

# Public investment and growth in highly indebted countries: an empirical assessment

(provisional draft, comments are welcome)

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## Abstract

In this paper we analyse both theoretically and empirically the impact of public investment on growth in highly indebted countries. The discussion focuses on the central point of the effects of the fiscal policy, constrained by indebtedness or favoured by debt relief, on economic growth through the influence of public investment on private investment. In the theoretical discussion we compare the implications of the orthodox and the structuralist perspectives. Then, to test the different assumptions of the models, a dynamic econometric procedure is implemented on a group of highly indebted countries. This is based on time-series cointegration strategy, estimation of a Vector Autoregressive Error Correction Model and impulse response analysis.

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## Introduction

A clear evaluation of the relationship between public investment and growth in highly indebted countries is a difficult but necessary task. The aim is twofold: improving the definition of long-run foreign debt sustainability and designing adequate policy packages to face macroeconomic disequilibria connected to high indebtedness.

The traditional definition of foreign debt sustainability given by World Bank and IMF is the following: “*a country can be said to achieve external debt sustainability if it can meet its current and future external debt service obligations in full, without recourse to debt rescheduling or the accumulation of arrears.*”<sup>1</sup> According to this definition, the foreign debt of a country is considered sustainable when its ratios with respect to GDP, exports and/or fiscal revenues do not overpass specific “thresholds of solvency”, evaluated on the basis of the past experience of developing countries.

However, from a dynamic point of view, reaching these thresholds at a single point in time is no guarantee against future debt problems. Starting from this observation, in a more recent report<sup>2</sup>, the above definition has been integrated with the consideration of the role of economic growth<sup>3</sup>: debt sustainability can be maintained in the long run by a certain country if and only if that country experiences adequate growth rates of income, fiscal revenues and exports.

Accordingly, if we admit that foreign transfers have some impact on income, exports and fiscal revenues, it is not possible to consider the traditional debt indicators separately from the growth perspectives. Therefore, the relationship between debt flows and growth becomes crucial in the definition of long-run foreign debt sustainability. The related fiscal aspects are particularly interesting and concern how foreign transfers affect the role of public sector in promoting economic growth.

Furthermore, in order to define correct policy packages to deal with macroeconomic disequilibria in highly indebted countries, a clear understanding of the relationship between fiscal policy and growth is crucial. The poor growth performances which characterize these countries represent a signal that more attention about the effects of adjustment policy on growth is necessary.

This paper is organised as follows. In the first part we discuss the two main theoretical approaches on adjustment and growth in highly indebted countries, the orthodox and the structuralist approaches, and we derive the implications in terms of fiscal policy.

In the second part, to test the different assumptions of the models and to understand the long-run relationships between the crucial variables of the matter (public investment, private investment, real

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<sup>1</sup> World Bank, 1998, p. 55.

<sup>2</sup> International Monetary Fund and World Bank (2001): “The challenge of maintaining long-term external debt sustainability”.

<sup>3</sup> The definition becomes: “*a country can be said to achieve external debt sustainability if it can meet its current and future external debt service obligations in full, without recourse to debt rescheduling or the accumulation of arrears and without compromising growth*” (IMF and World Bank, 2001, p. 4).

domestic product and debt service), a dynamic econometric procedure is implemented on a group of highly indebted countries. This is based on time-series cointegration strategy, estimation of a Vector Autoregressive Error Correction Model and impulse response analysis.

Finally we draw some conclusions.

## **1. Public investment and growth in highly indebted countries: a theoretical discussion**

Highly indebted countries are characterised by macroeconomic and fiscal disequilibria. A high debt service, especially if coupled with weak new capital inflows, implies high net financial transfers abroad. The problem of mobilising domestic financial resources to be transferred abroad is called budgetary problem (Reisen and Van Trotsenburg, 1988).

To face that problem “soft solutions” are sometime possible: increasing the gross domestic product or reducing the foreign exchange reserves. But when these options are not available, the only possible way to mobilise financial resources consists in decreasing the internal use of resources, which means a contraction of either consumption or investment. In this case the level of real expenditure is reduced below the level of real income by an amount equal to the net financial transfer abroad.

A connected but distinct problem is the transfer problem (Reisen and Van Trotsenburg, 1988). This consists in the necessity of converting in foreign currency the financial resources mobilized through the reduction of the domestic aggregate demand.

The solution of the budgetary problem does not automatically involve a solution of the transfer problem. Indeed, to face the latter, the reduction of the domestic use of resources (which is required by the former) must be accompanied by either an improvement of commercial balance or a reduction of foreign exchange reserves. If this second solution is not sufficient, an adjustment in production, consumption and commercial patterns may be necessary.

Moreover, when the most part of the foreign obligation are held or guaranteed by the public sector, a fiscal problem arises: the financial burden of the transfer significantly affects the public budget by increasing the expenditure and consequently the deficit. Thus in order to finance the net financial transfer in absence of new foreign debt it is necessary either cutting expenditures or mobilising resources from the private to the public sector. This latter solution may be performed by employing specific fiscal intervention, by issuing internal debt or by exploiting the so called “*inflation tax*”.

In this paper we concentrate our attention on the fiscal problem connected to foreign indebtedness and in particular on the effects of fiscal policy (constrained by debt service or favoured by debt relief) on economic growth through the impact of public investment on private investment. Two different perspectives are considered: the orthodox perspective and the structuralist one.

## 1.1 Public investment and growth: the orthodox perspective

The orthodox view on adjustment and growth is analysed following a paper written by Khan, Montiel and Haque (1990). In that paper the authors firstly present the two analytical approaches followed by the International Monetary Fund<sup>4</sup> and the World Bank: the first is ended to the short run adjustment of the balance of payments, while the second to the medium-long run growth. Secondly the authors attempt to merge the two models into a unique analytical framework.

The three different models are nested in a single general framework where the economy is divided in four sectors: private sector, public (government) sector, foreign sector and domestic banking system. The public sector receives taxes, spends the proceeds in consumption ( $C_G$ ), and by assumption is not engaged in any investment. What remain after consumption is accumulated in financial assets in the form of foreign financial assets ( $\Delta F_G$ ), net of borrowing received from the banking system ( $\Delta D_G$ ). Hence public investment is omitted, so that the public sector budget constraint is given by:

$$T - C_G \equiv \Delta F_G - \Delta D_G \quad (1.1)$$

### 1.1.1 The Fund approach: the adjustment program

The structure of all Fund programs is based on an analytical framework which links the financial sector with the balance of payments. The aim of this approach, called the monetary approach to the balance of payments (based on the Polak-Robineck tradition) consists in ensuring consistency between the monetary impact of policy changes and the desired balance of payments outcome.

The fundamental equation of the monetary approach to the balance of payments is the following<sup>5</sup>:

$$\Delta R = v\Delta P \bar{y}_{-1} + vP_{-1}\Delta \bar{y} - (\Delta \hat{D}_p + \Delta \hat{D}_G) \quad (1.2)$$

where  $\Delta R$  is the balance of payments (equal to the change in reserves),  $v$  the inverse of income velocity of money (given constant),  $y_{-1}$  the last period's real GDP,  $P_{-1}$  the last period's price level,  $\Delta y$  the change in real GDP (exogenous),  $\Delta P$  the change in domestic price level (endogenous), and finally  $\Delta D_p$  and  $\Delta D_G$  are respectively the private and the public net borrowing from the banking system. The caret (^) identifies policy variables, whereas the over-line ( $\bar{\quad}$ ) denotes exogenous variables.

The balance of payments is expressed as the difference between the private sector's flow of demand for money and the flow of domestic credit. An increase (decrease) in domestic credit must be offset

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<sup>4</sup> Hereafter Fund approach.

<sup>5</sup> For analytical details see Khan, Montiel and Haque (1990).

by an equal decrease (increase) in foreign reserves. Once a desired value of the endogenous variable  $\Delta R$  is chosen, eq. (1.2) allows finding the required expansion of domestic credit.

Eq. (1.2) contains two endogenous variables,  $\Delta R$  and  $\Delta P$ . This implies that it is not possible to find a unique solution for both these variables conditionally to a chosen level of expansion of domestic credit. This indeterminacy is removed by taking into account a second relationship between  $\Delta R$  and  $\Delta P$  (the ‘Polak model’)<sup>6</sup>:

$$\Delta R = (\overline{Exp} - \overline{\Delta F}) - a(Y_{-1} + P_{-1}\Delta\bar{y}) - ay_{-1}\Delta P, \quad (1.3)$$

where the term  $[a(Y_{-1} + P_{-1}\Delta\bar{y}) + ay_{-1}\Delta P]$  denotes import, the parameter  $a$  is the ratio of imports with respect to GDP,  $Exp$  exports and  $\Delta F$  the foreign assets accumulated by both private and public sector. The variables denoted with ( $\bar{\quad}$ ) all considered exogenous to the model.

A reduction in the rate of credit expansion allows reaching the two joint targets referred to balance of payments and domestic inflation. These targets become independent one of each other by taking into consideration a second policy instrument such as the exchange rate<sup>7</sup>.

The Fund model implies that a ceiling (upper limit) on the expansion of total domestic credit is a necessary measure to reach balance of payments targets. However Khan, Montiel and Haque point out that in the Fund’s experience this ceiling is frequently accompanied by a subceiling on the expansion of credit to the non-financial public sector. This subceiling ensures that the availability of credit to the private sector is not excessively curtailed. Therefore, given a certain target,  $\Delta D_p^*$ , the expansion of credit to the public sector must be:

$$\Delta\hat{D}_G = \Delta\hat{D} - \Delta D_p^*, \quad (1.4)$$

where  $\Delta D$  denotes the total net borrowing from the banking system, and the star (\*) the desired level of a certain variable.

Since the public sector budget constraint is given by:

$$T - C_G \equiv \overline{\Delta F} - \Delta\hat{D}_G, \quad (1.1bis)$$

where  $\Delta F$  is assumed exogenous, once the public sector chooses a certain level of deficit to be achieved, the adjustment must occur by increasing revenue and/or reducing expenditures.

### 1.1.2 The World Bank approach: the Revised Minimum Standard Model and the effects of fiscal adjustment on growth

The World Bank adopts the Revised Minimum Standard Model<sup>8</sup> in order to study the growth perspectives in the medium-long run with a particular attention to the foreign financing gap.

<sup>6</sup> For analytical details see Khan, Montiel and Haque (1990).

<sup>7</sup> In our discussion we do not consider exchange rate since it is not essential to our specific analysis.

In this model real output is not exogenous (as in the Fund approach), but it is a function of the level of investment given a certain incremental capital-output ratio,  $\rho$  (*ICOR*):

$$\Delta y^* = \rho^{-1} \Delta K, \quad (1.5)$$

where  $\Delta y^*$  is the desired change in the real output and  $\Delta K$  denotes aggregate domestic investment.

Output is determined on the basis of two equations which connect investment to output. While the first relationship is obtained from the *ICOR* relationship (1.5):

$$\Delta K = \rho y^* - \rho y_{-1}, \quad (1.6)$$

the second is derived from the national income accounting identity expressed as:

$$\Delta K = (y^* - \hat{T} - C_P) + (\hat{T} - \hat{C}_G) + (Imp - Exp), \quad (1.7)$$

where *Imp* and  $C_P$  respectively denote import and private consumption, and the other symbols are already known. The above identity shows that domestic investment equals the sum of private saving,  $(y^* - \hat{T} - C_P)$ , public saving,  $(\hat{T} - \hat{C}_G)$ , and the inflow of foreign saving,  $(Imp - Exp)$ . Given the import and the consumption functions and the hypothesis that exports are exogenously determined:

$$\begin{aligned} Imp &= ay^* \\ C_P &= (1-s)(y^* - \hat{T}) \\ Exp &= \overline{Exp}, \end{aligned}$$

we can rewrite the identity (1.7) as:

$$\Delta K = (s+a)y^* + (1-s)\hat{T} - \hat{C}_G - \overline{Exp}. \quad (1.8)$$

Equation (1.8) says that a rise in output increases both domestic saving, given the saving rate,  $s$ , and the inflow of foreign saving, given the marginal propensity to import,  $a$ . Consequently, increased saving implies a rise in investment on a one-for-one basis.

It is now possible to analyse the policy implications of the RMSM as presented by Khan, Montiel and Haque. The authorities can increase the level of investment through policy measures which increase the amount of domestic saving<sup>9</sup>. This can be obtained either through a reduction in public consumption, which increases public sector saving while leaving private saving unchanged, or through a rise in tax revenues, which is less effective because the increase in public saving is accompanied by a (smaller) reduction in private saving.

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<sup>8</sup> Hereafter RMSM.

<sup>9</sup> We remark that the model assume the neoclassical hypothesis that all the saving is automatically reinvested.

It is worthwhile noting that the model, as presented in Khan, Montiel and Haque (1990) is based on the public sector budget constraint described by identity (1.1), which assumes that the public sector is not engaged in any investment. Therefore a reduction in public consumption implies an increase in public saving which leads to an increase in domestic investment through an increase of the credit available to the private sector (see eq. (1.4)).

Different versions of the RMSM include public investment in the public sector budget constraint, as follows:

$$T - C_G - I_G \equiv \Delta F_G - \Delta D_G. \quad (1.1\text{ter})$$

In this case an increase in public saving due to either a reduction in public consumption or a rise in tax revenues may directly increase domestic investment through an increase in public investment. Such an observation allows emphasizing the importance of any hypothesis on the role of public investment in national growth performances. On this aspect we will further focus our attention from an empirical point of view in the second part of the paper.

### 1.1.3 The merged model

In the merged model developed by Khan, Montiel and Haque (1990) the Fund approach and the World Bank approach are unified in a single model. This attempt starts from the observation that the financial programming framework (in the Fund model) considers real output as exogenous, so that the mechanism underlying the RMSM can be employed to give the “missing” output equation (Montiel, 1990).

The merged model is again based on the public sector budget constraint expressed by the identity (1.1), which does not consider public investment. It can be summarized through two basic relationships between the change of real output,  $\Delta y$ , and the change of domestic prices,  $\Delta P_D$ <sup>10</sup>. The general analytical framework is the same as the models above.

The first basic relationship, the World Bank component, is derived from the ICOR relationship and defines the equilibrium of the growth model. This may be written as<sup>11</sup>:

$$\Delta P_D^* = \left[ -I_1 + [\rho - (s - v)]\Delta y^* \right] / (s - v)(1 - \theta)y_{-1}, \quad (1.9)$$

where  $I_1 = I_0 + (s - v)y_{-1}\theta\Delta\hat{e}$ ,  $I_0$  is the autonomous portion of nominal aggregate investment,  $\theta$  the share of importable in the overall price index and  $e$  is the exchange rate. We underline that the growth in the real GDP is set as a target in such a model, and then in (1.9)  $\Delta P_D^*$  is the change of domestic prices compatible with the desired change in real GDP.

<sup>10</sup> This synthetic exposition of the model follows the “positive” mode.

<sup>11</sup> For analytical details see Khan, Montiel and Haque (1990).

The second relationship, the Fund component, is derived from the equilibrium in the money market. This is the following<sup>12</sup>:

$$\Delta P_D = \frac{E_1 - (v + a)\Delta y}{(1 - \theta)y_{-1} + (c + b)}, \quad (1.10)$$

where  $E_1 = [Exp_{-1} - Imp_{-1} - \Delta \bar{F} - \Delta \hat{D}] + [X_{-1} - Imp_{-1} - \Delta \bar{F} + (b + c) - y_{-1}\theta + R_{-1}^f] \Delta \hat{e}$ ,  $b$  and  $c$  are the two coefficients of response of respectively imports and exports to the relative price, and  $R_{-1}^f$  is the foreign currency value of the previously existing stock of foreign exchange reserves.

For the sake of brevity we can say that, under some conditions<sup>13</sup> in eq. (1.9)  $\Delta P_D$  is positive function of  $\Delta y$  whereas in eq. (1.10)  $\Delta P_D$  is a negative function of  $\Delta y$ <sup>14</sup>.

The simultaneous solution of (1.9) and (1.10) allows expressing the two targets  $\Delta y$  and  $\Delta P_D$  as function of the exogenous and the policy variables. Hence the merged model is suggested by Khan, Montiel and Haque to be used for the simultaneous implementation of both adjustment and growth programs.

The implications of fiscal policy consist in the fact that an overall credit reduction coupled with an increase in the amount of credit to the private sector allows not only improving the balance of payments (as in the Fund model) but also rising domestic investment and then accelerating the growth rate of the economy. The basic idea is that, since investment is only private, a reduction in the credit to public sector reduces only (public) consumption; moreover if at the same time the credit to private sector is increased, private investment and then total domestic investment are consequently increased.

## 1.2 Public investment and growth: the structuralist perspective

In this section the three gaps model developed by Bacha (1990) is analysed. This model can be considered a representative model of the structuralist perspective concerning the effects of public investment on growth in highly indebted countries<sup>15</sup>.

Bacha develops a model of a fiscally-constrained highly-indebted developing economy. This model aims to study the impact of foreign transfers on the aggregate level of investment, which is considered a proxy for economic growth. Foreign transfers can constrain aggregate investment through three alternatively gaps: the savings gap, the foreign exchange gap and the fiscal gap.

<sup>12</sup> Again for analytical details see Khan, Montiel and Haque (1990).

<sup>13</sup> For which see Khan, Montiel and Haque (1990)

<sup>14</sup> We remark that the two relationships represent mere equilibrium conditions.

<sup>15</sup> See also Taylor (1994).

If income is fixed at its potential level,  $Y^*$ , the aggregate level of investment may be constrained by the aggregate level of saving:

$$IS = S_p^* + (T - G) + (F - J) \quad (1.11)$$

where  $S_p^*$  represents private saving at full employment level,  $(T - G)$  the primary budget surplus, that is the difference between government gross income,  $T$ , and government consumption,  $G$ , and  $(F - J)$  the net foreign transfers to the government, that is the difference between net capital inflows,  $F$ , and net factor services to abroad,  $J$ .

Alternatively, when the import content of investment is high, the binding constraint can be the foreign exchange gap. In this case the aggregate level of investment is given by:

$$IE = \left( \frac{1}{m} \right) [E^* + (F - J)], \quad (1.12)$$

where  $E^*$  is the upper level of net exports determined by world demand and  $0 < m < 1$  is the import content of investment. Net exports are defined as the difference between exports,  $\overline{Exp}$  (exogenously given), and “other imports”,  $Imp_0$ , that is total imports,  $Imp$ , minus complementary capital goods imports,  $Imp_K$  (where  $Imp_K = mI$ ).

Finally, the aggregate level of investment can be constrained by the fiscal gap because foreign transfers to abroad (i.e.  $F - J < 0$ ) reduce financial resources for public investment so that in highly indebted developing economies the main source of growth difficulties may derive from government budget limitations. The basic hypothesis is that, once capital formation,  $I$ , is split between government investment,  $I_G$ , and private investment,  $I_P$ , private investment is assumed to positively depend on government investment. Accordingly private investment maximum value is  $I_P = k^* I_G$ , where  $k^* > 0$ . Such an assumption is called the crowding-in hypothesis: government investment in infrastructure and basic industries sets an upper limit for profitable private investment to occur. If the fiscal gap is binding, the aggregate level of investment is given by:

$$IT = (1 + k^*) [f(p, h) + (T - G) + (F - J)], \quad (1.13)$$

where  $f(p, h) = \frac{dH}{P}$  denotes the domestic financing of budget deficit through seignorage (given by the ratio between the variation in nominal money holdings,  $dH$ , and the price level,  $P$ ). Seignorage is conceived to be a function of two variables: the rate of inflation,  $p$ , and the propensity to hoard,  $h$ <sup>16</sup>. Bacha (1990) assumes that for high rates of inflation the fiscal constraint does not bind.

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<sup>16</sup> By hypothesis there is no market for government bonds.

We argued that this three-gaps-model can be simplified in a two-gaps-model. Indeed the savings gap results to be only a particular case of the fiscal gap. The saving gap says that, when the economy is at the full employment level, aggregate investment can be limited by aggregate saving. Now, aggregate saving is the sum of three components: private saving,  $S_p$ , primary budget surplus,  $(T - G)$ , and net foreign transfers to the government,  $(F - J)$ . Since private saving is fixed at the full employment level, foreign transfers limit aggregate saving only through the public sector constraint. Since private investment is exogenously determined, the aggregate level of investment is determined by the level of public investment which depends on foreign transfers (once  $T$  and  $G$  are fixed). Therefore the savings gap is just a particular case of the fiscal gap when the economy is at the full employment level. In this case since private investment is exogenously determined, it does not depend on government investment. Then, if the economy is characterised by full employment, an increase in foreign transfers to the government implies a smaller increase in aggregate investment than in the case of presence of unused capacity (where private investment reacts positively to the increase of public investment).

In conclusion we can say that the impact of foreign transfer on the aggregate level of investment (considered as a proxy of potential GDP growth rate) depends on the interactions between two gaps: the fiscal gap and the foreign exchange gap.

These two constraints are related to the two macroeconomic problems analysed in paragraph 1.1, the budgetary and the transfer problems. Indeed the foreign exchange gap is originated by the transfer problem: since the financial resources must be transferred abroad in foreign currency, it is necessary to obtain an adequate improvement of commercial balance (increasing exports and/or decreasing imports) or a reduction in foreign exchange reserves. If exports are limited by world demand and the decrease of foreign exchange reserves is not sufficient, a contraction of imports is necessary. This contraction may compromise the fixed capital formation when it affects the imports of capital goods. In case the import content of investment is sufficiently high, the foreign exchange gap can be the binding constraint.

The fiscal gap derives instead from the budgetary problem when the fiscal policies implemented to face the fiscal disequilibrium affect the level of public investment. Indeed, given the crowding-in hypothesis, a reduction in public investment implies a contraction of fixed capital formation both directly (because public investment is a component of aggregate investment) and indirectly, through a reduction in private investment. Then, if a fiscal adjustment is necessary, it should not affect the public capital formation because it could compromise the economic growth.

### **1.3 Comparing the different implications of the models**

Two different implications for the effects of public investment on growth in highly indebted countries can be derived from the three different perspectives:

- i)* The orthodox approach developed by Khan, Montiel and Haque (1990) does not consider public investment in the public sector budget constraint. This means either that the fiscal adjustment necessary to face the budgetary problem implies (for historical or empirical reasons) only a reduction in public consumption (so that public investment can be neglected) or that public investment is not relevant for the gross fixed capital formation. In both cases the impact of public investment on economic growth would not be a matter of concern.

Accordingly, in the merged model a reduction in government spending decreases the borrowing to the public sector. This policy, coupled with a smaller increase in the supply of credit to the private sector, allows improving the balance of payments (since the overall domestic credit is reduced) and rising domestic investment (because the reduction in the credit to public sector reduces only public consumption, whereas the rise in the credit to the private sector increases private investment).

- ii)* In the structuralist model developed by Bacha, economic growth depends on the aggregate level of investment, given by the sum of public and private investment. The fiscal adjustment necessary to transfer resources abroad may negatively influence economic growth if it reduces public investment. Indeed Bacha assumes that the crowding-in hypothesis holds: government investment in infrastructure and basic industries determines an upper limit for profitable private investment to occur. Therefore a reduction in public investment cannot be compensated by a corresponding increase in private investment because public investment increases domestic investment more than on a one-for-one basis. Consequently, if the fiscal gap is binding, the inadequacy of public investment becomes the crucial variable which compromises the growth perspective in a highly indebted country.

As one can notice, the different implications of these two approaches depend on the different assumptions about two central questions:

- 1) Is public investment affected by the fiscal adjustment necessary to face the budgetary problem?

The validity of the implications of the merged model requires that public investment is not affected by fiscal adjustment, whereas the structuralist model does not impose this condition. Indeed the latter simply considers the possibility that foreign transfers affect public investment because by definition they are competitors in the use of financial resources.

- 2) Is private investment affected by public investment (Does the crowding-in hypothesis hold)?

If the crowding-in hypothesis holds, the structuralist approach models the relationship between public investment and growth in a more convenient way than the orthodox approach. Otherwise, if the crowding-in hypothesis does not hold, the orthodox perspective might be more appropriate.

An empirical investigation directed to test hypothesis on point 1) and point 2) in highly indebted countries is therefore crucial.

## **2. Public investment and growth in highly indebted countries: the empirical evidence**

### **2.1. Introduction**

In order to study the validity of the implications of the three above perspective a first crucial relationship to be investigated concerns the effects of public investment on private investment. If public investment crowds-in private investment, a reduction in government investment will constraint private investment and, if aggregate investment is a good proxy for economic growth, also the entire national production. Public investment may affect private investment by providing public capital which may be a positive externality to private sector. Firstly availability of economic and social infrastructures may create favourable conditions for private decisions to invest by offering essential services to production system both in the short and in the long run (transportation, communication, education). Moreover higher public capital may lead increments of total factor productivity and labour productivity and reductions in production costs (availability of streets, highways, electrical and gas facilities, mass transit, and so on). Finally public investment, by increasing total demand, may give rise to profit and sales expectation and spurs private decision to invest more. The test of the crowding-in hypothesis aims to verify if these potential relationships are valid and effective in the case of highly indebted countries. On the other hand even public spending can be affected by higher private production; this leads to a chain of positive feedbacks.

To assess the role of public investment for economic growth in highly indebted countries other two relationships need to be investigate. The first relationship concerns the total effects of public investment on output (both directly and indirectly through the impact on private investment). The second relationship concerns the sensitivity of public investment with respect to the fiscal adjustments necessary to transfer financial resources abroad. This relationship is different from the previous ones because, given the public sector budget constraint, debt service and public investment is for definition competitors in the use of government income. However, if empirically public investment is never sensitive to variations in debt service, this means that the role of public investment in adjustment programs is not relevant and omitting public investment does not distort the results of the model.

According to this reasoning, in this section we employ an econometric procedure to analyse the dynamic interrelationships between the following crucial variables: public investment, private investment, gross domestic product and debt service.

### **2.2. Testing the crowding-in hypothesis: the previous literature**

The relation between public and private investment has already been studied in the previous literature (for a review see Gramlich, 1994). The crowding-in hypothesis is tested against the

crowding-out hypothesis with different econometric techniques and somewhat different focuses (e.g. for either developing or developed countries).

The effects of public investment on private investment have become subject of discussion and empirical inquiry in particular after two seminal papers by Aschauer (1989a, 1989b), which focus on USA economy. Aschauer (1989a) finds high correlation between the net non-military public capital stock and alternative measures of private-sector productivity. Aschauer (1989b) offers further support to this fact. On one hand, higher public capital can be used by private sector for its required purposes rather than to expand private capacity. On the other, public infrastructures provide important services which are necessary to the production and the delivery of goods and services. Since the latter effect is proved to dominate with respect to the former, public investment is argued to enhance private investment through an increase of the profitability of private capital stock. In these works, the author adopts a neoclassical analytical framework and a single-equation static production function approach.

With regard to USA, Pereira (2001a, 2000) adopts a multivariate *VAR* approach relating private input, private output and public capital. The author extends the test of the effect of public investment on the evolution of private investment, by considering different types of both private and public investment (with alternative aggregate and disaggregate measure techniques). Pereira (2001b) studies a sample of twelve OECD countries. He applies a multivariate *VAR* procedure and impulse response analysis which includes public and private investment, labour and gross domestic product. The author concludes in favour of the crowding-in hypothesis.

Other works have empirically analyzed the same issue by paying attention on developing countries. For instance, Ramirez (1996) employs the estimation of a linear growth model which includes a number of relevant quantitative and qualitative variables, in order to study the effect of government investment spending on private productivity and economic growth for Latin American countries (2000), Mexico (1998) and Chile and Mexico (1996). The author's empirical results offer further support to the complementarity hypothesis.

Mallik (2001) applies a simulation analysis on Indian data and finds, among other results, that fiscal policy may positively affect national output through the impact of public investment on private investment.

### **2.3. The econometric strategy**

We mainly follow the methodological procedure used by Pereira (2000, 2001a, 2001b), although focusing on different variables and different sample. The aim is to pay particular attention on the dynamic behaviours of the series and on the presence of feedbacks in their mutual relations. Indeed, an approach based on the estimation of static, univariate production functions (for instance see Aschauer, 1989a, 1989b) may be criticized because of biased estimates due to non-stationarity of

the variables (spurious regression) or simultaneity<sup>17</sup>. Moreover this kind of method does not take into account dynamic behaviours and feedback effects which are crucial in a multivariate framework.

The procedure adopted in this paper is based on time series method, including a *VECM* (Vector Autoregressive Error Correction Model) estimation and impulse response analysis. This allows taking into account the dynamic interrelationships among the considered variables, the short run impacts as well as the adjustment processes over a longer time horizon (10 years).

The empirical analysis is employed on four crucial variables: public investment (*IG*), private investment (*IP*), gross domestic product (*GDP*), and public/government debt service (*DS*). All the variables are considered in logarithmic form.

Our sample consists of seven highly indebted countries (Cameroon, Congo Democratic Republic, Malawi, Myanmar, Nicaragua, Peru, Philippines) considered in a period covering the years 1970-1999 (but it changes somewhat depending on the availability of the data<sup>18</sup>). The countries included in the sample are chosen in consequence of the necessity of availability of a sufficient number of data.

The strategy is described in what follows. First of all, we allow for the presence of non-stationary trends due to autoregressive unit root. Indeed following the Engle-Granger methodology, we run a time series analysis for any variable under observation. So the Dickey-Fuller (*DF*), the augmented Dickey-Fuller (*ADF*) and the Phillips-Perron (*Z*) tests are implemented on our sample.

Then we verify for the cointegration among the variables in order to find out the existence of an economically significant relationship. Thus, on the one hand, we conduct the *ADF* on the residuals yielded by the long-run equilibrium regression among the variables (augmented Dickey-Fuller test for cointegration). On the other hand, we run the likelihood-based Johansen procedure which employs cointegration techniques within a multivariate system of equations.

As stated by the Granger theorem, variables which are found *I(1)* and cointegrated admit an error correction representation. Therefore we estimate a vector autoregressive error correction model (*VECM*). This allows us to study the dynamic relations among the series, also taking under consideration the adjustment mechanism.

Finally we implement the impulse response analysis. We evaluate the simulated behaviours of one series following an innovation on the other and highlight the direction of the impact so generated.

From this analysis we can draw some conclusions.

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<sup>17</sup> For a discussion on this aspect see Munnell, 1992.

<sup>18</sup> For a punctual description of the data see the appendix A.

## 2.4. Empirical results

### 2.4.1 Unit root tests

The results of the unit root tests (*DF*, *ADF*, Phillips-Perron) are observable in Table 1 and 2.

Constant and trend are included in the auxiliary regression when significant, according to the Dickey-Fuller significance test (critical values in Dickey-Fuller, 1981), after a graphical analysis of the plots of the series. While in the *ADF* the lag-length is chosen as suggested by the Akaike Information Criterion and the Schwartz Information Criterion, in the Phillips-Perron test the truncation lag-length follows the Newey-West method.

According to the three implemented tests, the null hypothesis of unit root is accepted for all the series in the sample. The significance is almost always very high, at the 10% level (with the only exception of few cases).

**Table 1. Unit root tests: *DF* and *ADF***

Country (obs.)	Variable	Trend & Constant	<i>DF</i> test		<i>ADF</i> test		
			Statistic	Result <sup>1</sup>	Statistic	Lags	Result <sup>1</sup>
Cameroon (25)	GDP	c	-2.34527	accept at 10%	-2.47258	2	accept at 10%
	DS	c	-2.35956	accept at 10%	-2.75888	1	accept at 5%
	IP	c & t	-3.38893	accept at 5%	-4.36591	2	accept at 10%
	IG	none	-0.05273	accept at 10%	-0.18245	1	accept at 10%
Congo Rep. Dep. (27)	GDP	none	-1.26007	accept at 10%	-0.90513	2	accept at 10%
	DS	none	2.66251	accept at 10%	1.10951	2	accept at 10%
	IP	c	-2.90466	accept at 5%	-2.06564	1	accept at 10%
	IG	none	0.70652	accept at 10%	0.67592	1	accept at 10%
Malawi (26)	GDP	c & t	-0.83007	accept at 10%	-1.26886	1	accept at 10%
	DS	c	-1.88815	accept at 10%	-1.83680	1	accept at 10%
	IP	c & t	-1.41606	accept at 10%	-2.30392	1	accept at 10%
	IG	c	-1.54766	accept at 10%	-2.03626	1	accept at 10%
Myanmar (26)	GDP	c & t	-1.27622	accept at 10%	-2.60028	2	accept at 10%
	DS	none	-1.28404	accept at 10%	-0.71030	2	accept at 10%
	IP	c	-1.95615	accept at 10%	-3.42917	2	accept at 1%
	IG	c	-1.26158	accept at 10%	-2.21952	2	accept at 10%
Nicaragua (26)	GDP	none	-0.20105	accept at 10%	-0.26980	1	accept at 10%
	DS	none	-0.87213	accept at 10%	-0.84175	1	accept at 10%
	IP	c	-2.65843	accept at 5%	-2.87623	1	accept at 5%
	IG	c	-2.73076	accept at 5%	-2.88407	1	accept at 5%
Peru (30)	GDP	c & t	-1.95644	accept at 10%	-2.97469	1	accept at 10%
	DS	c	-2.09778	accept at 10%	-1.82002	1	accept at 10%
	IP	c	-2.34082	accept at 10%	-2.65458	1	accept at 5%
	IG	c & t	-4.15696	accept at 1%	-2.74225	1	accept at 10%
Philippines (28)	GDP	c & t	-2.28939	accept at 10%	-3.00150	2	accept at 10%
	DS	none	0.41541	accept at 10%	0.44754	1	accept at 10%
	IP	c	-2.24890	accept at 10%	-3.48631	1	accept at 1%
	IG	c	-2.38608	accept at 10%	-1.87947	1	accept at 10%

<sup>1</sup>Critical values from Dickey-Fuller tables reported in MacKinnon (1991)

Furthermore we verify for the presence of roots of higher order. The hypothesis of  $I(2)$  is always strongly rejected (the empirical results are not shown there but the procedure applied is the same as above).

Hence we conclude that the four variables under consideration present a unit root, i.e. they are not stationary in levels, but are stationary in first differences.

**Table 2. Unit root test: Phillips-Perron**

Country (obs.)	Variable	Trend & Constant	Statistic	Truncation Lag(s)	Result <sup>1</sup>
Cameroon (25)	GDP	c	-2.19605	2	accept at 10%
	DS	c	-2.76624	2	accept at 5%
	IP	c & t	-2.02046	2	accept at 10%
	IG	none	-0.05631	2	accept at 10%
Congo Rep. Dep. (27)	GDP	none	-0.91744	2	accept at 10%
	DS	none	2.19002	2	accept at 10%
	IP	c	-3.05278	2	accept at 1%
	IG	none	0.91230	2	accept at 10%
Malawi (26)	GDP	c & t	-1.32443	2	accept at 10%
	DS	c	-1.94554	2	accept at 10%
	IP	c & t	-1.79216	2	accept at 10%
	IG	c	-1.58593	2	accept at 10%
Myanmar (26)	GDP	c & t	-1.91230	2	accept at 10%
	DS	none	-0.95279	2	accept at 10%
	IP	c	-2.05451	2	accept at 10%
	IG	c	-1.23853	2	accept at 10%
Nicaragua (26)	GDP	none	-0.19655	2	accept at 10%
	DS	none	-0.93778	2	accept at 10%
	IP	c	-2.33775	2	accept at 5%
	IG	c	-2.69784	2	accept at 5%
Peru (30)	GDP	c & t	-2.09653	3	accept at 10%
	DS	none	0.45453	3	accept at 10%
	IP	c	-2.10136	3	accept at 10%
	IG	c & t	-4.08574	3	accept at 1%
Philippines (28)	GDP	c & t	-3.00150	3	accept at 10%
	DS	c & t	-2.52365	3	accept at 10%
	IP	c	-2.49123	3	accept at 10%
	IG	c	-2.47755	3	accept at 10%

<sup>1</sup>critical values from Dickey-Fuller tables reported in MacKinnon (1991)

#### 2.4.2 Cointegration tests

The cointegration tests are employed on the group of variables: IG, IP, GDP and DS.

Firstly we apply the standard Engle and Granger procedure (Engle and Granger, 1987). We estimate the long run regression of each variable on the others. As above the choice of the lag-length follows what suggested by the Akaike and the Schwartz Information Criteria. Then we save the residuals from the four estimated equations and conduct the *ADF* test on these (the auxiliary regression does not include either intercept or trend). The output is reported in Table 3.

As one can notice, for the entire group of variables the null hypothesis of no cointegration is very strongly rejected (always at the 1% level, but few cases at the 5%).

**Table 3. Cointegration test: *ADF* on the residuals**

Country (obs.)	Equation regression	Lag(s)	Statistic	Result <sup>1</sup>
Cameroon (25) [Lags in VAR=2]	1	2	-3.04278	reject at 1%
	2	1	-5.31141	reject at 1%
	3	1	-3.69656	reject at 1%
	4	1	-2.30359	reject at 5%
Congo Rep. Dep. (27) [Lags in VAR=3]	1	1	-4.11473	reject at 1%
	2	1	-6.32241	reject at 1%
	3	1	-3.13248	reject at 1%
	4	1	-4.12101	reject at 1%
Malawi (26) [Lags in VAR=2]	1	1	-3.32878	reject at 1%
	2	1	-3.93804	reject at 1%
	3	1	-4.48283	reject at 1%
	4	2	-3.23330	reject at 1%
Myanmar (26) [Lags in VAR=2]	1	2	-3.75430	reject at 1%
	2	1	-3.99959	reject at 1%
	3	2	-3.07805	reject at 1%
	4	1	5.301786	reject at 1%
Nicaragua (26) [Lags in VAR=2]	1	2	-3.23538	reject at 1%
	2	1	-4.26116	reject at 1%
	3	2	-4.01972	reject at 1%
	4	1	-3.32890	reject at 1%
Peru (30) [Lags in VAR=3]	1	1	-3.90742	reject at 1%
	2	1	-3.60721	reject at 1%
	3	1	-3.85959	reject at 1%
	4	1	-4.84789	reject at 1%
Philippines (28) [Lags in VAR=2]	1	1	-3.84681	reject at 1%
	2	1	-3.91748	reject at 1%
	3	1	-2.78870	reject at 1%
	4	2	-5.01827	reject at 5%

Order of equations in the VAR, by dependent variables: DS, GDP, IG, IP

Secondly we perform the Johansen procedure (Johansen and Juselius, 1990) which verifies the presence of zero, at least one or more cointegrating vectors, i.e. cointegrating relationships. This test is of likelihood-based inference type; it circumvents some problems which arise for the *ADF* and has proved to be more powerful than alternative cointegration approaches (Gonzalo, 1994).

The assumption of none, linear or quadratic time trend in the data, as well as the presence of intercept and/or trend in the cointegrating regression are based, as usual, on the Akaike and the Schwartz Information Criteria.

In Table 4 we summarize the output of this procedure which confirms the results obtained from the *ADF*: the hypothesis of at least one cointegrating vector is accepted for the entire sample. Often, with different significance, we verify the presence of more than one cointegrating vector. However the hypothesis of four cointegrating vectors is always rejected, what was expected since otherwise it

would mean stationary of all the series (which we excluded according to the unit root analysis above).

The previous results lead us to conclude in favour of the hypothesis of cointegration for all the variables under consideration and for the whole sample.

**Table 4. Cointegration test: Johansen (IG, IP, GDP, DS)**

Country (obs.)	Data trend	Det. comp.	Eigenvalue	LR	No. of CE(s) <sup>1</sup>
Cameroon (25) [Lags in VAR=2]	none	none	0.87464	75.9094	none**
			0.60623	30.2256	at most 1**
			0.32430	9.72185	at most 2
			0.04868	1.09789	at most 3
Congo Rep. Dep. (27) [Lags in VAR=1]	none	c	0.67042	62.79088	none**
			0.54504	35.04239	at most 1*
			0.33570	15.35354	at most 2
			0.18545	5.12802	at most 3
Malawi (26) [Lags in VAR=2]	linear	c	0.65926	54.01591	none*
			0.48434	29.25315	at most 1
			0.43372	14.02010	at most 2
			0.04008	0.940863	at most 3
Myanmar (26) [Lags in VAR=2]	none	c	0.84071	93.79032	none**
			0.68556	51.53815	at most 1**
			0.54416	24.92790	at most 2**
			0.25785	6.85608	at most 3
Nicaragua (26) [Lags in VAR=]	linear	c & t	0.76757	65.37348	none*
			0.54008	31.81293	at most 1
			0.32102	13.94854	at most 2
			0.19692	5.04389	at most 3
Peru (30) [Lags in VAR=3]	linear	c & t	0.73423	74.99944	none**
			0.59218	40.54620	at most 1
			0.34211	17.22626	at most 2
			0.21637	6.33942	at most 3
Philippines (28) [Lags in VAR=2]	linear	c	0.73879	61.83136	none**
			0.53021	28.27092	at most 1
			0.30423	9.38400	at most 2
			0.01255	0.31567	at most 3

<sup>1</sup> Critical values in Johansen and Juselius (1990): \* denotes rejection of the hypothesis at 5% significance level; \*\* denotes rejection of the hypothesis at 1% significance level; if none star, the hypothesis is accepted

### 2.4.3 Vector Error Correction Model

In order to find the important dynamic interrelationship among the variables, we construct a non-structural vector error correction model (hereafter *VECM*) for the four variables under consideration, without imposing any zero constraint on the parameters<sup>19</sup>.

The *VECM* takes the following structure:

<sup>19</sup> About a discussion on the overparametrization of the unrestricted *VAR* see Sims (1980).

$$\begin{aligned}
ig_t &= \alpha_1 + \sum_{j=1}^n \beta_{1j} ig_{t-j} + \sum_{j=1}^n \gamma_{1j} ip_{t-j} + \sum_{j=1}^n \delta_{1j} gdp_{t-j} + \sum_{j=1}^n \zeta_{1j} ds_{t-j} + \sum_{k=1}^m \eta_{1k} (ecm)_{t-j} + \varepsilon_{1t} \\
ip_t &= \alpha_2 + \sum_{j=1}^n \beta_{2j} ig_{t-j} + \sum_{j=1}^n \gamma_{2j} ip_{t-j} + \sum_{j=1}^n \delta_{2j} gdp_{t-j} + \sum_{j=1}^n \zeta_{2j} ds_{t-j} + \sum_{k=1}^m \eta_{2k} (ecm)_{t-j} + \varepsilon_{2t} \\
gdp_t &= \alpha_3 + \sum_{j=1}^n \beta_{3j} ig_{t-j} + \sum_{j=1}^n \gamma_{3j} ip_{t-j} + \sum_{j=1}^n \delta_{3j} gdp_{t-j} + \sum_{j=1}^n \zeta_{3j} ds_{t-j} + \sum_{k=1}^m \eta_{3k} (ecm)_{t-j} + \varepsilon_{3t} \\
ds_t &= \alpha_4 + \sum_{j=1}^n \beta_{4j} ig_{t-j} + \sum_{j=1}^n \gamma_{4j} ip_{t-j} + \sum_{j=1}^n \delta_{4j} gdp_{t-j} + \sum_{j=1}^n \zeta_{4j} ds_{t-j} + \sum_{k=1}^m \eta_{4k} (ecm)_{t-j} + \varepsilon_{4t}
\end{aligned}$$

where the lowercase letters denote the first differences of the variables in log-form. As usual  $\varepsilon$  is a stochastic term. Finally the *ecm* term represents the deviation from the long run equilibrium, and it appears in the equations one or more times lagged.

The *VECM* specification may assume no deterministic trend, as well as linear or quadratic time trend in data; furthermore, in each case, either the intercept and/or the trend may be included in the cointegrating equation. The choice of the lag-length as well as the inclusion of trend and/or intercept follows the Akaike and the Schwartz Information Criteria. Finally the number of cointegrating vectors (i.e. the rank) is defined on the basis of the results of the Johansen procedure previously applied.

#### 2.4.4 Impulse response analysis

In this section we identify the interrelated dynamics of the sequences  $\{ig_t\}$ ,  $\{ip_t\}$ ,  $\{gdp_t\}$  and  $\{ds_t\}$  in response to shocks IG, paying attention to both the instantaneous effects (through the evaluation of the impact multipliers) and the subsequent paths of dynamic adjustment which inform about the persistence of the innovation on the time series.

It is a feature of the non-structural *VECM* that the residuals of any equation are contemporaneously correlated. Therefore, in order to purge the effect we are interested in from the spurious influence due to the residual correlation, additional restrictions are necessary. These restrictions on the residuals break the circular transmission of the shocks and make the identification of the impulse response possible. With this aim, we apply the Choleski decomposition which allows us to orthogonalize the matrix of contemporaneous correlations. So we introduce an asymmetry in the system, by defining an ordering of causality among the variables (i.e. imposing a priority) and preventing some impulses on one variable ( $x$ ) from having an instantaneous impact on one other ( $y$ ). As a consequence the latter ( $y$ ) is considered as a prior with respect to the former ( $x$ ).

The order we suggest for the present empirical analysis is justified by theoretical reasons consistent with previous arguments.

The dynamic interrelations among the considered variables can be summarized in three steps:

- The debt service is considered prior with respect to the other endogenous variables.

Indeed flows-out of repayment of the foreign debt does affect, even within one year, the availability of resources which is a condition for public investment to occur. But, it is plausible to suppose that DS does not respond immediately to shocks in the other variables. Hence, although financing flows are impacted by the subsequent behaviours of the other series, we set that IG, IP, and GDP are not able to produce an instantaneous effect on DS.

- The complementary relation between public investment and private investment operates from the former variable toward the latter<sup>20</sup>. It is reasonable that public sector is able to condition private decision even in the short run (within one year). Whereas public decisions may be supposed to adjust to private behaviours only with a time lag (at least one year), due to information, organizational, implementation problems. As a consequence of this theoretical premise, empirical implications follow: IG is a prior with respect to IP. The former instantaneously affects the latter but the reverse does not occur. Nevertheless the two variables mutually respond one to shocks in the other within the subsequent adjustment process.
- Finally GDP absorbs, preserves and transmits all the impulses received from the other series in the model.

To summarize we have:  $DS \rightarrow IG \rightarrow IP \rightarrow GDP$ .

Since the prior aim of this section consists in proving the effect of public on private investment and growth, in the impulse response analysis we concentrate our attention on the response of the variables to impact in IG.

In appendix B and C we report respectively the plots of the impulse response function and the values of the impulse response coefficients.

**Cameroon:** Starting our consideration with the response of DS to IG, we remind that this variable has been set as a prior. Thus the impact multiplier is necessarily zero. With the exception of the first years, the simulated series of DS lays below its original value, going down and down in subsequent periods. Such a result is not surprising: indeed we expect that debt service and public investment are competitors in the use of financial resources.

The second plot represents the response of IG to an innovation in itself. The exams of the adjustment path of the series informs about the persistency of the shock due to the dynamic autoregressive model. The graph shows an increasing trend up to the sixth year of the time horizon; after that the increment in IG tends to reduce its extent (still remaining positive).

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<sup>20</sup> The same hypothesis on the direction of causality between public and private investment is assumed also in other empirical work, for instance Pereira (2001b). Moreover it has been object of specific empirical test: an example is the Granger causality test employed by Mallik (2001).

Moreover, IP reacts positively to an increase in IG. This result may be interpreted as evidence of the crowding-in hypothesis: an increment of public capital creates favourable conditions for investing in the private sector.

Finally as argued in the previous sections, GDP receives both the direct positive effect of IG, and its indirect effect passing through IP. Since both are positive, GDP reasonably displays an upward movement.

**Congo Democratic Republic:** DS reacts negatively to the impulse in IG (although with weak significance) up to the fourth year. Later on the graph of DS displays an increasing trend.

After the first exogenous positive shock in IG, the impact in the variable itself decreases (still remaining always positive) during the first three years. Afterwards the positive effect is significantly increasing.

According to the response of IP to an innovation in public investment, one can observe from the graph that after a very short initial period (few months), IP trend reveals an increasing movement during the entire time horizon. This empirical fact suggests that the crowding-in effect acts with the lag of one period.

Finally the effects on GDP are the cumulative results of the previous dynamics. The gross domestic product shows a positive response which is dramatically increasing since the fourth year, offering support to the hypothesis of the positive effect of public investment on growth.

**Malawi:** Analysing the impulse response function of Malawi, one can notice that the effect of IG on DS is mostly negative, as expected. Indeed the graph is significantly below its original level during the period between the third and the eighth year. In the very first and in the very last period the response to the shock is positive, but not very significant.

The effect of IG to the innovation in itself is positive and highly significant. However it is decreasing in its extent over time.

As in the case of Congo Dem. Rep., the positive response of IP to the shock in public investment occurs with a lag of one period. Yet, after that, the function reveals a significantly increasing trend over the initial level of the series.

Finally the impact on GDP is positive and shows very high significance.

**Myanmar:** Following the usual order, first of all we notice that the impact on DS, consequent to a stochastic shock in IG, is negative and with increasing strength. This again confirms previous considerations about the negative relation existing between debt service and public investment.

The dynamics of IG and IP are quite similar one to each other. At time 1 (when the shock happens) the two variables receive a positive impact and instantaneously jump over their starting values. Yet afterwards, the trends show a decreasing movement, still remaining over the zero-line for almost three years. Later on, after one year in which the simulated series go below their original values, the trends of the response functions are in the positive half-plane and dramatically increasing. Therefore such empirical evidence can be interpreted in favour of the thesis of crowding-in hypothesis.

As consequence of the fact described above, after an innovation of IG, GDP displays a significant increase which is also very persistent. Indeed the response function remains always over its original level and increases over time.

**Nicaragua:** The case of Nicaragua is very consistent with all the previous considerations.

Accordingly DS responds very negatively to shocks in IG.

On the contrary all the other impulse response functions display significantly positive trends. Indeed the impact of the innovation on IG in itself is positive over the entire horizon, hence demonstrates strong persistence.

Private investment displays a very positive response which follows the simulated increase in public investment.

Finally, as expected, GDP response function is always above its original level, showing a positive effect on the variable.

**Peru:** As it is evident from the first graph, DS displays initially a dramatic and positive response to the noise in IG. Afterwards, the response function wiggles around its starting level. On this a caveat is compelling. Indeed the initial peak of the function seems to suggest the presence of some spurious effect on the impulse response analysis.

All the other figures show the expected empirical results. The positive shock in IG is persistent over the entire time horizon.

Finally both IP and GDP response functions are significantly over the initial level and display dramatically increasing behaviours. This result corroborates the idea of a complementary relation between IG and IP, and its positive effect on the domestic productive performances.

**Philippines:** For this country the impulse response analysis provides a strong support to the previous theoretical reasoning.

Indeed, with the only exception of the first period, DS reacts inversely and significantly to the stochastic innovation generated in IG.

Furthermore the study of the dynamics of IG informs about the significant persistence of the shock since the function remains above the zero line over the whole period and with relevant extent.

Consistently IP displays a positive jump as instantaneous response to the impulse in IG, and then continues to increase over time remaining dramatically over the initial level.

As a consequence of the behaviours of IG and IP, even the trend of GDP is significantly upward.

#### **2.4.5 Sensitivity analysis**

As we noted above, the results of the impulse response analysis are strictly dependent on the order of the variables which has been hypothesised for the instantaneous impact of the shocks.

In order to inform about the robustness results inferred from the adopted scenario (DS → IG → IP → GDP), we apply a sensitivity analysis relaxing some hypothesis.

Since we use four variables for the multivariate *VECM*, twenty-four different orders of causation would be possible for the Choleski decomposition.

Nevertheless we maintain that DS is not instantaneously affected by the other variables. Indeed debt service is defined consequently to policy decision which may take into account in the long run the performance of private and public investment, but it is plausible that IG, IP and GDP are not able to exert influence in a short period of time (shorter than one year). Accordingly we consider the hypothesis of priority of DS credible and respondent to the actual behaviour of the series rather than to strong theoretical assumptions.

On the other hand we replicate the impulse response analysis trying all the possible orders for the other three variables (IG, IP, GDP), although we conceive these scenarios less plausible.

As results, we report in appendix D the impulse response elasticities so obtained. As one can notice the conclusions are quite consistent with our central scenario. The elasticities of IP and GDP with respect to shocks in IG are almost always positive. The only exceptions are GDP of Cameroon and both GDP and IP of Myanmar which show negative elasticities for some scenarios. However these few inconsistent cases can be attributed to contemporaneous correlations of the residuals in the estimated *VECM*. Hence we can assert sufficient robustness of the result of empirical evidence of the crowding-in effect for the central case within the sample in consideration.

#### **2.4.6 Summary of the empirical results**

Time series empirical evidence obtained in our econometric analysis shows that the four considered variables (DS, IG, IP, GDP) are unit root and all cointegrated. Moreover the impulse response analysis for our central scenario (DS → IG → IP → GDP) allows drawing the following conclusions.

- a) DS is mostly negatively affected by positive shocks in IG in five out of seven cases.

- b) IG responds positively to a positive impulse in itself and the shock generally proves to have high persistence.
- c) IP receives positive impact by IG in all the cases under observation.
- d) GDP is positively influenced by IG in all the cases under observation.

The sensitivity analysis offers support to the robustness of these main conclusions.

### 3. Conclusions

Our econometric analysis has been employed in order to investigate the effects of public investment on growth with regard to a sample of seven highly indebted countries. To this end we tested the relationship existing among debt service, public investment, private investment and gross domestic product for our sample, paying special attention to the interrelated dynamics of the considered series, and evaluating direct and indirect effects as well as feedbacks.

The study has been run by implementing time series analysis, *VECM* estimation and impulse response function analysis.

The founded empirical results can be used as support to answer the two crucial questions that we posed in paragraph 1.3:

- 1) Is public investment affected by the fiscal adjustment necessary to face the budgetary problem?
- 2) Is private investment affected by public investment (Does the crowding-in hypothesis hold)?

We have concluded that, according to our sample, in the most of the considered:

- 1) Public investment and debt service are competitors in the use of financial resources, and
- 2) Public investment positively affects private investment.

With regard to the implications for the fiscal policy this involves what follows. Payments on debt service often imply a reduction in public investment since the two variables are competitors in the use of financial resources. Moreover, if public investment is able to exert a positive influence on private investment and gross domestic product, a fiscal adjustment policy due to debt service involves a constraint to growth.

As a consequence of these conclusions, it results clear that public investment has a crucial role that cannot be disregarded in any growth and adjustment program, especially in highly indebted countries which are the object of our empirical analysis.

The merged model of the orthodox approach is an attempt to structure an analytical framework to design policy packages for the simultaneous achievement of both adjustment and growth targets.

But since this model is drawn on the basis of the general framework of the Fund approach, it does not take into account the role of public investment. Hence public expenditure is supposed only consisting in unproductive<sup>21</sup> consumption which, as such, can be cut to achieve adjustment target without any negative effect on growth. On the contrary, as noted above, the empirical finding of positive effects produced by public to private investment suggests that the omission of government investment may be misleading for any implication derived from the model.

Once public investment is admitted to be relevant for private investment to occur (as it results from our econometric evidence), it is no more correct to assume that government is not engaged in any investment. This allows us to conclude in favour of the necessity of including public investment and the crowding-in effect into adjustment and growth models. The structuralist perspective is consistent with the crowding-in hypothesis. Thus the possibility that the fiscal adjustment necessary to face the budgetary problem may negatively affect economic growth is taken into account. Fiscal policy packages compatible with a growth perspective require considering the fact that, if the fiscal gap is binding, the inadequacy of public investment may become the constraint for a country to grow. On these premises, debt service policies which require curtailing government investment may compromise growth if not based on the careful consideration of all their possible consequences.

Moreover, since foreign transfers have some effects on growth perspectives through the fiscal channel, this issue must be considered in the definition<sup>22</sup> of long-run foreign debt sustainability.

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<sup>21</sup> Furthermore the implicit assumption of unproductiveness of public consumption would worth some comments, since, at least in the long-run, it is not necessary true that it holds. But here we cannot dedicate more space to this aspect of the issue.

<sup>22</sup> See note 3.

## **Appendix A: Data, sample and software**

All the data are annual and obtained from the World Bank Development Indicators 2001.

The variables we used are defined as follows:

- IG = Capital expenditure (constant LCU)
- IP = Private gross fixed capital formation (constant LCU). This is obtained by subtracting the capital expenditure from the gross fixed capital formation
- GDP = gross domestic product (constant LCU)
- DS = PPG debt service

All the variables are used in logarithmic form.

The sample periods are:

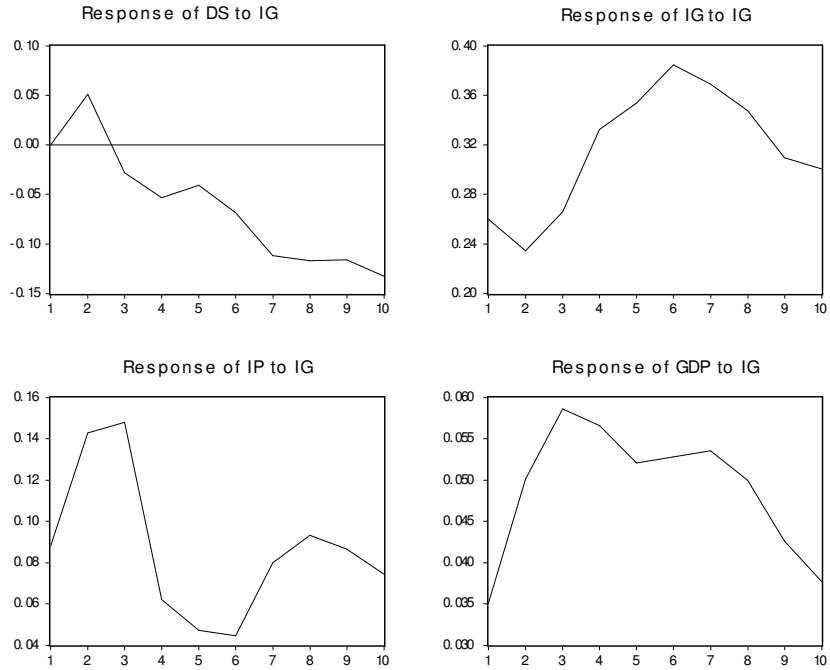
- |                               |                           |
|-------------------------------|---------------------------|
| 1) Cameroon: 1975-1999        | 5) Nicaragua: 1970-1995   |
| 2) Congo Dem. Rep.: 1971-1997 | 6) Peru: 1970-1999        |
| 3) Malawi: 1972-1997          | 7) Philippines: 1972-1999 |
| 4) Myanmar: 1973-1998         |                           |

The econometric software package used is E-Views.

## Appendix B: Impulse response functions

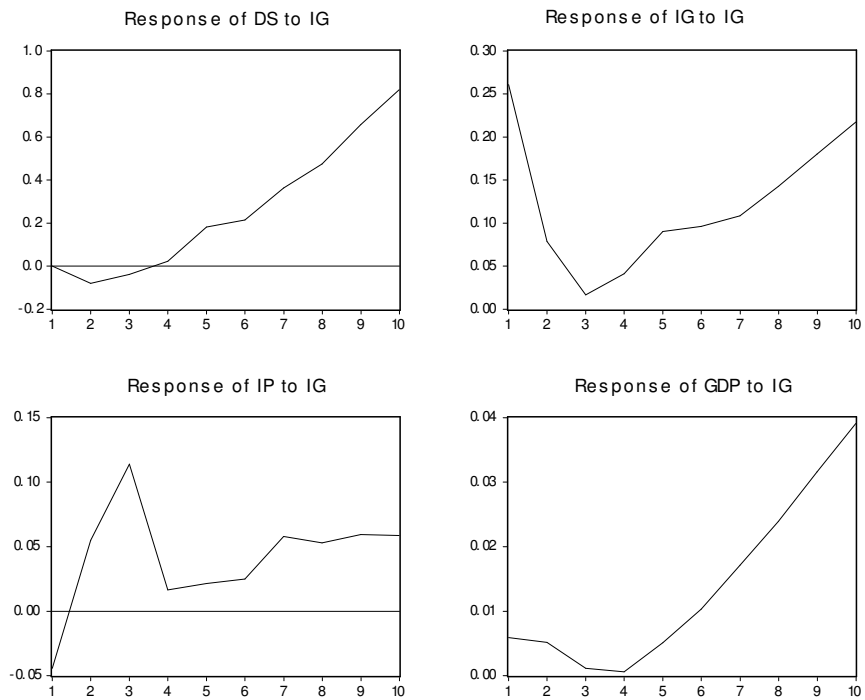
### 1. Cameroon

Response to One S.D. Innovations



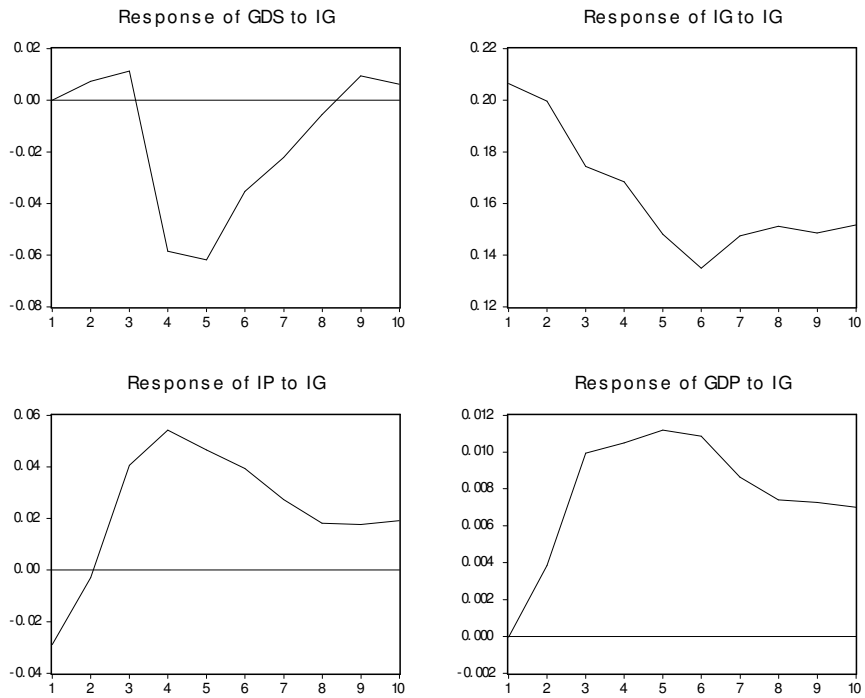
### 2. Congo Democratic Republic

Response to One S.D. Innovations



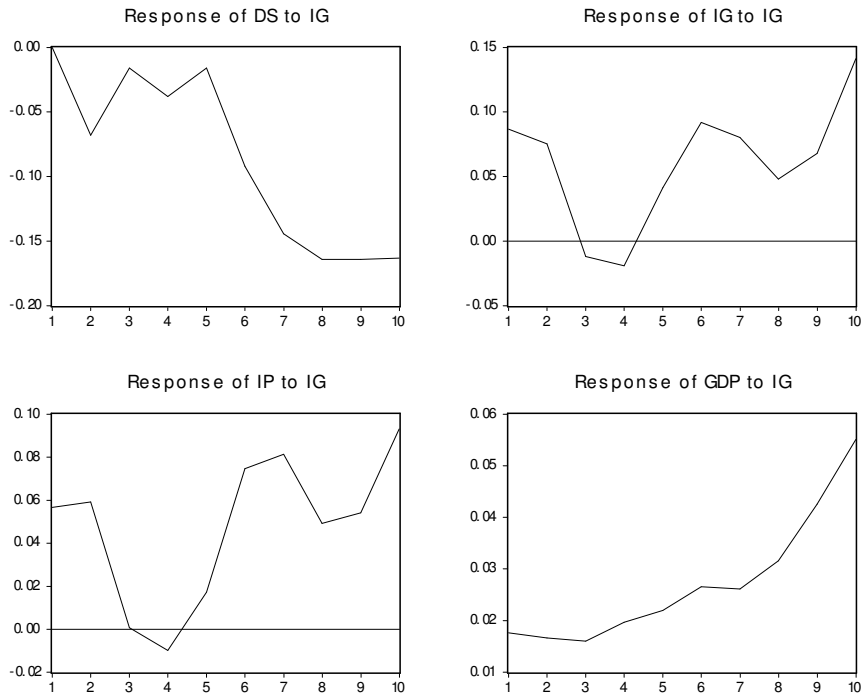
### 3. Malawi

Response to One S.D. Innovations



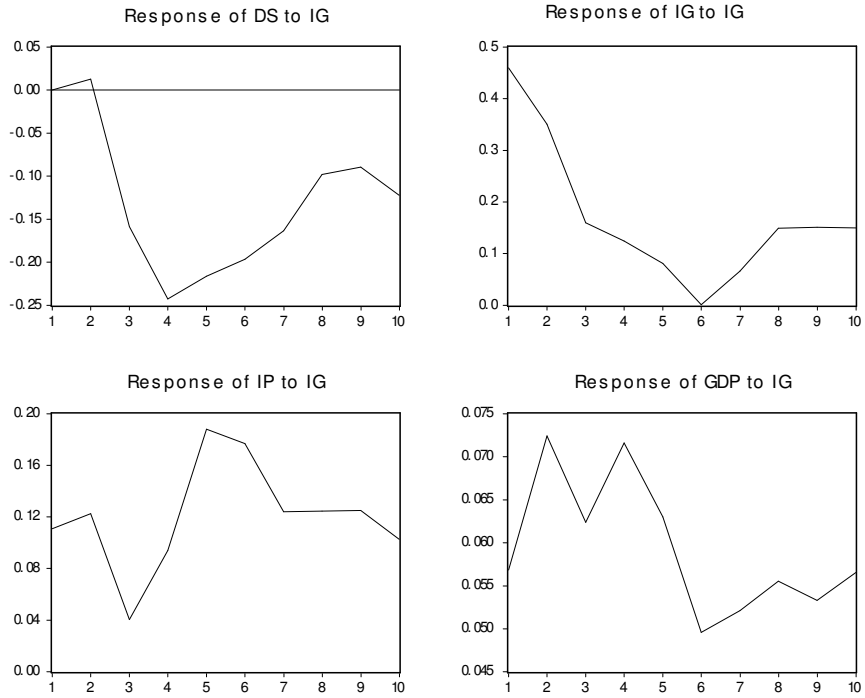
### 4. Myanmar

Response to One S.D. Innovations



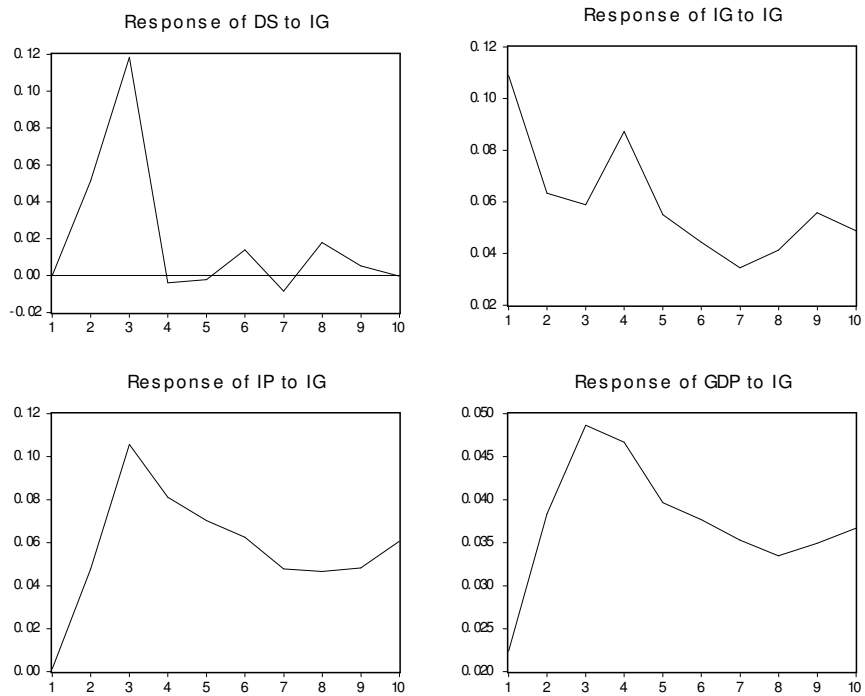
## 5. Nicaragua

Response to One S.D. Innovations



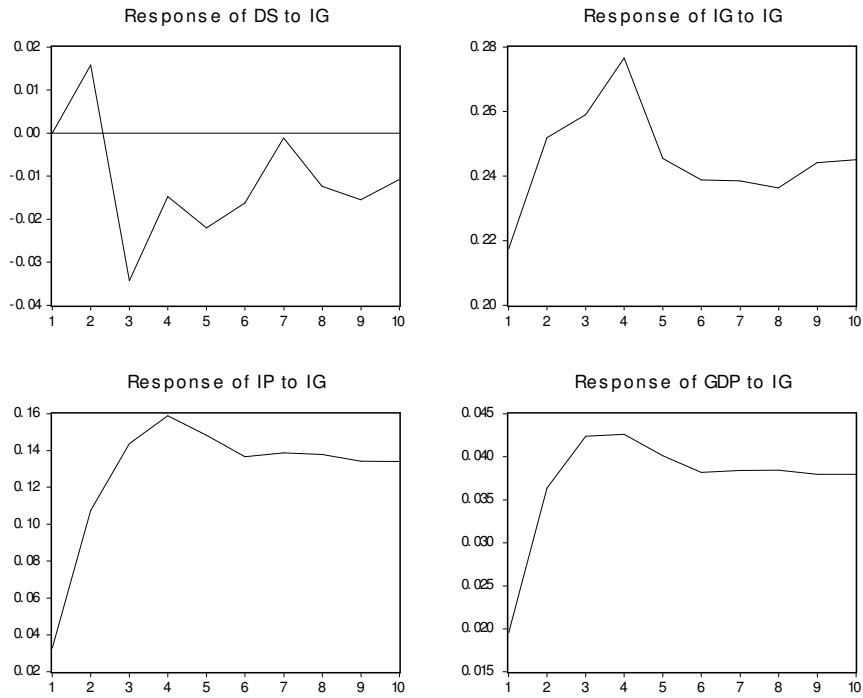
## 6. Peru

Response to One S.D. Innovations



## 7. Philippines

Response to One S.D. Innovations



### Appendix C: Impulse response elasticities tables

The central scenario (ordering: DS IG IP GDP)

Period	1. Cameroon				2. Congo Dem. Rep.			
	DS	IG	IP	GDP	DS	IG	IP	GDP
1	0.00000	0.00000	0.16441	0.00757	0.00000	0.26099	-0.04448	0.00591
2	-0.01617	0.06688	0.03856	0.00441	-0.07944	0.07876	0.05482	0.00515
3	-0.07678	0.06214	0.04812	0.00020	-0.03865	0.01664	0.11394	0.00116
4	-0.05003	0.17227	-0.00677	0.00123	0.02228	0.04096	0.01633	0.00060
5	-0.03547	0.14254	0.02884	0.00094	0.18179	0.09025	0.02133	0.00510
6	-0.08302	0.18265	0.03506	0.00637	0.21454	0.09614	0.02485	0.01033
7	-0.08611	0.17067	0.04255	0.00572	0.36305	0.10847	0.05779	0.01709
8	-0.07265	0.16931	0.03428	0.00272	0.47538	0.14251	0.05286	0.02390
9	-0.08467	0.16959	0.01999	0.00062	0.65802	0.18019	0.05917	0.03157
10	-0.09795	0.17918	0.02366	0.00092	0.82043	0.21737	0.05851	0.03906

Period	3. Malawi				4. Myanmar			
	DS	IG	IP	GDP	DS	IG	IP	GDP
1	0.00000	0.20642	-0.02886	-0.00004	0.00000	0.20642	-0.02886	-0.00004
2	0.00738	0.19969	-0.00291	0.00385	0.00738	0.19969	-0.00291	0.00385
3	0.01132	0.17433	0.04062	0.00994	0.01132	0.17433	0.04062	0.00994
4	-0.05852	0.16851	0.05419	0.01049	-0.05852	0.16851	0.05419	0.01049
5	-0.06183	0.14807	0.04655	0.01120	-0.06183	0.14807	0.04655	0.01120
6	-0.03532	0.13490	0.03931	0.01085	-0.03532	0.13490	0.03931	0.01085
7	-0.02217	0.14749	0.02729	0.00863	-0.02217	0.14749	0.02729	0.00863
8	-0.00556	0.15116	0.01816	0.00741	-0.00556	0.15116	0.01816	0.00741
9	0.00946	0.14854	0.01762	0.00727	0.00946	0.14854	0.01762	0.00727
10	0.00619	0.15171	0.01914	0.00700	0.00619	0.15171	0.01914	0.00700

Period	5. Nicaragua				6. Peru			
	DS	IG	IP	GDP	DS	IG	IP	GDP
1	0.00000	0.45915	0.11099	0.05683	0.00000	0.10891	0.00142	0.02238
2	0.01288	0.35107	0.12259	0.07242	0.05149	0.06331	0.04781	0.03834
3	-0.15869	0.15992	0.04050	0.06237	0.11846	0.05879	0.10558	0.04863
4	-0.24266	0.12443	0.09384	0.07162	-0.00390	0.08716	0.08111	0.04666
5	-0.21650	0.08123	0.18807	0.06298	-0.00214	0.05508	0.07019	0.03962
6	-0.19682	0.00074	0.17677	0.04956	0.01389	0.04438	0.06236	0.03768
7	-0.16342	0.06640	0.12403	0.05209	-0.00854	0.03439	0.04780	0.03530
8	-0.09816	0.14917	0.12432	0.05552	0.01802	0.04130	0.04667	0.03347
9	-0.08973	0.15069	0.12493	0.05330	0.00527	0.05573	0.04820	0.03494
10	-0.12215	0.14983	0.10270	0.05650	-0.00027	0.04888	0.06064	0.03668

Period	7. Philippines			
	DS	IG	IP	GDP
1	0.00000	0.21739	0.03281	0.01949
2	0.01581	0.25197	0.10739	0.03634
3	-0.03427	0.25904	0.14382	0.04239
4	-0.01476	0.27665	0.15897	0.04259
5	-0.02206	0.24555	0.14824	0.04009
6	-0.01629	0.23883	0.13667	0.03816
7	-0.00112	0.23855	0.13868	0.03838
8	-0.01234	0.23637	0.13790	0.03843
9	-0.01550	0.24421	0.13414	0.03794
10	-0.01076	0.24511	0.13407	0.03794

## Appendix D: Impulse response elasticities tables

### The alternative scenarios

#### 1. Cameroon

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.00000	0.16441	0.00757	1	0.00000	0.26026	0.08816	0.03512	1	0.00000	0.14856	0.00848	0.00000
2	-0.01617	0.06688	0.03856	0.00442	2	0.05097	0.23463	0.14278	0.05014	2	-0.03142	0.09449	0.01537	-0.00724
3	-0.07678	0.06214	0.04812	0.00020	3	-0.02817	0.26610	0.14793	0.05863	3	-0.13221	0.13657	0.02454	-0.00808
4	-0.05003	0.17227	-0.00677	0.00123	4	-0.05337	0.33216	0.06200	0.05659	4	-0.10695	0.13387	0.00833	-0.01603
5	-0.03547	0.14254	0.02884	0.00094	5	-0.04078	0.35380	0.04723	0.05208	5	-0.09092	0.10752	0.01375	-0.02328
6	-0.08302	0.18265	0.03506	0.00637	6	-0.06868	0.38453	0.04445	0.05279	6	-0.12706	0.12077	0.00253	-0.02434
7	-0.08611	0.17067	0.04255	0.00572	7	-0.11195	0.36909	0.07999	0.05354	7	-0.12659	0.12070	0.01796	-0.02443
8	-0.07265	0.16932	0.03428	0.00272	8	-0.11679	0.34764	0.09321	0.04998	8	-0.09545	0.11577	0.02074	-0.02550
9	-0.08467	0.16959	0.01999	0.00062	9	-0.11612	0.30977	0.08665	0.04262	9	-0.10021	0.11136	0.01659	-0.02541
10	-0.09795	0.17918	0.02366	0.00092	10	-0.13239	0.30067	0.07455	0.03774	10	-0.11015	0.12968	0.01142	-0.02343

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.14834	0.00000	0.00000	1	0.00000	0.22936	0.00000	0.02737	1	0.00000	0.14834	0.00000	0.00000
2	-0.02915	0.09139	0.01457	-0.00671	2	0.05256	0.17517	0.10761	0.04210	2	-0.02915	0.09139	0.01457	-0.00671
3	-0.12515	0.13316	0.02305	-0.00718	3	0.01146	0.20515	0.10763	0.05158	3	-0.12515	0.13316	0.02305	-0.00718
4	-0.10230	0.12506	0.00928	-0.01504	4	-0.02340	0.21132	0.05784	0.04929	4	-0.10230	0.12506	0.00928	-0.01504
5	-0.08731	0.10127	0.01237	-0.02216	5	-0.01918	0.24444	0.02800	0.04546	5	-0.08731	0.10127	0.01237	-0.02216
6	-0.12025	0.11231	0.00102	-0.02350	6	-0.02129	0.25258	0.02260	0.04352	6	-0.12025	0.11231	0.00102	-0.02350
7	-0.12016	0.11274	0.01610	-0.02354	7	-0.05797	0.24463	0.05039	0.04449	7	-0.12016	0.11274	0.01610	-0.02354
8	-0.09055	0.10774	0.01946	-0.02446	8	-0.06860	0.22636	0.06595	0.04276	8	-0.09055	0.10774	0.01946	-0.02446
9	-0.09451	0.10295	0.01614	-0.02434	9	-0.06233	0.19286	0.06692	0.03727	9	-0.09451	0.10295	0.01614	-0.02434
10	-0.10367	0.12018	0.01073	-0.02248	10	-0.07039	0.18031	0.05452	0.03282	10	-0.10367	0.12018	0.01073	-0.02248

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

## 2. Congo Democratic Republic

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.26099	-0.04448	0.00591	1	0.00000	0.26099	-0.04448	0.00591	1	0.00000	0.25723	-0.10418	0.00000
2	-0.07944	0.07876	0.05482	0.00515	2	-0.07944	0.07876	0.05482	0.00515	2	-0.14290	0.04958	0.00794	-0.00429
3	-0.03865	0.01664	0.11394	0.00116	3	-0.03865	0.01664	0.11394	0.00116	3	-0.16577	-0.04620	0.07552	-0.00961
4	0.02228	0.04096	0.01633	0.00060	4	0.02228	0.04096	0.01633	0.00060	4	-0.12825	-0.02346	-0.00727	-0.00956
5	0.18179	0.09025	0.02133	0.00510	5	0.18179	0.09025	0.02133	0.00510	5	-0.01019	0.03131	0.00186	-0.00405
6	0.21454	0.09614	0.02485	0.01033	6	0.21454	0.09614	0.02485	0.01033	6	-0.00669	0.03925	0.01905	0.00153
7	0.36306	0.10847	0.05779	0.01709	7	0.36306	0.10847	0.05779	0.01709	7	0.08749	0.04724	0.05471	0.00699
8	0.47538	0.14251	0.05286	0.02390	8	0.47538	0.14251	0.05286	0.02390	8	0.14916	0.07241	0.04920	0.01116
9	0.65802	0.18019	0.05917	0.03157	9	0.65802	0.18019	0.05917	0.03157	9	0.26064	0.09730	0.04896	0.01508
10	0.82043	0.21737	0.05851	0.03906	10	0.82043	0.21737	0.05851	0.03906	10	0.34498	0.11660	0.04328	0.01829

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.23946	0.00000	0.00000	1	0.00000	0.25969	0.00000	0.00864	1	0.00000	0.23946	0.00000	0.00000
2	-0.09031	0.06371	0.00161	-0.00095	2	-0.04159	0.09446	0.07536	0.01004	2	-0.09031	0.06371	0.00161	-0.00095
3	0.06698	0.04121	0.10858	0.00009	3	0.05782	0.05981	0.13695	0.00770	3	0.06698	0.04121	0.10858	0.00009
4	0.07715	0.06305	0.01241	0.00397	4	0.12505	0.08469	0.03040	0.00748	4	0.07715	0.06305	0.01241	0.00397
5	0.34603	0.12478	0.05955	0.01355	5	0.32811	0.13256	0.03968	0.01218	5	0.34603	0.12478	0.05955	0.01355
6	0.39223	0.15436	0.04995	0.02196	6	0.38126	0.14103	0.03253	0.01770	6	0.39223	0.15436	0.04995	0.02196
7	0.63928	0.18401	0.09005	0.03165	7	0.57961	0.15888	0.06493	0.02575	7	0.63928	0.18401	0.09005	0.03165
8	0.79007	0.23121	0.07626	0.04006	8	0.72973	0.20057	0.05892	0.03446	8	0.79007	0.23121	0.07626	0.04006
9	1.05518	0.27538	0.08065	0.04957	9	0.97005	0.24726	0.06900	0.04477	9	1.05518	0.27538	0.08065	0.04957
10	1.28496	0.32453	0.07362	0.05923	10	1.19201	0.29752	0.07043	0.05528	10	1.28496	0.32453	0.07362	0.05923

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

### 3. Malawi

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.20642	-0.02886	-0.00004	1	0.00000	0.20642	-0.02886	-0.00004	1	0.00000	0.20642	-0.02881	0.00000
2	0.00738	0.19969	-0.00291	0.00385	2	0.00738	0.19969	-0.00291	0.00385	2	0.00739	0.19969	-0.00281	0.00389
3	0.01132	0.17433	0.04062	0.00994	3	0.01132	0.17433	0.04062	0.00994	3	0.01121	0.17439	0.04072	0.00998
4	-0.05852	0.16851	0.05419	0.01049	4	-0.05852	0.16851	0.05419	0.01049	4	-0.05857	0.16851	0.05428	0.01054
5	-0.06183	0.14807	0.04655	0.01120	5	-0.06183	0.14807	0.04655	0.01120	5	-0.06181	0.14804	0.04663	0.01124
6	-0.03532	0.13490	0.03931	0.01086	6	-0.03532	0.13490	0.03931	0.01086	6	-0.03529	0.13489	0.03936	0.01089
7	-0.02217	0.14749	0.02729	0.00863	7	-0.02217	0.14749	0.02729	0.00863	7	-0.02211	0.14748	0.02732	0.00866
8	-0.00556	0.15116	0.01816	0.00741	8	-0.00556	0.15116	0.01816	0.00741	8	-0.00546	0.15114	0.01820	0.00744
9	0.00946	0.14854	0.01762	0.00727	9	0.00946	0.14854	0.01762	0.00727	9	0.00954	0.14854	0.01765	0.00730
10	0.00619	0.15171	0.01914	0.00700	10	0.00619	0.15171	0.01914	0.00700	10	0.00627	0.15171	0.01917	0.00704

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.13222	0.00000	0.00000	1	0.00000	0.16052	0.00000	0.01092	1	0.00000	0.13222	0.00000	0.00000
2	-0.01790	0.15297	0.01074	0.00190	2	-0.00371	0.16989	0.03448	0.01459	2	-0.01790	0.15297	0.01074	0.00190
3	0.00672	0.11208	0.03609	0.00680	3	-0.02121	0.15047	0.06614	0.01879	3	0.00672	0.11208	0.03609	0.00680
4	-0.01999	0.10018	0.04464	0.00689	4	-0.04897	0.12697	0.07094	0.01980	4	-0.01999	0.10018	0.04464	0.00689
5	-0.02578	0.09612	0.03146	0.00558	5	-0.03329	0.10516	0.05918	0.01925	5	-0.02578	0.09612	0.03146	0.00558
6	0.00460	0.08462	0.02108	0.00499	6	-0.00390	0.10178	0.04317	0.01717	6	0.00460	0.08462	0.02108	0.00499
7	0.02242	0.09120	0.01390	0.00349	7	0.02139	0.11009	0.02823	0.01480	7	0.02242	0.09120	0.01390	0.00349
8	0.02791	0.09896	0.00806	0.00231	8	0.04152	0.11359	0.02123	0.01362	8	0.02791	0.09896	0.00806	0.00231
9	0.03515	0.09693	0.00837	0.00242	9	0.04810	0.11538	0.02170	0.01332	9	0.03515	0.09693	0.00837	0.00242
10	0.03224	0.09715	0.01168	0.00262	10	0.04163	0.11747	0.02470	0.01342	10	0.03224	0.09715	0.01168	0.00262

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

#### 4. Myanmar

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.08679	0.05665	0.01764	1	0.00000	0.08679	0.05665	0.01764	1	0.00000	0.06019	0.03498	0.00000
2	-0.06786	0.07532	0.05909	0.01663	2	-0.06786	0.07532	0.05909	0.01663	2	0.02575	0.07696	0.01744	0.00029
3	-0.01605	-0.01195	0.00072	0.01599	3	-0.01605	-0.01195	0.00072	0.01599	3	0.03649	0.01405	-0.01632	-0.00122
4	-0.03814	-0.01911	-0.00984	0.01965	4	-0.03814	-0.01911	-0.00984	0.01965	4	0.10208	-0.03629	-0.07700	-0.00816
5	-0.01572	0.04143	0.01717	0.02196	5	-0.01572	0.04143	0.01717	0.02196	5	0.15020	-0.06164	-0.11496	-0.01553
6	-0.09203	0.09206	0.07464	0.02651	6	-0.09203	0.09206	0.07464	0.02651	6	0.14686	-0.06957	-0.10706	-0.02793
7	-0.14427	0.08045	0.08129	0.02611	7	-0.14427	0.08045	0.08129	0.02611	7	0.12495	-0.09743	-0.12108	-0.04622
8	-0.16397	0.04814	0.04912	0.03154	8	-0.16397	0.04814	0.04912	0.03154	8	0.09454	-0.16566	-0.15335	-0.06395
9	-0.16405	0.06783	0.05405	0.04255	9	-0.16405	0.06783	0.05405	0.04255	9	0.08862	-0.20879	-0.17502	-0.07878
10	-0.16319	0.14126	0.09306	0.05502	10	-0.16319	0.14126	0.09306	0.05502	10	0.11116	-0.20906	-0.17631	-0.08959

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.04694	0.00000	0.00000	1	0.00000	0.05323	0.00000	0.00900	1	0.00000	0.04694	0.00000	0.00000
2	0.01160	0.04104	-0.00314	0.00073	2	-0.04136	0.02615	0.01180	0.00915	2	0.01160	0.04104	-0.00314	0.00073
3	0.01317	0.00551	-0.02422	-0.00303	3	-0.02185	-0.01082	-0.01644	0.00538	3	0.01317	0.00551	-0.02422	-0.00303
4	0.06385	-0.04130	-0.07921	-0.00994	4	-0.02394	-0.03140	-0.04044	0.00434	4	0.06385	-0.04130	-0.07921	-0.00994
5	0.08128	-0.06574	-0.09526	-0.01568	5	-0.03045	-0.01015	-0.01538	0.00442	5	0.08128	-0.06574	-0.09526	-0.01568
6	0.08587	-0.06054	-0.08989	-0.02607	6	-0.06088	0.02873	0.01411	0.00400	6	0.08587	-0.06054	-0.08989	-0.02607
7	0.06939	-0.08033	-0.09629	-0.03815	7	-0.09003	0.02107	0.02108	0.00380	7	0.06939	-0.08033	-0.09629	-0.03815
8	0.04931	-0.12635	-0.11061	-0.05046	8	-0.10006	0.00342	0.01342	0.00581	8	0.04931	-0.12635	-0.11061	-0.05046
9	0.06309	-0.15527	-0.13190	-0.06086	9	-0.07798	0.01293	0.00722	0.01068	9	0.06309	-0.15527	-0.13190	-0.06086
10	0.09005	-0.15984	-0.13235	-0.06762	10	-0.06246	0.04488	0.02763	0.01752	10	0.09005	-0.15984	-0.13235	-0.06762

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

## 5. Nicaragua

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.45916	0.11099	0.05683	1	0.00000	0.45916	0.11099	0.05683	1	0.00000	0.17801	0.01264	0.00000
2	0.01288	0.35107	0.12259	0.07242	2	0.01288	0.35107	0.12259	0.07242	2	-0.04209	0.14510	0.06223	0.02165
3	-0.15869	0.15992	0.04050	0.06237	3	-0.15869	0.15992	0.04050	0.06237	3	-0.13122	0.11590	0.03458	0.02851
4	-0.24267	0.12443	0.09384	0.07162	4	-0.24267	0.12443	0.09384	0.07162	4	-0.16448	0.02420	0.05241	0.02616
5	-0.21650	0.08123	0.18807	0.06298	5	-0.21650	0.08123	0.18807	0.06298	5	-0.18736	-0.02408	0.09533	0.01979
6	-0.19682	0.00074	0.17677	0.04956	6	-0.19682	0.00074	0.17677	0.04956	6	-0.17290	-0.04117	0.10222	0.01670
7	-0.16342	0.06640	0.12403	0.05209	7	-0.16342	0.06640	0.12403	0.05209	7	-0.13547	-0.01548	0.08310	0.01456
8	-0.09816	0.14917	0.12432	0.05552	8	-0.09816	0.14917	0.12432	0.05552	8	-0.10412	0.01733	0.07285	0.01460
9	-0.08973	0.15069	0.12493	0.05330	9	-0.08973	0.15069	0.12493	0.05330	9	-0.09701	0.04111	0.06525	0.01600
10	-0.12215	0.14983	0.10270	0.05650	10	-0.12215	0.14983	0.10270	0.05650	10	-0.10437	0.04796	0.05898	0.01782

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.17789	0.00000	0.00000	1	0.00000	0.43793	0.00000	0.05353	1	0.00000	0.17789	0.00000	0.00000
2	-0.03831	0.15095	0.04963	0.02132	2	0.04202	0.38447	0.01301	0.06625	2	-0.03831	0.15095	0.04963	0.02132
3	-0.12794	0.12118	0.02817	0.02808	3	-0.12697	0.19860	-0.01391	0.05626	3	-0.12794	0.12118	0.02817	0.02808
4	-0.16440	0.02794	0.04375	0.02592	4	-0.23379	0.14914	0.01839	0.06636	4	-0.16440	0.02794	0.04375	0.02592
5	-0.18718	-0.01946	0.08457	0.01982	5	-0.20912	0.11409	0.09114	0.06029	5	-0.18718	-0.01946	0.08457	0.01982
6	-0.17222	-0.03681	0.09384	0.01664	6	-0.18595	0.03547	0.10052	0.04684	6	-0.17222	-0.03681	0.09384	0.01664
7	-0.13586	-0.01322	0.07546	0.01434	7	-0.16207	0.08076	0.05638	0.04774	7	-0.13586	-0.01322	0.07546	0.01434
8	-0.10474	0.01967	0.06395	0.01441	8	-0.10136	0.16056	0.04578	0.05124	8	-0.10474	0.01967	0.06395	0.01441
9	-0.09650	0.04451	0.05653	0.01583	9	-0.08378	0.17169	0.04755	0.04939	9	-0.09650	0.04451	0.05653	0.01583
10	-0.10350	0.05127	0.05075	0.01758	10	-0.11157	0.17033	0.03045	0.05181	10	-0.10350	0.05127	0.05075	0.01758

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

## 6. Peru

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.10891	0.00142	0.02238	1	0.00000	0.10891	0.00142	0.02238	1	0.00000	0.09076	-0.02837	0.00000
2	0.05149	0.06331	0.04781	0.03834	2	0.05149	0.06331	0.04781	0.03834	2	0.08822	0.05802	-0.02964	0.01372
3	0.11846	0.05879	0.10558	0.04863	3	0.11846	0.05879	0.10558	0.04863	3	0.15474	0.02155	0.04658	0.02848
4	-0.00390	0.08716	0.08111	0.04666	4	-0.00390	0.08716	0.08111	0.04666	4	0.10345	0.09103	0.04038	0.03170
5	-0.00214	0.05508	0.07019	0.03962	5	-0.00214	0.05508	0.07019	0.03962	5	0.05074	0.08538	0.03322	0.02812
6	0.01389	0.04438	0.06236	0.03768	6	0.01389	0.04438	0.06236	0.03768	6	0.07557	0.05444	0.05137	0.02905
7	-0.00854	0.03439	0.04780	0.03530	7	-0.00854	0.03439	0.04780	0.03530	7	0.04493	0.04600	0.03532	0.02640
8	0.01802	0.04130	0.04667	0.03347	8	0.01802	0.04130	0.04667	0.03347	8	0.05654	0.04347	0.01248	0.02010
9	0.00527	0.05573	0.04820	0.03494	9	0.00527	0.05573	0.04820	0.03494	9	0.07644	0.04912	0.00563	0.01992
10	-0.00027	0.04888	0.06064	0.03668	10	-0.00027	0.04888	0.06064	0.03668	10	0.07191	0.04759	0.01955	0.02371

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.08521	0.00000	0.00000	1	0.00000	0.10890	0.00000	0.02209	1	0.00000	0.08521	0.00000	0.00000
2	0.12885	0.04876	-0.03008	0.00805	2	0.05053	0.06359	0.04681	0.03823	2	0.12885	0.04876	-0.03008	0.00805
3	0.16008	0.01575	0.04505	0.02083	3	0.11879	0.05852	0.10488	0.04865	3	0.16008	0.01575	0.04505	0.02083
4	0.15242	0.08829	0.03046	0.02615	4	-0.00423	0.08734	0.08095	0.04668	4	0.15242	0.08829	0.03046	0.02615
5	0.10198	0.08294	0.03971	0.02573	5	-0.00328	0.05559	0.06948	0.03957	5	0.10198	0.08294	0.03971	0.02573
6	0.12805	0.06475	0.06338	0.02890	6	0.01282	0.04416	0.06180	0.03758	6	0.12805	0.06475	0.06338	0.02890
7	0.08348	0.05604	0.05110	0.02668	7	-0.00922	0.03419	0.04708	0.03518	7	0.08348	0.05604	0.05110	0.02668
8	0.09553	0.04852	0.02951	0.01997	8	0.01713	0.04116	0.04561	0.03331	8	0.09553	0.04852	0.02951	0.01997
9	0.11394	0.05011	0.01614	0.01871	9	0.00487	0.05562	0.04727	0.03479	9	0.11394	0.05011	0.01614	0.01871
10	0.11391	0.04564	0.02536	0.02148	10	-0.00083	0.04895	0.05990	0.03659	10	0.11391	0.04564	0.02536	0.02148

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

## 7. Philippines

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.21739	0.03281	0.01949	1	0.00000	0.21739	0.03281	0.01949	1	0.00000	0.14188	-0.01421	0.00000
2	0.01581	0.25197	0.10739	0.03634	2	0.01581	0.25197	0.10739	0.03634	2	0.02989	0.17098	0.02549	0.00349
3	-0.03427	0.25904	0.14382	0.04239	3	-0.03427	0.25904	0.14382	0.04239	3	-0.02174	0.15245	0.05618	0.00585
4	-0.01476	0.27665	0.15897	0.04259	4	-0.01476	0.27665	0.15897	0.04259	4	-0.01955	0.15144	0.07254	0.00681
5	-0.02206	0.24555	0.14824	0.04009	5	-0.02206	0.24555	0.14824	0.04009	5	-0.01643	0.11755	0.06703	0.00644
6	-0.01629	0.23883	0.13667	0.03816	6	-0.01629	0.23883	0.13667	0.03816	6	-0.00916	0.10368	0.05409	0.00557
7	-0.00112	0.23855	0.13868	0.03838	7	-0.00112	0.23855	0.13868	0.03838	7	0.00555	0.10888	0.04947	0.00542
8	-0.01234	0.23637	0.13790	0.03843	8	-0.01234	0.23637	0.13790	0.03843	8	-0.00149	0.11517	0.04547	0.00496
9	-0.01550	0.24421	0.13414	0.03794	9	-0.01550	0.24421	0.13414	0.03794	9	-0.00646	0.12648	0.04284	0.00434
10	-0.01076	0.24511	0.13407	0.03794	10	-0.01076	0.24511	0.13407	0.03794	10	-0.00407	0.12953	0.04623	0.00452

Ordering: DS IG IP GDP

Ordering: DS IG GDP IP

Ordering: DS GDP IG IP

Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP	Period	DS	IG	IP	GDP
1	0.00000	0.13321	0.00000	0.00000	1	0.00000	0.19141	0.00000	0.01102	1	0.00000	0.13321	0.00000	0.00000
2	-0.00174	0.15601	0.02530	0.00106	2	0.04948	0.22897	0.07182	0.02417	2	-0.00174	0.15601	0.02530	0.00106
3	-0.03907	0.14154	0.04381	0.00192	3	-0.01352	0.22146	0.11627	0.02992	3	-0.03907	0.14154	0.04381	0.00192
4	-0.02098	0.13230	0.06584	0.00405	4	-0.01548	0.23818	0.12689	0.02942	4	-0.02098	0.13230	0.06584	0.00405
5	-0.02483	0.09795	0.06808	0.00488	5	-0.01217	0.20646	0.11166	0.02680	5	-0.02483	0.09795	0.06808	0.00488
6	-0.02609	0.09015	0.05244	0.00358	6	0.00169	0.19139	0.10194	0.02571	6	-0.02609	0.09015	0.05244	0.00358
7	-0.01069	0.09614	0.04102	0.00252	7	0.01598	0.19277	0.10704	0.02657	7	-0.01069	0.09614	0.04102	0.00252
8	-0.01028	0.10134	0.03818	0.00223	8	0.00008	0.19519	0.10387	0.02624	8	-0.01028	0.10134	0.03818	0.00223
9	-0.01484	0.11174	0.04117	0.00232	9	-0.00420	0.20528	0.09569	0.02508	9	-0.01484	0.11174	0.04117	0.00232
10	-0.01877	0.11523	0.04478	0.00249	10	0.00505	0.20671	0.09691	0.02518	10	-0.01877	0.11523	0.04478	0.00249

Ordering: DS GDP IP IG

Ordering: DS IP IG GDP

Ordering: DS IP GDP IG

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