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Is Public Capital Productive in Europe?

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Abstract

This paper addresses the issue of whether and by how much public investment or public capital can enhance economic performance. In comparison with the literature on the subject, we apply many different methodologies to answer these questions. A VAR model (for France, Italy, Germany, the UK and the USA), a panel composed of 6 European countries (Austria, Belgium, France, Germany, Italy and the Netherlands) and a regional panel (French regions) are therefore estimated. Public investment is shown to be a significant determinant of output; this is also true for public capital but to a lesser extent than public investment with a VAR methodology. The size of the estimated coefficient is also more realistic than those obtained in the literature. This empirical result confirms that the focus of some economists on safeguarding the level of public investment is not misplaced. The debate on the introduction of a “golden rule of public finance” in EMU is legitimate.

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Introduction

It is widely recognised that the Stability and Growth Pact (SGP) has lost most if not all of its capacity to refrain European governments from implementing over-expansionary policies, notably pro-cyclical policies when economic growth is over its potential. In this context, modifying the way fiscal policies are being implemented in Europe still keeps on being a very important issue¹.

Three main kinds of reform to the current SGP have been considered so far². First, considering that governments are mature enough to reach fiscal discipline, they should not have to resort to rules, commitments and so forth. Their track-records would testify for this evidence. However, basing upon history and political economy arguments, most economists still disregard this option. If such a reform has been promoted by some (the argument is present in Kopits, 2001, and in Arestis and Sawyer, 2001, that recognise that the Pact should be based on “essentially Keynesian analysis of the economy”), it is still far from “fashionable”. The second way for a reform would introduce slight modifications to the actual Pact. Buti et al. (2003) and the European Commission (2002) stood as the most zealous promoters of what Creel (2003) called a “low-fat reform”. A third proposal has been made in favour of the application of a “golden rule of public finance” to the European Union (EU). Blanchard and Giavazzi (2003) have endorsed this reform. The proposal by the Italian Minister of Finance, M. Giulio Tremonti, to implement a European-wide public investment program in order to boost growth, while at the same time removing the incurred expenditures

¹ The nominal convergence period before the advent of the Euro had already produced major discussions between the pros (Bovenberg and de Jong, 1997; Bovenberg et al., 1991; Wyplosz, 1991) and cons (Buiter et al., 1993) of debt and deficit ceilings.

² Buti et al. (2003) present a synthetic table of most of the reforms which have been proposed since 2000. Institutional reforms, like those proposed by Wyplosz (2002) – the seminal paper and proposal can be found in

from the deficit target of the SGP is a recent concrete example of what a “golden rule” would be at the European level. Some countries have also recently experienced this fiscal setting (the UK, see Emmerson and Frayne, 2001; and Australia, see Robinson, 2002).

In March 2005, a “Reform” of the SGP was adopted by EU governments. This “reform” hinges extensively on earlier Commission’s proposal, with only a change at the margin with the introduction of a public debt target in the SGP. Countries with a low public debt to GDP ratio will be authorized to target a higher public deficit to GDP ratio in the mid-run than countries with high debt ratios.

The purpose of this paper is, first, to question the relevance of this still in our sense “low-fat reform” and, after having argued that the new Pact lacks a long-run dimension, to question the relevance of implementing a long-run public investment policy in the EU. The second part of the paper will hinge on estimations of the impact of public investment on economic growth. Two methods will be used in that respect. VARs and panel regressions will be presented. VARs will be performed considering economic arguments – the underlying models will focus alternatively on aggregate demand and aggregate supply – and panel regressions will be performed with a Cobb-Douglas production function using national data and regional data. This extensive use of new available data will give us empirical insight in the debate on the Golden rule of public finance.

The paper is organised as follows. Section 1 briefly presents the current situation of public finances in the Euro area. The gap between the “proximate goal” of the SGP and outcomes appears to be wide. Section 2 focuses on the recent proposals by Buti et al. (2003) and the EC for improving the Pact. A critical view is adopted. Finally, pros and cons of

adopting a “golden rule” in the EU are discussed in section 3. Section 4 is dedicated to empirical estimations. Section 5 concludes.

1. The Stability and Growth Pact in debate

In contrast to the central monetary policy implemented by the European Central Bank (ECB), fiscal policies in the euro area are still in the hands of national governments. In order to remove the supposedly negative cross-border effects of a domestic fiscal policy over its partners, be they European countries or the ECB, the Maastricht and Amsterdam treaties have introduced limits to public debts and deficits³.

1.1. The current situation

Though much was written to demonstrate that deficit ceilings would not be breached, so that automatic stabilisers would be fully effective⁴, since 2002 at least three countries (Portugal, Germany, France) have recorded public deficit above 3% of GDP (table 1). France has been the first country in the euro area history to acknowledge a public deficit above the limit for two consecutive years.

This situation is at odds with the goals of the SGP, namely ensuring fiscal prudence and discipline. It is thus reasonable to consider that the SGP is actually flawed and that EU citizens deserve a better Pact. The question remains on which features the Pact should adopt.

³ Beetsma (2001) reviews arguments in favour of the SGP.

⁴ Three contributions can be found in Brunila et al. (2001).

Table 1. Net borrowing (-), general government, as a percentage of GDP

	2001	2002	2003	2004	2005 ⁽²⁾
Germany	-2.8	-3.6	-3.8	-3.7	-3.3
France	-1.5	-3.1 ⁽¹⁾	-4.2	-3.7	-3.0
Italy	-2.6	-2.3	-2.9	-3.0	-3.6
Portugal	-4.2	-2.7	-2.9	-2.9	-4.9
Euro area	-1.6	-2.2	-2.8	-2.8	-2.6

Source: EC Spring forecasts 2005.

⁽¹⁾: including a capital endowment to Réseau Ferré de France.

⁽²⁾: forecasts

1.2. A “low-fat reform” for the Stability and Growth Pact

As a consequence of their mild assessment of the SGP, Buti et al. (2003) elaborated some reform proposals for the Pact, some of which have finally been adopted by the EU council of March 2005. We present and discuss their relevance in the following.

Buti et al. focused on the following properties of an “ideal fiscal rule” (Kopits and Symansky, 1998): transparency, efficiency, flexibility, and enforceability; that they considered to have been the Achille’s heels of the SGP.

In order to improve transparency as well as to enhance efficiency, the authors proposed that one-off measures be publicized and be excluded from the domestic structural balance targets insofar as they are really temporary. This part of the reform would reduce governments’ incentives to contract public deficits on a temporary basis in order not to breach the deficit ceiling, as the latter would be assessed exclusive of these “one-off measures”; meanwhile, they could be implemented in order to cope with a deterioration in economic growth. More flexibility would thus be gained. But it necessitates an “agreed definition of one-off measures (which) should complement the existing agreement on how to compute cyclically-adjusted balances” (p.25). Unfortunately, Buti et al. gave no information on the

methodology to be used in order to define these “one-off measures”. Moreover, as regards the “efficiency property”, it is not sure that less “one-off measures” will lead governments to implement tax reforms. The expected positive effects of these reforms are, at best, long to come, whereas their negative impact on public finances comes first⁵, so that governments might still face substantial difficulties limiting their deficits and in the meantime implementing tax reforms. In the new draft of the pact, these “one-off measures” have been substituted with a wider range of “relevant factors” in comparison with the original SGP, as we will discuss later.

In order to improve flexibility, Buti et al. favoured the adoption of cyclically-adjusted targets for the deficits (a measure which has been under way since 2001, see EC, 2001), but with a special feature: fiscal rules would become heterogeneous, i.e. countries with higher debt and/or larger automatic stabilisers would target a lower cyclically-adjusted deficit, while other countries would benefit from higher deficit targets. This special feature is inconsistent with the adoption of structural targets, for which one would rather have automatic stabilisers play fully with no distinction as regards public debt; no doubt that it showed that Buti et al. (2003) still emphasized the 3%-of-GDP target for the overall public deficit. Adopting a uniform cyclically-adjusted deficit limit in the EU would create very different overall public deficits, with indebted countries being likely to breach the 3%-of-GDP limit as their interest payments are substantial. Buti et al. rejected this situation in advance.

They also promoted “rainy-day-funds” so that tax pot episodes are not used for electoral matters but, rather, are saved for worse (“rainy”) days. It would actually imply a constructive major change in the SGP: the Pact would be symmetric with a maximum allowed worsening of cyclically-adjusted balance agreed upon by European governments. This point however

⁵ A reduction in tax *rates* generally decreases tax *receipts* in the short run. “Reaganomics” are a good

raises a very specific issue related to democracy. At the question: what governments ought to do with extra-receipts, democratic governments could generally answer by either buying back some public debt, or lowering the deficit, or engaging in a discretionary policy. With the reform envisaged by Buti et al., governments could only reduce their deficit... What would they be elected for?

Buti et al.'s last proposal may be viewed as even less "democratic" than the previous one: they proposed that the EC implemented the fiscal rules, while the European Council would decide on the corrective measures to be implemented by the defaulting country. To make enforcement easier, Buti et al. further suggested that EC recommendations became proposals, which would necessitate that unanimity, rather than qualified majority, be reached to reject it. While their proposition would certainly enhance enforcement, it would increase the EU democratic deficit. This may impede transparency as more power in the hands of the Commission may reduce its accountability. The EU has yet one authority whose accountability is almost non-existent (at least, is not incorporated in any treaty)⁶; so does it deserve another one?

Finally, the EU Council of 22-23 March 2005 adopted the report of the ECOFIN Council entitled: "Improving the implementation of the Stability and Growth Pact". The proposals elaborated by the Commission and endorsed by the Council have had strong roots in Buti et al.'s proposals, most notably as regards the symmetry of the Pact as regards economic fluctuations and the reliance of fiscal rules on the level of public debt.

example.

⁶ The Maastricht treaty defines the statutes of the European System of Central Banks. Accountability of the ECB reduces to an annual report and a meeting for its President at the European Parliament where the latter has no executive power and cannot give an impulse to a change in the ECB's statutes, unlike the US Congress towards the Fed. As for the Commission, it is (at least) collectively accountable *vis-à-vis* the European Parliament.

The “new Pact” recalls that fiscal discipline remains the cornerstone of fiscal policies in the EU; fiscal discipline still means that the public deficit is lower than 3% of GDP. The main novelty with this “new Pact” is the emphasis on improving the Pact’s enforcement. In this respect, the Pact’s rules have been made more flexible across a range of areas. For example, member states will avoid an excessive deficit procedure (EDP) if they experience any negative growth at all (previously -2%, with possible exception below -0.75%) or an accumulated loss of output during a protracted period of very low growth relative to potential growth: in this sense, cyclically-adjusted deficits are fully taken into account. Member states will also face the possibility to draw on more “relevant factors” to avoid an EDP and will have longer deadlines if they do move into an EDP. Among those “relevant factors”, one finds so-called structural reforms (related to labour markets, pension systems, etc.), policies encouraging R&D, policies that enhance employment rates consistently with the Lisbon strategy, policies encouraging public investment, etc.

Another novelty has to do with the sustainability of public finances which is now a specific objective of the SGP; the debt to GDP ratio below 60% which was absent from the former regulations dealing with the SGP is now a key component for the assessment of “viable public finances”. Public debt hence serves as a means of discriminating between “good” and “bad” countries and of blaming the latter; member states with high debt ratios will have to reduce their deficit further and more quickly than member states with low debt ratios.

Member states are also urged to grasp economic upswings to increase surpluses and reduce debt. Nevertheless, pure “rainy-day funds” have not been set up. Hence, the least democratic features of Buti et al.’s proposals have been disregarded.

The overall reform of the SGP has actually given more leeway to fiscal policies: reliance on automatic stabilisers has been enhanced in the short run. Moreover, member states willing

to reconcile automatic stabilisers and the goals of the Lisbon strategy will be able to do so. In the short run, means will be made compatible with goals.

At least one drawback emerges in this new version of the SGP: flexibility is limited exclusively to the short-run, although policies like those encouraging R&D will show their effects only in the mid (at best!) to long run. Meanwhile, member states will not be able to draw on these “relevant factors” to justify the breach of the 3%-of-GDP limit for the public deficit. They will then have to cut other expenditures or to levy taxes; the risk is therefore that projects in progress are stopped before they produce their effects. All this means that the new Pact will not dramatically change the spirit surrounding the implementation of fiscal policies in the EU.

1.3. Adopting a Golden Rule

Confronted with the inability of the original SGP to manage transparency, flexibility, enforceability, consistency, efficiency, etc., there have also been proposals for the adoption of a “golden rule of public finance” in the EU (most recent contributions are Fitoussi and Creel, 2002; Le Cacheux, 2002; Blanchard and Giavazzi, 2003). Such a rule states that, over the cycle, government borrowing should not exceed net government capital formation; hence, current expenditures should be financed by current receipts. The question remains on how to evaluate the depreciation rate of public capital formation in order to compute *net* capital formation data, maybe one reason why Germany’s legislation, for instance, still hinges on *gross* fixed capital formation⁷.

⁷ The “net” vs. “gross” capital formation debate is beyond the scope of this paper. In fact, this issue could be incorporated in the transparency component of an “ideal fiscal rule”. The debate at stake is mostly one of terminology: if a “golden rule” were implemented in the EU, be it in terms of “net” or “gross” capital formation, politicians and policymakers should make it the most transparent as possible, so that no confusion arises.

Theoretical rationale for excluding public capital expenditures from the public deficit's target is linked to the necessity of spreading the costs of public capital formation over the years during which they will be used⁸. Empirical rationale for doing this can be linked to the bias against public investment which is a consequence of the actual SGP: as documented in Balassone and Franco (2000)⁹, there has been a close relationship between fiscal consolidation and cuts in capital spending in Europe during the eighties and nineties. This relationship has still been prominent after the adoption of the Euro: Portugal has reduced public investment substantially after its public deficit breached the Pact's ceiling in 2001. Adopting a "golden rule" would put an end to this negative bias.

Two additional advantages with this rule should be noted. First, as European countries aim at "creating the most innovative area in the world" (Lisbon summit recommendation), there should be budgetary scope for improving infrastructures and human capital for which *public* capital (considered quite widely and loosely) should be of great help. The final target would be, of course, to boost potential and actual economic growth¹⁰. Promoting economic growth *via* public investment stems from two channels. First, public investment provides public goods like transport infrastructures which benefit users and directly or indirectly improve total factor productivity. Second, public investment also raises overall welfare when it participates in the protection of environment or enhances the fairness in resource distribution.

⁸ Though the welfare benefits of boosting public investment may be unevenly distributed across generations – public investment should increase private capital formation and wages, but the latter rise only gradually whereas the former is in the hands of the "elderly" –, Heijdra and Meijdam (2002) show that financing some part of public investment with public bonds enhances equality across generations. A "golden rule" is thus theoretically welfare-improving.

⁹ See also EC (2003) and notably, table III.3 which shows that fiscal consolidation induced by high debt levels and the need to satisfy the Maastricht criteria coincided with relatively larger cuts in public investment.

¹⁰ Some contributions to the debate on "productive public capital" are Aschauer (1989), Bleaney et al. (2001) and Knight et al. (1993). They all find a significant and positive impact of public investment or public capital on the output, but in the case of Bleaney et al. only insofar as distortive taxes do not finance expenditures. A more comprehensive survey is available in section 2.

Another advantage in adopting a fiscal rule which would exclude public capital formation from the deficit target would be to narrow the gap in budget practices in the Euro area with that in the UK. This may produce further incentives for the UK to join the Euro area in a not-too-far future. Indeed, the UK budget incorporates a medium-run target for the net-of-public investment deficit, where the medium-run corresponds to a cycle. Over this cycle, this deficit should be balanced. The ensuing “golden rule” is associated with a “sustainable investment rule” (HM Treasury, 2002)¹¹ in order to prevent any overstatement for public investment and to limit net public debt below 40% of GDP.

The supposedly “unsustainable” feature of a “golden rule” is the major drawback discussed by its opponents. It is at least part of the reason for adopting a “sustainable investment rule” in the UK.

Hence, as discussed in EC (2003, part III), a “golden rule of public finance” in the EU would stop the reduction in public debts. Part of the rationale for slowing down public debt to GDP ratios in the Euro area has been related to monetary policy. High public debts are seen as a threat to price stability and to the independence of the ECB. Though the latter cannot “monetize” public debts, on statutory grounds, high debts might increase default risk which, if it materialized, would necessitate monetary policy to be accommodative or the ECB to be the lender of last resort. Both actions might prove inflationary.

However, the argument is generally biased against public debt as it neglects the demand side of the market for public bonds. Two important determinants of the demand for bonds are liquidity and a low risk. Public bonds incorporate both. And the relevance of these two determinants would also explain why, when public debt decreases – as was the case in the USA at the end of the nineties – the demand for public bonds switches to bonds issued by

¹¹ See also Buiter (2001).

government-sponsored enterprises like *Fannie Mae* fund or *Freddy Mac* fund in the USA, or *Kreditanstalt für Wiederaufbau* in Germany. The optimal ratio of net public debt to GDP is thus sizably different from zero; it may also be different in some EU countries from the debt ceiling in the Maastricht treaty, or from 40% of GDP in the UK. It should also be kept in mind that high public debt levels in Belgium have neither prevented the Belgian economy from reaching low inflation rate levels nor the *Franc belge* from being fixed *vis-à-vis* the *Deutschemmark* during the EMS period. Limiting supply of public debt should not be left unlinked to the demand side.

Yet, the consequences of adopting a “golden rule of public finance” on public debt levels in the EU need an assessment. In fact, as shown in Creel (2003), adopting a rule based on the *cyclically-adjusted net-of-public-investment deficit* (Fitoussi and Creel, 2002, Le Cacheux, 2002) without any “sustainable investment rule”, would *endogenously* limit public investment’s growth. To understand the underlying mechanism, a two-step analysis is needed. First, financing public investment by borrowing (obviously) incurs interest payments. Second, these payments hinder structural expenditures other than public investment. As the reduction in these structural ‘non-public-investment’ expenditures will always face a lower bound, interest payments’ growth will therefore face a ceiling, hence also public borrowing’s and public investment’s growth.

This is an argument against those who consider that adopting a “golden rule” would provoke a steep and unsustainable increase in public borrowing. In the Euro area, it would take the public debt to GDP ratio more than a *hundred* years to rise up to 104% if the ratio of public investment to GDP were permanently increased by a one-percent point (see the appendix in Creel, 2003). Though it may be considered a “steep” – though slow – increase, it would not be unsustainable insofar as public investment would enhance potential growth, and insofar as higher debt is balanced by a higher demand for public bonds. This could happen

either through a higher nominal yield, in parallel to higher economic growth rates, or through a higher demand for liquid-assets. The latter could result, for instance, from the generalisation of fully-funded pension systems in the Euro area.

The endogenous limit to public investment which is incorporated in the rule based upon the cyclically-adjusted net-of-public-investment deficit, is also an answer to Buti et al. (2003) when they state that “the possibility of borrowing without strict limits in order to finance investments can lower the attention paid when evaluating the costs and benefits of each project.” (p.18). As the growth in public investment is limited by the necessity to pay interests on public debt, it is in the interest of government to implement investments whose cost/benefits ratio is the lowest.

Besides public debt’s growth or the cost/benefits analysis, other criticisms to the adoption of a “golden rule” in the Euro area are worth mentioning. Balassone and Franco (2000) consider that the “golden rule”, as it is promoting public investment, will result in a bias in favour of physical assets, at the expense of health and education expenditures. Hence, the definition of “public investment” in national account statistics includes transactions that lead to changes in the stock of physical capital (like the construction of infrastructures or the purchase of computer hardware), but excludes large amounts of expenditures related to the accumulation of human capital, like training or R&D.

Of course, a broader assessment of “public investment” should be promoted (Blanchard and Giavazzi, 2003), but only insofar as changes in the “accounting rules” are made possible, say, every 5 years – a delay known *ex ante* – in order to prevent an opportunistic behaviour by the governments.

Another criticism to the “golden rule” is that it promotes public capital, though it is overall capital from the public and private sectors that should be promoted. To counter this

argument, which can also be found in Balassone and Franco (2000)¹², one can state that there are sectors or regions in which the existence of public capital may have substantial positive externalities on activity and on private investment. Two channels of transmission of the impact of public infrastructures on growth are generally distinguished: first, through the production capacities which may show complementarities between public and private investment, and thus improve total factor productivity¹³. Second, the output of private firms depends not only on how much labour and private capital they employ, but also on the quality of the environment in which they operate. Many facets of this environment, such as the legal framework, the quality of the transport network and, to some extent, the quality of telecommunications are at least partly supplied by governments, hence by complementarities between public and private capital expenditures.

Let us briefly summarise at this point how the “golden rule” could be formulated in order to prevent most criticisms. Within the Euro area, adjusting the deficit to economic fluctuations while excluding public investment from the deficit ceiling would give a fiscal rule with a zero ceiling of the cyclically-adjusted, net-of-public-investment deficit on GDP ratio. This can be viewed as a “modified golden rule”, though this remains in line with Robinson’s (1998) definition of the “golden rule”¹⁴. In fact, this is a “modified rule” as regards the rule advocated, for instance, by Blanchard and Giavazzi (2003): they favoured a ceiling on the *total* budget net of public investment. This leaves open the question of fiscal

¹² OLS estimates of the direct effect of public investment on private investment have been performed by the EC (2003, table III.2) and are inconclusive, except for Spain and Portugal (for which positive “crowding-in” effects are found) and the UK (for which a negative “crowding out” effect is found). In this latter country, according to the EC, the negative relationship between public and private investment might result from a *coincidence*: the privatisation process would have decreased public investment while increasing “to a certain extent” investment in the private sector.

¹³ This channel was at the core of Aschauer (1989)’s paper. He showed that the slowdown in productivity growth in the US private sector during the seventies and eighties was the consequence of a shortage of investment in public infrastructure.

¹⁴ “It is commonplace (...) for the golden rule to be viewed as requiring structurally balanced accrual budgets” (Robinson, 1998, p.449).

automatic stabilisers. Following Blanchard and Giavazzi's proposal, provided governments have recovered some margins for manoeuvre, they would face a trade-off between implementing a contracyclical policy and increasing public investment. The bias against public investment during economic slowdown would persist.

Moreover, the "modified rule" would be more stringent than the rule advocated by Buiter et al. (1993), though their rule is assumed to be consistent with the "golden rule", provided that optimal public investment is equal to 3% of GDP in each EU country. Adopting a *primary* cyclically-adjusted deficit ceiling of 3% of GDP would be unsustainable, as there would be no intrinsic forces stopping interest payments and public debts, expressed in terms of GDP, from growing.

Since the "modified golden rule" would be meant to boost potential growth without jeopardizing price stability, consistency with monetary policy in the Euro area and in the EU should perform well. The "new" fiscal framework would also give some leeway to governments as regards their management of the cyclically-adjusted deficit. They could at the same time implement a tax reform and a public investment program, insofar as they are able to reduce some extra-expenditures or insofar as they expect larger economic growth from both measures. Governments could also prefer to reform (and reduce) tax *rates* and not to enhance public investment; doing this, they would save some extra-interest charges in order to cope with short-run reductions in tax *receipts*.

2. Empirical findings

Recent years have witnessed a remarkable swell of interest in public investment spending as a strategy to promote economic development; the Lisbon strategy is not the least example in this respect. The economic intuition behind the relationship between public investment spending and economic growth is rather simple and consists in thinking that some

infrastructures improve private factors productivity through spillover effects. However, if public investment effects are recognised in theory (Barro, 1990), empirical results are not clear-cut. In this paper, we thus propose several tests (VAR and panel specifications) to study the impact of public capital on economic activity and try to gauge the robustness of their possible causal relationship.

2.1. *VAR Studies*

2.1.1. Methodology and literature review

The VAR framework offers a number of advantages relative to estimating structural economic models of public capital. Indeed, VAR models offer an alternative means of investigating the dynamic relationship between public capital and other relevant economic variables which does not depend upon a fully specified model of capital. In a VAR model, a limited number of variables are distinguished that are explained by their own lags and lags of the other variables, meaning that all variables are treated as jointly determined. So, the VAR method explicitly recognises the endogeneity of public investment.

A further advantage of using a VAR framework is that it provides a unified approach for examining capital behaviour across countries in a manner that is suitable for comparing results. Finally, no a priori causality directions are imposed or other identifying conditions derived from economic theory are needed.

Despite these advantages of the VAR approach, we have come up with only 6 studies in which this method is conducted to test the effect of public capital (or public investment) on economic activity (or on private sector). These studies are reported in table 2a; one reason why there are only few studies may be that, so far, their conclusions are mixed: whereas some studies found no relationship between public capital (or investment) and indicators of

economic growth (McMillin and Smyth, 1994, Otto and Voss, 1996), some found a positive one (Sturm, Jacobs and Grote, 1999, Ligthart, 2000) whereas another found a negative one (Otto and Voss, 2002). Clarida (1993) was unable to conclude on the causality.

Table 2a. VAR studies

Study	data	Variables	Conclusions
Clarida (1993)	USA, France, Germany, United Kingdom: 1964-1989	Multifactor productivity, public capital stock	MFP and public capital are cointegrated but direction of causality is unclear
McMillin and Smyth (1994)	USA: 1952-1990	Hours of work per unit of capital; relative price of energy; ratio public capital to private capital; inflation	No significant effect of public capital
Otto and Voss (1996)	Australia: 1959-1982	Private sector GDP; private capital stock; public capital stock; number of working hours	No significant relation between public capital and output
Sturm, Jacobs and Grote (1999)	Netherlands: 1863-1913	Private sector GDP; private capital stock; public capital stock; private labor	Public infrastructure Granger-causes output
Ligthart (2000)	Portugal : 1965-1995	GDP; private capital stock; public capital stock; private labor	Public capital Granger-causes output
Otto and Voss (2002)	USA : 1951-1997 Canada :1951-1996	GDP, relative price of public and private investment goods, real interest rate and shares of private and public investment in output	Public investment crowds out private investment in both countries

In the following, we have followed a very systematic methodology for assessing the possible impact of public capital and public investment, respectively on economic growth. Unlike other above-mentioned studies, we have relied on few data and simple relationships. Data are: public investment, private investment, GDP, public capital, private capital and employment. All data come from the OECD database, except capital stocks which come from

Kamps (2004). These capital series have been estimated according to the perpetual inventory method from the OECD series of private and public investments. One of the main advantages of these data is the international comparability of the definition used for the public sector.

As for relationships and although VARs are usually a-theoretical, we have relied on two underlying theories: First, to investigate the impact of public investment on economic growth, we have assumed the existence of an economy driven by aggregate demand: public investment, like public expenditures, should increase demand unless crowding-out effects are large. This choice of theoretical setting has no strong consequences on the VAR model, except that it fixes the ordering of variables: public investment would come first, private investment second, and GDP third. To check for robustness, we will also perform VARs inverting the respective ordering of public and private investments. A break in the sample will also be investigated.

Second, VARs which are relying implicitly on supply-side economics test a Cobb-Douglas production function where capital is split between private and public capital. Usually, inputs are assumed to have no lagged effect on GDP. Here, we will assume that such a lag exists: implementation and organisation delays impede inputs to have an immediate impact on production. The lag we have chosen was one year. The benchmark supply-side VAR will introduce 4 variables with the following ordering: lagged public capital, lagged private investment, lagged employment, GDP. To check for robustness, we will also change the ordering, introduce a time break and transform variables in first difference.

For the choice of the optimal lag for each VAR, we have followed a general-to-specific approach, taking 5 lags as a maximum and using 5 criteria: a sequential modified LR test, the final predictor error, and the Akaike, Schwartz and Hannan-Quinn respective criteria. To ensure consistency, 4 maximum lags were chosen with the production-function approach (one lag was incorporated for inputs), and 3 maximum lags were chosen when data were set in first

difference. The optimal lag was chosen so that it had a majority of optimal response among the 5 criteria. In case of equality, the smallest lag was chosen.

2.1.2. VAR results

VARs were performed on four European countries, plus the USA for comparison reasons, and estimations were computed between 1960 (1963 for France) and 2004 on an annual basis.

Outcomes resulting from the driving-aggregate-demand framework generally show a statistically significant and robust impact of public investment shock on GDP¹⁵. However, this impact is short-lived: for Germany and the USA, the impact is no longer statistically significant 3 or 4 years after the shock; for UK and France (where the impact is weakly significant), it is no longer 2 years after the shock.

Italy is more puzzling: in the first ordering, a public investment shock has no significant impact on GDP and the crowding-out effect of public investment on private investment is statistically significant. Only with the second ordering is the impact of public investment shock on GDP statistically significant one year after the shock, with a value of the immediate response comparable to France's. Italy's and France's response in the short run is almost half that of the other countries under study.

Except Italy, no other country shows crowding-out effects. In France and Germany, there are even statistically significant signs of crowding-in effects: a public investment shock induces a rise in private investment. Such phenomena occur in Germany with the first ordering and for two different samples: the full sample and a subsample excluding the years before 1981; and in France with the first ordering but only over the subsample.

¹⁵ Main impulse response functions are reported in figures 1 to 6 in the appendix. Other IRFs are available from the authors upon request.

For Euro area member states (France, Germany, Italy), it is noteworthy that estimations performed on a subsample give a bigger and more significant impact of public investment shock on GDP¹⁶. If one remembers that those years witnessed a progressive political rejection of structural fiscal policies in these countries, this latter outcome is a pity: had these three countries raised funds to finance public investment projects, they would have enhanced economic growth perspectives. Instead these countries have reduced public investment expenditures in the nineties to cope with the Maastricht public finance criteria (Balassone and Franco, 2000).

Outcomes stemming from “supply-side” VARs, where an underlying production function with lagged inputs is estimated, are quite different from those reported so far. The most important of these differences has to deal with the “crowding-out effect”. In this new setting, it is more frequent to see a shock to public capital reducing private capital: such substitutability between both occurs in the UK (in most cases, on the subsample), in the US (robust for all specification with the first ordering), in France (only over the full sample if variables have not been transformed in first difference) and in Italy (over the full sample with the first ordering). Except in the UK and France, “crowding-out effects” are not robust to the change in the ordering of variables, and for the UK with variables transformed in first difference and over the full sample, results even show statistically significant crowding in effects, whatever the ordering of variables.

The diversity of interactions between public and private capital among the countries which are part of the study leads to a wide range of impact of public capital shock on GDP. This conclusion is at odds with the relative homogeneity of GDP responses to public investment shocks that have been discussed above. And contrary to these responses, we have

¹⁶ Estimations on the same subsample for the USA and the UK blur the first results.

now also found negative responses of GDP to shocks to public capital: such is the case in the UK for the same specifications that lead to crowding-out effects, but it also occurs in France after variables have been transformed in first difference over the subsample, whatever the ordering of variables. Germany is a special case here: we have found a mysterious negative impact of public capital on GDP. The mystery arises because, whatever the sample, for variables transformed or not transformed in first difference, with the first ordering, all inputs are growing but GDP decreases. Changing the ordering makes the mystery vanish however. Positive responses of GDP to public capital shock can be found in France, whatever the sample and ordering, provided variables have not been transformed in first difference, in Germany over the full sample, with the second ordering and provided variables have been transformed in first difference, and in the USA over the full sample with the second ordering. Finally, we have been unable to show a statistically significant impact of a shock to public capital on Italy's GDP.

The diversity of results raises two conclusive comments. First, papers dealing exclusively with the dynamic effects of public capital may blur the incidence of the public sector on economic growth: the public sector not only intervenes through public capital but also through public investment; the effect of the latter on economic growth seems less disputable than that of the former. Second, as far as public capital is concerned, time series on a national basis and on a relatively short time span may not show much variance; increasing the sample to a panel of countries may well increase variance and the power of the test.

2.2. *Panel studies*

Using panel data allows us to combine information provided by chronological data with that given by international or regional variance of data. However, results may be very dependent on the specification form (time and/or individual effects).

2.2.1. A short review for multi-national panels

As regards multi-national panels, to our knowledge there are only very few articles dealing with this issue. We can quote the study by Evans and Karras (1994) because their conclusions are representative of the critics often addressed to the panel approach. They estimated three alternative regressions for a panel of seven OECD countries from 1963 to 1988. Their variables had been set in first difference. They found that, once State fixed effects were included, the contribution of public capital to production was no longer significant. Evans and Karras argued that “(they) found that government capital is estimated to have large and highly significant productivity only if (they) misspecify the production function by ignoring time and individual effects in productivity growth. Under the most plausible specifications, the estimates are not statistically significantly different from zero at conventional levels. Moreover, the estimates are fragile in the sense that minor changes in specification can appreciably affect them.”

The high instability of estimations in Evans and Karras’ study illustrates a strong correlation between these effects and the explaining variables (Hausman test, 1978). Countries with a high rate of economic growth are likely to have more public and private capital.

Contrary to Evans and Karras’ article, the results presented in our paper (in the following section) will be shown to be stable. However, the introduction of individual effects leads to a slight reduction in the estimated output elasticity of public capital.

2.2.2. A multinational panel: Data, specification tests, estimation results

To our knowledge, no study has ever analysed the role of public capital in Europe using a panel. This shortage may come from the lack of capital data for European countries. This lack was filled in by Kamps (2004) who calculated capital data series for OECD countries. These data were essential to perform our panel tests.

We have considered a panel of 6 EMU countries (Austria, Belgium, Germany, France, Italy, Netherlands) over the period 1969-2002. Data on GDP, total employment, total private capital and total public capital are used. GDP and employment variables come from the OECD database (Economic Outlook, 2005); capital stock data are calculated by Kamps (2004).

We specify a simple Cobb-Douglas production function for ease of comparison to other estimates in the literature and we employ several specifications of the error term.

Our basic equation is as follows:

$$y_{it} - l_{it} = a_i + \alpha(k_{it} - l_{it}) + \beta(kg_{it} - l_{it}) + \varepsilon_{it} \quad (1)$$

where Y , L , K and KG are respectively GDP, total employment, private capital and public capital. α and β are the elasticities of Y to K and KG . All variables are in logs (lower-case letters). The subindices i and t refer to country and time.

The various specifications of this basic equation involve different assumptions about the constant term, a , and the term error, ε . Indeed, a lot of factors can affect the explained variable coefficient and yet some of these factors may not be explicitly introduced as explaining variables in equation (1). These factors are approximated by residuals structure. In the panel approach, three factors can be envisaged: factors affecting the endogenous variable in a different way according to the period and/or the individual (country, here) considered; factors

having the same impact on all individuals but whose influence depends on the period (time effects); and other factors can reflect structural differences between individuals, i.e. independent to time (individual effect). Time and individual effects can be combined. Individual effects can be fixed (totally heterogeneous structure) or random (intermediary specification between no individual effect and fixed effects).

These different effects will be tested although a Hausman test will allow to choose the optimal specification.

Before specifying the relevant regression, we have controlled for the stationarity of variables. For panel data, statistical distributions of the null hypothesis test were proposed by Levin, Lin and Chu (2002). The tests we performed indicate nonstationarity only for the employment series. With variables per head, all variables are $I(0)$. Regressions will thus be expressed with variables per head (table 3 in appendix). Noteworthy, we do not use variables in first difference because the panel-induced common response to nonstationarity might not be appropriate if the variables are subject to measurement error (McGuire, 1992).

The introduction of time effect is justified by the existence of different political regimes over the sample.

Table 4 reports the results of three specifications of the basic equation (1). In column (1), the specification is an OLS with annual time dummies (fixed time effects) and no country effects. In column (2), the specification is a GLS with fixed time effects and random country effects. Column (3) displays an OLS specification with fixed country and time effects.

Table 4. Log-linear production function estimates. 1969-2002

	(1)	(2)	(3)
	No country effects	Random country effects	Fixed country effects
Private capital per head	0.43 (12.56)	0.37 (17.31)	0.37 (17.23)
Public capital per head	0.09 (4.33)	0.14 (11.55)	0.14 (11.55)
No. of obs.	204	204	204
R ²	0.90	0.99	0.99

Notes: Each regression includes a complete set of time dummy variables. The dependant variable is the log of Y/L. Similarly, the reported explanatory variables are all in logarithms. The figures in parentheses are *t*-statistics.

Without controlling for country effects, the estimated elasticity for public capital is 0.09. Once we control for either fixed country effects or random country effects, the estimated coefficient on public capital is slightly higher (0.14). These close estimations tend to prove that the bias linked to a potential correlation seems relatively weak.

Whatever specification we choose, the order of magnitude for the coefficients is the same. But, to be precise, a Hausman test is performed. This test examines the correlation between specific effects and explaining variables. It assumes no correlation at the null hypothesis (table 5 in appendix). It could be assumed on economic grounds that capital stocks are determined conditionally on structural national specificities. Yet, this test indicates the random effects hypothesis can not be rejected. Consequently, and contrary to Evans and Karras' (1994) results, the introduction of individual effects does not call into question the impact of public capital on GDP.

In order to take account of the change of economic regime during the three decades under study, we have performed the same specification after decomposing the sample into two periods: 1969-1985 (appendix, table 6); and 1986-2002 (appendix, table 7). Each sample has still a large number of observations. Still, Hausman test has indicated the random effect

hypothesis cannot be rejected (appendix, table 5). With this specification, the productive role of public capital is confirmed. However, the estimated elasticity (0.05) is lower than those obtained in table 3.

With a European panel, the introduction of individual effects has been shown unable to reject the hypothesis of a productive role for public capital. Furthermore, these effects have a realistic order of magnitude; moreover, they are statistically significant, contrary to those generally obtained in the literature.

The next section now examines the public capital effects for France basing on a regional panel procedure.

2.2.3. Regional panels: a growing literature

As shown in table 2b, most panel studies are based on regional data with maximum computed effects of public capital on output occurring in Japan.

The first regional panel study was Mera (1973). He estimated the technical relationship between various types of infrastructure and other inputs for Japan. Using pooled data of nine regions from 1954 to 1963, he estimated a Cobb-Douglas production function for each of three major economic sectors and four types of infrastructure. He found that, when the infrastructure variable entered as a separate factor of production, its elasticity ranged most frequently around 0.2. After this article, regional panel studies were performed only for the United States during two decades.

Table 2b. Panel studies

Study	Country	Data	Output elasticity of public capital
Mera (1973)	9 Japanese regions	1954-63	0.20
Eberts (1986)	38 US metropolitan areas	1958-78	0.03-0.04
Nijkamp (1986)	Dutch regions	1970-90	0.15
Da Silva Costa and al. (1987)	48 American States	1970-86	0.19
Munnell (1990)	48 American states	1970-86	0.15
Merriman (1990)	9 Japanese regions	1954-63	0.43-0.58
Hulten and Schwab (1991)	16 American regions	1970-86	insignificant
Eisner (1991)	48 American States	1970-86	0.15
Garcia-Mila and McGuire (1992)	48 American states	1969-83	0.04
Holtz-Eakin (1994)	48 American States	1969-86	insignificant
Evans and Karras (1994)	48 American States	1970-86	insignificant
Holtz-Eakin and Schwartz (1995)	48 American States	1971-86	insignificant
Garcia-Mila and McGuire (1996)	48 American states	1970-86	insignificant
Mas and al. (1996)	17 Spanish regions	1964-1991	0.07
Balmaseda (1997)	48 American States	1970-86	insignificant

In 1986, Eberts (1986) estimated the direct effect of public capital stock on manufacturing output. Public capital stock was estimated using the perpetual inventory technique for each of 38 American metropolitan areas between 1958 and 1978. He estimated a translog production function and found that public capital stock made a positive and statistically significant contribution to manufacturing output, supporting the concept of public capital stock as an unpaid factor of production. Eberts also found that public and private capital were complements while the private capital/labour pair and the public capital/labour pair were substitutes.

At the state level, Da Silva Costa, Ellson and Martin (1987) estimated the contribution of public capital stock to manufacturing output by estimating a translog production function.

They found that public capital stock made a statistically significant contribution to manufacturing output.

Contrary to Eberts, Da Silva Costa and al. also found private and public capital to be substitutes and public capital and labour to be complements. Moreover, their article confirmed the hypothesis of decreasing returns for public capital since the larger the stock of public capital relative to private capital within a state, and the larger the stock of public capital per capita, the smaller the impact of public capital stock on manufacturing production.

However, Munnell's article (1990) is undoubtedly the most famous one concerning regional studies. Equations were estimated using pooled State output, capital and labour data for the period 1970 through 1986. The regressions confirmed at the state level that public capital had a significant positive impact (0.15) on the level of output and indeed belonged to the production function. Contrary to Da Silva Costa and al, she found increasing returns for public capital and a substitutability relation with employment. These results seem more realistic than those obtained with aggregated data and were later confirmed by Eisner (1991) who found an elasticity of 1% for public capital.

Following this seminal article, a lot of researchers have studied the impact of public capital by using the panel method with American regional data. These articles insist on the introduction of specific effects. Using a sample of 16 American regions from 1970 to 1986, Hulten and Schwab (1991) did not find any significant impact of public infrastructures on total factor productivity. They showed that average productivity growth rates in the Sunbelt and the Snowbelt were very close whereas public equipments had strongly increased in the Snowbelt.

Garcia-Mila and McGuire (1992) added fixed effects to the regression estimated by Hulten and Schwab (1991) and found a significant elasticity for highway infrastructures (4.5 %) and for education spending (16.5 %).

Only few studies have been devoted to other OECD countries. In 1986, Nijkamp found that the productive contribution of public infrastructure in Dutch regions was 15 %. More recently, Mas and al. (1996) studied the public capital impact on output using Spanish regional data. With fixed effects and a linear trend in the regression, they obtained an elasticity of roughly 7 %. Three recent studies concerned Italy. Picci (1995) estimated a production function including public capital as an input and found that the latter had a positive and significant effect on production (between 0.35 and 0.43). In 1999, Annoncia and Del Monte estimated the contribution to real GDP growth of government spending in infrastructure and in consumption. They found that infrastructure investment was associated with higher growth, especially in the manufacturing sector. Bonaglia and La Ferrara (2000) also found that the impact of public capital was positive and significant for Italian regions.

Results obtained with regional panel must be interpreted with caution. Indeed, Munnell (1992) noticed that the contribution of public capital was higher when national data, rather than regional data, were used. With regional data, the public capital elasticity is often non significant, or close to zero. This result is explained by the fact that one cannot capture the entire payoff of an infrastructure investment by looking at a small geographical area. Indeed, regional spillovers from local infrastructures can positively affect output in the neighbouring regions (highways, airports...). The same argument was put forward by Argimon and al. (1993) to justify their results about public capital in Spain: “The elasticity of output to infrastructure obtained in this paper can be observed to lie in the upper band of the estimations found in other countries. However, it is similar to the elasticity estimated in studies that use time series at a national level. The lower value of the output elasticity

obtained in other works that use more disaggregated data (states, regions, towns) may be due to the loss of the externality effect which public capital at a regional level has on private productivity in other regions.”

Hulten (1996) further explained that estimates in regional studies will in general exhibit a bias that depends on the size and nature of the spillovers; nevertheless, it could be neutral if spillovers are perfectly symmetric and if public capital increases at a uniform rate everywhere.

However, Balmaseda (1996) showed these diffusion effects are insignificant. This conclusion confirmed Holtz-Eakin and Schwartz (1995). With tests on a panel of 48 American States, they found there was no space diffusion for highway infrastructures. Holtz-Eakin (1994) showed that using state or regional data hardly changes the estimates of public capital contribution.

Mas et al. (1996) were the only ones to find regional externalities, with Spanish data; a positive correlation between the output in one region and infrastructures in neighbouring regions was brought to the fore. On the contrary, Balmaseda (1997) showed the existence of an aggregation bias which can in part explain the high estimates obtained with aggregated data in Aschauer (1989) and Munnell (1990).

2.2.4. A French panel

Public capital is not just composed of infrastructures, but also of education and health spending. These items can well contribute to economic growth. Hereafter, we will label

investments in education and health “social public investment”. We use this concept for the French case. Eurostat services provide regional statistics for France from 1995 to 2002¹⁷.

In the following, we use 4 variables: GDP, employment, “social public investment” and “other investments”. Capital data are not available. All variables are expressed per head to avoid a size effect in the regressions, given French regions are very heterogeneous. Due to the very short sample, no time effect has been introduced.

The Eurostat database raises at least one problem because it does not make a difference between private and public investment. For France, it is clear that investments in education and health sectors are mostly public. The variable “other investments” can be public or private because some sectors (e.g in the transportation or in communication sectors) use both private and public investments. So results for this variable will be examined with caution. Table 8 reports results of the regressions.

Table 8. Impact of “social public capital in France”. 1995-2002

	Pool specification
Social public investments (per head)	0.11 (5.01)
Other investments (per head)	0.52 (12.57)
No. of obs.	184
R²	0.54

Note: The figures in parentheses are *t*-statistics.
Source: Eurostat

In each regression, the “social public investments” variable turns out to have a significant impact on GDP. However, tests reject the hypothesis of individual effects and a pool

¹⁷ A sectoral decomposition of investments is not available over a long period for France. The sectors are: agriculture, industry (excluding construction), hotel and restaurants, wholesale and retail trade, transport, storage and communication, finance services, public administration, education, health.

specification must be performed. In that case, a 1%-increase in health and education investments spending entails a 0.11%-increase in GDP. This result is interesting because it shows that infrastructure investments are not the only public spending contributing to GDP growth: preserving the French social model would enhance economic growth.

Finally, we have tried to construct a “public services” variable including investment spending in education, health and transport. The variable “transport” is not only composed of public investment. But in the French case, we can assume this sector is essentially financed by public funds. Moreover, the goal of the following regression is to show sectors where investment projects must be encouraged be they public or private.

Table 9a. Public services and GDP (1995-2002).

	Pool specification
Public services investments (per head)	0.17 (8.77)
Other investments (per head)	0.39 (8.24)
No. of obs.	184
R²	0.54

Note: The figures in parentheses are *t*-statistics.
Source: Eurostat

Table 9b. Transport as a third explaining variable.

	Pool specification
Public services investments (per head)	0.11 (4.50)
Transport investments (per head)	0.08 (5.74)
Other investments (per head)	0.38 (7.64)
No. of obs.	184
R²	0.56

Note: The figures in parentheses are *t*-statistics.

Source: Eurostat

Table 9a confirms the productive role of public investments that had stemmed from VAR specifications. The “public services investment” variable has a relatively high coefficient of 0.17. Some critics may argue this coefficient is significant thanks to the inclusion of the transport variable. Opposing arguments are twofold. First, we have already shown that education and health investments had an impact on GDP (table 6). Second, if transport is considered as a third independent explaining variable, education and health investments remain statistically significant (table 9 b).

This regional panel shows that sectors where public sector is dominant (education, health, transport) have a significant role to play in the economic growth. It would be harmful that these item spending be sacrificed on the altar of fiscal discipline.

Conclusion

This paper has investigated the growth effects of public capital and public investment in Europe using VAR and panel approaches. All methods conclude to a significant role for public investment or public capital, except with some VARs trying to replicate production

functions. The size of different estimated production elasticities in the European panel are more realistic (with coefficients between 0.10 and 0.14) than those obtained with time-series regressions. Furthermore, we show with the French example that social investment spending must not be neglected because they also have (as much as infrastructures spending) a productive impact.

These results confirm that public investment should be protected from political temptations to cut them in one concern to fiscal discipline. The binding limits to public deficit in the mid-run in the EU, as they still emerge from the “new” Stability and Growth Pact, may continue to put heavy pressure on public investment and public capital in Europe; in this respect, the results obtained in this paper lead one to conclude that economic growth perspectives will still be blurred by the Pact.

The introduction of a “golden rule of public finances” could be a better means to encourage public investment programs and economic growth. European governments seem to be reluctant to adopt such a rule, despite it being applied in one of them – the UK –, but we have showed that the reasons for its rejection are generally not legitimate. Among these reasons, the textbook drawback associated with higher public expenditures – the crowding out effect – has already been argued to be weak theoretically (see Arestis and Sawyer, 2003; Creel et al., 2004); here, it is argued that empirically, this effect should not be overstated: it does not preclude higher economic growth and in many cases, it is not statistically significant.

Table 3. Panel Unit Root Test¹

variable	Levin Lin and Chu Stat ²	Prob.
y	-9.10	0.00
kg	-4.97	0.00
kp	-5.32	0.00
l	1.34	0.91
y-l	-13.63	0.00
kg-l	-4.66	0.00
kp-l	-5.35	0,00

¹: The test are conducted with an individual intercept

²: The null hypothesis assumes common unit root process.

All variables are I(0), except the employment series. Using per head variables allows us to have only stationary variables in our regressions, which is necessary to perform OLS estimations.

Table 5. Hausman tests¹

	Chi-sq stat	Prob.
1969-2002:Cross-section random	0.19	0.91
1969-1985:Cross-section random	1.39	0.50
1996-2002:Cross-section random	0.03	0.98

¹: The null hypothesis assumes that there is no misspecification, i.e random effects must be included.

Table 6. Cobb-Douglas function, 1969-1985

	No country effects	Random country effects	Fixed country effects
Private capital per head	0.47 (6,91)	0.18 (3.98)	0.17 (3,64)
Public capital per head	0.08 (2,03)	0.10 (6.16)	0.10 (6,08)
No. of obs.	102	102	102
R²	0.82	0.99	0.99

Table 7. Cobb-Douglas function, 1986-2002

	No country effects	Random country effects	Fixed country effects
Private capital per head	0.42 (9,82)	0.49 (15.12)	0.49 (15,06)
Public capital per head	0.09 (3,59)	0.05 (2.00)	0.05 (1,97)
No. of obs.	102	102	102
R²	0.68	0.98	0.99

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Figure 1.
Aggregate demand driven economy, 1st ordering, full sample

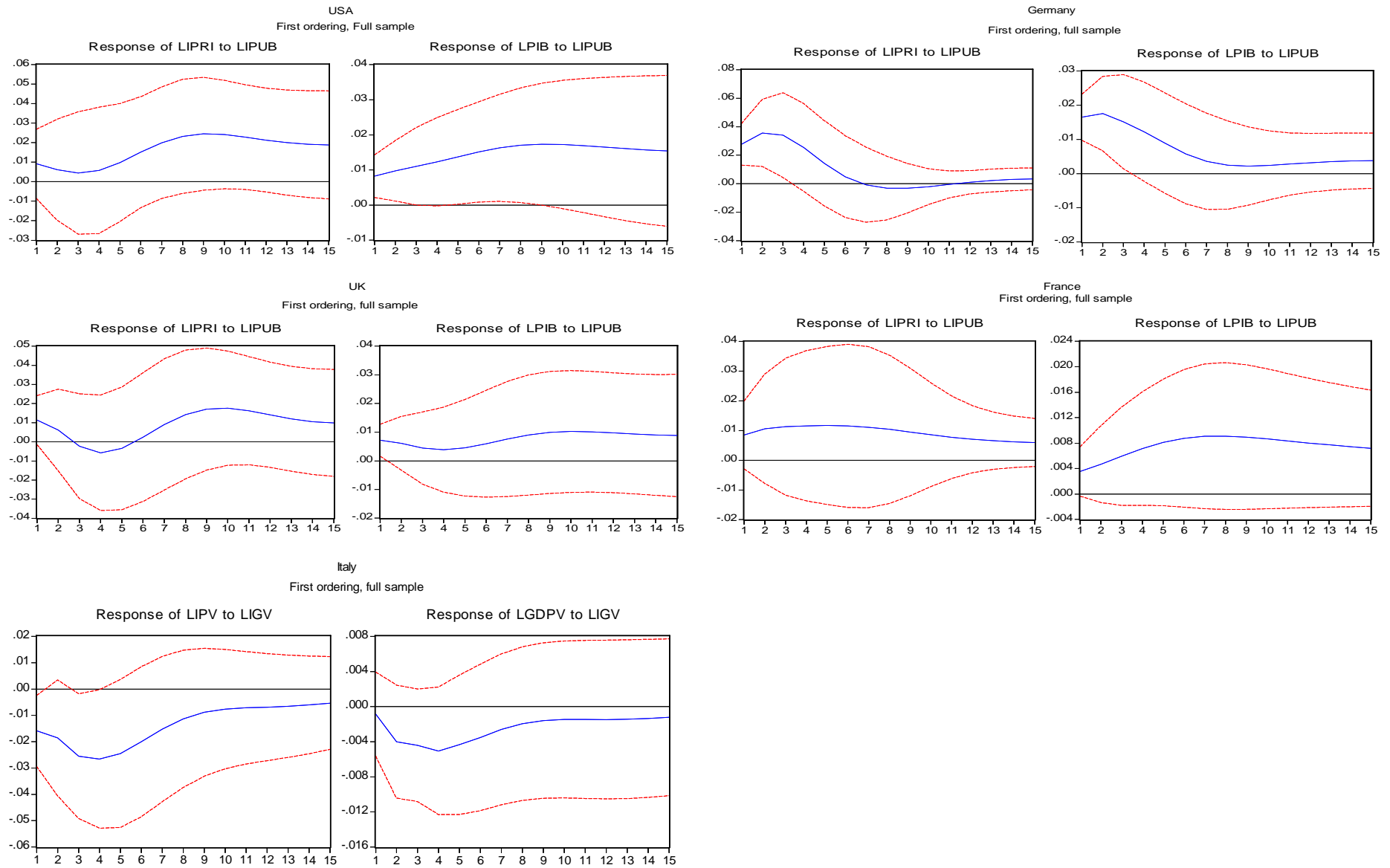


Figure 2.
Aggregate demand driven economy, 2nd ordering, full sample

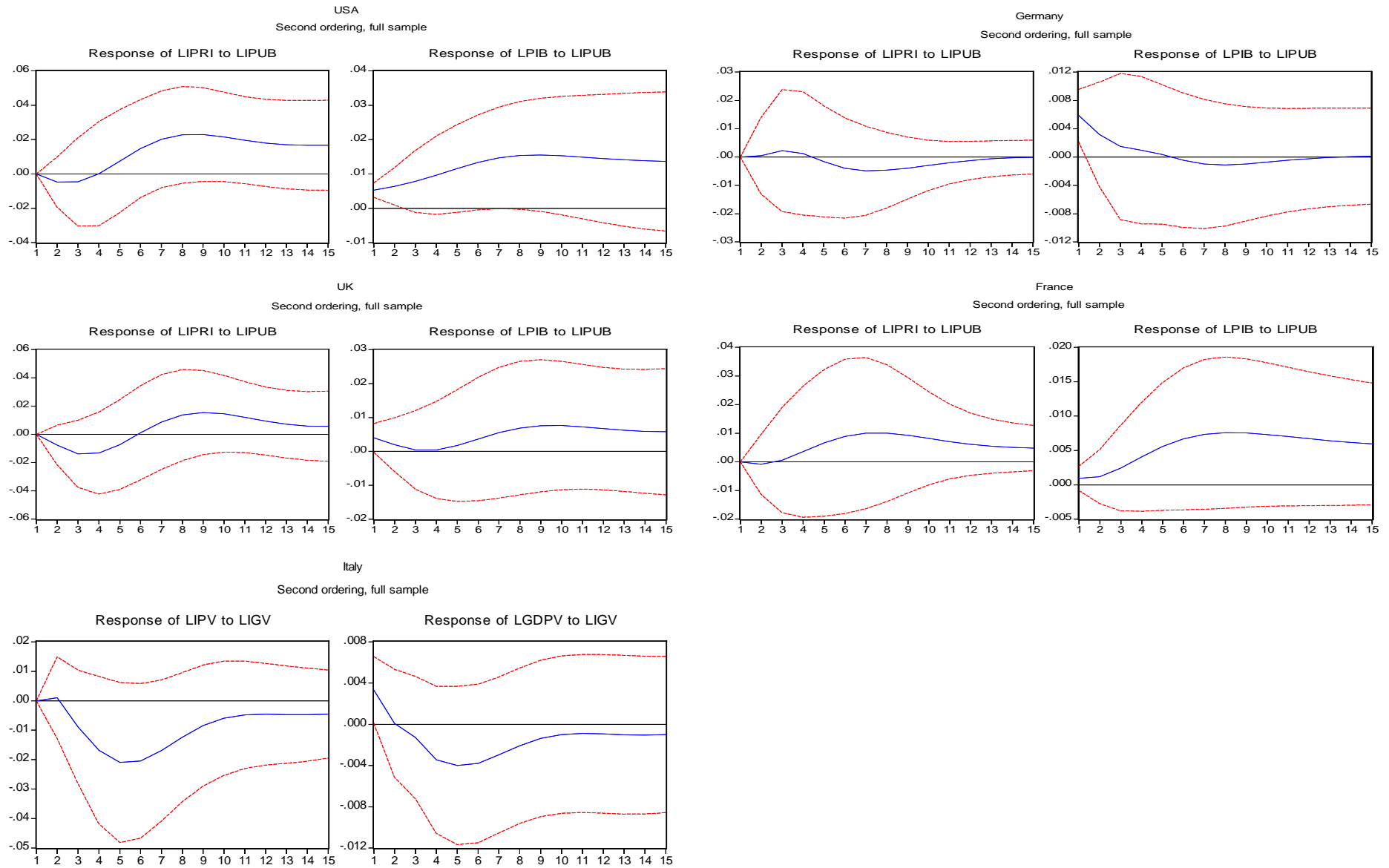


Figure 3.
Aggregate demand driven economy, 1st ordering, subsample

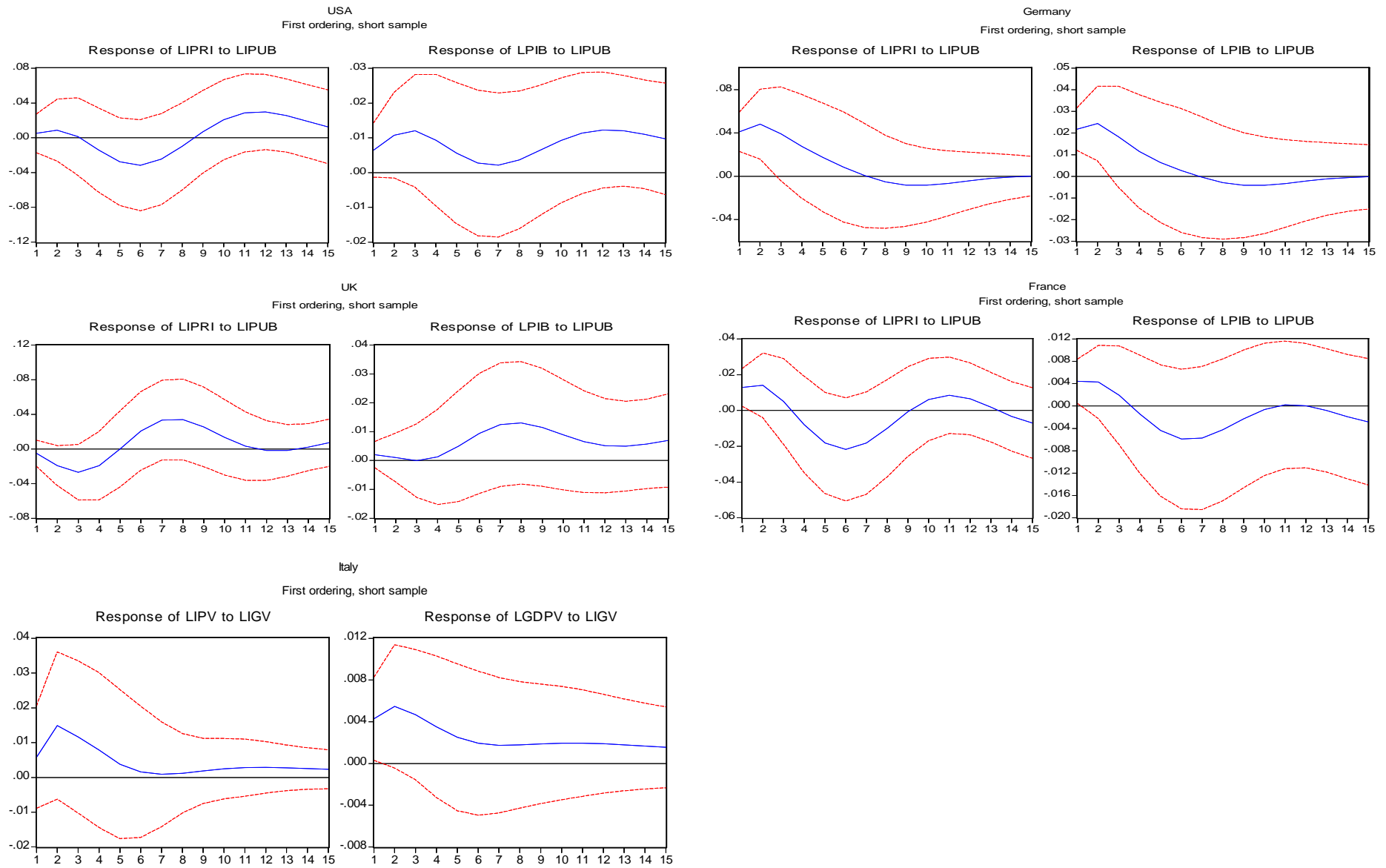


Figure 4.

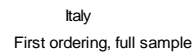
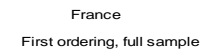
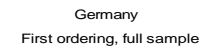
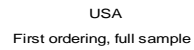


Figure 5.
Aggregate supply driven economy, 2nd ordering, full sample

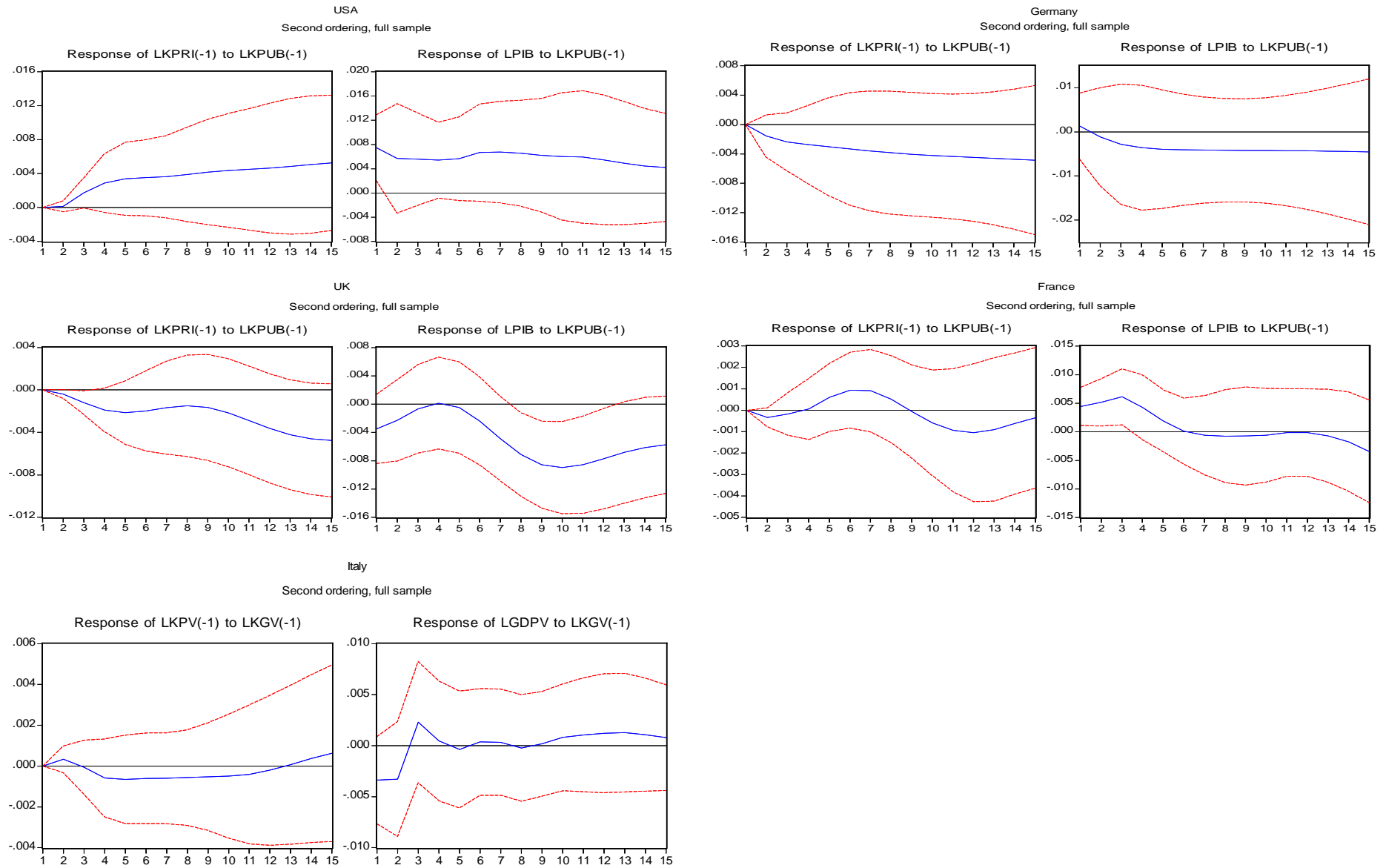


Figure 6.
Aggregate supply driven economy, 1st ordering, subsample

