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The Golden Rule of Public Finance and the Productivity of Public Capital

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Abstract:

This paper concentrates on the golden rule of public finance. It reviews the main advantages and disadvantages of the potential implementation of this rule in the European Union. Often the question of the productivity of public capital is at the heart of the rule's discussions. As this issue has mostly been investigated for the United States, we try to estimate the productivity of public capital using data on the current member states of the European Union. Working both with data on net capital stocks and gross capital formation, we come to the conclusion that there is a cointegrating relationship between capital and output and that this relationship is in most cases positive. However, as there are also other expenditures classified as current spending that have a positive effect on the output in the long run, we argue that the golden rule should not be introduced in the European Union if the current definition of public capital investment does not change for the rule's purposes.

Keywords: Golden rule of public finance, European Union, Cointegration, Productivity of capital, Cobb-Douglas production function

JEL: C23, E22, E62, H52, H62

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ABBREVIATIONS

EC – European Commission

EESC – European Economic and Social Committee

EMU – European Economic and Monetary Union

ESA – European System of Accounts

EU – European Union

EUR – euro

FE – Fixed Effects

GDP – Gross Domestic Product

GLS – Generalized Least Squares

ln, log – natural logarithm

OECD – Organization for Economic Co-operation and Development

OLS – Ordinary Least Squares

RE – Random Effects

SGP – Stability and Growth Pact

UK – United Kingdom

US, USA – United States of America

VAR – Vector Autoregression

1 Introduction

Reforms of the Stability and Growth Pact (SGP), the main fiscal rule of the European Economic and Monetary Union (EMU), have been discussed since its inception and many suggestions how to improve it have emerged. One of the proposals has been that the EMU's fiscal rule should getcloser to the 'golden rule of public finance'. Basically, such rule says that current public expenditures should be financed by taxes while public capital investment may be financed by borrowing.

The level of public capital spending has decreased in the European Union (EU) since the 1970's, which is often attributed also to the SGP. The golden rule is expected to be able to change this trend and to induce an increase in public capital investment. It thus appears that public capital is perceived to be at a suboptimally low level in the EU.

One important assumption underlying the debates about the golden rule is the productivity of public capital. This issue has already been explored by many researchers.However, these concentrated mostly on the United States (US) or Organization for Economic Co-operation and Development (OECD) members. As we discuss the possible introduction of the golden rule in the EU, we investigate the productivity of the public capital for the EU countries.

We first introduce the golden rule as such, providing also examples of countries where such rule has already been implemented. Second, we discuss the possible implementation of the golden rule in the EU, both from the conceptual and the practical points of view. Third, and foremost, we investigate the productivity of public capital in the EU, using both data on net capital stocks and on (cumulative totals of) gross capital formation. Most importantly, we detect cointegration, i.e. a long-run relationship, both between net capital stock and GDP and gross capital formation and GDP. We find that at the aggregate level public capital is productive. However, we identify also such kinds of public capital that seem to have a negative effect on the output and, on the other hand, current expenditures whose effect on the output is positive in the long run.

The paper is organized as follows: in Section 2 we introduce and discuss the golden rule of public finance. In Section 3 we investigate the productivity of public capital in the EU. In Section 4 we conclude.

2 The Golden Rule of Public Finance

The golden rule of public finance basically says that current expenses by the state should be covered by current revenues and that governments can only borrow to invest. Such description is, however, rather vague. Furthermore, many research papers operate with the golden rule without actually stating the definition of the rule – how exactly it is perceived and used. Nevertheless, several authors provide such definition.

Kellermann (2007) states that according to the 'golden rule of public borrowing', 'government deficit is accepted if accompanied by an increase in assets so that the government's net asset position does not deteriorate. Thus current expenditures must be covered by current receipts while for investment expenditure recourse to debt is allowed' (pp. 1089). This is in line with the definition of the golden rule as Creel (2003) uses it: 'over the cycle, government borrowing should not exceed net government capital formation; hence current expenditures should be financed by current receipts' (pp. 14).

It is well known that the golden rule was introduced in the United Kingdom (UK) in 1997. We can read in HM Treasury (1997) that 'over the economic cycle, the Government will only borrow to invest – public consumption (including the consumption of capital) will be paid for by taxation' (pp. 1). However, as, according to the HM Treasury, this rule would not guarantee the sustainability of public finances becausea lot of public investment yields social returns but not necessarily taxable economic output, the sustainable investment rule also applies: 'over the economic cycle, the Government will ensure the level of public debt as a proportion of national income is held at a stable and prudent level' (pp. 1). In the UK the net debt of 40% of GDP is consideredto be prudent.[1]

Balassone& Franco (2000) recall that a kind of golden rule is also in place in Germany: according to article 115 of the Constitution, 'borrowing cannot exceed the total investment expenditure in the budget; exceptions are only allowed to avoid disturbances to the overall economic equilibrium'.

Researchers have very differing views on the potential implementation of a golden rule in the EU – it seems that there are as many proponents of this rule as its opponents. This Section will present the most debated issues underlying the introduction of the golden rule.

2.1 Fiscalconsolidation and public investment

The view that during fiscal consolidation public investment is cut more than current spending is commonly shared in the literature.[2] It is thus not surprising that the fiscal consolidation in the EU due to the introduction of the Stability and Growth Pact is often blamed for the decrease in public investment spending. Kellermann (2007) argues that one of the reasons for cuts in investment during fiscal consolidation is that lowering investment is politically more feasible than lowering current expenditures. Woods (2008) claims that this bias against investment was the reason why the golden rule wasintroduced in the UK.

[1]The rule operateswithnetdebtbecausethisshouldensurethatcurrenttaxpayerspayforthemaintananceofcapitalstock.

[2]SeeBlanchard&Giavazzi (2003),Buti et al. (2002), Balassone and Franco (2000) or de Haan et al. (1996).

Balassone& Franco (2000) argue that as under the SGP the budgets should be close to balance or in surplus, most capital investments have to be financed by taxes. This brings a disincentive to invest into large projects. The authors remind one of their models where they show that a policymaker with a finite horizon decreases public investment when a deficit ceiling is put in place. However, they remind that it has already been shown that even under a benevolent planner total welfare is lower when a ceiling on investment is applied because when a project is indivisible, it needs to be financed by higher (distortionary) taxes which then are not smoothed over time. Also, very realistically, they note that when a deficit limit is introduced, voters would prefer a cut in investment to a cut in current spending.

The European Commission (EC) (2003) looks at the development of the public capital formation in aggregate for the whole EU and compares the data with those for Japan and the US. The drop in public capital formation in the EU, especially in comparison with the other two countries, is much more pronounced, and the data furthermore suggest that this drop coincides with the run up to the SGP. Kamps (2005) notes that the EC saw this problem even before – in 2001 in the Broad Economic Policy guidelines it appealed to the member states to ensure an appropriate balance between public investment and decrease in public debt and taxes.

2.2 Assumptions underlying the desired increase in public investment

It is usually supposed that the introduction of the golden rule would increase public investment. However, this seems to have two implicit assumptions: first, that the level of capital in the EU is suboptimally low, and, second, that public investment is productive (and thus has a positive impact on the economy).

As for the first assumption, it is not sure whether this holds, especially in the case of the more developed EU member states. Kamps (2005) shows, using a simple model of endogenous growth, that in most EU countries the level of public capital stock is not suboptimally low.

Concerning the productivity of public capital, a lot of researchers have already investigated this topic and they have often come to different conclusions, some even finding that the productivity of public capital is negative. Most of the studies have been done for the United States and we do not know of any that would work with data for all the current EU member states. Therefore, we devote most of this paper to the issue of the productivity of public capital in the EU.

2.3 *Intergenerational equity*

One of the HM Treasury's[3] basic arguments supporting the introduction of the golden rule is that such rule promotes fairness between generations: current spending basically benefits only today's taxpayers, so the burden of such spending should not be passed on to future generations. On the other hand, when an investment is made, today's but also future taxpayers profit from such expenditure so they can also share the costs of the investment. This view is supported by many researchers; however, it is strongly opposed e.g. by Buiter (1998) and Buti et al. (2002).

The former admits that the golden rule allows for a smoothing of consumption and distortionary taxes over time and let households and firms borrow under better conditions than in the market (thanks to the tax and transfers system). However, he argues that the effect of public investment on intergenerational fairness may only be comprehensively captured by generational accounts and that even this picture may be partial and misleading . Doing such evaluation thus becomes extremely complex, if not impossible.

The underlying uncertainty of the future benefits of many projects supports the view that it is very difficult to quantify these benefits when trying to assess whether to finance an investment from taxes or debt to ensure intergenerational equity.

2.4 *Optimal level of public debt*

Blanchard &Giavazzi (2003) note that as under the SGP the budget deficit (including interest) should be balanced over the cycle, the public debt should eventually approach zero. However, according to them, there are many reasons why the public debt should be higher than zero – such as intergenerational transfers or public investment projects with a large social rate of return. This view is supported e.g. by Creel (2003).

On the other hand, Kellermann (2007), using a simple growth model with public capital, shows that debt financing of investment may not be optimal because it might negatively affect social welfare and the stock of public and private debt.

2.5 *Definition of public capital investment*

There is also the issue of the definition of public capital investment for the purposes of the golden rule. Buiter (1998) stresses the importance of the distinction between current and capital expenditure. He defines public consumption as spending whose 'benefits are exhausted within the accounting or reporting period', while public capital expenditure as spending that 'yields an (uncertain) stream of future returns beyond the current accounting or reporting period' (pp. 7). The (pecuniary) returns can be both direct and indirect. However, he

[3] HM Treasury (1998).

also claims that public investment should be done if future social returns are higher than social opportunity cost, i.e. these do not necessarily have to be pecuniary.

Sawyer (1997) outlines two possible notions of capital: the first one relates to gross capital formation, i.e. to fixed assets, and the other one is such expenditure that yields a stream a future benefits. These may, but do not have to be appropriated by the state and need not be tangible. Kellermann (2007) notes that it is very difficult to distinguish between productive and 'consumptive' public capital investment. To this he adds that certain types of expenditure, such as that on education, could also be considered as enhancing growth. Already the EESC (2006) mentioned the possibility of defining R&D and education expenditure as investment. Blanchard &Giavazzi (2003) and Creel (2003) agree on the fact that should a golden rule be introduced in the EU, the definition of the public investment would have to be broadened.

This would prevent the potential bias towards physical assets and against expenditure on growth enhancing intangible assets, such as human capital. This bias is also one of the arguments of Buti et al. (2002) against the introduction of the golden rule using the current definition of public capital.

2.6 Other practical issues

There are also many practical issues connected with the introduction of the golden rule in the European Union.

First, there is the question whether a significant change to the EU's fiscal rules is possible at all. Blanchard &Giavazzi (2003) note that a large change to the SGP which would require a modification of theTreaty would be very difficult to push through. They, however, think that changing the way public investment is accounted for in public budgeting would be possible without a modification to the Treaty.

Second, there is the problem of flexibility under the golden rule. Balassone& Franco (2000) argue that the golden rule is not helpful during downswings as capital investment expenditures take place with a significant delay. On the other hand, Ardy et al. (2006) argue that the golden rule allows sufficient flexibility to the governments as the length of the cycle is unknown and also because the definition of investment may be debated.[4]

Third, there are opposing views on whether the golden rule would improve transparency of the fiscal rules. While Blanchard &Giavazzi (2003) claim that the golden rule would introduce more transparency to the budgets,[5]Buti et al. (2002) and Balassone& Franco (2000)

[4]They provide a very good example of this, reminding that the British Labour government referred to all public expenditure as to investment in public services. This may, however, count against the golden rule: it only shows that it may happen that nothing changes with the rule's introduction if the definition of investment is cleverly made.

[5]They use Italy as example: in this country the government performs investments through a special agency that borrows money on the market and whose balance is not consolidated in the government accounts.

claim that the introduction of the golden rule would lead to opportunistic behaviour because of the incentive to classify current expenditures as capital expenditures, and that the multilateral surveillance would become even more complex and difficult. In this context, however, Balassone& Franco (2000) claim that if the governments self-impose the golden rule, like e.g. in the UK, there would be no problem of multilateral surveillance.

Finally, the transition to the golden rule is also perceived as problematic. Both Buti et al. (2002) and Balassone& Franco (2000) agree that an excessive burden would be placed on the current generations as they would not only have to pay the interest on previously made debts, but they would also have to fund new investments.

3 Empirical evidence on the productivity of public capital in the EU

As we already discussed in the previous Section, one important assumption underlying the desired increase in public capital investment is that public capital is productive. Many studies have been devoted to this question but the majority of them were performed for the US. For the needs of our discussion of the introduction of the golden rule in the EU,we investigate this issue for all 27 EU member states.

In this section we first review the literature treating the productivity of public capital. Second, we describe and discuss the data and the method used. Third, we present our estimation results and,at the end, we provide a brief summary of our findings.

3.1 Related literature

The question whether investment into public capital enhances economic growth has been investigated since the 1970's. Several approaches to this issue have been taken, varying from estimation of a production function, a translog production function, a profit or cost function to estimation of different kinds of VAR models.

Batina&Ihori (2005) provide a large overview of research on public investment's effect on economic growth, mainly in the US. The first important paper, which evoked a lot of reactions, was that of Aschauer (1989). He estimated a Cobb-Douglas production function (adding a time trend into it and assuming constant returns to scale) and concluded that the elasticity of private output with respect to public capital was 0.39, public capital being more productive than labour or private capital. He also found that infrastructure, such as motorways, mass transit, airports, electrical and gas facilities and sewers, has an output elasticity of 0.24. On the other hand, the output elasticity of hospitals was estimated to be 0.04 and that of educational buildings even negative (-0.01). Nevertheless, this all was done for aggregated data, i.e. for the whole USA. When in Aschauer (1990) disaggregated and time averaged data were used (i.e. data for individual US states were averaged over time), the output elasticities were estimated to be much lower than in the previous paper.

Most other research classified as 'early studies' by Batina&Ihori (2005) also found that public capital is productive. These studies took a production function, cost function and profit function approaches. However, they were criticised very soon, mainly from the statistical point of view.

Further studies used both aggregated and disaggregated data for the US. We especially focus on those using disaggregated data because we do not want to ignore differences among the EU countries' economies. Studies using disaggregated data that are reviewed by Batina&Ihori (2005) used more approaches than the 'early studies': system estimation or VAR models can also be found there. These papers reach various conclusions on the productivity of public capital; some even claim that state public capital has a negative impact on the output.

Munell (1990) estimated panel data for the US and her result was that public capital had a positive effect on the state output, the coefficient being 0.15. However, when constant returns to scale were imposed on all the inputs, the estimate was only 0.06.

The results of Holtz-Eakin (1994) were different. He estimated a production function where the error term was composed of a random variable, a state-specific and a time-specific effect. He estimated his data using several approaches and in most cases the effect of public capital on private output was negative.

Garcia-Mila et al. (1996) estimated a production function using panel data for the US and as proxy for public capital stock they included different kinds of infrastructure. Their estimates of the effect of public capital on private output were positive, irrespective of whether random or fixed effects were used. However, the authors came to the conclusion that the estimation should be done in first differences, based on different specification issues, and when this approach was used, the estimates were negative and insignificant. Therefore the conclusion of the authors is that 'there is no evidence of a positive linkage between public capital and private output' (pp. 180).

When comparing the results of estimation of aggregated and disaggregated data, Batina&Ihori (2005) note that cross section may dominate in panel data analysis and public capital can thus appear less productive. This is the reason why the use of aggregated data usually yields higher estimates of the public capital productivity. As already noted above, this was in fact confirmed by Aschauer's 1989 and 1990 papers.

Sturm et al. (1998) and De Haan& Romp (2005) provide an overview of research into the relation of public capital and economic growth in a more 'problem-based' manner than

Batina&Ihori (2005). They point out several issues that may be important for our own estimation, which is discussed below.

First, there is the issue of how public capital should be defined. If we think of core infrastructure, such as roads, rails, power stations etc., we need to take into account that not all these are provided by the state (e.g. the power stations). Another problem is that public investment can be put into roads, hospitals or schools, but also into equipment such as a swimming pool, which is usually not considered to be productive. Therefore, not all government's expenditures on capital are productive. Furthermore, if we take government spending on capital as a regressor, we have to take into account that the height of current investment very likely depends on the current level of capital.

Second, there is the problem of the kind of production function we estimate. One issue is how public capital (G) enters the production function. Let us have the following production function:

$$Y_t=A_t(G_t).f(K_t,L_t,G_t) \qquad (1)$$

where*A* stands for technology, *K* for private capital, *L* for labour and *G* for public capital.

Very often we can see that public capital enters it in the same way as e.g. private capital or labour. However, De Haan& Romp (2005) suggest that it may be more reasonable to insert it into the production function as something that influences productivity (*A*). This problem was in fact solved by Sturm et al. (1998) who came to the conclusion that when a Cobb-Douglas production function is estimated in log levels, both approaches lead to similar equations to be estimated.

Other issues that we should take into account during the estimation are the following: it seems to be very important to do the estimation with country specific effects – otherwise the estimates could be biased and inconsistent. Also, it may be important to find whether public and private capitals are complements or substitutes because of possible crowding-out effects.

Third, there is the issue of possible problems with the data. Most cited is the non-stationarity of data, which may be a problem even for panel data sets. In some cases this may be solved by first differencing the given variables, but, as explained e.g. by Munnell (1992), this may deprive us from the possibility to estimate any long-run relationship between inputs and the output, because in such estimation the output in a given year depends only on inputs from that year. This was confirmed by Garcia-Mila et al. (1996), as already described above.

Furthermore, Sturm et al. (1998) note that researchers should also investigate whether the variables are cointegrated (i.e. whether they grow together and converge to their long-run relationship).

Fourth, there is the problem of reverse causation or simultaneity bias. Usually the causality is expected to be the following: public capital determines output. But it is also possible that there is a feedback from output to the capital stock, as higher output can have a positive effect on the demand for infrastructure. De Haan& Romp (2005) mention several possibilities of dealing with this problem. Those that are out of the scope of this paper are estimation using the generalized method of moments, estimation of simultaneous equations, a VAR model, or the use of instrumental variables.

Calderon &Serven (2002) estimate panel data and solve the problem of reverse causation by using the instrumental variables approach. They use demographic variables as instruments and supplement these with the lagged values of explanatory variables as weakly exogenous instruments. However, as the result of such estimation is very similar to the outcome of their pooled OLS model which they consider to be misspecified, they seem to be rather disappointed by the results of the instrumental variables approach.

Actually, it is possible that the bias of estimates caused by the reverse causation is not very significant: Cadot et al. (1999), working with data on French regions, took a simultaneous equations approach to the modeling and then compared their estimate of the elasticity of output with respect to public capital (0.101 for the whole of France) with that made by simple OLS (0.099). We can see that the difference between these two estimates is very small.

3.2 Data and Method

Our analysis is based on the Cobb-Douglas production function. As already noted earlier, when such production function is estimated in log levels, it does not matter how the public capital enters the function. Therefore let us have a production function in the following form:

$$Y_t = A_t K_t^{\alpha} G_t^{\beta} L_t^{\gamma} \qquad (2)$$

where$Y$ stands for output, A for technology, K for private capital, G for public capital, L for labour (i.e. the number of workers) and t is a subscript for time. Assuming constant returns to scale, i.e. $\alpha+\beta+\gamma=1$, we can express the equation in per worker terms:

$$\frac{Y_t}{L_t} = A_t \left(\frac{K_t}{L_t}\right)^{\alpha} \left(\frac{G_t}{L_t}\right)^{\beta} \qquad (3)$$

Expressing the variables per workerby lower case letters and taking the natural logarithm, we get the following equation:

$$\ln y_t = \ln A_t + \alpha \ln k_t + \beta \ln g_t \qquad (4)$$

Basically, we should estimate the following equation:

$$\ln y_{i,t} = \tau + \alpha \ln k_{i,t} + \beta \ln g_{i,t} + u_{i,t} \qquad (5)$$

In the estimation of this equation the constant τ will approximate the logarithm of technology. Based on previous research, we expect that a simple pooled OLS would very likely yield misspecified estimates, due to e.g. differences in production technology across countries. Therefore we do our estimation with country-specific and time-specific effects. This leads us to suppose that the error term has the following form:

$$u_{i,t} = \mu_i + \upsilon_t + \varepsilon_{i,t} \qquad (6)$$

where we suppose that μ_i is the country-specific component, υ_t is the time-specific component and $\varepsilon_{i,t}$ is an i.i.d. error with a zero mean. Either we may take the approach of a fixed-effects model (FE model) where we suppose that $\mu_i$captures the unobserved differences among the countries, or the approach of a random-effects model (RE model) where we suppose that $\mu_i$has zero mean and is uncorrelated with the explanatory variables (Wooldridge, 2006).

We suppose that the public capital does not crowd out private capital. This is not refuted in the literature: de Haan et al. (1996) investigated this issue and concluded that public and private investment are complements. The results of the European Commission (2003) were rather inconclusive.

We work with a panel of annual data for 27 EU countries in the period 1960 – 2009. Nevertheless, for many countries a lot of observations are missing, especially for certain variables.

Our data were mostly retrieved from the Eurostat database. However, several important variables were taken from other sources.

Data on gross domestic product and employment were retrieved from the Ameco database of the European Commission. In this database, figures on GDP were more complete and available for a longer time period than in the Eurostat database).

Data on net capital stock, both for the general government and the private sector, were provided by the Kiel Institute for World Economy (estimates were done by Christophe Kamps in 2004). The estimates of capital stocks exist from 1960 to 2001 for 22 OECD countries, of which only 14 are EU members. Figures on gross capital formation, both for the general government and the private sector, were retrieved from Eurostat. They are available since the 1970's, although for some of the countries since the 1990's only.Figures on different kinds of gross capital formation are usually available from the 1990's on.

All our variables are expressed in EUR per person employed and in natural logarithms, if not stated otherwise.

Our key variables are the following: gross domestic product (*GDP*) as the dependent variable, and net publiccapital stock (*NGCS*) and net private non-residential capital stock (*NPCS*)as explanatory variables. As the net capital stock variables are only available for 14 EU countries that are also OECD members, we suppose that the countries are sufficiently homogenous so that there is no problem with poolability of the data. Following Aschauer (1993), we add a time[6] (and time squared) variable to proxy for the technological progress.

We first look at the statistical properties of the key variables. In the Appendix we included three figures showing the key variables (Figures A1-3). Given these figures we did not expect the variables to be stationary. This was confirmed by the unit root tests that we performed on all the variables: we could not reject the null hypothesis of unit root at any of the usual levels of significance. The results are presented in the Appendix, Table A1.

As the variables are all integrated of order 1, we investigate whether there is a cointegrating relationship among them, i.e. whether it is possible to find a linear combination of them that would yield disturbances that are integrated of order 0, which would mean that the difference among them is stable and they thus grow at roughly the same rate (Greene, 2002).

Therefore, we apply the Pedroni residual cointegration test to find whether there is panel cointegration between the two capital stock variables and GDP. As shown in the Appendix, Table A2, the null hypothesis of no cointegration was rejected at the 1% level of significance using the Augmented Dickey-Fuller test statistic and at 10% level of significance using the Phillips-Peron test statistic.[7]

To quantify the long-term relationship between capital stock and GDP we estimate an OLS model and then we try whether the inclusion of fixed or random effects is appropriate. Granger (1981) and Engle & Granger (1987) showed that due to acointegrating relationship between given variables, the coefficients that we obtain are super consistent, i.e. they converge to their true values faster than a usual OLS estimator with stationary variables. However, the standard errors are not consistent.

To account for the possible simultaneity bias, we also do the estimation using first lags of our explanatory variables. We are aware of the fact that this method is very simplistic and has many limitations, but the simultaneous equations approach or instrumental variables method are out of the scope of this paper, especially due to the lack of data available for such procedures.

Data on net public capital stock are not available in a more detailed breakdown. As we assume that different kinds of capital have different productivity, we also work with data on gross capital formation that exist for several categories.[8]To be able to use these as stock variables, we compute their cumulative totals per person employed and express these in natural logarithms.

[6]Thevariable*time*rangesfrom 1 to 50.

[7] Anytime we tested for cointegrating relationship among given variables, we ensured that this relationship does not disappear when time trend and time^{2}were included. To save space, the results of these are not presented.

[8] Net figures are not available.

Data on gross capital formation are available aggregated for the private and public sector (*PGCF* and *GGCF*, respectively) and also in different functional categories for the public sector (the Classification of Functions of Government in ESA 95). Following Kappeler&Välilä (2007) we sort those that we assume could be productive into three groups: infrastructure (economic affairs – *GGCF_IN*), health and education (health, education – *GGCF_HE*) and public goods (defence, general public services, environment, public order and safety – *GGCF_PG*). For illustration we also show the graphs of *GGCF* and *PGCF* in the Appendix, Figure A4. We can see that these two variables do not seem to be stationary, which was also confirmed by statistical tests:in the case of *PGCF* we could not reject the null hypothesis of unit root on any of the usual levels of significance and in the case of *GGCF* we could not reject it at the 1% level of significance. We, however, bear in mind that the results of the tests are not 100% reliable as the length of the time series varies only between 15 and 39 observations. The results are presented in the Appendix, Table A3.

Therefore, we test whether there is a cointegrating relationship between *GDP* and *PGCF* and *GGCF*. The result of the test is in the Appendix, Table A4. We can see that the null hypothesis of no cointegration is strongly rejected. We continue by replacing *GGCF* with the three different kinds of this variable. We test these three variables and *PGCF* for cointegration with *GDP*. The result of this test is presented in the same table in the Appendix. We can see that the null hypothesis of no cointegration is rejected at the 1% level of significance. We again note that as the number of observations does not exceed 20 for any of the countries, the result of the test is not 100% conclusive. However, it remains useful for having a picture on the roles of the different kinds of public expenditures. Thus, based on the tests, we assume that from OLS estimation in all the cases we should get consistent coefficients.

Nevertheless, there are also other types of government's expenditure that are considered to be very important for economic growth. These are especially resourcesspent on research and development (*R&D_G*) and on education (*EXP_E_G*), which can be considered as a kind of investment into human capital, both being expressed in logarithms of their cumulative totals. Their graphs are shown in the Appendix, Figure A5. These variables do not seem to be stationary, which was confirmed by the unit root tests: in the case of *EXP_E_G* we could not reject the null hypothesis of unit root at any of the usual levels of significance and in the case of *R&D_G* we did not reject this hypothesis both at the 1% and 5% level of significance (see Table A5in the Appendix). Like in the previous unit root testing, we note that as the length of the time series is limited, so are the test's results, which will also hold for the following cointegration testing.

We tested for cointegration between *GDP* and *PGCF,GGCF, R&D_G,* and *EXP_E_G.* The results of the test are in the Appendix, Table A6. We did reject the null hypothesis of no cointegration among the variables. We thus expect our estimators to be consistent.

3.3 Estimation results

3.3.1 Net capital stocks

We begin with the estimation of net capital stock variables as determinants of GDP. Table 1 presents the results. In all models presented in the table the coefficients have the expected sign. We begin with the pooled OLS in Model 1. Its result is that public capital is only slightly less productive than private capital. However, when country-specific fixed effects are included in Model 2, the productivity of the public capital decreases significantly, to 0.34.

Table 1 – Estimationresults – net capital stocks

Dependent variable: GDP	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Const	0.2501 **	0.1199	0.2004 ***	0.2598 ***	0.1255 ***	0.2061 ***
NGCS	0.4284 ***	0.3380 ***	0.2293 ***	0.2213 ***	0.3432 ***	0.2371 ***
NPCS	0.5376 ***	0.6439 ***	0.4679 ***	0.4561 ***	0.6385 ***	0.4649 ***
time			0.0359 ***			0.0353 ***
$time^2$			-0.0020 *			-0.0002 ***
fixed effects (cross-section)	no	yes	yes	yes	no	no
fixed effects (time)	no	no	no	yes	no	no
random effects	no	no	no	no	yes	yes
Adjusted R2	0.9778	0.9933	0.9959	0.9958		
Akaike criterion	-444.6	-1127.9	-1416.1	-1362.8	-412.6	-395.9
F statistic	12882.9 ***	5734.8 ***	8330.3 ***	2456.9 ***		
Test statistic for common intercept		103.360 ***	154.940 ***	150.097 ***		
Test statistic for consistence of GLS estimates					2.8188	5.4454
Test statistic for normality of residuals	36.137 ***	72.840 ***	66.220 ***	67.205 ***	37.651 ***	52.393 ***
Number of observations	585	585	585	585	585	585

Note: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) standard errors are HAC robust

On the other hand, the productivity of private capital increases and gets nearly twice as high as the productivity of the public capital (0.64). When we add two variables proxying for thetechnological progress, *time* and *time*^{2}, in Model 3, we can see that the coefficients on both capital stocks decrease but that the productivity of private capital remains double that of private capital. Furthermore, the fit of Model 3 is much better than the fit of Model 2.

When we exclude the proxies for technological progress but add to the estimation the time fixed effects that can account for common factors such as the business cycle, we can see in Model 4 that in comparison with Model 3 the fit did not improve and that the coefficients remained nearly the same.[9] In all models where fixed effects were used the tests for common intercept suggest that the use of this kind of model is more appropriate than the use of pooled OLS.

We then proceed by estimating the basic model with the inclusion of the random effects. The results of Model 5 are very similar to the results of Model 2 and both types of capital are very productive. However, when we include the two time variables in Model 6, we can see that the coefficients decrease to levels similar to Models 3 and 4. We can see from the test statistic for consistence of GLS estimates that the use of random effects is appropriate.

All models where either the time variables or time fixed effects were included predict an elasticity of GDP with respect to the public capital stock to be at least 0.22, i.e. when *NGCS* increases by 1%, *GDP* increases by 0.22%. When these time specific effects are not included, the productivity of public capital is predicted to be more than 0.33. Also the elasticity of *GDP* with respect to the private (non-residential) capital stock is predicted to be higher by models without time specific effects (up to 0.64) and lower when these effects are included (around 0.46). As there is a cointegrating relationship among the variables, the estimators should be super consistent, while the standard errors are inconsistent and thus not decisive. In none of the models we could accept the null hypothesis of normally distributed residuals.

Our results suggest that both capital stocks are highly productive, although not as much as e.g. in Aschauer (1989) who also uses figures on net public capital stock. This is not surprising because Aschauer uses aggregated data while we use disaggregated (country-level) data and, as we have already noted, the productivity of capital is usually estimated to be lower when disaggregated data are used.

To account for the possible problem of reverse causation, we run the estimation again but including the first lag of the explanatory variables, as current level of GDP can hardly have a backwards influence on the past period level of capital stock. As can be seen in Table 2, the coefficients did not change much: in the case of NGCS the decrease was never greater than by 0.03 and in the case of NPCS the decrease was by 0.04 at most. The private capital has

[9] We note that when both the time variables and time fixed effects were included into the regression, logically the coefficients were the same as in Model 4, except for the constant.

remained twice as much productive as public capital. As in the previous estimation, GLS estimators seem to be consistent.

The finding that the coefficients were nearly the same as in the previous estimation suggests that the simultaneity bias might really be rather small.

Table 2 – Estimation results – lagged values of net capital stocks

Dependent variable: GDP	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
const	0.3853	***	0.2570	**	0.2497	***	1.5794	***	0.2644	***	0.2597	***
NGCS (-1)	0.4271	***	0.3369	***	0.1987	**	0.2010	**	0.3437	***	0.2115	***
NPCS (-1)	0.5183	***	0.6239	***	0.4287	***	0.4262	***	0.6168	***	0.4246	***
time					0.0493	***					0.0479	***
time2					-0.0004	***					-0.0004	***
fixed effects (cross-section)	no		yes		yes		yes		no		no	
fixed effects (time)	no		no		no		yes		no		no	
random effects	no		no		no		no		yes		yes	
Adjusted R2	0.9755		0.9909		0.9941		0.9943					
Akaike criterion	-409.9		-974.7		-1225.5		-1208.9		-381.2		-306.3	
F statistic	11643.4	***	4232.7	***	5771.5	***	1813.3	***				
Test statistic for common intercept			76.382	***	111.843	***	113.525	***				
Test statistic for consistence of GLS estimates									2.7387		8.1177	*
Test statistic for normality of residuals	32.77	***	58.85	***	51.09	***	57.06	***	30.96	***	89.16	***
Number of observations	585		585		585		585		585		585	

Note: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) standard errors are HAC robust

3.3.2 Gross capital formation

To be able to account for differences in productivity of different kinds of capital, we continue by estimating the effect on GDP of the cumulative totals of public and private gross capital formation, as these data are available for several categories. We begin by including into the estimation the private and public gross capital formation in aggregate form. The results of this estimation are shown in Table 3.

In all models the coefficients have the expected sign, except for the proxies for technological progress. Like in the previous estimation, we can see that in the pooled model (Model 1) both coefficients on gross capital formation, but especially that on *PGCF*, are higher than in the other models where fixed effects were included.

Model 4, where both the country-specific and time-specific fixed effects are included, seems to be best specified. According to it, private gross capital formation is nearly three times more productive than public gross capital formation. Again, given the cointegrating relationship among the variables, our estimators should be consistent. GLS estimates, on the other hand, were not consistent in any model, as indicated by the test statistics.

As for the negative coefficient on time, it seems that this variable has become a strange proxy for technological progress. It is not very realistic that technologies would face such a downward sloping trend. This finding also seems to be at odds with all growth theories claiming that economic growth is based on technological progress.

Table 3 – Estimation results – cumulative gross capital formation

Dependent variable: GDP	Model 1		Model 2		Model 3		Model 4	
const	1.7564	***	2.6467	***	6.0412	***	2.4948	***
PGCF	0.4407	***	0.2045	***	0.2089	**	0.2325	**
GGCF	0.0999		0.0697		0.0693		0.0859	
time					-0.1665	***		
time2					0.0020	***		
fixed effects (cross-section)	no		yes		yes		yes	
fixed effects (time)	no		no		no		yes	
Adjusted R2	0.7342		0.9695		0.9738		0.9751	
Akaike criterion	429.769		-444.240		-504.86		-510.26	
F statistic	572.9	***	471.6	***	513.8	***	345.5	***
Test statistic for common intercept			123.407	***	55.432	***	50.98	***
Test statistic for consistence of GLS estimates			232.262	***	207.313	***	220.549	***
Test statistic for normality of residuals	9.568	***	50.683	***	48.964	***	47.882	***
Number of observations	415		415		415		415	

Note: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) standard errors are HAC robust

Not surprisingly, our estimators are significantly lower than those presented in Table 1. This is probably caused by the fact that at the beginning we worked with net figures while now gross figures are used. It is logical that the effect of variables expressed in gross terms on GDP is lower because they were not netted of depreciation etc. Nevertheless, this is what is usually best available and what we can work with when discussing fiscal rules.

To be able to see the effects of different kinds of the public gross capital formation, we include into the regression the three categories of this variable. The results of this estimation are in Table 4. We can see that the pooled OLS model,in comparison with the fixed effects models and also in comparison with the fixed effects models presented in Table 3, strongly overestimates the coefficient on *PGCF*. In the current three fixed effects models the coefficients on *PGCF* are very similar, ranging from 0.087 to 0.112, but they are significantly lower than in fixed effects models shown in Table 3.

Table 4 – Estimation results – subcategories of cumulative gross capital formation

Dependent variable: GDP	Model 1		Model 2		Model 3		Model 4	
const	1.8188	***	3.1327	***	6.9366	***	3.0409	***
PGCF	0.4650	***	0.0877		0.0948		0.1119	***
GGCF_IN	0.0913		0.1125		0.0521		0.0699	
GGCF_HE	0.0426		0.1154		0.1522		0.1527	
GCCF_PG	-0.0563		-0.0485		-0.0366		-0.0332	
time					-0.1889	***		
time2					0.0023	***		
fixed effects (cross-section)	no		yes		yes		yes	
fixed effects (time)	no		no		no		yes	
Adjusted R2	0.7363		0.9719		0.9768		0.9773	
Akaike criterion	-201.94		-445.89		-518.94		-513.56	
F statistic	276.08	***	455.44	***	518.52	***	347.49	***
Test statistic for common intercept			126.803	***	61.125	***	55.648	***
Test statistic for consistence of GLS estimates			211.904	***	243.464	***	220.44	***
Test statistic for normality of residuals	10.971	***	56.069	***	46.868	***	52.030	***
Number of observations	395		395		395		395	

Note: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) standard errors are HAC robust

In Model 2, where no account was taken of the time (or technology), the effect of infrastructure gross capital formation seems to be overstated, as it is by 0.5 – 0.6 higher than in Models 3 and 4. On the other hand, Model 2 seems to underestimate the effect of investment into health and schooling: in Models 3 and 4 the coefficients on this kind of investment are by approximately 0.04 higher. In all the models, the coefficient on gross pubic capital formation in the field of public goods is relatively small, but negative, which would suggest that money spent like this is not invested in a financially productive way. As in the previous estimation, the coefficient on *time* is negative. GLS estimates were not consistent in any of the models, as indicated by the test statistics.

Again, given the cointegrating relationship among the variables, we suppose that we have obtained consistent estimators.

However, as we already mentioned, there are also other public expenditures that are not capital investments but which are considered to be important for economic growth, such as expenditures on R&D or education.

Table 5 –cumulative gross capital formation and other expenditures

Dependent variable: GDP	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
const	8.8141	***	5.8332	***	2.9167	***	5.3027	***	2.6714	***	6.7446	***	2.6037	***
PGCF	0.0338		0.0712		0.1037		0.1435	*	0.1731	**	0.1248		0.1357	
GGCF	0.0898		0.0006		0.0098		0.0039		0.0094		0.0549		0.0674	
R&D_G	0.1364	***	0.1689	***	0.1631	***	0.1818	***	0.1732	***				
EXP_E_G	0.3599	***	0.0955		0.0875						0.0949		0.1182	
time	-0.2693	***	-0.1471				-0.1247				-0.1984	***		
time2	0.0027	***	0.0018	*			0.0016	*			0.0024	***		
fixed effects (cross-section)	no		yes		yes		yes		yes		yes		yes	
fixed effects (time)	no		no		yes		no		yes		no		yes	
Adjusted R2	0.9284		0.9779		0.9787		0.9784		0.9786		0.9762		0.9768	
Akaike criterion	-64.55		-423.11		-408.89		-421.23		-409.09		-509.8		-505.67	
F statistic	681.75	***	452.82	***	301.63	***	462.66	***	301.43	***	521.48	***	346.79	***
Test statistic for common intercept			29.023	***	26.001	***	38.581	***	35.006	***	43.042	***	38.597	***
Test statistic for consistence of GLS estimates			104.913	***	138.157	***	116.881	***	156.736	***	248.228	***	191.600	***
Test statistic for normality of residuals	20.551	***	49.245	***	58.147	***	59.006	***	72.619	***	47.132	***	49.679	***
Number of observations	316		316		316		316		316		316		316	

Note: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) standard errors are HAC robust

To find what their effect on GDP is, we used their cumulative totals as explanatory variables, together with the gross capital formation variables. The results of the estimation are shown in Table 5. In Models 1 to 3, all variables were included. In Models 4 and 5, apart gross capital formation, only R&D expenditures were included and in Models 6 and 7, apart gross capital formation, only expenditures on education were included.

As we can see, the effect of the private gross capital formation increased only slightly in comparison with the previous estimation, but it remained lower than in models presented in Table 3. We can, however, see that expenditures on R&D have a much higher effect on GDP than any public gross capital formation (the coefficient is around 0.17 in all fixed effects models) and that the effect of expenditures on education on GDP is nearly as high as that of public gross capital formation in the field of education and health in the previous table (the coefficient ranges from 0.087 to 0.118 in all the fixed effects models in Table 5 and the coefficient on GGCF_HE ranged from 0.115 to 0.153 in fixed effects models in Table 4). GLS estimates were not consistent in any of the models, which can be seen from the test statistics.

As in the previous estimations the coefficient on *time* is negative and again our estimates should be consistent given the cointegrating relationship among the variables.

3.4 Brief summary

Our results suggest that there is a positive long-run relationship between GDP and capital, both private and public. We came to this conclusion working with net and gross figures, depending on their availability. We found that both the net capital stocks and the cumulative totals of the gross capital formation are cointegrated with GDP. In most estimations private capital was more productive than public capital. From different kinds of public gross capital formation, investment into health and education was usually the most productive. However, we found that expenditures on R&D and education also have a positive effect on GDP.

Given that we did our estimation with gross capital formation, we can assume that if net figures were available, the effect of public investment on GDP would be higher at least in those areas where depreciation is relatively high. Investment into public goods does not seem to be productive, maybe because this type of investment does not offset the distortionary impact of taxation, at least in monetary terms.

From the technical point of view, we can say that the pooled OLS model was every time misspecified. Concerning the nature of the country-specific effects, when we worked with capital stock variables, GLS estimators were consistent, i.e. the use of random effects was appropriate. However, when working with the cumulative totals of gross capital formation, GLS estimators were inconsistent, i.e. the use of fixed effects was appropriate. This may be caused by the fact that as we used cumulative totals of the gross capital formation, the unobserved country-specific effects reflected the previously accumulated gross capital stock for which we did not have data, and thus this error component could not have a zero mean and was correlated with the explanatory variables.

4 Conclusion

In this paper we investigated the productivity of public capital from the point of view of the golden rule. We first introduced the golden rule as such, providing also examples of countries where this kind of rule has already been introduced.

We then discussed the possible implementation of the golden rule in the EU. There are many problematic issues connected with the golden rule, both conceptual and practical. One of the important assumptions underlying the introduction of the golden rule, which is supposed to induce a rise in public capital investment, is that public capital is productive. As most studies treating this topic have been performed for the US and not for the EU, we devote most of the paper to this question.

Using data for the EU (all 27 member states when possible) we investigated the issue of the productivity of public capital. The most important finding is the existence of a cointegrating relationship between both the net capital stocks and the cumulative totals of the gross capital formation and GDP. Apart data on net capital stocks we also worked with data on gross capital formation because these were available also disaggregated into several categories.

This long-run relationship among the variables proved to be positive in most cases. In the case of the net capital stocks the productivity was found to be higher than in the case of the cumulative totals of the gross capital formation, which we attribute to the fact that gross capital formation is not netted of depreciation and thus has a lower effect on GDP.

Concerning the different kinds of gross public capital formation, we have found that investments into infrastructure and health and education are productive. On the other hand, investments into public goods do not seem to have a positive effect on output, as they probably do not offset, in monetary terms, the distortive effects of taxation. However, we have found that also current expenditures on R&D or education have a significant positive effect on GDP.

This all leads us to the conclusion that at the aggregate level public capital is productive. However, there are many kinds of public capital which are likely to be unproductive and there also are many kinds of current expenditures that have a positive effect on output in the long run. Therefore, we are of the following view concerning the assumption of productivity of the public capital that usually underlies the discussions of the golden rule: supposing that the introduction of the golden rule in the EU should promote public capital investment, it would not be reasonable to introduce such rule if the definition of public capital investment does not change.

It may be helpful to add growth-enhancing current expenditures to the category of public investment for this purpose and maybe to exclude unproductive investments from it. It would, however, be very difficult to determine which kinds of public investment should be treated as unproductive, also taking into account that not all benefits stemming from an investment can be expressed in monetary terms and thus have a significant positive effect on the output.

Furthermore, as the sub-optimality of the level of public capital is debatable and the need for more public investment in many EU countries is thus uncertain, we are not proponents of the introduction of a golden rule in the EU in today's conditions.

APPENDIX

Figure A1– ln GDP per person employed over the period 1960 – 2009

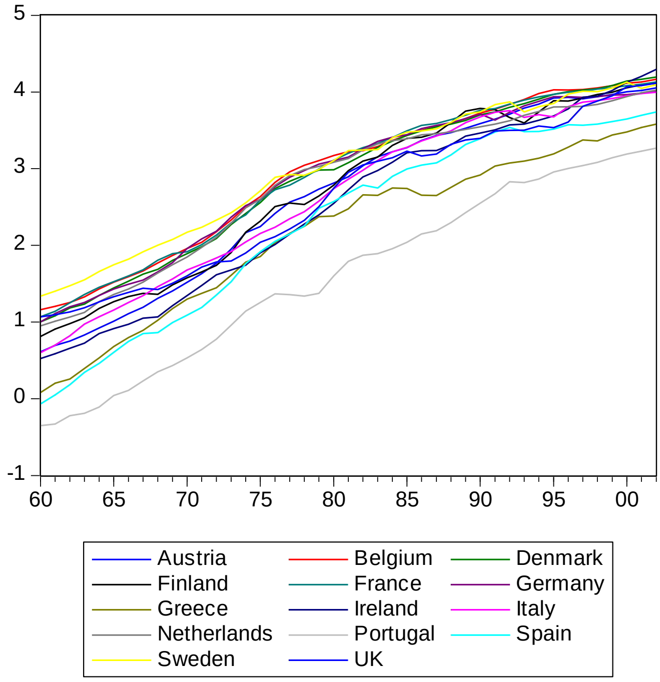


Figure A2 – ln net publiccapital stock per person employed over the period 1960 – 2009

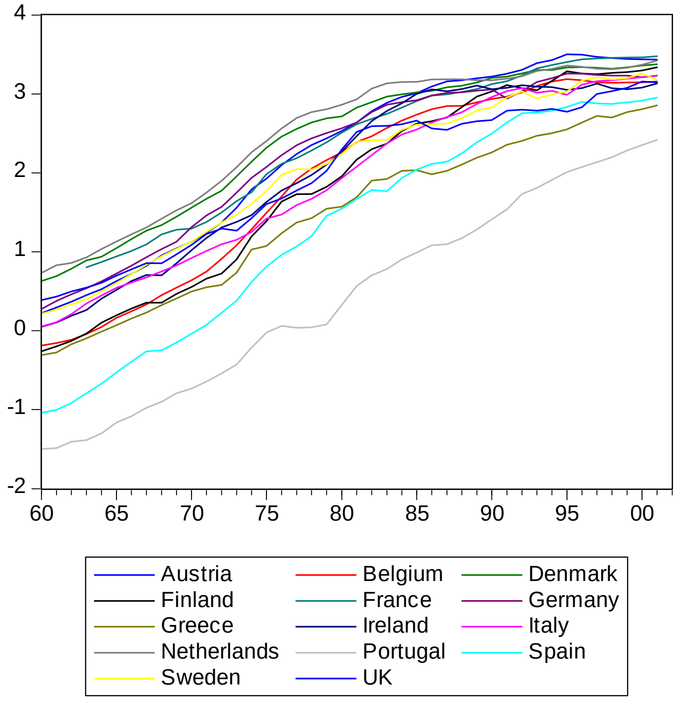


Figure A3 – ln net private non-residential capital stock per person employed over the period 1960 – 2009

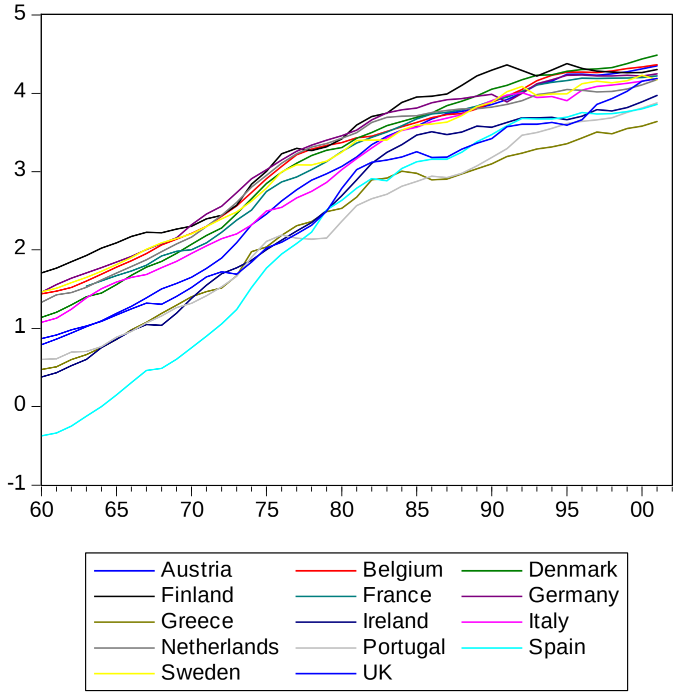


Table A1 – Panel integration test – GDP and net capital stocks

	GDP	NGCS	NPCS
ADF – Statistic	47.045	8.468	2.419

Notes: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) individual intercepts and trends were included in the test equation; the number of lags was chosen automatically using the Hannan-Quinn information criterion
3) we assumed individual unit root processes.

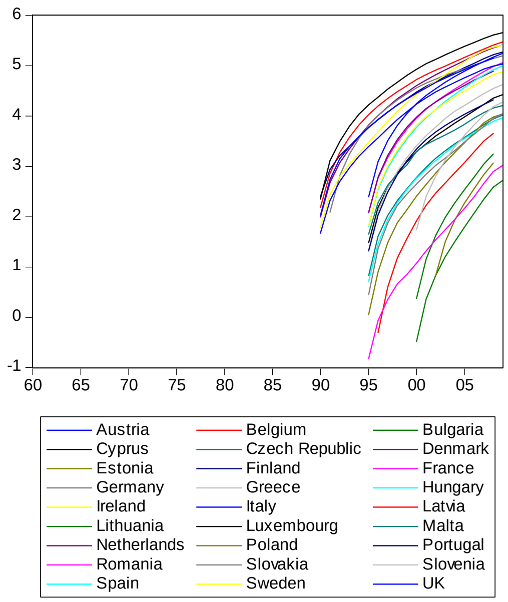
Table A2 – Panel cointegration test – net capital stocks

	GDP with NGCS and NPCS
ADF – Statistic	-5.4998 ***
PP – Statistic	-1.8316 *

Notes: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively.
2) the number of lags was chosen automatically using the Hannan-Quinn information criterion and individual intercepts were included in the test equation.
3) we assumed individual AR coefficients, but when common AR coefficients were considered, the ADF statistic and PP statistic were also significant at 1% and 5% level of significance, respectively.
4) the null hypothesis was also rejected when time and time^2 were added to the net capital stock variables.

Figure A4 – ln private and governmental gross capital formation over the period 1960 – 2009

PGCF



GGCF

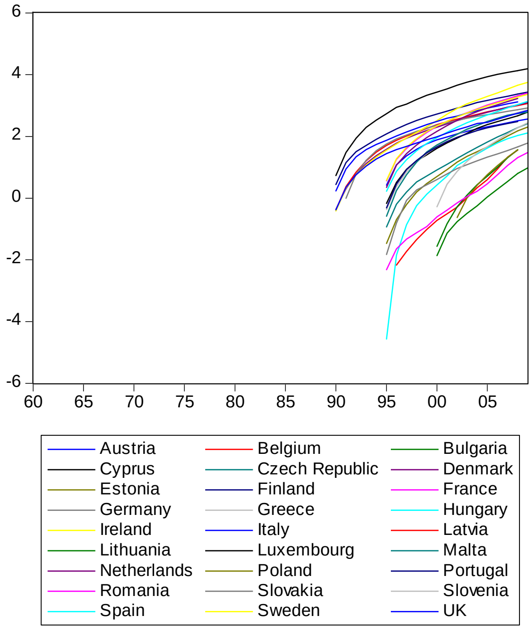


Table A3 – Panel integration test – gross capital formation

	PGCF	GGCF
ADF – Statistic	8.468	63.15 **

Notes: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) individual intercepts and trends were included in the test equation; the number of lags was chosen automatically using the Hannan-Quinn information criterion
3) we assumed individual unit root processes.

Table A4 – Panel cointegration test – gross capital formation

	GDP with GGCF and PGCF	GDP with PGCF, GGCF_HE, GGCF_IN and GGCF_PG
ADF – Statistic	-4.6725 ***	-4.4660 ***
PP – Statistic	- 2.9143 ***	-4.4241 ***

Notes: 1) *** indicates 1% level of significance.
2) the number of lags was chosen automatically using the Hannan-Quinn information criterion and individual intercepts were included in the test equation.
3) se assumed individual AR coefficients, but when common AR coefficients were considered, the ADF statistic and PP statistic were also significant at 1% level of significance.
4) the null hypothesis was also rejected when time and time^2 were added to the gross capital formation variables

Figure A5 – ln public expenditures on education and ln public expenses on R&D over the period 1960 – 2009

EXP_E_G R&D_G

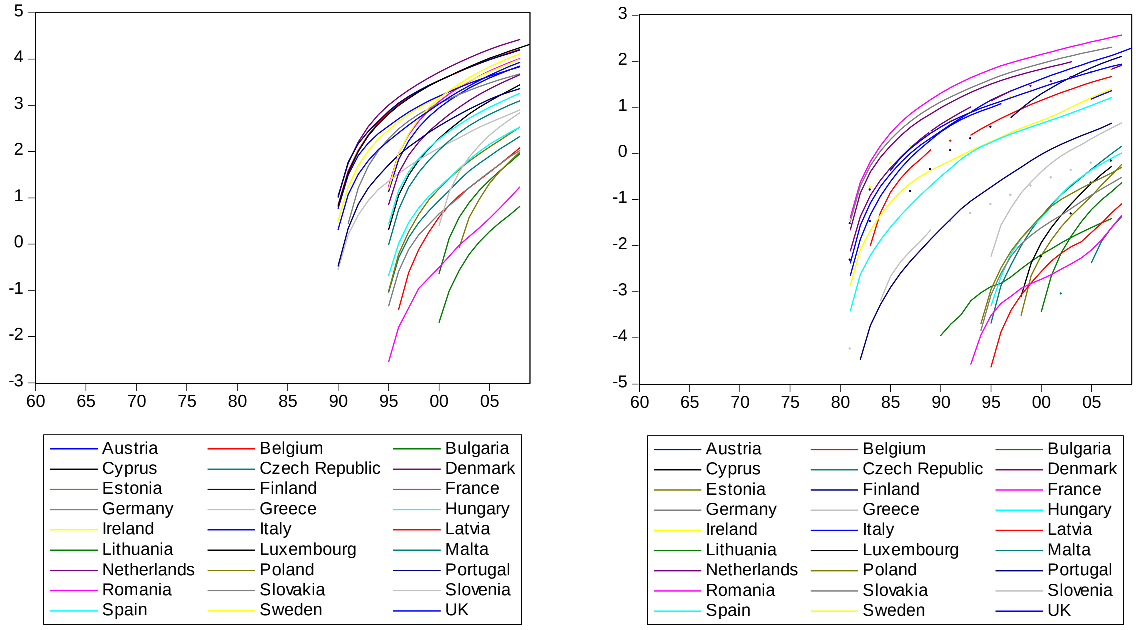


Table A5 – Panel integration test – expenditures on R&D and education

	R&D	EXP_E_G
ADF – Statistic	59.056 *	52.754

Notes: 1) ***, **, * indicate 1%, 5% and 10% level of significance, respectively
2) individual intercepts and trends were included in the test equation; the number of lags was chosen automatically using the Hannan-Quinn information criterion
3) we assumed individual unit root processes.

Table A6 – Panel cointegration test – expenditures on R&D and education

	GDP with PGCF, GGCF, R&D_G and EXP_E_G	GDP with PGCF, GGCF, and EXP_E_G	GDP with PGCF, GGCF, R&D_G, time and time2
ADF - Statistic	-5.5707 ***	-5.8552 ***	-8.1524 ***
PP - Statistic	-13.4088 ***	-4.0470 ***	-31.8443 ***

Notes: 1) *** indicates 1% level of significance.
2) the number of lags was chosen automatically using the Hannan-Quinn information criterion and individual intercepts were included in the test equation.
3) we assumed individual AR coefficients, but when common AR coefficients were considered, the ADF statistic and PP statistic were also significant at 1% level of significance, except for the first column.
4) when in the third column the time variables were not included, we could not reject the null hypothesis of no cointegration. However, in the case of the first two columns, the inclusion of the time variables did not change our conclusion.

REFERENCES

Aschauer, D. A. (1989). 'Is Public Expenditure Productive?',Journal of Monetary Economicsvol. 23, pp. 177-200.

Aschauer, D. A. (1990). 'Why Is Infrastructure Important?',Conference Series of the Federal Reserve Bank of Boston, pp. 21-68.

Aschauer, D. A. (1993).'Public Capital and Economic Growth. In Public Policy Brief no. 4/1993 – Public Infrastructure Investment: A Bridge to Productivity Growth', The Jerome Levy Economics Institute of BardCollege, pp. 9-30.

Balassone, F. & Franco, D. (2000). 'Public Investment, the Stability Pact and the ’Golden Rule‘', Fiscal Studies vol. 21 (2), pp. 207-229.

Batina, R. G. &Ihori, T. (2005).'Public Goods - Theories and Evidence', Springer, Germany.

Blanchard, O. &Giavazzi, F. (2003). 'Improving the SGP Through a Proper Accounting of Public Investment', CEPR discussion paper no. 4220.

Buiter, W. H. (1998). 'Notes on ‘A Code for Fiscal Stability‘', NBER working paper no. 6522.

Buti, M.; Eijffinger, S. & Franco, D. (2002). 'Revisiting the Stability and Growth Pact: Grand Design or Internal Adjustment? ', CEPR discussion paper no. 3692.

Cadot, O.; Röller, L.-H.& Stephan, A. (1999).'A Political Economy Model of Infrastructure Allocation: An Empirical Assessment', FS IV 99 - 15, Wissenschaftszentrum Berlin.

Calderon, C. &Serven, L. (2002).'The Output Cost of Latin America's Infrastructure Gap', Central Bank of Chile Working Paper no. 186.

Creel, J. (2003).'Ranking Fiscal Policy Rules:the Golden Rule of Public Finance vs. the Stability and Growth Pact', OFCE working paper no. 2003-04. Available at: http://ssrn.com/abstract=826285

De Haan, J.; Sturm, J. E. &Sikken, B. J. (1996). 'Government Capital Formation: Explaining the Decline', Review of World Economics, vol. 132, pp. 55-74.

De Haan, J. & Romp, W. (2005). 'Public Capital and Economic Growth: A Critical Survey', European Investment Bank Papersvol. 10, pp. 41-70.

Engle, R. F. & Granger, C. W. J. (1987). 'Co-Integration and Error Correction: Representation, Estimation, and Testing', Econometrica, vol. 55 (2), pp. 251-276.

European Commission (2001).'2001 Broad Economic Policy Guidelines', European Economy 72/2001.

European Commission (2003). 'Public Finances in EMU 2003', European Economy 3/2003.

European Commission (2009). 'Public Finances in EMU 2009', European Economy 5/2009.

European Economic and Social Committe (2006). 'Opinion of the European Economic and Social Committee on Strengthening economic governance — The reform of the Stability and Growth Pact', Official Journal C 88/15.

Garcia-Mila, T.; McGuire, T. J. & Porter, R. H. (1996). 'The Effect of Public Capital in State-Level Production Functions Reconsidered', The Review of Economics and Statisticsvol. 78, no. 1, pp. 177-180.

Granger, C. W. J. (1981). 'Some Properties of Time Series Data and Their Use in Econometric Model Specification', Journal of Econometrics, vol. 16 (1), pp. 121-130.

Greene, W. H. (2002). 'Econometric Analysis', Pearson Education, Inc., New Jersey. Fifth edition.

HM Treasury (1997). 'A Code for Fiscal Stability', London. Available at: http://archive.treasury.gov.uk/pub/html/docs/fpp/code/code.pdf, accessed on 20 May 2010.

HM Treasury (1998). 'Fiscal Policy: Current and capital spending', London. Available at: http://archive.treasury.gov.uk/pub/html/fpccs.pdf, accessed on 20 May 2010.

Holtz-Eakin, D. (1994). 'Public-Sector Capital and the Productivity Puzzle', The Review of Economics and Statisticsvol. 76 (1), pp. 12-21.

Kamps, C. (2005). 'Is There a Lack of Capital in the European Union? ' EIB working paper no. 3/2005.

Kappeler, A. &Välilä, T. (2007).'Composition of Public Investment and Fiscal Federalism: Panel Data Evidence from Europe', European Investment Bank, Economic and Financial Report 2007/02.

Kellermann, K. (2007). 'Debt Financing of Public Investment. On a Popular Misinterpretation of ‘the Golden Rule of Public Sector Borrowing’', European Journal of Political Economy vol. 23, pp. 1088-1104.

Munnell, A. H. (1990). 'How Does Public Infrastructure Affect Regional Economic Performance?',Federal Reserve Bank of Boston - Conference Series 34, pp. 69-112.

Sawyer, M. (1997).'On Budget Deficits and Capital Expenditure', Macroeconomics 9802012, EconWPA.

Sturm, J.-E.; De Haan, J. &Kuper, G. (1998). 'Market Behaviour and Macroeconomic Modelling', MacMillan, chapter Modelling Government Investment and Economic Growth on a Macro Level: A Review, pp. 359-406.

Wooldridge, J. M. (2006).'Introductory Econometrics - A Modern Approach', Thomson South-Western, USA.Third edition.

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