DETERMINING FACTORS OF INVESTMENT ACTIVITY IN GREECE IN THE FIELD OF PROCESSING

Nicolaos Dritsakis¹

Summary

This paper is an endeavour to investigate the factors effecting investment in Greece. It is limited to the presentation of certain results related to the processing sector. Investment activities were investigated with the help of investment equations, which belong to a restricted macro-econometric sample. The estimates of the equations from the model were made with the ordinary least squares method in two stages, using cumulative data (from the public and private sectors) for the period of 1961 to 1992. The Gross National Product, the long-term interest rate and the profit margin were used as determining variables in the investment equations. The control of the sensitivity of investment activities in various economic policies (income and monetary) was done with the help of the dynamically simulated sample and the corresponding dynamic multipliers.

1. Introduction

In terms of annual percentage changes, investment (at steady rates) in Greece showed a spectacular increase between 1961 and 1973, and after 1974 to 1984 they showed a significant drop. Since 1985, there have sometimes been increases (1985, 1988-1990) and sometimes decreases (1986-1987, 1991-1992). This investment behaviour has caused the Greek economy to develop problematically over the last decade, as is shown by the low annual percentage increase in GNP and the high level of unemployment.

Furthermore, the low profit, the massive gross public debt, and the very high inflation rate had resulted in various governments following spasmodic, restrictive economic policies, both with regard to income and monetary policy, and this resulted in keeping a tight rein on wages and a reduction in the money supply, leading to the maintenance of interest rates at a high level.

The objective of this paper is to investigate factors determining investment in Greece, particularly in the processing sector.

Part 2 of this paper presents the specialisation of the model used to investigate investment activity. The estimates of this model, as well as the significance of these investment are discussed in part 3. Part 4 deals with the ability to forecast and sensitivity controls on the dynamically simulated model. Finally, part 5 summarises the basic conclusions of this paper.

¹ Department of Applied Informatics, University of Macedonia, Thessaloniki (Greece).
2. The theoretical model

The investment equations are perhaps the most basic equations in macro-economic models, moreover there is significant diversification in these equations, both with regard to their analytic expression and the interpretative variables that they include. Following the work of Haavelmo (1960), Klein and Goldberger (1964), Almon (1968), Carter and Brondy (1968), Hawkins and Pearce (1971), Gandolfo (1981), Knight and Wymer (1981), Catinat et al (1987), Kaskarelis (1993), we assume that the actual level of investment in processing (IM) depends on the following factors:

1. The level of actual cumulative demand (GNP): The higher the demand, the higher is the level of investment.
2. The level of profitability of the capital (PROF): The higher the level of profitability, the higher the level of investment.
3. The level of long-term interest rates (RL): The higher the level of interest rates, the lower the level of investment.
4. The dynamism of investments: Investments of one period depend on the investment of the previous period.

According to the above suppositions, the equation for investment in processing is written in linear form as follows:

\[ IM_t = a_0 + a_1 GNP_t + a_2 PROF_t + a_3 RL_t + a_4 IM_{t-1} \]  

where: \( a_1 > 0, \ a_2 > 0, \ a_3 < 0, \ 0 < a_4 < 1 \)

Equation (1) may be considered the result of the theory of «cost profit model of the accelerator» (Catinat et al, 1987: Katos et al 1996).

Following Pindyck and Rubinfeld (1986), Durnbush and Fischer (1990) and Parking (1993) the above equation is accompanied by the following equations:

The equation identifying the long-term interest rate (RL), regarding which we suppose that the level of the long-term interest rate depends on the following factors:

1. On the level of actual cumulative demand (GNP): The higher the demand, the higher the level of the long-term interest rate.
2. The short-term interest rate level (RS): The higher is the level of the short-term interest rate, the higher is the level of the long-term interest rate.
3. The inflation rate (PR): The higher the inflation rate, the higher is the level of the long-term interest rate.
4. The dynamism for long-term interest rate: The level of the interest rate in one period depends on the level of the interest rate in the preceding period.
According to the above suppositions, the equation for the long-term interest rate is written in linear form as follows:

\[ RL_t = b_0 + b_1 GNP_t + b_2 RS_t + b_3 PR_t + b_4 RL_{t-1} \]  

(2)

where:  \( b_1 > 0, \ b_2 > 0, \ b_3 > 0, \ 0 < b_4 < 1 \)

The equation identifying the short term interest rate (RS), for which we suppose that the level of the short-term interest rate depends on the following factors:

1. The level of actual cumulative demand (GNP): The higher the demand, the higher the level of the short-term interest rate.
2. The level of the money supply (MS): The higher the money supply level, the lower the level of the short-term interest rate.
3. The dynamism of the short-term interest rate: The level of the interest rate in one period depends on the level of the interest rate in the previous period.

According to the above suppositions, the equation of the short-term interest rate is written in linear form as follows:

\[ RS_t = c_0 + c_1 GNP_t + c_2 MS_t + c_3 RS_{t-1} \]  

(3)

where:  \( c_1 > 0, \ c_2 < 0, \ 0 < c_3 < 1 \)

The equation defining the prices levels (PR), regarding which we suppose that the level of prices depends on the following factors:

1. The level of wages (IWAGES): The higher the level of wages, the higher the level of prices.
2. The level of the money supply (MS): The higher the level of the money supply, the higher the level of prices.
3. The dynamism of prices: The prices of one period depend on the prices of the previous period.

According to the above suppositions the equation for the level of prices is written in linear form as follows:

\[ PR_t = d_0 + d_1 IWAGES_t + d_2 MS_t + d_3 PR_{t-1} \]  

(4)

where:  \( d_1 > 0, \ d_2 > 0, \ 0 < d_3 < 1 \)

In the system of the above four equations, the clearly external factors are cumulative demand (Q), profitability (PROF), the money supply (MS), and the level of wages (IWAGES). Of these external variables, the money supply and wages may be considered to be variables of monetary and incomes policy respectively.
The estimated model

The model of the four simultaneous equations was assessed using the ordinary least squares method in two stages (2SLS), using the Microfit 3.11 package.

The identification of data used in the assessments is as follows:
- IM = Gross investment of fixed asset in processing at steady 1970 rates (Greek National Statistical Services, National Accounts).
- GNP = Gross National Product at steady 1970 rates (Greek National Statistical Services, National Accounts).
- PROF = Profitability of capital (%) (Eurostat and Commission Services).
- MS = Money supply at steady 1970 rates (Bank of Greece, monthly Statistics bulletins).
- PR = The deflator Gross National Product (Greek National Statistical Services, National Accounts).
- IWAGES = Indicator of workers’ wages with 1970 as a base (European Economy).
- t = Time trend.

**The function for investment in processing:**

\[
IM_t = -13528.8 + 0.019333 GNP_t + 108.0002 PROF_t -7.2376 RL_t + 0.29384 IM_{t-1} \quad (5)
\]

\[
\begin{array}{ccc}
\beta_1 & \beta_2 & \beta_3 \\
\end{array}
\]

\[
\tilde{R}^2 = 0.96459 \quad h = 0.98142 \quad F(4,26) = 198.500
\]

- A: \(X^2(1) = 1.6959, (0.193)\)
- B: \(X^2(1) = 0.0839, (0.772)\)
- C: \(X^2(2) = 0.0545, (0.973)\)
- D: \(X^2(1) = 0.6034, (0.437)\)
- E: \(X^2(7) = 10.795, (0.148)\)

**The function long-term interest rate:**

\[
RL_t = -4.0039 + 0.00003228 GNP_t + 0.94723 RS_t -2.2781 PR_t + 0.45314 RL_{t-1} \quad (6)
\]

\[
\begin{array}{ccc}
\beta_1 & \beta_2 & \beta_3 \\
\end{array}
\]

\[
\tilde{R}^2 = 0.98925 \quad h = 1.1185 \quad F(5,25) = 552.953
\]
Function of the short-term interest rate:

\[ RS_t = -4,2632 + 0,00004713 \text{ GNP}_t - 0,00000538 \text{ MS}_t \]
\[ + 0,72342 RS_{t-1} \quad (7) \]

\[ R^2 = 0,96763 \quad h = 1,17452 \quad F(4,26) = 225,209 \]

Function for the level of prices:

\[ PR_t = 46,3026 + 0,28327 \text{ IWAGES}_t + 0,0002931 \text{ MS}_t \]
\[ + 0,13793 PR_{t-1} \quad (8) \]

\[ R^2 = 0,99962 \quad h = 0,85481 \quad F(3,27) = 2613,0 \]
In the above estimates, the symbols indicate:

\( \bar{R}^2 \) = Coefficient of determination (corrected for the degrees of freedom).

\( h \) = Durbin's h statistic.

\( F(i,j) \) = Statistic of distribution F for the regression.

A: \( X^2(i) \) = Lagrange multiplier test of residual serial correlation.

B: \( X^2(i) \) = Ramsey's RESET test using the square of the fitted values, for apuation specification.

C: \( X^2(i) \) = Based on a test of skewness and kurtosis of residuals, for testing normality.

D: \( X^2(i) \) = Based on the regression of squared residuals on squared fitted values, for testing heteroscedasticity.

E: \( X^2(i) \) = Sargan's test using the (2SLS) method.

[ ] = The numbers in brackets under the coefficients represent the t-statistics.

( ) = The number in parentheses under the diagnostic tests represent the level of significance.

The above estimations are generally accepted, as shown by the statistical and diagnostic controls accompanying the estimations, as well as the fact that the signs of the parameters that we estimated coincide with the signs of the a priori restrictions we developed in the model of part 2.

Although in the following section we will present the prognostic capability of the dynamically simulated model, we consider it advisable to point out here the average flexibility that results from the estimations of the four equations of the model. These flexibilities are presented in table 1. (The corresponding long-term flexibilities are noted in brackets).

### Table 1

**The elasticity at the sample means**

<table>
<thead>
<tr>
<th></th>
<th>GNP</th>
<th>PROF</th>
<th>RL</th>
<th>RS</th>
<th>MS</th>
<th>PR</th>
<th>IWAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.65637</td>
<td>0.71266</td>
<td>-0.5236</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.9294)</td>
<td>(1.0092)</td>
<td>(-0.741)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RL</td>
<td>0.85315</td>
<td></td>
<td></td>
<td>0.67796</td>
<td>0.09818</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.5600)</td>
<td></td>
<td></td>
<td>(1.2397)</td>
<td>(0.1795)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS</td>
<td>1.74357</td>
<td></td>
<td></td>
<td></td>
<td>-0.2106</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(6.3040)</td>
<td></td>
<td></td>
<td></td>
<td>(-0.761)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.24382</td>
<td>0.54023</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.2828)</td>
<td>(0.6266)</td>
</tr>
</tbody>
</table>

From the data in table 1, it is clear that the investment in processing are inflexible as regards cumulative demand in the Greek economy. The long-term interest rate is inflexible as regards cumulative demand, unlike the short-term interest rate that is flexible. With regard to the remaining flexibilities, it is clear that all flexibilities are considerably less than one unit.
4. The simulated model.

Table 2 shows the indicators of the variables of the model, which we took from the dynamic simulation of the system of the four estimated equations, using PCTSP 4.2. In these table:
CC = Correlation coefficients of actual and predicted variables.
RC = Regression coefficients of actual on predicted variables.
U = Theil’s inequality coefficient.
UM = Fraction of error due to bias.
US = Fraction of error due to different variation.
UC = Fraction of error due to difference covariation.

<table>
<thead>
<tr>
<th></th>
<th>CC</th>
<th>RC</th>
<th>U</th>
<th>UM</th>
<th>US</th>
<th>UC</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.97674</td>
<td>1.01657</td>
<td>0.06384</td>
<td>0.000006</td>
<td>0.03321</td>
<td>0.96679</td>
</tr>
<tr>
<td>RL</td>
<td>0.98378</td>
<td>1.00192</td>
<td>0.07223</td>
<td>0.000003</td>
<td>0.01019</td>
<td>0.98981</td>
</tr>
<tr>
<td>RS</td>
<td>0.98474</td>
<td>0.99548</td>
<td>0.07885</td>
<td>0.000016</td>
<td>0.00384</td>
<td>0.99601</td>
</tr>
<tr>
<td>PR</td>
<td>0.99955</td>
<td>0.99818</td>
<td>0.02278</td>
<td>0.000171</td>
<td>0.00205</td>
<td>0.99779</td>
</tr>
</tbody>
</table>

The indicators in table 2 show that the prognostic capacity of the dynamically simulated model is quite satisfactory, so that it is possible to use it either for forecasts or for analysis of sensitivity in various economic policies.

Tables 3 and 4 present the dynamic multipliers % of the four endogenous variables of the model. These multipliers came from disturbances in the external variables «money supply» and «wages levels». These disturbances concern the increase in the price of the corresponding external variables for a certain year (e.g. 1962) and are equal to 5% of the actual rate corresponding to this year. The rates of the multipliers are the reasons % of the dynamic solution of simulation which came from the disturbance of external variables, as regards the dynamic solution of simulation (that is the basic solution, without the disturbance).

<table>
<thead>
<tr>
<th>Year</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM</td>
<td>0.02135</td>
<td>0.03342</td>
<td>0.06909</td>
<td>0.04173</td>
<td>0.00932</td>
<td>0.17491</td>
</tr>
<tr>
<td>RL</td>
<td>0</td>
<td>0.09302</td>
<td>0.16592</td>
<td>0.18604</td>
<td>0.17325</td>
<td>0.61824</td>
</tr>
<tr>
<td>RS</td>
<td>0</td>
<td>0.06524</td>
<td>0.08927</td>
<td>0.11508</td>
<td>0.12602</td>
<td>0.39561</td>
</tr>
<tr>
<td>PR</td>
<td>1.20481</td>
<td>2.85522</td>
<td>1.74853</td>
<td>1.38641</td>
<td>0.87682</td>
<td>8.07179</td>
</tr>
</tbody>
</table>
From tables 3 and 4 show the following:
1. The multipliers are larger (at absolute rates) when they are calculated for «autonomous» variables in the money supply, than when they are calculated for changes in the level of wages.
2. The greatest action of the multipliers takes place in the first five years, and thereafter they head for saturation level in relation to time.
3. Most multipliers reach their rate (positive or negative) in the first or second year of the disturbance and thereafter move smoothly towards zero.
4. The economic analysis of the multipliers is as follows: The result of an initial increase in the money supply is a direct increase in inflation and a reduction in the short-term interest rate, and indirectly, a reduction in the long-term interest rate. As a result of the reduction in interest rates, investment increase. On the other hand, an initial increase in the level of wages causes an immediate increase in inflation levels, which cause the long-term interest rate to rise, although the short-term interest rate does not appear to be significantly affected. Investment in processing show minimal increase.

5. **Conclusions**

The econometric investigation of the model showed that:

With regard to the factors determining investments in processing, according to the assumptions made in part 2, it seems that the proportion of profit is the most important factor in determining investments (beta=0,78053), the following factor is the interest rate level (beta=0,65115), and the final factor is the cumulative demand (beta=0.63187). In particular, small decreases in interest rates or small increases in wages do not bring about significant changes in the investment activity in processing. Additionally, other important factors affecting investment in processing are the following.
1. Recession and competitive tendencies at home and abroad.
2. The course of inflation as it influences financial-economic indicators and the forecast of the costs and benefits of investment.
3. Devaluations of major currencies, the course of interest rates internationally, the available incomes and consumer preferences.
4. Technological investment.
5. Environmental controls.
6. The rate of increase of GNP, since when the national product stops increasing as much as in the past, the level of economic activity falls.
7. The rate of change of the money supply, as it has a direct effect on investment from the banking systems.
6. References


