THE DETERMINANTS OF INVESTMENT AND THE IMPORTANCE OF THE EXTERNAL CONSTRAINT HYPOTHESIS. SOME EVIDENCE FROM GREECE AND PORTUGAL (*)

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1 — Introduction

According to the demand orientated theory, the capital stock, and net or gross investment, are endogenous in the growth process responding to changes in demand conditions (output), and the whole process is explained by the well known theory of the accelerator principle. This approach is opposed to the neoclassical theory where the capital stock and investment are derived indirectly (as factor inputs) from the production function, and hence exogenously determined by factors such as, the price of output, the user cost of capital, profits, etc., which maximize capital accumulation and investment decisions. In this paper, the principle of the accelerator mechanism will be tested and adapted to changes in demand conditions, such as changes in output, changes in export performance, changes in credit conditions, etc., which leads to the well known flexible accelerator mechanism. The whole process will be modeled with different specifications of the investment demand function (at the macro level) and will be tested empirically. In particular, the empirical testing will examine two main hypotheses: the relative importance of demand factors and relative prices in the investment function for Greece, and the external constraint hypothesis in the investment function for Greece and Portugal.

2 — Theoretical considerations on the determinants of the investment function

The controversy of the crucial determinants of investment is between the neoclassical school led by Jorgenson and the demand orientated theorists. Jorgenson (1963, 1971) argues that relative prices of output and factor inputs are important determinants of investment while the demand orientated analysis based on the accelerator principle considers that changes in output (demand factors) are mostly important and relative prices unimportant.

The contrast of the two approaches shows fundamental differences, the most important being that the former is based on supply factors as the determinants of investment behaviour (mainly reflected by the impact of relative factor

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prices), and the latter focuses on the changes in demand conditions as the major determinants of investment. However, the empirical framework of the two approaches does not reflect the extent of the theoretical gap, since the neo-classical theory also uses the accelerator mechanism and their findings suggest that the most significant determinant in the investment function is output ([1]).

Among other theories of investment is the profit (or liquidity) theory of investment which postulates that the optimal capital stock is some function of the level of profits or expected profits, where actual profits in the past are used to predict expected profits. The accelerator theorists argue that, since profits would be expected to be some function of the level of output or sales, the above models empirically are indistinguishable from the accelerator type functions. Within this type of research Eisner (1962) provided evidence that profits were only a proxy variable which lost their significance when sales were included. Evans (1969), contributing to the dispute of whether profits are important in the investment function, argued that the fact that firms invest to maximize future profits does not necessarily imply that high future profits are translated into higher investment. It is only if sales are high that more investment will be needed to maximize profits. What determines the long-run investment decision is the production function behaviour and not the profit rate. This view is consistent with the demand side theorists (see Kaldor, 1955), that profit is the result of investment by entrepreneurs, not its cause.

Several other macroeconomic variables have been included in the macro-investment function to test their significance. Green and Villanueva (1991) in a study referring to 23 developing countries during the period 1975-87 found evidence that the ratio of private investment to GDP was positively related to real GDP growth, the level of per capita income, and the rate of public sector investment, and negatively related to real interest rates, domestic inflation, the debt-service ratio, and the ratio of the external debt to GDP. The inclusion of the per capita income variable in the investment function has been justified by the fact that higher income countries have a greater ability to devote resources to saving, and hence a substantial part of investment projects can be financed through domestic savings. Regarding the effects of the public sector investment, it has been argued that public investment activity may be complementary or a substitute for private investment, thus generating crowding-in or crowding-out effects respectively. The crowding-in effects are generally longer-term effects, related to public investment activities which involve useful infrastructure systems (such as transportation, schools, water and telecommunication systems). Projects in these areas influence positively the expected return on private investment (especially those activities directly affected) and encourages further investment. On the other hand, the crowding out results are shorter-term effects, which may occur when: the public sector is involved in parastatal enterprises producing goods that compete with the private sector, and therefore, in this case public investment dis-

([1]) For more details on the differences between the neo-classical approach to investment and the accelerator principle see Soukiazis (1995). The same author also provides extensive empirical evidence which confirms the validity of the accelerator principle in the case of the OECD countries.

places private investors from profitable projects opportunities; when high public deficits (financed by bond issues) lead to higher interest rates and restricts credit demand by the private sector; when the public deficit is financed by monetary expansion causing inflation and business uncertainty, and finally, when the funding of the deficit is made through external debt which reduces the confidence of foreign and domestic investors. In a study for the Indian economy considering 18 sectors, Pradhan, et al. (1990) provide evidence which shows that public investment crowds out private investment in the short-run, but in the long-run, total investment and generally the whole economy is better off with increased public investment. Tun and Wong (1982) in a study of five countries (Greece, Korea, Malaysia, Mexico and Thailand) provide evidence which confirm that government investment, the change in credit conditions to the private sector and capital inflow to the private sector (foreign direct investment), play important roles in determining private investment. Finally, FitzGerald, Jansen and Vos (1993) developed an alternative approach showing that the external constraint hypothesis on investment is significant especially for the less developed countries. According to this approach, import capacity plays an important role in determining private investment, and external factors, such as, export competitiveness, structure of international specialization, the terms of trade, capital inflows and external debt (or interest payments on debt) can affect seriously funds available for investment.

There is an unlimited volume of empirical studies in the investment literature and the results are contradictory, and little agreement exists on the appropriate form of the investment function. This is because there are differences in the specification of the investment function, in the definition of the variables, in the time period studied, in the data used, in the estimation method, and so on. Perhaps the most convincing conclusion of the empirical work is the statement that some index of future output or demand is more important than expected relative prices in explaining investment behaviour ([2]). There are however two problems stemming from this. The first is to find an adequate measure of demand, and the second is to find an appropriate specification to incorporate a measure of future demand into the investment function. A common consensus is that investment responds more rapidly to changes in output (with a shorter lag) than to changes in relative prices. As a policy implication, this evidence would suggest that changes in aggregate demand is a more potent factor affecting investment.

3 — The investment function of Greece

In this section we focus on Greece ([3]) and an attempt is made to identify the main determinants which can explain the investment pattern over the last

([2]) Nickell (1978) argues that the omission of any direct demand proxy, such as sales, output, gross national product and orders is a serious mis-specification of the investment function.

([3]) It was not possible to find a similar data structure for Portugal and to provide a similar empirical analysis for this country.

three decades. For this reason some important key-series are given in table 3.1 below, which are divided into two sets: the first characterized as the set of the quantity variables, columns (1) to (8); and the second, as the set of the price variables, columns (9) to (13). In particular: column (1) and (2) record the ratio of the real gross private and public investment to gross national income, *PRI/GNI* and *PUBI/GNI* respectively, over the period 1954-1988; in column (3) and (5) are the growth rates of the real gross national income (*GGNI*) and gross domestic product (*GGDP*), over the period 1955-1988 and 1961-1991, respectively; columns (4) and (6) give the ratio of gross fixed capital formation to GDP and the growth rate in manufacturing investment, *GFCF/GDP* and GMI respectively, over the period 1960-1991 and 1958-1990; column (7) gives the growth rate of real exports (*GX*) for the period 1961-1991, and column (8) provides the growth rate of manufacturing output (*GMQ*) from 1958 to 1990. The set of the price variables reports: column (9) the nominal interest rate (*ni*) measured by the discount rate of the central Bank of Greece; column (10) reports the real long-term interest rate (*ri*), measured as the difference ($r - \Delta p$), where r is the banks' interest rate for long term industrial loans and p is the implicit investment price deflator in manufacturing; column (11) is a measure of profitability (*prof*) in the manufacturing sector, defined as the ratio of net profits to own capital; column (12) gives a measure of the labour cost, defined as the change in real wages in manufacturing, (*rw*), and finally, column (13) reports the inflation rate (*inf*), as derived from the consumer price indices ([4]). The same table also reports the average values of the respective series for the entire period and some subperiods.

A preliminary inspection of the data reveals that, on average, in the pre-1973 period there was a higher ratio of private investment than in the post-1973 period (16.2 % versus 14.4 %); higher total gross investment (27.0 % versus 20.8 %), and higher growth rate of manufacturing investment (10.2 % versus 0.7 % and 3.2 %). The above performance was associated with a higher ratio of government investment (7.1 % versus 6.1 %), a higher growth rate of gross national income (6.7 % versus 2.1 %) or gross domestic product (7.4 % versus 2.2 %), a higher rate of growth of manufacturing output (8.9 % versus 1.5 %) and higher export growth (13 % versus 6.4 %). Over the years 1968-1973, investment performance was the best ever, with private and public investment achieving the highest rates as a percentage of GNI, with 21.3 % in 1973 for the former and 9.4 % in 1972 for the latter. The ratio of total gross investment to GDP is also the highest in 1973 (31.4 %), and the rate of growth of manufacturing investment rose again to high levels (more than 10 % and 17.6 % in 1970) after a two-year slump in 1966-1967. That was the time of especially high output growth rates (more than 5 % per year), high export growth (23 % in 1972-1973), and favourable developments in profits and input costs (negative real interest rates and slow or negative real wage growth). As Kaskarelis (1993) explains, in the post-war period, several investment incentives had been introduced by the Greek authorities, such as low interest rates for long-term loans to the industrial sector, tax benefits, exemptions from import duties, etc., all measures which had the objective of creating favourable conditions in the productive structure orientated to export markets.

([4]) A detailed definition of the variables and data sources are given in table (3.1).

TABLE 3.1

The investment pattern of Greece and some important determinants

	PRI/GNI (1)	*GPUBI/GNI* (2)	*GGNI* (3)	*GFCF/GDP* (4)	*GGDP* (5)	*GMI* (6)	*GX* (7)	*GMO %* (8)	*ni* (9)	*ri* (10)	*prof* (11)	*rw* (12)	*inf* (13)
1954	10.9	3.15	–	–	–	–	–	–	10.0	–	–	–	–
1955	11.4	4.12	6.6	–	–	–	–	–	9.0	–	–	–	–
1956	12.5	5.36	8.7	–	–	–	–	–	10.0	–	–	–	–
1957	11.6	5.58	6.2	–	–	–	–	–	10.0	–	–	–	–
1958	14.3	6.08	3.5	–	–	20.9	–	9.9	11.0	13.7	5.6	6.2	–
1959	13.4	6.31	3.9	–	–	–12.0	–	1.0	9.0	– 4.8	7.5	–12.8	–
1960	14.7	7.32	3.4	23.8	–	– 7.0	–	9.3	6.0	– 0.2	11.1	– 1.5	–
1961	13.5	8.52	10.8	23.2	10.6	23.5	13.6	4.8	6.0	6.6	8.7	9.0	1.19
1962	15.1	8.56	0.9	24.7	1.5	16.4	10.4	5.0	6.0	– 4.5	11.0	– 8.0	0.00
1963	15.1	6.73	9.7	23.7	9.7	2.5	6.5	11.1	5.5	6.9	12.0	4.9	3.53
1964	17.6	8.88	7.3	26.4	7.9	24.8	2.0	10.0	5.5	3.5	10.4	6.9	0.00
1965	18.4	8.06	8.8	27.2	9.0	21.9	12.0	7.9	5.5	7.4	11.1	8.8	3.41
1966	18.2	7.33	5.2	26.4	5.9	– 5.1	34.5	13.6	5.5	1.5	8.8	5.8	5.49
1967	16.3	7.29	4.7	24.7	5.3	– 9.6	5.3	2.6	4.5	4.2	5.9	7.8	1.04
1968	19.7	6.66	5.7	28.0	6.4	18.0	– 0.8	7.0	5.0	3.1	7.9	2.6	1.03
1969	21.0	8.39	8.7	30.3	9.4	15.1	14.4	10.7	6.5	9.6	12.3	12.1	2.04
1970	19.3	7.78	7.9	27.7	7.7	17.6	12.2	10.2	6.5	– 0.2	15.3	– 1.8	3.00
1971	19.3	8.55	8.2	29.4	6.9	10.0	11.9	9.5	6.5	– 2.9	11.7	– 2.4	2.91
1972	0.5	9.37	8.7	31.3	8.5	17.4	23.0	14.3	6.5	– 5.3	12.8	– 3.8	4.72
1973	21.3	8.44	8.2	31.4	7.0	8.6	23.3	14.8	9.0	– 5,4	18.5	1.2	15.32
1974	15.7	7.51	– 2.1	24.2	– 3.7	3.3	0.2	– 2.0	8.0	– 8.2	13.3	5.0	26.56
1975	15.5	9.12	4.5	22.9	5.9	–13.0	10.7	4.4	10.0	– 4.6	6,5	6.9	13.58
1976	16.0	8.22	5.6	23.0	6.2	– 1.7	16.3	10.0	10.0	– 5.0	7.1	9.6	13.04
1977	17.7	5.34	3.6	23.9	3.4	– 3.3	1.8	1.5	11.0	– 2.3	4.9	6.1	12.50
1978	17.5	5.15	5.4	23.8	6.5	–10.7	16.3	7.3	14.0	– 4.0	3.8	6,3	12.39
1979	18.2	5.41	4.4	24.9	3.6	21.0	6.8	5.9	15.9	– 3.0	8.0	1.6	19.01
1980	16.4	5.18	2.1	22.9	1.7	7.6	6.9	1.0	19.8	– 0.7	7.8	6.5	24.92
1981	14.8	5.19	– 0.1	21.2	0.0	– 7.1	– 5.9	– 1.3	20.5	2.0	5.4	8.1	24.55
1982	14.1	5.55	0.0	20.7	0.4	– 5.9	– 7.2	– 5.3	20.5	2.2	– 4.7	15.1	20.94
1983	13.1	6.34	– 0.7	20.3	0.4	– 7.2	7.9	– 0.4	20.5	– 3.7	– 3.5	– 4.0	20.20
1984	11.2	6.85	2.0	18.7	2.7	– 1.3	16.9	2.2	20.5	3.3	–13.6	8.7	18.36
1985	11.1	7.34	2.4	19.1	3.1	– 9.0	1.3	1.2	20.5	0.7	–11.7	0.7	19.33
1986	11.3	5.99	0.1	17.6	1.6	17.3	14.0	– 0.7	20.5	– 5.6	– 0.4	–11.6	23.00

	PRI/GNI (1)	*GPUBI/GNI* (2)	*GGNI* (3)	*GFCF/GDP* (4)	*GGDP* (5)	*GMI* (6)	*GX* (7)	*GMO %* (8)	*ni* (9)	*ri* (10)	*prof* (11)	*rw* (12)	*inf* (13)
1987	11.7	4.23	0.2	16.8	− 0.7	− 2.0	16.1	− 2.1	20.5	9.6	2.4	3.2	16.42
1988	12.4	4.17	4.5	17.6	4.0	11.3	8.9	5.0	19.0	7.8	1.1	4.2	13.48
1989	–	–	–	18.7	3.4	5.0	1.4	2.3	19.0	1.6	5.1	− 3.0	13.72
1990	–	–	–	19.8	− 0.1	8.3	0.9	− 2.8	19.0	13.3	4.9	3.4	20.40
1991	–	–	–	19.1	1.8	–	2.5	–	19.0	–	–	–	19.51
Average:													
1954-1988	15.4	6.7	4.7	–	–	–	–	–	–	–	–	–	–
1954-1973	16.2	7.1	6.7	–	–	–	–	–	–	–	–	–	–
1974-1988	14.4	6.1	2.1	–	–	–	–	–	–	–	–	–	–
1960-1991	–	–	–	23.5	4.4	5.3	9.2	–	–	–	–	–	–
1960-1973	–	–	–	27.0	7.4	10.2	13.0	–	–	–	–	–	–
1974-1991	–	–	–	20.8	2.2	0.7	6.4	–	–	–	–	–	–
1979-1991	–	–	–	19.8	1.7	3.2	5.4	–	–	–	–	–	–
1954-1991	–	–	–	–	–	–	–	5.1	11.9	–	–	–	–
1954-1973	–	–	–	–	–	–	–	8.9	7.2	–	–	–	–
1974-1991	–	–	–	–	–	–	–	1.5	17.1	–	–	–	–
1979-1991	–	–	–	–	–	–	–	0.4	19.6	–	–	–	–
1959-1990	–	–	–	–	–	–	–	–	–	1.1	6.3	3.1	12.1
1958-1973	–	–	–	–	–	–	–	–	–	2.1	10.7	2.2	3.4
1974-1990	–	–	–	–	–	–	–	–	–	0.2	2.1	3.9	18.4
1979-1990	–	–	–	–	–	–	–	–	–	2.3	0.7	2.7	19.5

List of variables and sources

(*PRI*) is gross private investment, (*GNI*) is gross national income, and (*PUBI*) is public investment in million drs., and at constant 1970 prices [Paleologos (1989), appendix A and B].

(*GFCF/GDP*) is the ratio of gross fixed capital formation (total gross investment) to GDP at constant 1985 prices (OECD National Accounts).

(*GMI*) is the growth rate of investment in the Greek manufacturing sector (gross fixed capital formation in manufacturing at constant 1970 prices, and (*GMQ*) is the growth rate of manufacturing output [Kaskarelis (1993), table 1].

(*GX*) is the rate of growth of real exports (OECD National Accounts).

(*ni*) is the interest rate defined as the discount rate of the central bank in Greece, and (*inf*) is the inflation rate calculated from consumer price indices, 1985 = 100 (IMF International Financial Statistics Yearbook).

(*ri*) is the real long-term interest rate obtained from the relation $(r - \Delta p)$ were r is the banks' interest rate for long-term industrial loans and p is the implicit investment price deflator in manufacturing, (*prof*) is a measure of capital profitability, defined as the ratio of net profits to own capital, and (*rw*) is manufacturing real wage defined as $\Delta(w - p)$ where w is the hourly earnings in manufacturing [Kaskarelis (1993), table 1].

On the other hand, the historical evidence of table 3.1 shows that investment volume fell rapidly after the two oil price crises (manufacturing investment growth reaching its minimum level of – 13 % in 1975), and the poor investment performance after 1973 is accompanied, on average, by lower output and export growth rates, higher nominal and real interest rates (especially in the latest period, 1979-1991), higher real wage growth (3.9 % versus 2.2 % in the pre-1973 period), higher inflation rate (18.4 % versus 3.4 %) and lower profitability (2.1 % versus 10.7 % in the pre-1973 period). In general, the evidence indicates that investment in Greece responds positively to quantity variables (output, government investment, exports) and negatively to relative price variables (interest rates, wages, inflation) and this is consistent with the flexible accelerator principle which includes both effects. To find the relative importance of the quantity and price variables is a question of formulating and estimating the investment function.

Some alternative specifications of the investment function have been estimated attempting to introduce the set of variables cited in table 3.1 and to measure their relative importance. The empirical analysis at this stage will avoid the difficult issue of finding the exact functional form of the investment function, since there is no agreement on this. Accordingly, the analysis is more of an exploratory data analysis, trying to identify the crucial factors which explain private investment behaviour in Greece. Within this context, the first estimated equation takes the form of an accelerator-relative costs-profits specification and considers the ratio of private investment to gross national income as a linear function of the lagged real GNI growth rate (the accelerator factor), the ratio of public investment to GNI (additional demand factor), the real interest rate and real wage rate (input cost factors), and finally the rate of profitability in manufacturing (financing constraint factor). The functional specification which attempts to reconcile the acceleration theory and neo-classical relative costs theory, assumes the standard acceleration form, and subtracts the relative cost factor, taking the form which is explained below ([5]):

$$I_t = (1 - \beta) I_{t-1} + a\beta(\Delta Y_t) - c\beta\sigma[\Delta(W/C)_t] \qquad \textbf{(3.1)}$$

where β is the coefficient of adjustment, a and c are the coefficients of output and relative cost, respectively, in the desired capital stock equation, σ is the elasticity of substitution between labour and capital, C is the user cost and W the unit cost of labour. If $\sigma = 0$, the model is reduced to the flexible accelerator, and $\sigma = 1$ reflects the pure neo-classical version of the flexible accelerator.

A number of different forms of equation **3.1** have been estimated, and the equation which gives the best results, for the period 1959-1988, is reported below:

$$\underset{(6.4)}{(PRI/GNI)_t} = \underset{(3.15)}{12.6 + 0.466(GGNI)_{t-1}} + \underset{(0.105)}{0.032(PUBI/GNI)_t} - \underset{(-0.33)}{0.030(ri)_t} + \qquad \textbf{(3.2)}$$

$$+ \underset{(1.17)}{0.088(rw)_t} + \underset{(1.77)}{0.127(prof)_{t-1}}$$

([5]) For this specification see Kaskarelis (1993).

$$R^2 = 0.535,\ SE = 2.05,\ DW = 1.48$$

$$\text{Func. form.} = 3.88,\ \underset{(1,23)}{}\ \text{heter.} = 5.40,\ \underset{(1,28)}{}\ n = 30$$

The regression results of equation **3.2** indicate that the accelerator is the predominant factor in explaining private investment in Greece, both in terms of its absolute magnitude and its statistical significance. The effect of public investment is positive, and this supports the hypothesis of «crowding-in» effects of public investment to private investment with complementary characteristics. However, its importance is dubious since it is found to be statistically insignificant ([6]). The effect of the real interest rate as a factor cost occurs with the negative sign, as expected, but it is also not statistically significant. On the other hand, the effect of real wages carries the wrong (positive) sign, but it is not statistically significant. Finally, lagged profits are found to affect positively private investment, and its impact is statistically significant at the 10 percent level. The estimated equation **3.2** seems to suggest (with certain statistical limitations), that an accelerator-profit, rather than an accelerator-relative cost-profit, version is more appropriate to explain private investment in Greece ([7]).

It has been argued by Green and Villanueva (1991) that, especially for countries with imperfections in capital markets (limited stock exchange markets, credit rationing, interest rate ceilings, etc.), income per capita is an important factor in the realization of private investment projects, since a substantial part must be financed through domestic savings. Within this context, private investment activity is expected to be positively related to the per capita income variable. To test this hypothesis, the level of per capita income (*GDPpc*) — at constant 1985 US dollars — has been introduced in equation **3.2** as an additional explanatory variable. With this new specification, it can be argued that private investment in Greece is financed by two important domestic streams: the retained profits and previously accumulated private savings. When equation **3.2** is estimated with the level of per capita income variable, over the period 1960-1988, it yields the following results:

$$\underset{(1.85)}{(PRI/GNI)_t = 7.06} + \underset{(2.42)}{0.356(GGNI)_{t-1}} + \underset{(1.01)}{0.328(PUBI/GNI)_t} + \qquad \textbf{(3.3)}$$

$$+ \underset{(0.26)}{0.025(ri)_t} + \underset{(3.55)}{0.244(prof)_t} + \underset{(1.75)}{0.118(rw)_t} + \underset{(1.67)}{0.0012(GDPpc)_t}$$

$$R^2 = 0.64,\ SE = 1.81,\ D.W. = 1.35$$

$$\text{Func. form.} = 0.03,\ \underset{(1,21)}{}\ \text{heter.} = 0.44,\ \underset{(1,27)}{}\ n = 29$$

([6]) Tun Wai and Wong (1982) also found a positive response (and statistically significant) of private investment to government investment in the case of Greece.

([7]) Kaskarelis (1993) derives the same conclusion estimating an error correction model of manufacturing investment in Greece.

Comparing equations **3.2** and **3.3** the latter shows an improvement in the degree of explanation of the explanatory variables (from 53 % to 64 %), a smaller standard error of the regression, and an improvement in the acceptance level of the functional form and homoscedasticity. The per capita income variable exerts a positive impact on private investment and it is statistically significant at the 10 % level. With the introduction of the per capita income variable, the impact and significance of the profit and government investment variables have been improved, and the constant term is less important. The impacts of the relative cost variables, however, continue to be statistically insignificant. The results of the estimated equation **3.3**, in general, appear to suggest that the accelerator-profit version of the investment function is improved substantially when the level of per-capita income variable is introduced, reflecting the importance of domestic savings as a source of financing investment projects in Greece.

4 — The importance of the external constraint on investment. The case of Greece and Portugal

It has been argued especially for the case of the developing countries that foreign exchange can be a constraint on investment and that investment is very sensitive to import capacity. When a country is highly dependent on the import of capital goods and other inputs, such as machinery, raw materials, new technology, energy etc., and suffers from a chronic deficit on the external account, then investment and growth in the long-run is likely to be constrained by a shortage of foreign exchange. In this case, normally, the authorities will be forced to regulate growth in order to meet balance of payments or exchange rate targets.

The important issue of the influence of external conditions on investment decisions is considered here examining the question of whether the investment performance in Greece and Portugal is subject to an external constraint. Greece experienced a chronic balance of payments deficit, especially in the post oil-crisis period, and policy measures have been taken to regulate external imbalances. These measures have often involved short austerity programmes (1983, 1986, 1990) which have been accompanied by restrictions on demand and high interest rates (in order to attract capital flows from abroad), both measures which are inimical to the domestic investment environment. Similar balance of payments problems appear to explain the external debt crisis in Portugal, especially for the period 1974-1986. The democratization process after the collapse of the dictatorial regime in 1974, is characterized by a greater openness and interdependence of the economy with other OECD countries (especially with EEC countries). The deterioration of the external payments situation forced the country to accept the IMF intervention, signing two stand-by agreements in 1979 and 1983 respectively, followed by the usual structural stabilization programmes and restrictive measures on demand. Only since 1986, has Portugal shown signs of recovering, which coincides with Portugal's membership of the EC and relative political stability.

To test the external constraint hypothesis in the investment function, FitzGerald, Jansen and Vos (1993) have suggested a simple approach where investment is a function of the change in import capacity, the latter defined as the sum of exports, net capital inflows less the interest payments on external

debt. Consequently, import capacity is limited by external factors, such as, export competitiveness, the terms of trade, external credit rationing and exogenous increases in interest rates on outstanding international debt. All the above factors will reduce funds available for investment. Estimating the above relation, in a pooled cross section-time series analysis, for a sample of 22 less developed countries, the above authors found a strong positive impact of the change in import capacity on private investment, showing that external factors are important in explaining private investment behaviour in developing countries.

A similar approach is used here to test the importance of the external constraint on investment behaviour in Greece and Portugal. The model assumes that the actual capital stock is exclusively a function of the import capacity, hence the investment function based on the accelerator principle can be specified in the following simple linear form:

$$GDI_t = a_0 + a_1(MC_t - MC_{t-1}) + a_2 GDI_{t-1} \qquad \textbf{(4.1)}$$

where *GDI* is gross domestic investment and *MC* is the capacity to import, both measured in domestic currency at 1980 prices (billions of 1980 Greek drachmas and Portuguese escudos, respectively), and the data are taken from the World Tables of the World Bank (1993). The estimation of equation **4.1**, for the period 1967-1987, yielded the following results:

Greece:

$$GDI_t = \underset{(1.78)}{78.75} + \underset{(2.46)}{0.927}\, DMC_t + \underset{(5.98)}{0.736}\, GDI_{t-1} \qquad \textbf{(4.2)}$$

$$R^2 = 0.67,\ SE. = 38.2,\ D\text{-}h. = 0.14$$

$$\underset{(1,17)}{\text{Func. form.} = 0.25},\ \underset{(1,19)}{\text{heter.} = 2.16}$$

Portugal:

$$GDI_t = \underset{(1.56)}{66.89} + \underset{(1.19)}{0.242}\, DMC_t + \underset{(6.07)}{0.798}\, GDI_{t-1} \qquad \textbf{(4.3)}$$

$$R^2 = 0.64,\ SE. = 43.2,\ D\text{-}h. = 1.95$$

$$\underset{(1,17)}{\text{Func. form.} = 1.44},\ \underset{(1,19)}{\text{heter.} = 7.74}$$

As can be seen, the estimated equation **4.2** for Greece is well determined, showing a strong positive accelerator effect of the change in the capacity to import variable on gross domestic investment, and this impact is statistically significant at the conventional probability levels. The response of gross investment to changes in the capacity import variable is also positive in the case of Portugal, but statistically insignificant. Further attempts to estimate equation **4.3** for Portugal, using different sources of data and different periods of estimation, showed that the relation is unstable and very sensitive to different periods of

estimation. For instance, a regression over the period 1967-1982 gives an estimated coefficient of the change in capacity import variable of 0.493 with a *t*-ratio of 2.66 which is statistically significant at the 5 % level. Another estimation over the short period 1972-1982, gives an estimated coefficient of 1.02 with a *t*-ratio of 3.33. The relation also appeared to be very sensitive to the introduction of dummy variables expressing the unfavourable conditions of political instability during the democratization process. The most disturbing years appeared to be 1974-1975, during the fall of the dictatorial regime and the installation of democracy, and 1984-1985 after the second financial aid agreement with the IMF. Despite the statistical inefficiencies in the case of Portugal, the evidence for both countries seems to suggest that external market conditions (related to the balance of payments performance) have a reasonable influence on the investment process, and these conditions cannot be ignored when the investment activity is modelled.

To test further the effects of the external factors on investment behaviour, an alternative form of the investment function has been estimated where the external variables (exports, capital flows, and external debt or interest payments on debt) are entered individually. For Greece, the most satisfactory results are obtained when the gross domestic investment-output ratio (*GDI/GDP*) is specified as a function of the growth rate of exports (*GX*), the growth rate of net capital flows (*GNCF*) and the change in the amount of the external debt ($\Delta DEBT$) ([8]). All variables are measured in current US dollars, except for the investment-output ratio which is measured in domestic currency at 1980 prices [the data are taken from the World Bank, World tables (1993)]. The estimated equation covers the period 1970-1987 and gave the following results ([9]):

Greece:

$$(GDI/GDP)_t = \underset{}{27.7} + \underset{(16.3)}{0.165}(GX)_t + \underset{(2.61)}{0.063}(GNCF)_t - \underset{(2.33)}{0.0039}(\Delta DEBT)_t \quad \underset{(-4.20)}{} \quad \textbf{(4.4)}$$

$$R^2 = 0.73,\ SE = 3.18,\ DW = 1.76$$

$$\underset{(1,12)}{\text{Func. form.} = 1.63},\ \underset{(1,15)}{\text{heter.} = 0.36},$$

$$\underset{(3,13)}{F - \text{stat.} = 15.2},\ \underset{(1,12)}{\text{Serial correl.} = 0.012},\ n = 17$$

The regression results reveal that the investment-output ratio in Greece is positively related to the growth of exports and the growth of capital inflows ([10]),

([8]) The change in long-term interest payments on debt has also a negative effect on investment but was found to be less significant.

([9]) The investment-output ratio measured in dollars at 1985 price level also has been used as the dependent variable, but the results were identical to equation **4.4**.

([10]) Tun and Wong (1982), in a study for a sample of developing countries, also found that capital inflows had a positive effect on private investment in Greece, for the period 1960-1976. They conclude that foreign capital inflow helps to overcome the savings constraint in the financing of investment.

and negatively related to the change in the amount of the external debt, and all effects are statistically significant at the conventional probability levels. Export growth appears to have a more significant impact (in absolute magnitude) on gross investment, than other external factors, and this confirms Kaldor's argument that the growth of exports is a fundamental determinant of investment, and in some circumstances is the engine of economic growth. The negative effect of the change in external debt (or interest payments on debt) shows that this factor is a significant external constraint on gross investment in Greece.

In the case of Portugal, some selected estimated equations are reported below which give some insights into the importance of the external determinants of investment and the relevance of the external constraint hypothesis:

Portugal — period 1971-1989:

$$(GDI/GDP)_t = \underset{(1.51)}{10.07} + \underset{(2.18)}{0.113}(GX)_t + \underset{(1.57)}{0.0016}(dNCF)_t - \underset{(-1.69)}{0.00024}(DEBT)_{t-1} + \underset{(4.22)}{0.702}(GDI/GDP)_{t-1} \quad \textbf{(4.5)}$$

$R^2 = 0.70$, $SE = 3.22$, $D\text{-}h = 1.25$

Func. form. = 0.075, heter. = 0.92, $n = 18$
(1,12) (1,16)

Portugal — period 1971-1989:

$$(GDI/GDP)_t = \underset{(1.49)}{9.65} + \underset{(2.10)}{0.109}(GX)_t + \underset{(1.51)}{0.0015}(dNCF)_t - \underset{(-1.71)}{0.00032}(INTP)_{t-1} + \underset{(4.28)}{0.705}(GDI/GDP)_{t-1} \quad \textbf{(4.6)}$$

$R^2 = 0.70$, $SE = 3.21$, $D\text{-}h = 1.14$

Func. form. = 0.22, heter. = 0.001, $n = 18$
(1,12) (1,16)

Portugal — period 1972-1985:

$$(GDI/GDP)_t = \underset{(1.64)}{10.21} + \underset{(2.18)}{0.134}(GX)_t + \underset{(3.25)}{0.0048}(dNCF)_t - \underset{(-1.08)}{0.00016}(DEBT)_{t-1} + \underset{(4.14)}{0.674}(GDI/GDP)_{t-1} \quad \textbf{(4.7)}$$

$R^2 = 0.74$, $SE = 2.80$, $D\text{-}h = 0.86$

Func. form. = 0.85, heter. = 0.45
(1,12) (1,16)

Predictive failure = 2.05, $n = 14$.
(4,9)

Equations **4.5** and **4.6** both estimate the investment-output ratio (*GDI/GDP*) of Portugal for the whole period 1971-1989 where data are available, and the only difference is that the former uses external debt (*DEBT*) as an explanatory variable and the latter uses the long-term interest payments on the outstanding debt (*INTP*), while all other variables are the same. Both equations confirm that the most significant accelerator effect on the investment-output ratio comes from the growth of exports. The impact of the change in net capital flows is also positive as expected, but not statistically significant. The outstanding debt or the external debt service payments of the previous period have also the expected negative influence on investment, but are also statistically insignificant. Finally, when the estimated equation covers the shorter period 1972-1985, the only insignificant effect comes from the external debt variable, while the impact of export growth and the change in capital flows is relatively stronger on the investment-output ratio.

In sum, it has been found that another exogenous demand factor as measured by the import capacity variable (reflecting the effects of change in external conditions) can influence substantially investment behaviour, in countries such as Greece and Portugal with balance of payments difficulties. In particular, export growth seems to exert a dynamic significant influence on investment, and to a lesser extent changes in capital flows, while the change in external debt (or interest rate payments on debt) seems to suggest a serious external constraint on investment, especially in the case of Greece. The empirical analysis of Greece and Portugal provides evidence that the increase in export growth and reduction in capital flight and external debt are essential to lift existing constraints on investment.

5 — Final concluding remarks

In first place, the empirical analysis of the private investment function in Greece reveals that demand factors, such as, the growth of output, per capita income, and to a lesser extent public investment, are important determinants of private investment, while relative factor costs are less important. Profitability is also shown to have a substantial influence on private investment, suggesting that a flexible accelerator-profit variable specification is more appropriate to explain the private investment pattern in Greece. The empirical analysis has also shown that the flexible accelerator-profit specification is improved when per capita income is included as an explanatory variable.

In second place, the empirical analysis of investment in Greece and Portugal, when modified to include external determinants, shows that gross domestic investment is very sensitive (especially for Greece) to changes in external conditions, as measured by the import capacity variable, suggesting that export receipts, capital flows and sustained external debt can generate important domestic funds to be allocated to investment projects. The emphasis is given to the dynamic effects of exports on investment, which confirms Kaldor's early argument that exports can release the foreign exchange constraint and it is the only component that can pay the import content of other components of demand, such as investment.

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