GDP ratio, by funding source

	2006-2009 average, in percent of GDP		HWM test results for a comparison between the OMS and the NMS
	Old member states	New member states	
Total	3.90	5.07	0.578*
Government	1.35	2.81	0.712*
Private	2.55	2.25	0.528*
Corporate	2.22	1.93	0.501
PPP	0.19	0.18	0.384
Non-PPP project	0.14	0.15	0.376
Number of observations	11	7	

Source: Eurostat, Projectware, EIB/EPEC; own calcuations

Notes: The HWM critical value for samples with 11 (OMS) and 7 (NMS) observations is 0.512, 0.593, 0.673 and 0.766 at the 90th, 95th, 97.5 and 99th percentile, respectively (see Hinloopen *et al.* 2008). Differences that are significant at the 10-percent level are indicated with an asterisk.

Figure 3. Composition of infrastructure finance across sectors of activity



Source: Eurostat, Projectware, EIB/EPEC

Table 2. Average infrastructure finance to GDP ratio, by sector of activity

	2006-2009 average, in percent of GDP		HWM test results for a comparison between the OMS and the NMS
	Old member states	New member states	
Total	3.7	5.3	0.751*
Education	0.4	0.5	0.460
Health	0.6	0.5	0.444
Transport	2.1	2.9	0.555*
Utilities	0.6	1.4	0.836*
Number of observations	15	10	

Source: Eurostat, Projectware, EIB/EPEC; own calculations

Notes: The HWM critical value for samples with 15 (OMS) and 10 (NMS) observations is 0.504, 0.588, 0.653 and 0.746 at the 90th, 95th, 97.5 and 99th percentile, respectively (see Hinloopen *et al.* 2008). Differences that are significant at the 10-percent level are indicated with an asterisk.

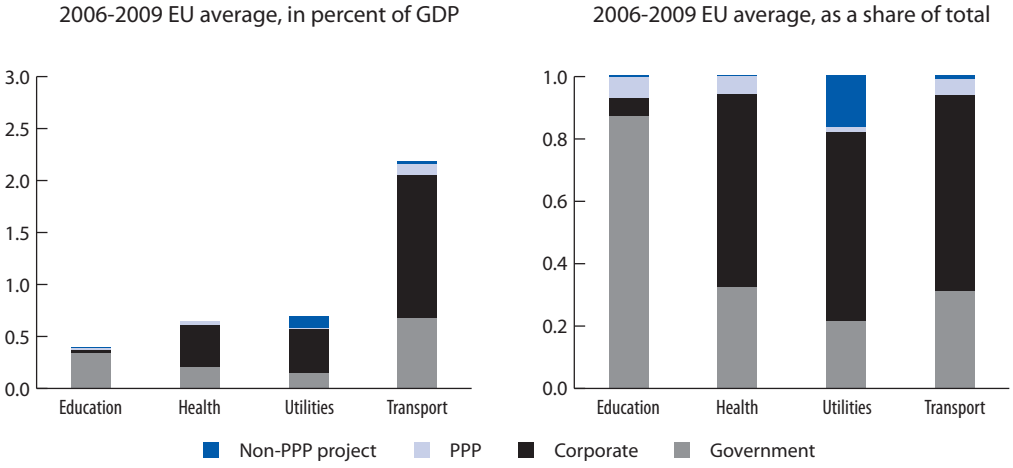
Considering the sources of finance (Figure 4 and Table 3) in the EU, there are important differences between Education and the other sectors. The public sector accounts for more than 85 percent of investment in Education. In the health sector, private finance (68 percent) is more than twice the size

of public finance (32 percent). In the social sectors, PPP projects have a share of about 6 to 7 percent in total finance but are found in only a relatively small number of countries. Non-PPP project finance is nearly non-existent.

As to economic infrastructure, between one fifth and one third of it is financed by governments. Corporations finance about 60 percent of economic infrastructure. There are no statistically significant differences between the transport and utility sectors in the shares of either government or corporate-sector finance. By contrast, the type of project finance differs significantly between Transport and Utilities. The share of PPP finance is significantly higher in the transport sector (5.1 percent) than in the utility sector (1.8 percent). Conversely, the share of non-PPP project finance is significantly higher in the utility sector (16.4 percent) than in the transport sector (1.1 percent).

Government accounts for more than 85 percent of investment in Education and for one fifth to one third in Health, Utilities, and Transport.

Figure 4. Composition of infrastructure finance across sources, by sector of activity



Source: Eurostat, Projectware, EIB/EPEC

Table 3. Composition of infrastructure finance in the EU across sources, by sector of activity

	2006-2009 average, in percent of total finance				HWM test results for a comparison between sectors		
	Education	Health	Transport	Utilities	HWM (All)	HWM (Education, Health)	HWM (Transport, Utilities)
Government	87.1	32.4	31.2	21.5	1.812*	1.353*	0.423
Private	12.9	67.6	68.8	78.5	1.812*	1.353*	0.423
Corporate	5.7	61.6	62.6	60.3	1.672*	1.365*	0.249
PPP	6.7	5.8	5.1	1.8	1.057*	0.096	0.700*
Non-PPP	0.5	0.2	1.1	16.4	1.485*	0.204	0.708*
Number of observations	24	24	20	20			

Source: Eurostat, Projectware, EIB/EPEC; own calculations

Notes: The HWM critical value for 4 samples with 20 (OMS+NMS) observations is 0.84, 0.91, 0.97 and 1.05 at the 90th, 95th, 97.5 and 99th percentile, respectively. The HWM critical value for 2 samples with 20 (OMS+NMS) observations is 0.5060, 0.5850, 0.656 and 0.7518 at the 90th, 95th, 97.5 and 99th percentile respectively. The latter values can also be used for a comparison of 2 samples with 24 observations (see Hinloopen *et al.* 2008). Differences that are significant at the 10-percent level are indicated with an asterisk.

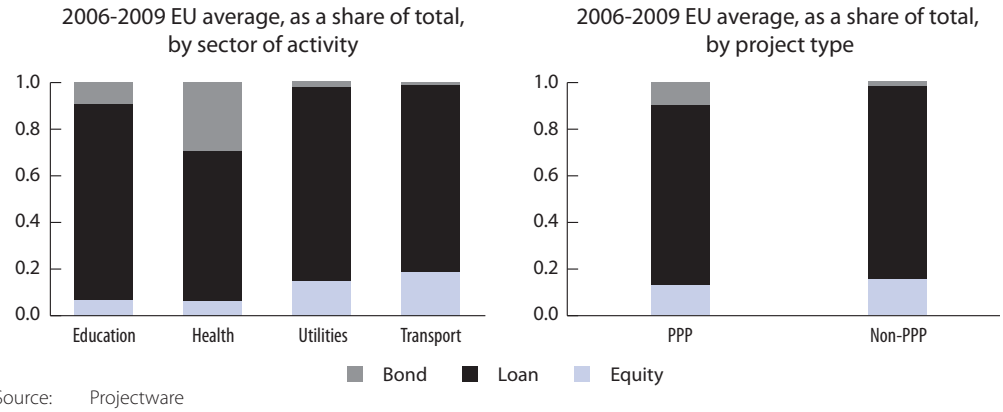
2.3 Instruments of project finance

On average, about 80 percent of a project is funded by loans, 6 percent by bonds and 14 percent by equity.

Finally, we further decompose infrastructure finance along financial instruments. This can only be done for infrastructure investment financed through project finance/PPPs.[7] Figure 5 shows the composition of project finance at financial close. The lion's share of project finance consists of loans, which are often supplied by a syndicate of lenders. On average, about 80 percent of a project (77 percent for PPPs and 83 percent for non-PPPs) is funded by loans. Bond finance contributes another 6 percent, which leaves an equity share of 14 percent. The average debt-to-equity ratio is thus approximately six, implying that overall, projects have a higher gearing ratio than corporations. There are no significant differences in capital structure between PPP and non-PPP projects (Table 4).

Projects in the education and health sectors are, on average, more highly leveraged than projects in the transport and utilities sectors. For example, the equity share is only 6 percent in the health sector while it is 19 percent in Utilities. In particular, bond finance is more important in social infrastructure than in economic infrastructure. Education and health projects are concentrated on a small number of countries. That said, the total number of social-infrastructure projects (28 percent of the total) is in line with the share of social infrastructure in total infrastructure investment.

Figure 5. Composition of project finance across financial instruments



Source: Projectware

Table 4. Average capital structure of EU projects

	2006-2009 average, in percent of total		HWM test results for a comparison between PPP and non-PPP projects
	PPP	Non-PPP	
Equity	12	15	0.309
Debt	88	85	0.309
Loan	77	83	0.232
Bond	10	2	0.099
Number of observations	16	16	

Source: Projectware; own calculations

Notes: The HWM critical value for samples with 16 (OMS+NMS) observations is 0.5082, 0.5856, 0.6629 and 0.7513 at the 90th, 95th, 97.5 and 99th percentile, respectively (see Hinloopen *et al.* 2008). Differences that are significant at the 10-percent level are indicated with an asterisk.

7 No breakdown of infrastructure finance is available for the corporate sector as it is difficult to disentangle infrastructure finance from the financing of other business activity. As to government investment, it may be seen as 100 percent debt-financed in countries where governments run budget deficits in excess of their infrastructure investment, which was and still is the case for most EU member states.

2.4 Main findings

The main findings on the decomposition of infrastructure finance presented above can be summarized as follows:

1. Total infrastructure investment in the NMS is higher than in the OMS because government investment is higher. As a share of GDP, the NMS invest more than the OMS in economic infrastructure and as much as the OMS in social infrastructure.

2. In the OMS, the government sector accounts for one third of infrastructure finance. In the NMS, governments finance half of all infrastructure.

3. The largest part of private finance consists of finance by the corporate sector. Project finance accounts for slightly less than ten percent of total finance. In both the old and new member states, slightly more than half of project finance volume is used to fund PPPs.

4. Considering the breakdown of infrastructure finance by sector of activity, the government is by far the most important source of investment finance in Education. In contrast, private finance is about twice as big as public finance in the health sector. The government sector finances about one fifth to one third of the economic infrastructure.

5. On average, 86 percent of a project is debt-financed. Projects in social infrastructure are more leveraged than projects in economic infrastructure.

Project finance accounts for slightly less than ten percent of total infrastructure finance in the EU.

To finish where we started, it needs to be re-emphasised that the breakdowns presented in this section should be considered as a first attempt with many remaining *caveats*. The fact that gross fixed capital formation bundles investment in narrowly defined infrastructure assets (*i.e.* assets with network characteristics) and other assets, such as equipment, is perhaps the biggest problem.

3. Long-term evolution

The finance source composition of the previous section reflects the situation at the end of the first decade of the 21st century. As will be demonstrated next, in the past the government sector played a more important role in the financing of infrastructure.

Total government investment as a ratio to GDP fell from almost 5 percent in the 1970s to less than 2.5 percent at the turn of the century (Figure 6). Obviously, total government investment includes more than infrastructure investment only, as it also includes public goods, such as defence and environment, and, re-distribution, such as social protection and recreation. However, we know from previous studies that the share of infrastructure in overall government investment has remained fairly stable over time, implying that government infrastructure investment fell at about the same pace as overall government investment. Infrastructure investment accounts on average for about half of total government investment (Alegre *et al.* 2008). By putting these two elements together, we can estimate the (smoothed) evolution of government infrastructure investment, which is depicted by the dotted line in Figure 6. Drawn-out episodes of fiscal consolidation, ultimately aimed at addressing fiscal sustainability concerns, were the key factor behind the fall in government investment (Välilä *et al.* 2005). The reasonably steep decline in government infrastructure investment levelled off at the end of the 1990s.

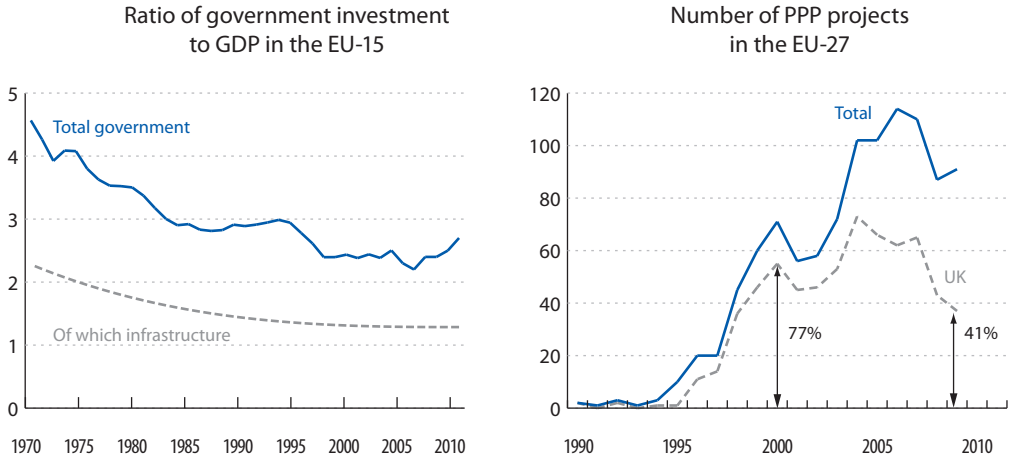
What about private finance? As said before, private finance comes in different forms. Although we cannot quantify the change in total private finance due to a lack of data, perhaps the most striking and illustrative development is the rise in Public-Private Partnerships (see right panel of Figure 6). They were introduced in the UK in the beginning of the 1990s. About ten years later, a significant number of PPPs had also been undertaken in other EU countries. In the year 2000, about 80 percent of PPPs

were realised in the UK. Today, the majority of PPPs are realised outside the UK. As demonstrated by Kappeler and Nemoz (2010), the PPP market in Europe continues to diversify across countries and sectors.

The increase in private infrastructure finance has partly offset the decline in public finance.

The first main finding of the long-term analysis thus is that public finance declined while private project finance increased. These two major events suggest that over the last forty years, at least qualitatively, the decline in government finance has been partly offset by an increase in the relative importance of private finance. Quantitatively, however, the increase in private finance remains relatively small because the share of project finance in infrastructure is so far relatively small. Overall, there has thus been a decline in infrastructure investment.

Figure 6. Long-term evolution of public and private finance sources



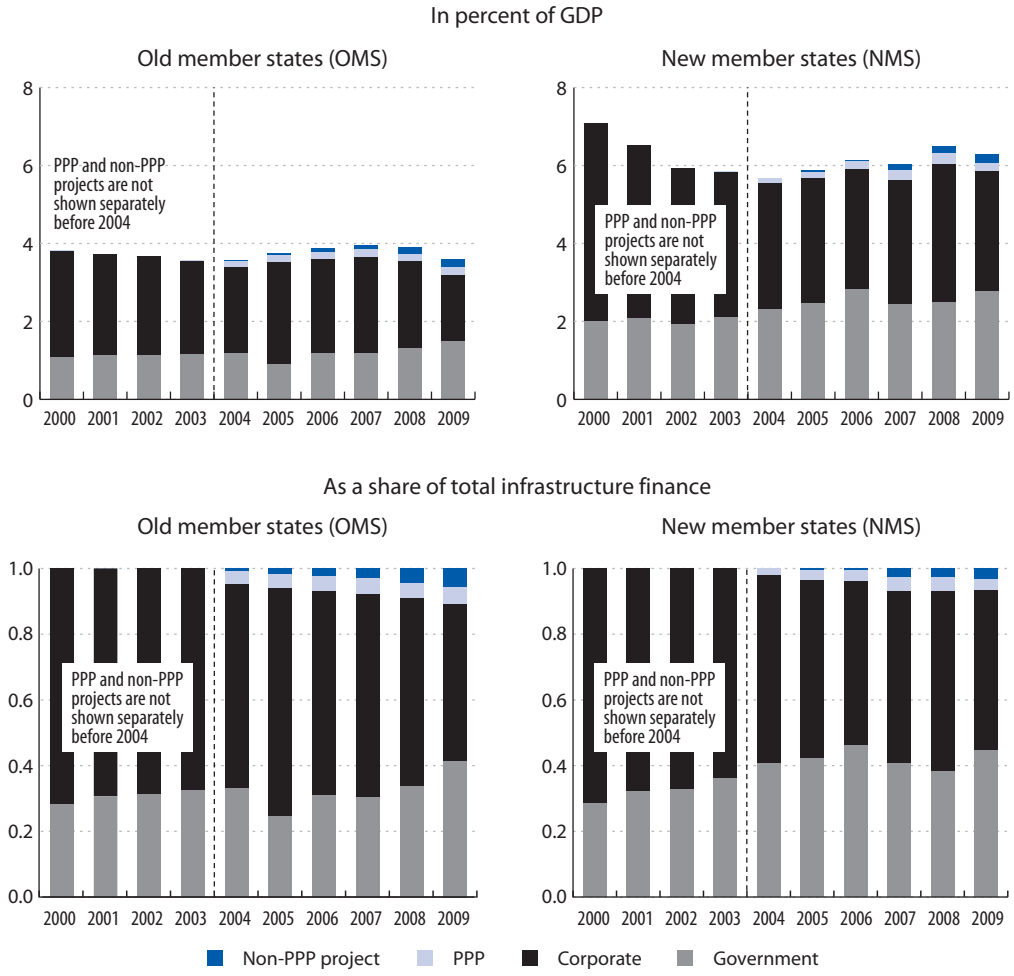
Source: OECD, EPEC

A second finding reported in the literature relates to the cyclical component of public infrastructure investment. In general, infrastructure investment is pro-cyclical (Välilä *et al.* 2005). Higher levels of GDP tend to be associated with higher public infrastructure investment. However, examples exist of episodes during which government investment behaved counter-cyclically. In times of extreme economic conditions, as during the great depression of the 1930s, governments became the crutch of capital by increasing their spending on infrastructure (Margairaz 2009).

Let us dig slightly deeper into the evolution of the different finance sources in the last decade as more detailed data are available for this period. We first look at the role private and public sectors play in the evolution of infrastructure investment in the economy. This part of the analysis is based on both Eurostat and Projectware data. As before, Eurostat flow data show the amount of investment in a particular year, while the stock data on project finance show the total capital value of the project reaching financial close in that same year. As in Section 2, the two data sets are made compatible by distributing the project capital values proportionally over the five years following the financial close date. The data here thus refer to the contribution of the different finance sources to investment in a particular year. They do not necessarily reflect the moment of the finance decision, which may precede the investment flow by a number of years.

The upper two charts of Figure 7 indicate that infrastructure investment closely followed the business cycle in the last ten years. Total investment as a share of GDP fell between 2001 and 2003 after the burst of the dotcom bubble in the year 2000. It rose during the period of economic recovery between 2004 and 2007 before falling back in 2009 as a result of the crisis. There are no major differences between old and new member states in these developments. As discussed in Section 2, investment is, however, substantially higher in the NMS than in the OMS.

Figure 7. Evolution of infrastructure finance by institutional sector



Source: Eurostat, Projectware, EIB/EPEC

The cyclicality of total infrastructure investment (as a share of GDP) in the last decade is entirely explained by business cycle fluctuations in private finance. In contrast, government infrastructure investment as a share of GDP was rather stable in the EU as a whole, and actually increased slightly in 2008 and 2009. To what extent the latter is due to a fall in GDP or the result of an increase in government investment volumes is analysed in the next section.

The cyclicality of total infrastructure investment in the last decade is entirely explained by business cycle fluctuations in private finance.

As a result, the share of government finance in total infrastructure finance has recently increased. The bottom two panels of Figure 7 show the relative importance of each funding source in total finance. For example, in the OMS, the share of public finance rose from 30 percent in 2007 to 41 percent in 2009. In the NMS, the government share rose from 41 percent to 44 percent over the same period for a select number of countries for which longer-term data are available.

The rise in the share of project finance, in particular PPPs, is a more structural phenomenon as it started well before the recent crisis. The share of (annual) investment financed through projects rose from 5 percent in 2004 to 11 percent in 2009 in the OMS, and from 2 to 7 percent in the NMS. Project data are not available before 2004. We need to stress, however, that Figure 7 does not reflect the timing of the project approval. As we show next, part of the rise in project finance shares in 2008 and 2009 stem from projects that were launched already before the recent crisis.

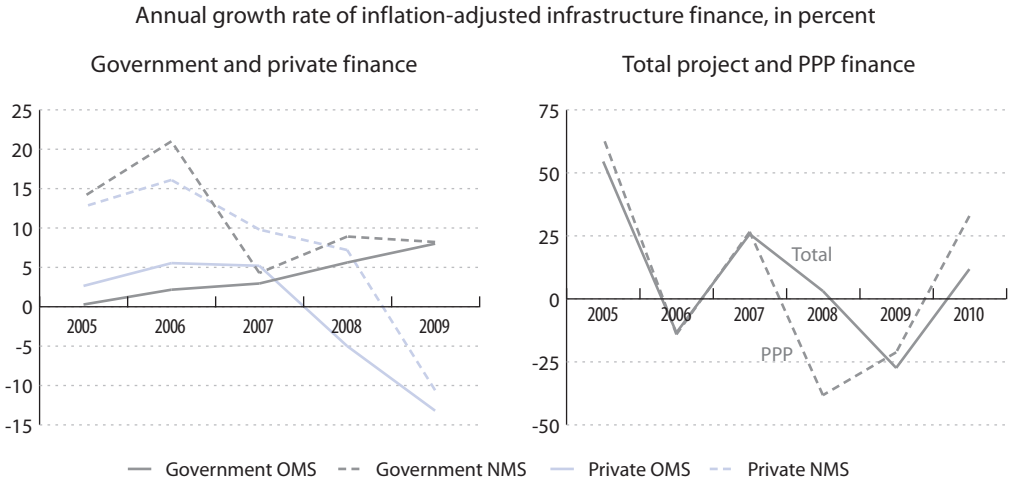
4. Crisis impact

4.1 Crisis impact by institutional sector

Private finance fell by more than 15 percent since the beginning of the crisis while government finance kept increasing.

To get a clearer picture of the crisis impact, we next present the annual growth rates of inflation-adjusted absolute investment. Since infrastructure finance in general is pro-cyclical, the variance in absolute volume tends to be higher than the variance in the ratio of investment volume to GDP. Figure 8 confirms this, and shows striking differences between public and private finance sources. Since the recent crisis began, the increase in public finance, which stood at 3 percent in the OMS in 2007, has risen to 8 percent. In contrast, private finance fell by 4 percent in 2008 and another 13 percent in 2009 (Table 5). In total, private finance thus fell by more than 15 percent since the beginning of the recent crisis. On average, there are no important differences between the OMS and the NMS in this respect.

Figure 8. Crisis impact on infrastructure finance



Source: Eurostat, Projectware, EIB/EPEC

Table 5. Annual growth rate of inflation-adjusted infrastructure finance

	EU average, in percent	
	Government	Private
2005	1.7	3.3
2006	4.4	6.3
2007	3.1	5.8
2008	6.1	-4.3
2009	7.8	-13.2
Number of observations	19	19

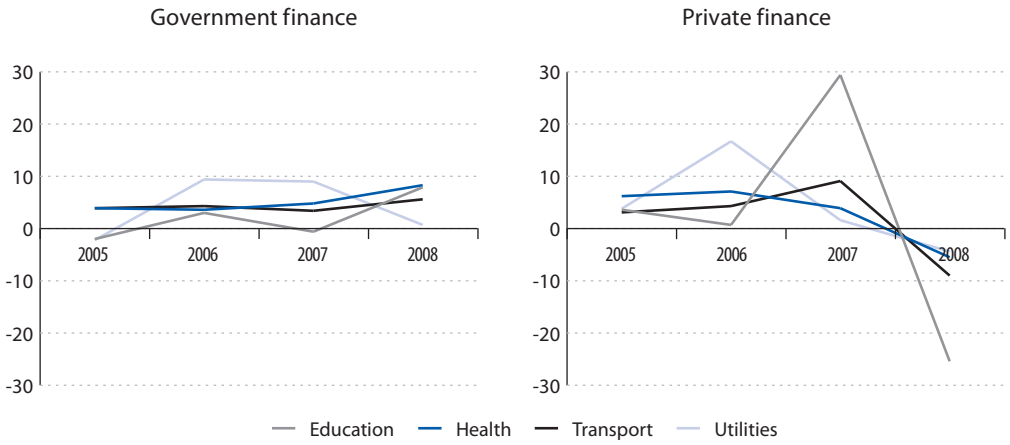
Source: Eurostat, Projectware, EIB/EPEC

However, there are important differences between individual countries. To mention the extremes, in the UK, government finance was up by a cumulative 25 percent from 2007 to 2009 whereas in Lithuania, government finance was down by 16 percent over the same period. In all countries except Finland, the Czech Republic and Cyprus, private investment is lower than before the recent crisis, but the degree to which private finance has shrunk varies considerably.

Figure 9 depicts the crisis impact on infrastructure finance by sector of activity. It reveals no major differences across sectors as private investment volumes fell in all sectors. The annual growth rate of government investment rose in all sectors except in Utilities where it nevertheless remained positive. In accordance with this result, simple cross country relationships cannot confirm the hypothesis that countries with high public deficits or high public debt cut back their infrastructure investment in the last two years (Box 2).

Figure 9. Crisis impact on infrastructure finance, by sector of activity

Annual growth rate of inflation-adjusted infrastructure finance, in percent



Source: Eurostat, Projectware, EIB/EPEC

An important part of the fall in private finance is explained by corporations reducing investment. But other sources of private finance also fell substantially, in particular project finance. So far, we have shown the percentage change in annual investment. Now we switch to project finance, looking at the percentage change in the capital value of new projects reaching financial close, which represents investment over the whole life of the project.

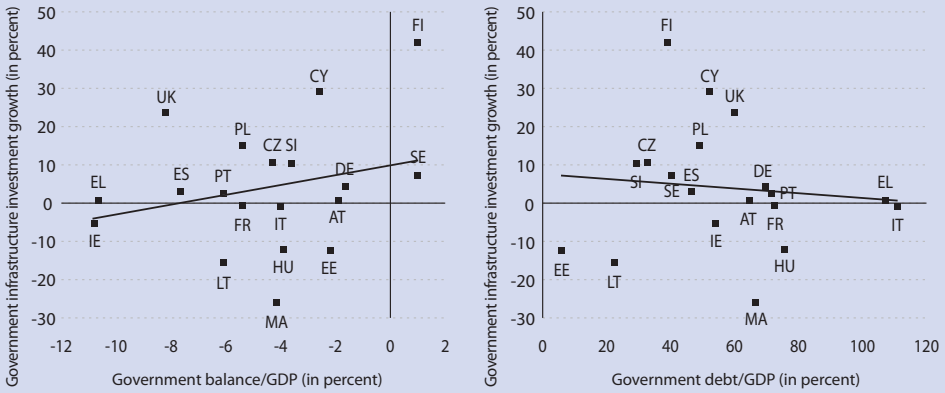
In terms of percentage decline, the crisis impact on PPP infrastructure finance is larger than on any other finance source. Compared to the 2007 peak level, the capital value of PPP projects reaching financial close fell by almost 40 percent in 2008 (see right panel of Figure 8). In 2009, it fell a further 20 percent before bouncing back sharply in 2010. When comparing the first eight months of this year to the same period last year, PPP finance is up by more than 30 percent. Still, the total capital values of PPP and non-PPP contracts remain about 35 percent below their peak levels. It should be noted, however, that these levels were reached in a short period of very rapid expansion before the recent crisis.

Compared to the 2007 peak, the capital value of new PPP projects fell by almost 40 percent in 2008 and 20 percent in 2009 before bouncing back sharply in 2010.

Box 2. Government infrastructure investment and the fiscal situation

Välilä *et al.* (2005) analyse possible determinants of long-term trends in government investment by applying co-integration and cross-section regression methods. They find that drawn-out episodes of fiscal consolidation to address debt sustainability concerns are the main driver of significant falls in government investment in the past. As shown in the main text, government investment in infrastructure sectors so far has not fallen in the EU as a whole, and actually slightly increased in the recent crisis. There is still the question, however, whether or not government infrastructure investment was restrained by the fiscal situation of a significant number of member states.

Figure B2. Government infrastructure investment growth against the government balance-to-GDP ratio (left panel) and the government debt-to-GDP ratio (right panel), 2008-2009 average



Source: Eurostat

The results of a simple cross-section analysis suggest that EU countries with high levels of deficit or debt so far have not been characterized by a particular retrenchment of government infrastructure investment. Figure B2 shows the relationship between, on the one hand, the public deficit or public debt as a share of GDP, and, on the other hand, the growth in government infrastructure investment. Neither the slope of the upward line in the left panel nor the slope of the downward line in the other panel is statistically significant. In other words, government infrastructure spending during the recent crisis has not been determined by fiscal considerations.

4.2 Crisis impact on project finance by financial instrument

The equity share of total project finance has been rather stable since 2005.

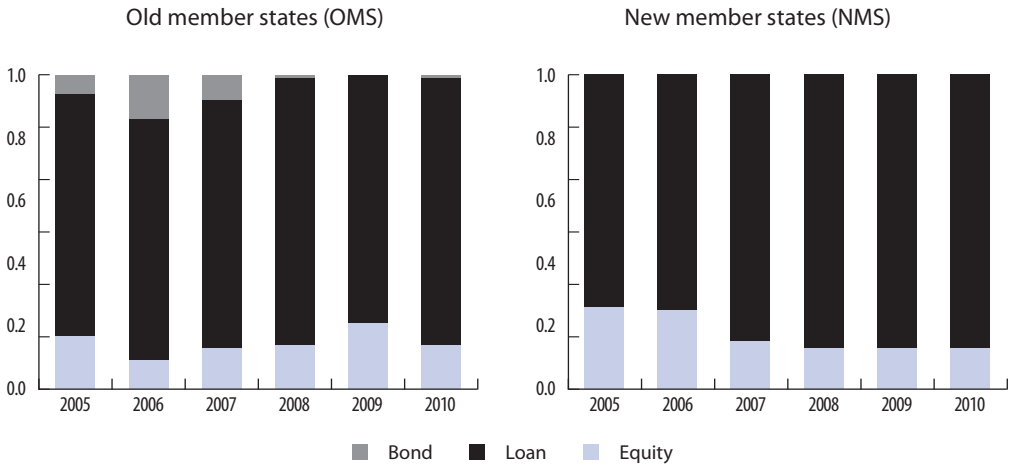
To dig again deeper into project finance, we finally analyse the crisis impact on different finance instruments. Recall that this is a breakdown of a relatively small part of private finance.

On average, the capital structure of projects has not changed significantly as a result of the recent crisis. Figure 10 shows that the equity share of total project finance is rather stable. Since 2008, the equity share has actually been lower than before the crisis and remarkably stable in the NMS. In the OMS, the equity share rose in 2009 but has fallen back to the average pre-crisis level in the first eight

months of 2010. Interestingly, bond finance in new projects, as indicated by the components at the top of the bars, dried up almost completely in the crisis. At first sight, this may be somewhat surprising since last year bond finance by corporations in the infrastructure sectors reached a record level and was 50 percent higher than in previous years. Many corporations tapped the bond market to re-finance existing debt at more attractive rates. Yet, bonds were hardly used in new projects. One possible explanation for this striking result is the disappearance of monoline insurance early on in the crisis. This was important for institutional investors who are bound by investment guidelines, and who rely on services by third parties in relation to the handling of complex bonds. Compared to pre-crisis years, the share of loans slightly increased in the crisis. Banks were less sensitive to the breakdown of the monolines because as lenders, they traditionally do much of the project appraisal and monitoring themselves.

Bond finance in new projects dried up almost completely during the crisis, possibly due to the disappearance of monoline insurance.

Figure 10. Crisis impact on the financing structure of projects



Source: Projectware

5. Conclusion

This article sheds light on the composition and evolution of infrastructure finance in Europe. It is important to emphasise that this exercise should be seen as the first attempt to compile comprehensive data on infrastructure finance, and that a number of *caveats* apply due to insufficient data. Therefore, the presented results should be considered as indicative only.

Our main findings are as follows. In the EU, the government sector finances about one third of all infrastructure investment. Most of the remaining part is financed by the corporate sector, and the rest through project finance (about 10 percent). Infrastructure investment in the new member states is higher than in the old ones owing to higher government investment. While the NMS invest a substantially higher share of GDP in the economic sectors (*i.e.* Transport and Utilities), the OMS and the NMS spend about an equal share of GDP on social infrastructure (*i.e.* Education and Health).

Over the last decade, total infrastructure finance was clearly pro-cyclical, owing to strong fluctuations in private finance. Previous studies have shown that in general, government infrastructure is also pro-cyclical: higher levels of GDP tend to be associated with higher public investment. However, so far in the recent crisis, which has been far deeper than a typical cyclical downturn, government infrastructure investment has not fallen. Seen from a European aggregate perspective, governments have even slightly increased the rate of expansion of their investment in 2008 and again in 2009.

In the past, episodes of fiscal consolidation were the key factor behind fallouts in government investment. Given the need for significant and sustained fiscal consolidation, the outlook for public infrastructure finance in Europe thus seems bleak.

Unlike government finance, private finance of infrastructure has fallen substantially during the recent crisis. The impact on the amount of PPP finance is particularly large. It should be noted, however, that PPP finance exhibited very high growth before the recent crisis. In the first eight months of this year, PPP finance was up by about 30 percent but remains in the aggregate largely below the peak level.

The recent crisis has reversed, at least temporarily, the longer-term trend of more private and less public financing of infrastructure.

All in all, the recent crisis has thus reversed, at least temporarily, the longer-term trend of more private and less public financing of infrastructure. Looking ahead, it is commonly argued that investment needs are big in the coming decade, most notably in the area of the environment and in new communication networks but also in terms of upgrading of the existing infrastructure. Given the constraints to government finance, there seems to be only one option: more finance will need to come from private sources.

Annex 1. Technical notes

A.1.1 Notes on Eurostat data

The breakdown of *total* Gross Fixed Capital Formation (GFCF) by sector of activity is based on the "Nomenclature statistique des Activités économiques dans la Communauté Européenne" (NACE) whereas the breakdown of *government* GFCF by sector of activity is based on the "Classification of the Functions of Government" (COFOG).

For some years, government GFCF has been missing for a number of EU countries. In these cases, we estimate government GFCF by sector of activity in period *t* by using the ECFIN forecast for total government GFCF and by assuming that the sector shares are the same as in the previous period:

$$Gov\ GFCF\ by\ sector_t = Total\ Gov\ GFCF_t * \frac{Gov\ GFCF\quad by\ sector_{t-1}}{Total\ Gov\ GFCF_{t-1}}. \tag{A1}$$

In other words, it is assumed that the composition of government investment across sectors of activity does not change between period *t-1* and period *t* if GFCF is missing in period *t*. For countries where government GFCF is not available at all (*i.e.* Germany, Luxembourg and Slovenia), government investment refers to Gross Capital formation (GCF). Comparing data for countries where both GCF and GFCF are provided by Eurostat suggests that differences are small, and hence GCF is a good approximation of GFCF.

In a small number of cases, total GFCF is smaller than reported numbers for government GFCF. If so, we set the value of total GFCF equal to government GFCF. Differences in the definition of sectors between COFOG and NACE as well as inconsistencies in the figures reported by national authorities are most likely behind these discrepancies.

A.1.2 Notes on project data

Data on individual projects are provided by Projectware (Dealogic) and the European PPP Expertise Centre (EPEC). All EU-27 projects, entailing infrastructure investment, which have reached financial close[8] and have not been cancelled, are included except certain refinancing operations. Refinancing operations are excluded if:

- they already appear under another project identification number in Projectware;
- they refer to projects, which were closed under another project more than two years ago but not included in Projectware; and
- the construction of the facility was finalized before the financial close of the refinancing operation.

Other types of refinancing operations, such as acquisitions and recapitalisations, are included.

The Projectware database contains both Public-Private Partnerships (PPPs) and non-PPP projects. To determine infrastructure investment through PPPs we refer to volumes presented in Kappeler and Nemoz (2010) who use the EPEC database, which includes PPP projects that are not included in Projectware. Furthermore, the definition of PPPs differs between Projectware and the EPEC database.

8 The financial close date is understood as the date at which all project contract and financing documentation have been signed, and conditions precedent to initial drawing of the debt have been fulfilled. From this moment there is a legally binding commitment for equity holders or debt financiers to provide or mobilize funding for the project.

For some projects, Projectware only reports the total capital value and not the type of financing (loan, bond, or equity). As a result, the figures in the main text that show the capital structure of projects are based on a smaller number of projects than those showing the composition of infrastructure finance across institutional sectors.

A.1.3 Definition of sectors

Our definition of infrastructure comprises four sectors: Education, Health, Transport, and Utilities. Table A1 shows the selected branches by sector of activity and database. Note that the labeling of sectors can differ across databases.

Table A1. Definition of infrastructure sectors by database

	Total GFCF (Eurostat, NACE)	**Government GFCF (Eurostat, COFOG)**	**Projects (Projectware and EPEC)**
Transport	Transport Communication Storage	Transport Communication	Transport Communication
Health	Health Social services	Health	Hospitals
Education	Education	Education	Schools Universities
Utility	Electricity Gas Water supply	Fuel and energy (Waste-)Water, Waste management	Fuel and energy (Waste-)Water, Waste management

Source: Eurostat, Projectware, EIB/EPEC

Annex 2. Data description

Table A2 shows total and government investment in all infrastructure sectors and the sector composition. Table A3 shows total infrastructure investment carried out through projects and its composition by sector and project type.

Table A2. Total and government investment in infrastructure sectors of EU countries, by sector of activity

	2004	2005	2006	2007	2008	2009
			Total investment, in millions of euros			
	358,773	378,959	402,561	426,842	408,377	354,781
			By sector of activity, in percent of total			
Education	11	10	10	10	10	10
Health	16	16	16	16	17	17
Transport	56	56	56	56	56	55
Utility	17	17	18	17	18	18
Total	100	100	100	100	100	100
			Government investment, in millions of euros			
	130,738	110,551	141,222	145,462	153,677	165,376
			By sector of activity, in percent of total			
Education	28	34	27	26	27	27
Health	15	18	14	15	15	15
Transport	48	59	48	48	48	48
Utility	10	-11	10	11	11	10
Total	100	100	100	100	100	100

Source: Eurostat
Note: Belgium, Bulgaria, Denmark, Latvia, Netherlands, Romania and Slovakia are excluded.

Table A3. Number of projects and corresponding investment volumes in infrastructure sectors of EU countries over the period 2004-2009, by sector of activity and project type

	Number of projects	Infrastructure investment, in millions of euros
	1,573	230,517
	By sector of activity, in percent of total	
Education	13	41
Health	15	10
Transport	18	41
Utility	53	8
Total	100	100
	By project type, in percent of total	
PPP	39	49
non-PPP	61	51
Total	100	100

Source: Projectware, EIB/EPEC

References

Alegre, J.G., Kappeler, A., Kolev, A. and Välilä, T. (2008). "Composition of government investment in Europe: Some forensic evidence". *EIB Papers*, (13:1), pp. 23-54.

Chan, C., Forwood, D., Roper, H. and Sayers, C. (2009). "Public infrastructure financing: An international perspective". Productivity Commission Staff Working Paper, Australian Government.

Congressional Budget Office (2010). "Public spending on transportation and water infrastructure". Pub. No. 4088.

Gramlich, E.M. (1994). "Infrastructure investment: A review essay". *Journal of Economic Literature*, (32), pp. 1176-1196, September.

Hinloopen, J. and Wagenvoort, R. (2010). "Identifying all distinct sample p-p plots, with an application to the exact finite sample distribution of the L1-FCvM test statistic". Tinbergen Institute discussion paper, TI 2010-083/1.

Hinloopen, J., Wagenvoort, R. and van Marrewijk, C. (2008). "A *K*-sample Homogeneity test based on the quantification of the p-p plot". Tinbergen Institute discussion paper, TI 2008-100/1.

Kappeler, A. and Nemoz, M. (2010). "Public-Private Partnerships in Europe – before and during the recent financial crisis". Economic and Financial Report No. 2010/04, European Investment Bank.

Margairaz, M. (2009). "Infrastructure funding: A long-term perspective". *Revue d'économie financière*", Special issue on sovereign wealth funds, pp. 47-57.

Riess, A. (2005). "Is the PPP model applicable across sectors?". *EIB Papers*, (10:2), pp. 10-30.

Välilä, T. (2005). "How expensive are cost savings? On the economics of public-private partnerships". *EIB Papers*, (10:1), pp. 95-119.

Välilä, T., Kozluk, T. and Mehrotra, A. (2005). "Roads on a downhill? Trends in EU infrastructure investment". *EIB Papers*, (10:1), pp. 19-38.