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Public Investment and Budgetary Consolidation in Portugal [(*)]

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Abstract

In this paper we find that public investment in durable goods has a positive effect on long-term economic performance in Portugal. We also find that these positive effects are not strong enough for public investment to pay for itself in the form of future tax revenues. Therefore, cuts in public investment in durable goods, although costly in terms of long-term economic performance seem to be an effective way of alleviating pressure on the public budget. It is important to note, however, that this general result contrasts sharply with the evidence found in this paper for public investment in equipment, a small component of public investment in durable goods, as well as with evidence elsewhere for public investment in transportation infrastructures. For these, the effects on output are strong enough for public investment to pay for itself. Therefore, cuts in these two types of public investment, would have negative long-term economic effects as well as negative long-term budgetary effects. Clearly, not all public investment is created equal.

JEL Codes: C32, E62, H54, O52

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

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1. Introduction

For some time, fiscal consolidation has been one of the most difficult economic challenges in Portugal. Indeed, 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. Furthermore, there is no escaping the fact that, on one hand, the bulk of public spending is in the form of public employees' wages - a sector heavily unionized, and of social benefits and transfers - which are difficult to control, and, on the other hand, that public opinion is steadfast against tax hikes. Faced with these budgetary pressures and political constraints, the margin of maneuver 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, however, is whether or not political expediency comes at a cost, first in terms of long-term economic performance and second in terms of future budgetary consolidation efforts.

The first possible cost of cuts in public investment is in the form of losses in economic performance. Indeed, it is a common view that public investment tends to improve long-term economic performance [see, for example, Baxter and King (1993) for an early theoretical discussion of this issue]. At an empirical level, however, evidence as to the magnitude and even the sign of such effects is less clear [see, for example IMF (2004)]. Furthermore, in more developed countries, where the role of the private sector in the provision of infrastructures is expected to increase and where there may be a trend toward smaller government, the link between public investment and long-term economic performance is less clear even at the conceptual level. At any rate, whether or not reductions in public investment will lead to undesirable effects in terms of long-term economic performance is a matter to be decided empirically.

The second possible cost of cuts in public investment is in the form of losses of future tax revenues. Indeed, to the extent that public investment increases output in the long-term, it also expands the tax base and, therefore, tax revenues. 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, a possibility that underlies golden rule arguments. 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 economic performance and make the future budgetary situation worse. In the second case, cuts in public investment hurt 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 this paper, we address these issues from an empirical perspective in the context of public investment in durable goods in Portugal. Our objective is to determine empirically the long-term economic effect of public investment and, if these effects are positive, to what extent they are large enough for public investment to pay for itself. Our empirical analysis follows a vector auto-regressive (VAR) approach which relates output, employment, private investment, and public investment. This approach highlights the dynamic feedbacks among the different variables and captures both direct and indirect channels (through its effects on employment and private investment) through which public investment affects output. The specifics of the identification and measurement of the effects of public investment, inspired by the literature on the effects of

monetary policies, follow the approach developed in Pereira (2000, 2001) in the context of the analysis of the effects of public investment in infrastructure in the US. This approach was adapted to the Portuguese case in Pereira and Andraz (2005).

From a methodological perspective, this paper is also akin to the growing body of research attempting to estimate the macroeconomic effects of distinct fiscal policies through the use of VAR models routinely used to evaluate the effects of monetary policy [see Blanchard and Perroti (2002) and Alesina et al (2002) for early contributions, Kamps (2005) for a discussion of estimates of the effects of public investment, and Perotti (2004, 2005) for a review of the macroeconomic effect of various tax policies]. Overall, VAR models have clearly become the instrument of choice in the debate on the macroeconomic impact of fiscal policy as well as the debate on the effect of infrastructures. Methodologically, this paper is in the confluence of these two bodies of literature.

2. Data and preliminary empirical results

2.1 Data and some stylised facts

The variables considered are output (y), employment (l), private investment (ip), and public-sector investment in durable goods (ig). We use annual data for the period 1976-2003. The data for the period 1976-1995 was obtained from the long series for the Portuguese economy published by Banco de Portugal and available on-line at www.bportugal.pt. The data for the period 1996-2003 was obtained from the national accounts publications for 1995-1999 and 2000-2003 published by the Instituto Nacional de Estatística and available on-line at www.ine.pt. All variables are measured in millions of euros in 1995 prices, except for employment, which is measured in thousand of employees.

Public investment in durable goods 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 the aggregate measure of public investment in durable goods, we consider two disaggregated measures: public investment in construction (igc) and public investment in equipment (ige), which includes transportation and other equipment. Some basic information about public investment is presented in Table 1. Over the sample period, public investment averages 3.7% of the GDP of which 81.6% is construction spending. In terms of its recent evolution, a notable decline in public investment as a percentage of the GDP from a peak value of 4.1% in 1996 to 3.3% in 2003 is observed. This aggregate decline is mostly due to reductions in public construction spending, which declined from 3.3% of the GDP to 2.7% over the same period. Investment spending in equipment also declined from 0.8% to 0.5%, a smaller change in absolute terms. Also, it should be noted that these changes relative to GDP actually imply a decline of public investment in absolute terms. Overall, it can be said that budgetary consolidation in Portugal in recent years has been accompanied by a reduction in public investment spending, mostly in the form of reductions in construction spending.

***** Insert Table 1*****

The sample covers a period in which important institutional changes occurred in Portugal, all of

which present a potentially significant impact on the structure of the economy. Portugal joined the EU in 1986, structural transfers from the EU started in 1989 [see, for example, Pereira (1999b) and Boldrin and Canova (2001) on the effects of these policies], and the mechanisms of the Economic and Monetary Union started to apply in 1999 [see for example Pereira (1999a) and Canova and Pappa (2005) on the effects of these mechanisms]. Clearly these changes were anticipated by the domestic economic agents and, therefore, their effects reverberated throughout the economy both before and after the actual institutional changes occurred. Given these facts, the possibility of structural breaks was considered in each and every step of our analysis: unit root tests, cointegration tests, and VAR specification and estimations.

2.2 Univariate and cointegration analysis

In order to address the issue of the stationarity properties of the different data series we started by using the standard ADF unit root tests. We used the BIC to determine the optimal number of lags and included deterministic components when statistically significant. We found that for all of the variables in log-levels the t-statistics were greater than the 5% critical value and that, therefore, we could not reject the null hypothesis of a unit root for any of the variables. When applied to the first differences of the log-levels, i.e., in growth rates of the original variables, we found that all the t-statistics are lower than the 5% critical values. Accordingly, the ADF tests allowed us to reject the null hypothesis of a unit roots for all variables in growth rates.

The standard ADF unit root tests, however, are known to lead to the underrejection of the null hypothesis of a unit root in the presence of structural change [see, for example, Perron (1989)]. Therefore, we used the Zivot-Andrews unit root tests [see Zivot and Andrews (1992)] which accommodate the presence of such change. We allow for a break both in the intercept and in the trend and use the BIC to determine the optimal number of lagged differences. Test results are reported in Table 2. For all of the variables in log-levels the test statistics are greater than the critical value at the 5% significance level and, therefore, we cannot reject the null hypothesis of a unit root for any of the variables. In turn, for the variables in growth rates the tests allow us to reject the null hypothesis of the unit roots for all variables at the 10% significance level and for three of the variables at the 5% level. Therefore, we conclude that all variables are I(1) or stationary in growth rates.

***** Insert Table 2*****

We now test for cointegration among output, employment, private investment and public-sector investment both at the aggregate level and at the disaggregated level considering either public investment in construction or public investment in equipment. Due to our relatively small sample we started by using 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 [see, for example, Gonzalo and Lee (1998) and Gonzalo and Pitarakis, (1999)]. Following the standard Engle-Granger procedure, in each case we performed 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 applied the ADF t-test to the residuals of the different regressions. The optimal lag structure was chosen using the BIC and we considered

alternative specifications for the deterministic components.

We found that, at aggregate level and in the case of public investment in construction, the test statistics were consistently greater that the 5% critical values, and therefore, in no case could we reject the null hypothesis of a unit root in the residuals of the estimated equations. In the case of public investment in equipment two of the four tests suggested the possibility of cointegration. Further testing using the Johansen likelihood ratio test also suggested no cointegration at the aggregate level and for the case of public investment in constructions but for the case of public investment in equipment they suggested, albeit marginally, one cointegration relationship. The marginal evidence for cointegration in the case of public investment in equipment, however, is not robust to any small sample correction of the relevant critical values which would lead to small-sample critical values greater than the standard ones [see, for example, Harris and Judge (1998)]. Accordingly, the evidence of both the Engle-Granger procedure and the Johansen tests strongly suggests no cointegration for any of the models. Nevertheless, neither the Engle-Granger procedure nor the Johansen tests account for the possibility of structural change, a possibility we now turn to.

It is also known that the standard ADF tests for cointegration tend to underreject the null hypothesis of no cointegration in the presence of structural change [see, for example, Gregory, Nason, and Watt (1996)]. Therefore, we used the Gregory-Hansen test [see Gregory and Hansen (1996)] to test the null hypothesis of no cointegration against the alternative of cointegration in the presence of a possible regime shift. The optimal lag structure was chosen using the BIC and alternative specifications for the deterministic components were considered. Test results are reported in Table 3. We found that, in all but one case the test statistics were greater that the critical values at the 5% significance levels and that, therefore, we could not reject the null hypothesis of no cointegration. Accordingly, we concluded that the variables are not cointegrated either at the aggregate or at the disaggregated levels. In the case of economies in a transition stage of their development, such as the Portuguese economy, not finding cointegration is hardly surprising. It means that the data does not show evidence of convergence to the so-called great ratios among the e variables in the economy.

***** Insert Table 3*****

One of the important side notes of the Zivot-Andrews unit root tests and the Gregory-Hansen cointegration tests is that they indicate the most likely date of the structural break. In the case of Zivot-Andrews unit root tests, we found a cluster of possible structural breaks in the middle to late 1980s as well as middle to late 1990s. In turn, in the case of the Gregory-Hansen cointegration tests we found a cluster of possible structural breaks, although associated with an alternative hypothesis that we ultimately rejected, in the early 1990s and in the late 1990s. We take this evidence as suggesting that the three structural changes we have mentioned associated with 1986, 1989, and 1999, should be considered in the specification and estimation of the VAR models.

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

3.1 VAR specification and estimation

Having established that all of the variables are stationary in growth rates and that they are not cointegrated we followed the standard procedure in the literature and proceeded to specify and estimate VAR models in growth rates. We considered three VAR models, all of which include output, employment, and private investment. In addition, each of the models includes a different public investment variable - aggregated public investment, public investment in construction, and public investment in equipment.

The VAR model specifications were determined using the BIC. For each model, the VAR specification has three jointly-determined dimensions - the choice of the lag length, the choice of the deterministic components, and the modeling of structural change. The use of this strategy in the determination of the lag length and deterministic components is rather conventional while its extension to include the determination of structural breaks is suggested among others by Kim and Maddala (1991) and Maddala and Kim (2002). In term of the lag length, we considered options up to second order while in terms of the deterministic component we considered three alternatives – no deterministic component, a constant, and a constant and a trend. Finally, in terms of the structural changes we considered three possible structural breaks – a first break in the intercept in 1986, the date Portugal joined the EU, a second break in 1989, the starting date for EU structural transfers, and a third in 1999, the date Portugal joined the Economic and Monetary Union. Test results, reported in Table 4, suggest that the best specification, in both the aggregate and the two disaggregated models, is a VAR(1) model with a constant term and trend and structural breaks in the intercept in 1986, 1989, and 1999. Since the econometrics literature suggests while for forecasting purposes the BIC may be the best way to select a VAR specification, for certain other purposes the AIC may be a better choice than the BIC [see, for example, Lutkepohl (1993)] we replicated all the above VAR specification steps using the AIC criterion. Without exceptions, the AIC results coincide with the BIC results as described above. This suggests that our choice of the VAR specification is rather robust.

***** Insert Table 4*****

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 are close to being block diagonal. Indeed, innovations in public investment show relatively low contemporaneous correlations with the remaining variables. The correlations between innovations in public investment and innovations in the other three variables are all in absolute value lower than 0.35 and in five of the nine cases are in the single digits. By contrast, contemporaneous correlations among innovations in private-sector variables are relatively large exceeding 0.35 in absolute value in six of the nine cases and 0.75 in three of the nine cases. This pattern is consistent with evidence in the literature [see, for example, Pereira and Andraz (2005)] and suggests that innovations in public investment and private sector variables are for most part close to being statistically uncorrelated. This is important because it implies the orthogonalization strategies to be discussed below will not be overly imposing on the estimates of the long-term effects of public investment.

3.2 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 investment that are not contemporaneously correlated to innovations in the other variables. 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 (2005)**.**

Ideally, the identification of exogenous innovations in 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 context of our VAR estimates, these policy functions are the reduced form estimates of the VAR equation where the public investment variable is the endogenous variable.

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 investment lead innovations in the other variables. This means that we allow innovations in public investment to affect contemporaneously the other variables, 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 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. The accumulated impulse response functions with respect to the different public investment variables obtained under this central scenario, as well as the corresponding 90% standard error bands, are presented in Figures 1 – 3.

Despite the imminent plausibility of this central scenario, when first report (in Table 6) the effects of public 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. Note, however, that this range of variation does not have any interpretation in terms of the statistical significance of the effects but rather informs as to how the central results relate to all possible orthogonalization results.

The policy functions are reported in Table 5. At both the aggregate and disaggregated levels our results suggest that changes in public investment are positively correlated with lagged changes in output, negatively correlated with lagged changes in private investment, and uncorrelated with lagged changes in employment. This means that public investment is not an exogenous variable. Indeed, growing output also means a growing tax base and the potential for greater public investment while growing private investment tends to discourage public investment in that both are competing for the same type of durable goods. It is interesting to note that this result is in contrast with the findings in Pereira and Andraz (2005) 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 decades has been linked mostly to the EU structural transfers.

***** Insert Table 5*****

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

We consider the effects of one-time one-percentage point innovations in the growth rate of public 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 may translate into permanent effects on the levels of these variables, a fact fully captured in our results.

The long-term elasticities of the different variables with respect to public investment as well as the corresponding ranges of variation are reported in Table 6. 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. Formally, the long-term elasticity of variable x with respect to public investment ig, i.e. $E_{x,ig}$, is given by:

$$E_{x,ig} = d \log(x)/d \log(ig) \quad (1)$$

where, both the numerator and the denominator are long-term values obtained from the accumulated response function of x with respect to innovations in ig. This definition recognizes the fact that the initial exogenous innovation in public investment is followed over time by other endogenous innovations induced by the dynamic feedback mechanisms on public investment from the other variables. The standardization of the effects of public investment is, therefore, made using the long-term accumulated innovation in public investment and not the initial innovation.

***** Insert Table 6*****

In Tables 7 and 8 we report the marginal product of the different variables with respect to public investment. These figures measure the permanent change in millions of euros in output and private investment and the number of permanent jobs created for a million euros permanent change in public-investment. We obtain the marginal products by multiplying the average ratio of the private sector variable to the public investment variable by the corresponding elasticity. We use the average ratio for the last ten years to reflect the relative scarcity of public investment at the end of the sample while at the same time neutralizing business cycle effects on the ratio. Formally, the marginal product of variable x with respect to public investment ig, i.e., $MP_{x,ig}$, is given by:

$$MP_{x,ig} = E_{x,ig}\, x/ig\, dig \quad (2)$$

where, the change in public investment, i.e. dig, is normalized to one million euros.

Finally, rates of return are calculated from the marginal products of output with respect to public investment by assuming a life horizon of twenty years for all types of public capital assets, that is, a linear depreciation rate of 5%. These are the rates which, if applied to one euro over a twenty-year period, yield the value of the marginal products. Formally, the rate of return, r, is

$$r: \ MP_{x,ig} = (1+r)^{20} \quad (3)$$

4. Public investment and economic performance

4.1 On the economic effects of public investment

Estimation results reported in Table 7 suggest that public investment has a positive effect on both employment and private investment. At the aggregate level, the elasticities of employment and private investment with respect to public-sector investment are 0.064 and 0.232. These figures imply that a permanent increase of one million euros in public investment will in the long-term create 92 permanent jobs and will increase private investment permanently by 1.405 million euros.

At the disaggregated level we find that, in the long term, a permanent increase of one million euros in public construction spending leads to the creation of 68 permanent jobs and a permanent increase of 1.191 million euros in private investment. In turn, a permanent increase of one million euros in public equipment spending leads to the creation of 331 permanent jobs and to a permanent increase of 3.569 million euros in private investment.

***** Insert Table 7*****

Estimation results reported in Table 8 suggest that public investment has a positive effect on output. The elasticity of output with respect to public investment is 0.058. This figure implies that a permanent increase of one million euros in public investment leads to a permanent long-term increase in output of 1.589 million euros. The corresponding annual rate of return is 2.3%, a rate below what one would expect from private-sector investments. At the disaggregate level, we find that the elasticity of output with respect to public construction spending is 0.021 while with respect to public-sector equipment spending it is 0.050. These figures correspond to marginal products of 0.686 and 7.722, and to rates of return of -1.9% and 10.8%, respectively. Naturally, here as above considering the effects on employment and private investment, the aggregate results are somewhere between the two disaggregated results but much closer to the results for construction spending, the bulk of the public investment.

***** Insert Table 8*****

From the standpoint of the central motivation of this paper, our results imply that cuts in public investment will have harmful effects on the long-term economic performance in Portugal. They will harm long-term employment and private capital accumulation and therefore, not surprisingly, long-term output. This is a worrisome fact since a sharp decline in public investment to GDP ratio is visible after the late 1990s. Still, this change has occurred primarily but not exclusively in public construction spending where the long-term costs of public investment cuts are the lowest.

4.2 On the budgetary effects of public investment

Having established that public investment affects output positively in the long-term, we now turn to

its potential long-term budgetary impact. The discussion that follows although a direct corollary of the VAR analysis and results presented above is not directly based on the explicit use of budget variables, e.g. tax revenues, in the VAR analysis.

To understand the issue we need to recognize that a positive effect on output also means an increase in the tax base and, therefore, translates into increased tax revenues. It is, therefore, conceivable that over time public investment will have 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 investment to pay for itself. In the first case, cuts in public investment will hurt the long-term economic performance of the country and will also hurt the budgetary situation in the long-term. In the second case, such cuts will hurt the long-term economic performance but will help the long-term budgetary situation.

For the period 1994-2003 the average effective tax rate in Portugal was 22.9% [see, for example, the Statistical Annex of the European Economy (2006) at http://ec.europa.eu/economy_finance/publications]. This is a comprehensive figure, which includes both direct and indirect taxes but excludes social contributions and miscellaneous revenues. We consider a ten-year average to capture the economic conditions at the end of the sample period while avoiding business cycle effects. To generate the expected tax revenue effects of changes in public investment we apply this average effective tax rate to the estimated change in output induced by a one million dollar change in public investment. The indirect effects on private investment and employment are not considered directly in these computations but are considered indirectly in that the effective tax rate is obtained using output as the tax base. Results are reported in Table 9.

Given that a permanent increase of one million euros in public investment will lead to a permanent increase in output of 1.589 million euros, the tax revenues will also increase permanently in the long term by 0.364 million euros. Accordingly, public investment does not pay for itself in the form of future tax revenues. To put it differently, a permanent decrease of one million euros in public investment spending only leads to a permanent decrease in tax revenues of 0.364 million euros. Therefore, cuts in public investment although undesirable from the standpoint of long-term economic performance do not have an adverse effect on the long-term budgetary position of the public sector. Indeed, they are effective in reducing the public deficit.

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 investment. Indeed, a permanent increase of one million euros in construction spending increases tax revenues in the long term permanently by 0.157 million euros. The situation, however, is different with respect to equipment spending, a more marginal component of public investment in durable goods. In this case, a permanent increase of one million euros in spending increases tax revenues permanently by 1.768 million euros. These results mean that cuts in public investment in construction adversely affect output in the long-term but do not seem to impair efforts for budgetary consolidation. Cuts in equipment spending, however, have adverse long-term effects on both output and the budgetary situation.

***** Insert Table 9*****

From the perspective of the main focus of this paper, we conclude that the strategy of using public investment cuts is harmful from an economic perspective but is effective in terms of budgetary consolidation,

in particular when the bulk of the cuts comes from public construction as it seems to be the case in Portugal in the recent past. Cuts in public equipment, however, are to be avoided in that they are detrimental for both the economy and for the long-term budgetary position.

One should not ignore the fact that the effective tax rate in Portugal is one of the lowest in the euro area. This is important because any efforts to reduce tax evasion and/or tax avoidance or any other marginal changes in the tax codes may increase these effective rates in an important manner. Simple calculations, however, suggest that our conclusions are very robust even to substantial changes in the effective tax rate over time. Indeed, the equilibrium tax rates, i.e., the tax rate such that public investment would just pay for itself are either forbiddingly high or unrealistically low. See the last column of Table 9 for details.

Finally, it is relevant to compare these results with the results in Pereira and Andraz (2005) 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 2.176 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 it 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, cuts in public investment in transportation infrastructures are a bad strategy in the long term from both an economic perspective and a budgetary perspective. Clearly not all types of public investment are the same.

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 investment. While the long-term impact of public investment on output is important in itself, it is also clearly important from a 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 investment pays for itself in the form of future tax revenues. If it does, then current cuts in public investment not only jeopardize long-term growth but also make the long-term budgetary situation more difficult. If not, then only the negative long-term economic effects remain but public investment cuts do help the budgetary situation in the long-term.

In this paper we find that public investment has a positive effect on the long-term economic performance of the country. Therefore, public-investment cuts to help 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 investment spending to pay for itself in the form of future tax revenues. Therefore, cuts in public investment seem to be an effective way of dealing with the public budgetary situation in the short term without jeopardizing the long-term budgetary situation. It is important to note, however, that this result is in contrast with the specific results we found for public investment in equipment, a component that accounts for less than 20% of public investment. In this case, the effects on output are very strong and cuts in this type of public investment would endanger not only long-term economic performance but also the long-term budgetary situation. Furthermore, our general result also contrast recent evidence in

Pereira and Andraz (2005) 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, despite all semantic similarities, not all public investments are created equal.

As a final note, although this paper focuses on the Portuguese case and deals with issues that are of the utmost importance for policy making in Portugal, its interest is not merely parochial. Indeed, the issue of the effects of public investment on economic performance and budgetary consolidation is a matter of great importance for countries, such as France, Germany, Greece, Italy, and Netherlands, which are currently facing or have recently faced serious budgetary difficulties. It is particularly important for countries, like Greece, Ireland, and Spain, which have been engaged in the last two decades in major modernization 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 modernization of their public sectors while at the same time they are expected to undertake a major process of budgetary consolidation.

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Table 1: Summary data

Investment as percentage of GDP (%)							
	1976-80	**1980-84**	**1985-89**	**1990-94**	**1995-99**	**2000-03**	**1976-2003**
ig	3.1	4.2%	3.3%	3.7%	3.7%	3.6%	3.7%
igc	2.6	3.5%	2.6%	3.1%	3.0%	3.0%	3.0%
ige	0.5	0.7%	0.7%	0.7%	0.7%	0.6%	0.7%
Decomposition of public investment (% of total)							
igc	82.9%	82.6%	78.6%	81.9%	81.5%	82.9%	81.6%
ige	17.1%	17.4%	21.4%	18.1%	18.5%	17.1%	18.4%

Table 2: Zivot-Andrews unit root tests allowing for a break in intercept and trend

	lags	**year of minimum statistic**	**minimum t-statistic**
y	1	1989	-3.80294
l	0	1983	-2.82916
ip	2	1990	-4.97079*
ig	1	1982	-3.77699
igc	1	1992	-4.04953
ige	0	1996	-4.36117
Δy	0	1986	-5.32923 **
Δl	0	1995	-4.99580*
Δip	0	1997	-5.44087**
Δig	0	1982	-4.88112 *
Δigc	0	1982	-4.92751*
Δige	0	1985	-8.04377***

Note: *significant at 10% level; **significant at 5% level ** *significant at 1% level.
Critical values -4.82, -5.08 and -5.57 respectively for 10%, 5% and 1%.

Table 3: Gregory-Hansen cointegration tests

	lags	**year of minimum statistic**	**minimum t-statistic**
y	0	1980	-4.13848
l	0	1999	-4.14007
ip	0	1994	-4.97851
ig	1	1991	-4.52625
y	0	1994	-3.63599
l	0	1999	-4.13733
ip	0	1994	-4.95432
igc	1	1991	-4.95863
y	0	1991	-4.61643
l	0	1999	-4.34111
ip	0	1994	-4.64069
ig	0	1980	-5.62080*

Note: *significant at 5% level;** significant at 1% level.
Critical values -5.57 and -6.05 respectively for 5% and 1%.

Table 4: BIC tests for VAR specification

VAR with ...		dummy	none	constant	constant and trend
Δig	**VAR(1)**	**---**	-24.23992	-24.50473	-24.71576
		1986	-24.45094	-24.61508	-25.49094
		1986, 1989	-24.95834	-25.11462	-25.84030
		1986, 1989, 1999	-25.03765	-25.30737	**-26.18727**
	VAR(2)	**---**	-22.51008	-22.79582	-22.66843
		1986	-22.67702	-22.73862	-23.88791
		1986, 1989	-23.66605	-24.08067	-24.87291
		1986, 1989, 1999	-24.07142	-24.37244	-25.56844
Δigc	**VAR(1)**	**---**	-24.19303	-24.42789	-24.62681
		1986	-24.37360	-24.53156	-25.39289
		1986, 1989	-24.83444	-24.98285	-25.72357
		1986, 1989, 1999	-24.91474	-25.18487	**-26.09345**
	VAR(2)	**---**	-22.42154	-22.75403	-22.60194
		1986	-22.56805	-22.68067	-23.87264
		1986, 1989	-23.59048	-24.06037	-24.86645
		1986, 1989, 1999	-23.98866	-24.35268	-25.55818
Δige	**VAR(1)**	**---**	-23.46373	-23.59394	-23.78233
		1986	-23.70933	-23.72408	--24.57350
		1986, 1989	-24.25629	-24.26447	-24.90379
		1986, 1989, 1999	-24.34350	-24.41329	**-25.10855**
	VAR(2)	**---**	-22.08002	-22.64006	-22.30484
		1986	-22.54123	-22.53342	-23.55080
		1986, 1989	-23.33235	-23.43945	-24.28604
		1986, 1989, 1999	-23.77755	-23.87035	-24.97870

Table 5: Policy functions for public investment

	Dummy 1986	**Dummy 1989**	**Dummy 1999**	**constant**	**trend**	**Δig(-1)**	**Δip(-1)**	**Δl(-1)**	**Δy(-1)**
Δig	0.107	-0.034	0.091	-0.032	-0.008	0.123	-0.553	-0.092	3.712
	(1.398)	(-0.444)	(1.201)	(-0.346)	(-0.868)	(0.793)	(-2.689)**	(-0.063)	(2.720)**
Δigc	0.110	0.008	0.116	(-0.007)	-0.109	(0.150)	(-0.456)	-0.345	3.504
	(1.335)	(0.096)	(1.425)	(-0.068)	(-1.146)	(0.940)	(-2.059)**	(-0.209)	(2.377)**
Δige	0.102	-0.221	-0..037	-0.147	0.007	0.103	-1.062	1.532	4.303
	(0.820)	(-1.760) *	(-0.299)	(-0.940)	(0.460)	(0.901)	(-3.001)*	(0.615)	(1.973)**

Note: t-statistics in parenthesis. * significant at 10% level and ** at 5% level.

Table 6: Long-term accumulated elasticities with respect to public investment

	output	employment	private investment
aggregate public investment			
central case	0.058	0.064	0.232
range of variation	[-0.031;0.063]	[-0.003;0.067]	[0.082;0.259]
public investment in construction			
central case	0.021	0.039	0.152
range of variation	[-0.081;0.027]	[-0.033;0.042]	[0.081;0.182]
public investment in equipment			
central case	0.050	0.040	0.104
range of variation	[0.037;0.051]	[0.029;0.041]	[0.081;0.116]

Note: Central case refers to the central orthogonalization assumption while range of variation refers to all possible values under the Choleski decomposition approach.

Table 7: Long-term permanent effects on employment and private investment

	employment		private investment	
	elasticities	**number of jobs**	**elasticities**	**marginal products**
aggregate public investment	0.064	92	0.232	1.405
public investment in construction	0.039	68	0.152	1.191
public investment in equipment	0.036	331	0.104	3.569

Note: Number of jobs and marginal products measure the long-term permanent effects of a one million euro permanent increase in public investment.

Table 8: Long-term permanent effects on output

	elasticities	marginal products	rates of return
aggregate public investment	0.058	1.589	2.3
public investment in construction	0.021	0.686	-1.9
public investment in equipment	0.050	7.722	10.8

Note: Marginal products measure the long-term permanent effects of a one million euro permanent increase in public investment. The rates of return are the rates that when applied to one euro over a twenty-year period, yield the value of the marginal products.

Table 9: Long-term permanent effects on tax revenues

	marginal products	effective tax rate	marginal tax revenues	equilibrium tax rates
aggregate public investment	1.589	22.9%	0.364	62.9%
public investment in construction	0.686	22.9%	0.157	145.8%
public investment in equipment	7.722	22.9%	1.768	12.9%

Note: Marginal products and marginal tax revenues measure the long-term permanent effects of a one million euro permanent increase in public investment. The equilibrium tax rate measure the tax rate necessary for public investment to pay for itself in the long term.

Figure 1 – Accumulated IRFs for Aggregate Public Investment

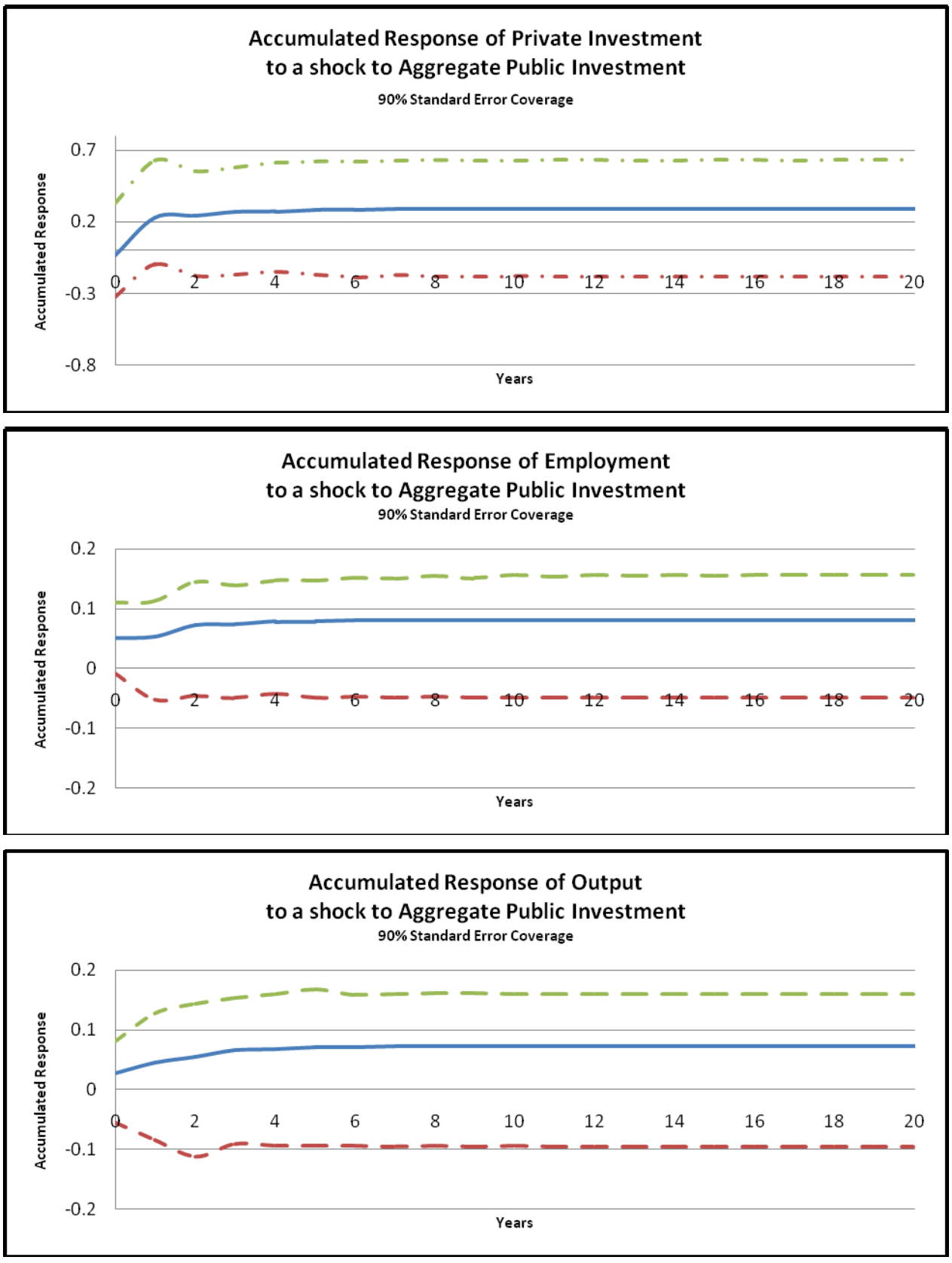

Figure 2 – Accumulated IRFs for Public Investment in Construction

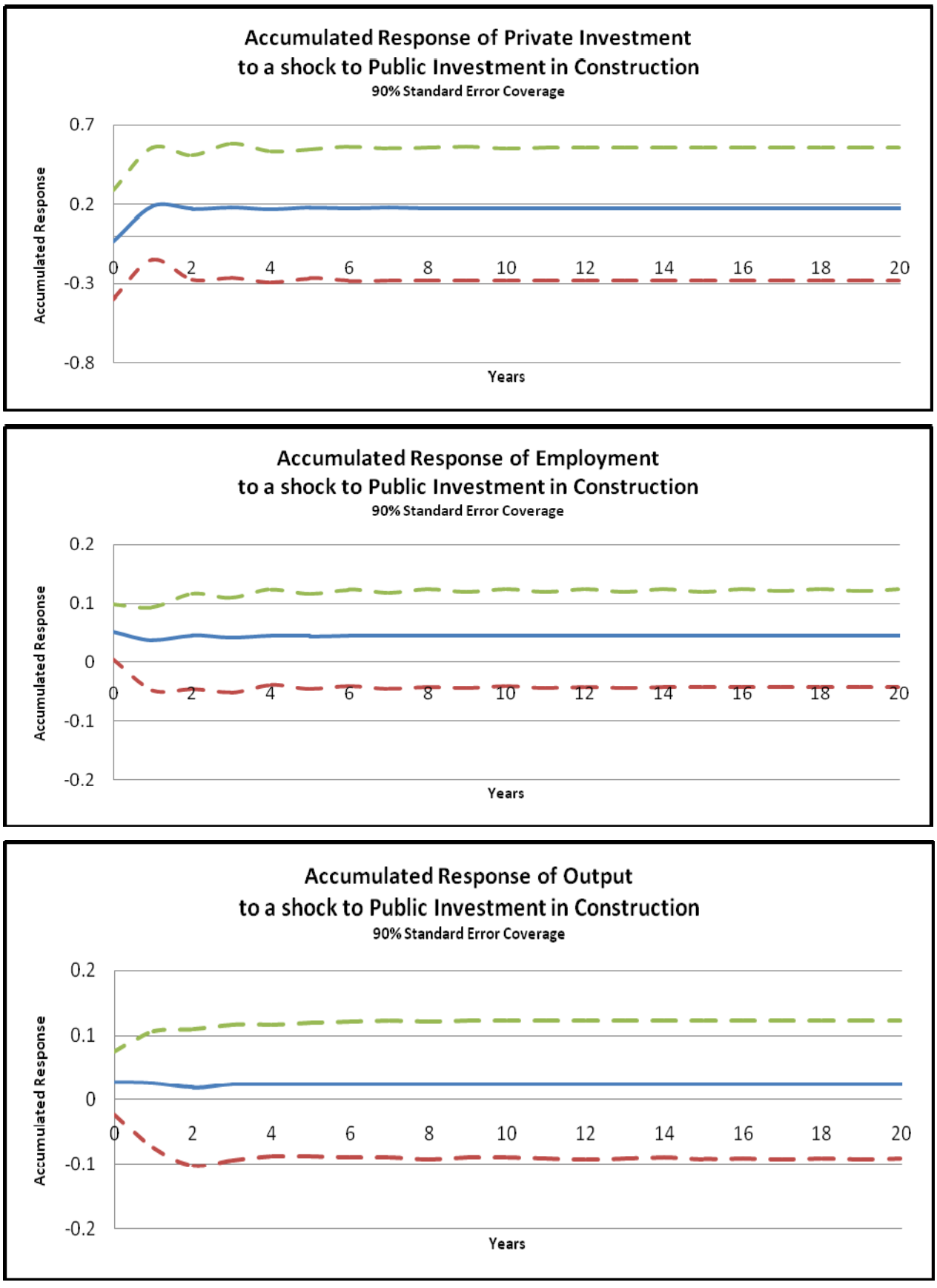

Figure 3 – Accumulated IRFs for Public Investment in Equipment