On the Long-term Economic and Budgetary Effects of Public-Sector Investment

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Abstract - This paper addresses a question of the utmost importance in the context of budgetary policy in Portugal – the long-term economic and budgetary impact of public-sector investment spending in durable goods. Since a positive impact of public investment on output represents also a positive impact on the tax base, a natural question is whether or not public investment pays for itself in the form of future tax revenues. If it does, then cuts in public investment to help current budgetary consolidation efforts not only jeopardise long-term growth but also aggravate the budgetary situation in the long term. If it does not, then the negative long-term growth effects remain but cuts would help the long-term budgetary situation.

In this paper we find that public sector investment has a positive effect on long-term economic performance and therefore, cuts have a price in terms of long-term economic performance. We find, however, that the positive effects are not strong enough for public investment spending to pay for itself in the form of future tax revenues. Therefore, cuts in public-sector investment spending seem to be an effective way to deal with the public budgetary situation. It is important to note, however, that this result is in contrast with recent evidence that suggests that cuts in public investment in transportation infrastructures would affect output so strongly that would also have negative long-term effects on the effort toward fiscal consolidation. Clearly, not all public investment is created equal.

JEL Classification: C32, E62, H54, O52

Keywords: public-sector investment, economic growth, budgetary consolidation, Portugal

1. Introduction

Fiscal consolidation has been for some time one of the most difficult economic challenges in Portugal. There is no escaping the fact that market pressures and international commitments in the context of the Stability and Growth Pact place serious constraints on the public budget and on the ability of the domestic authorities to run public budget deficits. There is no escaping either the fact that the bulk of public spending is in the form of public employees' wages – a sector heavily unionized - and that public opinion is steadfast against tax hikes. Faced with these budgetary pressures and political constraints, the margin of manoeuvre in budgetary matters is very limited and cuts in public investment have often been regarded, at least implicitly, as the easy way out. Indeed, unlike the effects of reductions in other types of spending or of tax hikes, the effects of cuts in public investment take some time to reverberate throughout the economy. Therefore, they are particularly expedient from a political perspective.

A critical question is whether or not political expediency comes at a cost, in terms of both long-term economic performance and future budgetary consolidation efforts. One would expect any type of investment, including public investment, to improve the long-term economic performance. Moreover, to the extent that public investment increases output in the long-term, it also expands the tax base and, therefore, tax revenues in the long term. It is conceivable that public investment has such strong effects on output, that over time it generates enough additional tax revenues to pay for itself. It is equally plausible that the effects on output although positive are not strong enough for the public investment to pay for itself. In the first case, cuts in public investment hurt long-term growth and make the future budgetary situation worse. In the second case, cuts in public investment hurt the long-term economic performance without hurting the future budgetary situation. To identify which scenario applies in the Portuguese case is fundamental to access the impact, and ultimately the wisdom, of any public investment cuts.

In common parlance, the term public investment is used to refer to two rather different forms of public spending. First, the term sometimes refers to investment in public infrastructures, for example, roads and highways, which have characteristics of public goods, represent positive externalities to private production, and have typically been under the exclusive purview of the public sector. Second, the term sometimes refers to public-sector investment in durable goods, structures and equipment, to be used by the public sector. These are investments in goods that have the nature of private goods, but which happen to be used by the public-sector. It is important to keep in mind the distinction between these two fundamentally different types of public investment because the answer to the above policy question is not necessarily the same for both.

Recently, Pereira and Andraz (2004a, 2004b) studied the long-term effects of public investment in transportation infrastructures in Portugal, the first of the two notions of public investment mentioned above. Empirical results suggest that one million euros in public infrastructure spending increase output in the long-term by 9.5 million euros. If we consider that tax revenues are about 35% of the GDP, this implies that over time the public sector would collect 3.3 million euros in tax revenues for each million euros spent in public infrastructure. Accordingly, the strategy followed by the Portuguese authorities in the last two decades of investing in transportation infrastructures is justified in the long term from both economic and budgetary perspectives. Any cuts in this type of public investment would have detrimental effects on both accounts.

In this paper we address the same issue in the context of the second notion of public investment mentioned above, public-sector investment in durable goods. Specifically, we want to identify the long-term effects on output of public-sector investment in durable goods and to determine to what extent cuts in this type of public investment may turn out to be counter-productive in the long-term from a budgetary perspective. To do so, we follow a vector auto-regressive/error correction mechanism approach (VAR/ECM) developed in Pereira (2000, 2001) in the context of the analysis of the effects of public investment in infrastructure and adopted to the Portuguese case in Pereira and Andraz (2004a, 2004b).

This methodological approach is rooted in the public infrastructure debate [see Gramlich (1994), Munnell (1992), and Pereira and Andraz (2004c) for detailed surveys of the literature and Hulten and Schwab (1993) for a detailed presentation on the infrastructure debate]. The empirical evaluation of the

effects of public infrastructures was brought to the limelight by the work of Aschauer (1989a, 1989b) in the framework of a single-equation static production function in which private output is regressed on employment, private capital, and public capital. This approach, however, has been criticized on econometric grounds. It has been observed that the estimation of static, univariate production functions in levels is based on non-stationary variables and that in the absence of cointegration OLS estimates are spurious. Moreover, OLS estimates suffer from simultaneity bias and even if this bias is corrected, conclusions about causality still cannot be drawn. [See Jorgenson (1991) and Munnell (1992) for comprehensive discussion of these econometric problems.] The VAR/ECM approach includes output, employment, private investment, and public investment and is designed to address the aforementioned econometric criticisms in a rigorous and comprehensive manner while highlighting the dynamic feedbacks among the different variables as well as the endogeneity of public investment decisions.

As a final note, although this paper focuses on the Portuguese case and deals with issues that are of great importance for policy making in Portugal, its interest is not merely parochial. Indeed, the issue of the effects of public-sector investment on economic performance is a matter of concern to any country facing budgetary difficulties. It is particularly so for countries, like Greece, Ireland, and Spain, which have been engaged in the last two decades in major modernisation efforts intended to bridge the gap in their standards of living vis-à-vis the EU average. Furthermore, the eastward expansion of the EU has brought into the EU fold countries with similar problems. For these countries, economy development seems to depend, among other things, on the modernisation of their public sectors while they are expected to undertake a major process of budgetary consolidation.

This paper is organised as follows. In Section 2 we present the data, perform stationarity and co-integration tests, and proceed to determine the best VAR/ECM structures. In Section 3, we address the issue of the identification of exogenous innovations to public-sector investment as well as the measurement of the effects of such innovations. In Section 4 we present the main results on the long-term effects of public-sector investment on output, employment and private investment as well as the potential budgetary implications of such results. Finally in Section 5, we present some concluding remarks.

2. Data and preliminary empirical results

2.1 Data and some stylised facts

The variables considered are GDP (Y), employment (L), private investment (Ip), and public-sector investment in durable goods (Ig). Public-sector investment is defined as the fixed capital formation of the Public Administrations, which includes central, regional, and local administration as well as autonomous services and social security. In addition to aggregate public-sector investment, we consider at a disaggregated level, public-sector investment in equipment (Igeq), which includes transportation and other equipment, and public-sector investment in construction (Igc).

We use annual data for the period 1965-2001. The data for the period 1965-1995 was obtained from the long series for the Portuguese economy as published in Banco de Portugal (1997). The data was

extended to the period 1996-2001 by using information from the national account publications from the Instituto Nacional de Estatística (several years). All variables are measured in millions of constant 1995 Portuguese Escudos except for employment, which is measured in thousand of employees.

Some of the basic information about public-sector investment is displayed in Figures 1-3. Public-sector investment as a percentage of the GDP shows an increasing trend during our sample period, going from 2.1% in 1965 to 5.0% in 2001. When we consider the two disaggregated components of public-sector investment, we find that construction represented 1.9% of the GDP in 1965 and 4.1% in 2001, while equipment represented 0.2% of the GDP in 1965 and 0.9%, of the GDP in 2001. These figures suggest that construction spending which accounts for 90.5% of total public-sector investment in 1965 and for 80.9% in 2001, is the bulk of public-sector investment.

2.2 Univariate and cointegration analysis

We use the Augmented Dickey-Fuller (ADF) t-test to test the null hypothesis of a unit root and the Bayesian Information Criterion (BIC) to determine the optimal number of lagged differences. We include different alternatives for the deterministic components.

Test results are reported in Table 1. For all of the variables in log-levels the t-statistics are greater than the critical values, either at 5% or at 1% significance levels, and that, therefore, we cannot reject for any of the variables the null hypothesis of a unit root. When applied to the first differences of the log-levels, i.e., to the growth rates of the original variables, however, the ADF tests allow us to reject the null hypothesis of the unit roots for all variables, since all the t-statistics are lower than the 5% critical values. Therefore, we can infer that all variables are stationary in first differences. This is consistent with the macroeconomic literature and, in particular, with similar findings for the Portuguese case [see, for example, Pereira and Andraz, (2004a, 2004b)].

Having established that all variables are integrated of order one, we now test for cointegration among output, employment, private investment and public-sector investment (both at the aggregate and at the disaggregated levels). Due to our relatively small sample we use the Engle-Granger procedure, which is less vulnerable than the Johansen procedure to the small sample bias toward finding cointegration when it does not exist (Gonzalo and Lee, 1998; Gonzalo and Pitarakis, 1999). Following the standard Engle-Granger procedure, in each case we perform four tests, each one with a different endogenous variable. This is because it is possible that one of the variables enters the cointegrating relationship with a statistically insignificant coefficient. In this case, a test that uses such variable as the endogenous variable would not detect cointegration. We apply the ADF t-test to the residuals of the different regressions. The optimal lag structure is chosen using the BIC and we consider alternative specifications for the deterministic components.

Cointegration test results are reported in Table 2. We find that, in all cases the test statistics are higher that the 5% critical values, and therefore, in no case can we reject the null hypothesis of a unit root in the residuals of the estimated equations. Accordingly, we do not find evidence of cointegration among the variables at either the aggregate or disaggregated levels. The absence of cointegration is consistent with other results in the literature [see again Pereira and Andraz (2004a, 2004b) for the Portuguese case].

Furthermore, the absence of cointegration is not problematic conceptually either. In fact, in the case of economies in a transition stage of their development, such as the Portuguese economy, not finding cointegration is hardly surprising. This means that the data does not show evidence of convergence to the so-called great ratios among the aggregate variables in the economy.

2.3 VAR estimation

We have determined that all of the variables in log-levels are stationary in first differences and that they are not cointegrated. Accordingly, we follow the standard procedure in the literature and determine the specifications of the VAR models using growth rates of the original variables. We estimate three VAR models, all of which include output, employment, and private investment. In addition, each of the models includes a different public-sector investment variable - one for aggregated public-sector investment and one for each of the two different types of public-sector investment.

The model specifications are determined using the BIC. For each model, the VAR specification has two dimensions, which were determined jointly - the choice of the lag-length and the choice of the deterministic components. The test results, which are reported in Table 3, suggest that the best specification, in both the aggregate and the two disaggregated models, is a VAR model of first order with a constant term.

Details of the three VAR estimates are available upon request. The only point worth mentioning here is that the matrices of contemporaneous correlations among the estimated residuals show a block diagonal pattern, with innovations in public-sector investment showing a low contemporaneous correlation with the remaining variables. The correlations between innovations in public-sector investment and in the other three variables are all lower in absolute value than 0.13 in the aggregate case, 0.16 for construction and 0.42 for equipment. By contrast contemporaneous correlation among the private-sector variables range from 0.20 and 0.63 in these different cases.

3. On the identification and Measurement of the Effects of Innovations

3.1 Identifying Innovations in the public-sector investment variables

In order to determine the effects of public investment we use the impulse-response functions associated to the estimated VAR models. In determining these effects it is important to consider innovations in public-sector investment that are not contemporaneously correlated to shocks in the other variables, thereby avoiding reverse causation problems. In dealing with this issue, we draw from the approach in the monetary policy literature [see, for example Christiano, Eichenbaum and Evans (1996), Christiano, Eichenbaum and Evans (1998), and Rudebush (1998)]. This approach was adapted in Pereira (2000, 2001) to the area of public investment in infrastructures in the United States and applied to the Portuguese case in Pereira and Andraz (2004a, 2004b).

Ideally, the identification of exogenous shocks to public investment would result from knowing what fraction of the government appropriations is due to purely non-economic reasons. The econometric counterpart to this idea is to imagine a policy function, which relates the rate of growth of public investment to the relevant information set. In our case, the relevant information set could include the past and current observations of the growth rates of the private sector variables. The residuals from this policy function reflect the unexpected component to the evolution of public investment and are uncorrelated with other innovations.

In the central case, we assume that the relevant information set for the public sector includes past but not current values of the other variables. This is equivalent in the context of the standard Choleski decomposition to assuming that innovations in public-sector investment lead innovations in the other variables. This means that we allow innovations in public-sector investment to affect the other variables contemporaneously, but not the reverse. We have two reasons for making this our central case. First, it is reasonable to assume that the private sector reacts within a year to innovations in public-sector investment decisions. Second, it also seems reasonable to assume that the public sector is unable to adjust public investment decisions to innovations in the private-sector variables within a year. This is due to the time lags involved in information gathering and decision-making. Despite the imminent plausibility of this central case scenario, when reporting the effects of public-sector investment we consider all twenty-four possible orderings of the variables within the context of the Choleski decomposition and present the corresponding range of results.

The policy functions are reported in Table 4. At the aggregate level our result suggest that changes in public-sector investment are positively correlated to the lagged changes in output, negatively correlated to lagged changes in private investment, and uncorrelated to lagged changes in employment. This means that public-sector investment is not an exogenous variable but rather follows a well-defined policy rule. Indeed, growing output means also a growing tax base and the potential for greater public-sector investment while growing private investment tends to discourage public investment in that both are competing for the same type of durable goods. At the disaggregated level these effects are still present although in a manner that is less strong statistically. The exception is innovations in public investment in equipment which are very strongly negatively correlated with innovations in private investment.

It maybe interesting to note that the fact that public-sector investment follows a well defined policy rule is in contrast with the findings in Pereira and Andraz (2004a, 2004b) for public investment in transportation infrastructures in Portugal. In this case changes in public investment are uncorrelated with changes in the private sector variables and therefore public investment in transportation infrastructures is an exogenous variable. This is due to the fact that investment in public infrastructure in the last couple of decades, however, has been mostly linked to the EU Structural Transfer Programs.

3.2 Measuring the effects of innovations in the public-sector investment variables

We consider the effects of one-time one-percentage point innovations in the rates of growth of public-sector investment. We expect these innovations to have at least temporary effects on the growth

rates of the other variables. However, by definition, even temporary effects on the growth rates of the private sector variables will translate into permanent effects on the levels of these variables.

The long-term elasticities of the different variables with respect to public-sector investment as well as the corresponding ranges of variation are reported in Table 5. Long-term is defined as the time horizon over which the growth effects of innovations disappear, i.e., the accumulated impulse-response functions converge. These elasticities represent long-term accumulated percentage point changes per one percentage point in long-term accumulated change in public investment. A cursory look at the results suggests that the ranges of variation for the elasticity figures are always relatively small. This means that our central assumptions are not only the most plausible but are also robust. This fact offers no surprise, since as pointed out, the matrices of contemporaneous correlations among the estimated residuals display low correlations between innovations in public-sector investment and in private-sector variables.

In Tables 6 and 7 we report marginal product figures. These figures measure the change in million euros in output and private investment and the number of jobs created for one million euros in accumulated change in public-sector investment. We obtain the marginal products by multiplying the average ratio of the private sector variable to public-sector investment for the last ten years, by the corresponding elasticity. The choice of average ratio for the last ten years is designed to reflect the relative scarcity of public-sector investment without letting these ratios be overly affected by business cycle factors. In turn, rates of return are calculated from the marginal product figures by assuming a life horizon of twenty years for all types of public capital assets. These are the rates which, if applied to one euro over a twenty-year period, yield the value of the marginal products. They are adjusted to accommodate a linear depreciation rate of 5%, which is implicit in the life horizon of twenty years.

4. Public-sector investment and economic performance

4.1 On the effects of public-sector investment on employment and private investment

Estimation results reported in Table 6 suggest that public-sector investment has a positive effect on both employment and private investment. At the aggregate level, public-sector investment affects employment and private investment with elasticities of 0.017 and 0.326, respectively. These figures imply that in the long-term 21 jobs are created and that private investment increases in the long-term by 1.80 million euros for each million of euros in public-sector investment.

When we disaggregate public-sector investment, we find that, in the long term, one million euros in public-sector construction spending lead to a loss of 8 jobs and an increase of 1.62 million euros in private investment. In turn one million euros in public-sector equipment spending lead to the creation of 350 jobs and to an increase of 8.91 million euros in private investment. Naturally the aggregate results are somewhere between the two disaggregated results but much closer to the results for construction spending, the bulk of the public-sector investment.

4.2 On the effects of public-sector investment on output

Estimation results reported in Table 7 suggest that public-sector investment has a positive effect on output. The elasticity of output with respect to public-sector investment is 0.065, which corresponds to a marginal product of 1.55. This means that the increase of one million euros in public investment induces a long-term increase of 1.55 million euros in output. The corresponding annual rate of return is 2.2%, a rate clearly below what one would expect from private sector investments.

When we disaggregate, we find that the elasticity of output with respect to public-sector construction spending is 0.029, which corresponds to a marginal product of 0.84 and to an annual rate of return of -0.8%. In turn, the elasticity of output with respect to public-sector equipment spending is 0.111, which corresponds to a marginal product of 14.57 and to an annual rate of return of 14.3%. Again, the aggregate results are somewhere between the two disaggregated results but much closer to the results for construction spending, the bulk of the public-sector investment.

4.3 On the budgetary impact of public-sector investment

Having established that public-sector investment affects output positively in the long-term, we now turn to its potential long-term budgetary impact. To understand the issue we need to recognise that a positive effect of public-sector investment on output also means an increased tax base and, therefore, translates into increased tax revenues. It is, therefore, conceivable that over time public-sector investment has such strong effects on output that it generates enough additional tax revenues to pay for itself. It is equally plausible that the effects on output although positive are not strong enough for public-sector investment to pay for itself. In the first case, cuts in current public-sector investment not only hurt long-term growth but also make the future budgetary situation worse. In the second case, such cuts hurt the long-term output prospects but help budgetary situation in the long-term.

For the period 1995-2001 the effective tax rate in Portugal was 35.4%. Given that one million euros in public sector-investment lead to an accumulated increase in output of 1.55 million euros, this means that tax revenues increase in the long term by 0.54 million euros. Accordingly, public-sector investment does not pay for itself over time in the form of future tax revenues. Therefore, cuts in public-sector investment although undesirable from the standpoint of long-term output performance do not have an adverse effect in the long-term budgetary position of the public sector.

The analysis at the disaggregated level provides a richer picture. Not surprisingly, the aggregate patterns hold true with respect to construction spending, the bulk of the public-sector investment. Indeed, one million euros in construction spending increases tax revenues in the long term by just 0.30 million euros. The situation, however, is different with respect to equipment spending in that one million euros in spending increases tax revenues over time by 5.16 million euros. This means that while cuts in public-sector investment in general and in construction spending in particular affect adversely long-term GDP, cuts in equipment spending, a more marginal component of public-sector investment, have adverse long-term effects on both GDP and the budgetary situation.

It is, in this context, relevant to compare these results with the results obtained in Pereira and Andraz (2004a, 2004b) for public investment in transportation infrastructures, including national roads, municipal roads, highways, ports, airports and railroads. The estimated marginal product for these types

of public investments is 9.5 million euros. This implies that in the long-term the public sector would collect 3.33 million euros in tax revenues for each million euros in public infrastructure spending. Accordingly, public investment in transportation infrastructures more than pays for itself and is a good strategy from a long-term public budgetary perspective. The same pattern is found at the disaggregated level for all different types of public investment in transportation infrastructures. Accordingly, for all types of public investment in transportation infrastructures spending cuts are a bad strategy from both a long-term growth perspective and a long-term budgetary perspective. Clearly, despite all semantic similarities, not all public investments are created equal.

5. Concluding remarks

In this paper we address a question of the utmost importance in the context of budgetary policy in Portugal, namely, the long-term economic and budgetary effects of public-sector investment in durable goods. The impact of public-sector investment on output is important in itself from a long-term growth perspective. It is also important from a long-term budgetary perspective. This is because a positive impact on output also represents a positive impact on the tax base and therefore, leads to the critical empirical question of whether or not public-sector investment pays for itself in the form of future tax revenues. If it does, then current cuts in public investment spending not only jeopardise long-term growth but also make the long-term budgetary situation more difficult. If not then only the negative long-term growth effects remain but public investment cuts do help the budgetary situation in the long-term.

In this paper we find that public-sector investment in durable goods, construction and equipment, has a positive effect on long-term economic performance. Therefore, public-investment spending cuts to help current budgetary consolidation efforts come with a price in terms of long-term economic performance. We find, however, that overall the positive effects are not strong enough for public-sector investment spending to pay for itself in the form of future tax revenues. Therefore, cuts in public-sector investment spending seem to be an effective way to deal with the public budgetary situation in the short term without jeopardising the long-term budgetary situation. It is important to note, however, that this result is in contrast with recent evidence in Pereira and Andraz (2004a, 2004b) that suggests that cuts in public investment in transportation infrastructures would affect output so strongly that would also have negative long-term effects on the effort toward fiscal consolidation. Clearly not all types of public-sector investment are the same.

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Figure 1: Private investment and public-sector investment as % of GDP

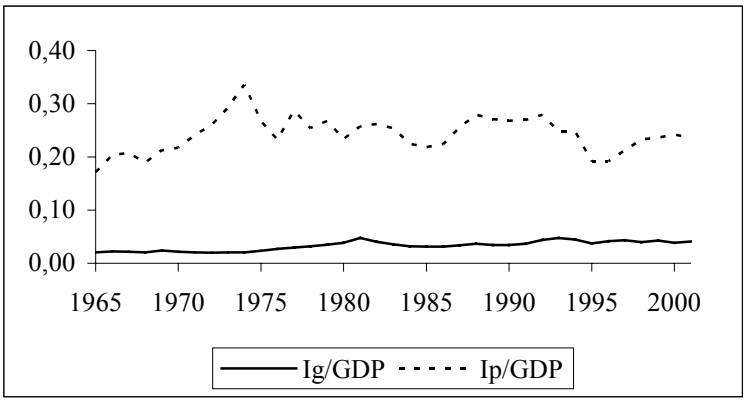

Figure 2: Decomposition of public-sector investment

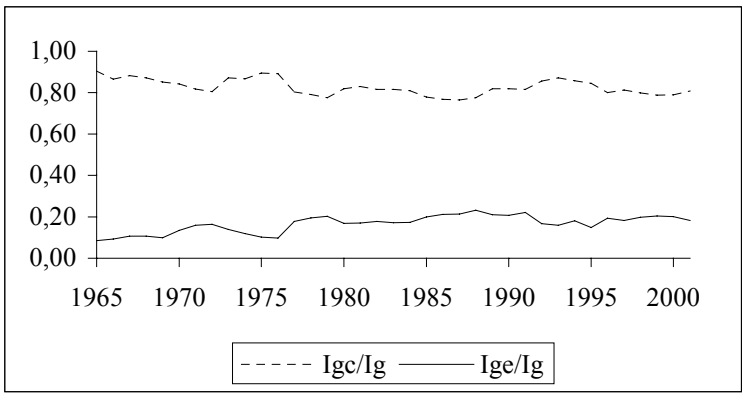

Figure 3: Public-sector investment as % of GDP

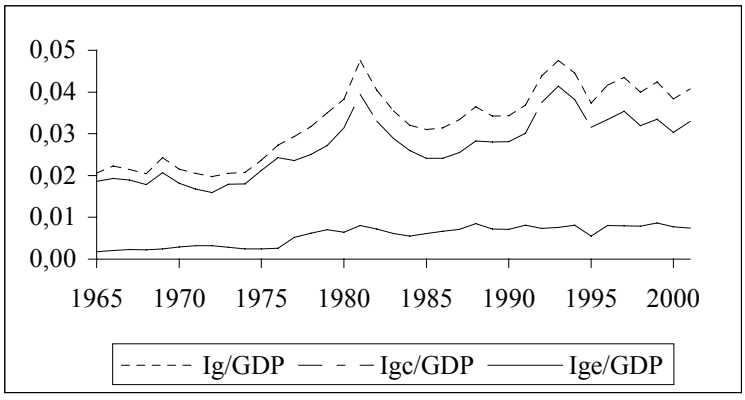

Table 1: Unit roots tests

	Augmented Dickey-Fuller					
	Constant		Trend and constant		None	
Series	lags	τ_μ	lags	τ_τ	lags	τ
Y	3	-2.598	3	-2.928	1	2.354
L	1	-0.964	3	-2.964	1	1.078
Ip	0	-2.103	0	-2.533	0	2.298
Ig	0	-0.628	1	-2.440	0	3.875
Igc	1	-0.411	1	-2.368	1	2.291
Igeq	0	-1.620	1	-2.398	0	2.594
Δ Y	2	-4.796**	1	-6.008**	0	-2.009*
Δ L	0	-3.594*	3	-4.194*	0	-3.327**
Δ Ip	0	-5.110**	0	-5.142**	0	-4.606**
Δ Ig	0	-3.944**	0	-3.867*	0	-3.070**
Δ Igc	0	-8.177**	0	-8.038**	0	-7.288**
Δ Igeq	0	-4.061**	0	-4.096*	0	-3.576**

*Significant at 5% level; ** significant at 1% level

Table 2: Co-integration tests

	Augmented Dickey-Fuller					
	Constant [a]		Trend and constant [b]		None [c]	
	lags	τ_μ	lags	τ_τ	lags	τ
Y	1	-3.149	1	-3.171	1	-3.253
L	3	-2.320	3	-2.253	3	-2.368
Ip	3	-2.498	3	-2.339	3	-2.411
Ig	0	-2.342	0	-2.301	0	-2.384
Y	0	-3.478	0	-3.580	0	-3.540
L	1	-3.089	1	-3.054	1	-3.135
Ip	0	-3.422	0	-3.497	0	-3.470
Igc	0	-3.991	0	-3.916	1	-2.859
Y	1	-3.146	1	-3.223	1	-3.249
L	1	-3.076	1	-3.041	1	-3.135
Ip	0	-3.289	0	-3.370	0	-3.335
Igeq	1	-1.980	1	-1.938	1	-2.035

* significant at 5% level; ** significant at 1% level
[a] critical values -4.11 and -4.73 at 5% and 1%, [b] critical values –4.16 and -4.65 at 5% and 1%,
[c] critical values –3.74 and -4.30 at 5% and 1%

Table 3: BIC tests for VAR specification

	constant	constant and trend	none
VAR(3)			
Ig	-22.36433	-22.00157	-22.06785
Igc	-19.92410	-19.59428	-19.56618
Igeq	-21.37838	-21.19440	-21.04041
VAR(2)			
Ig	-23.08191	-22.71249	-22.96674
Igc	-20.92517	-20.58665	-20.76900
Igeq	-22.42402	-22.22972	-22.19669
VAR(1)			
Ig	**-24.37373**	-24.05755	-24.14828
Igc	**-22.49077**	-22.16224	-22.26053
Igeq	**-23.64136**	-23.34386	-23.42797

Table 4: Policy Functions

	constant	Δ Y(-1)	Δ L(-1)	Δ Ip(-1)	Δ Ig_i(-1)
Δ Ig	-0.001 (-0.037)	1666 (2.225)	0.257 (0.237)	-0.434 (-2.922)	0.237 (1524)
Δ Igc	-0.005 (-0.146)	1.505 (1.764)	0.624 (0.505)	-0.287 (-1.710)	0.207 (1.269)
Δ Ige	0.017 (0.315)	2.195 (1.475)	0.325 (0.152)	-1.013 (-3.295)	0.288 (1.659)

t-statistics in parenthesis

Table 5: Long-term accumulated elasticities with respect to public-sector investment

variable	output	employment	private investment
aggregate public investment			
central case **range of variation**	0.065 [0.022;0.067]	0.017 [0.007; 0.029]	0.326 [0167; 0.326]
public investment in construction			
central case **range of variation**	0.029 [-0.041; 0.033]	-0.005 [-0.021; 0.006]	0.241 [-0.039; 0.245]
public investment in equipment			
central case **range of variation**	0.111 [0.098; 0.145]	0.050 [0.046; 0.052]	0.295 [0.295; 0.524]

Table 6: Long-term effects of public-sector investment on employment and private investment

Variable	employment		private investment	
	elasticity	number of jobs	elasticity	marginal product
aggregate public investment	0.017	21	0.326	1.799
public investment in construction	-0.005	-8	0.241	1.622
public investment in equipment	0.050	350	0.295	8.910

Table 7: Long-term effects of public-sector investment on output

Variable	elasticity	marginal product	rate of return
aggregate public investment	0.065	1.551	2.2%
public investment in construction	0.029	0.838	-0.8%
public investment in equipment	0.111	14.568	14.3%