Classical Theory of Investment. Panel Cointegration Evidence from Thirteen EU Countries

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9 December 2014

CLASSICAL THEORY OF INVESTMENT: PANEL COINTEGRATION EVIDENCE FROM THIRTEEN EU COUNTRIES

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Abstract

In the realm of macroeconomic theory, is well established that investment decisions play an instrumental role in the determination of the level of output and employment; nevertheless, little progress has been made in relation to the theoretical aspects of these decisions. This paper, inspired by the classical approach to capital accumulation as well as the Keynesian theory of effective demand, attempts to enhance our empirical understanding of what determines investment decisions by exploring profitability, financial as well as demand factors. In so doing, a *Fully Modified OLS* panel cointegration framework, for a cluster of two distinct groups of EU countries classified as core and the peripheral economies, provides the platform upon which our econometric investigation takes place. The respective evidence generated from the estimation process is in line with the theoretical framework proposed in this study.

Key Words: Investment demand, incremental rate of profit, panel data, European economies

Jel Classifications: B50, B51, E20, E22, C51, C52

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1. Introduction

The great recession of 2008 in conjunction with its concomitant implications i.e. the slowdown in capital accumulation and the inexorable high levels of unemployment across many EU countries, has naturally given rise to a host of questions regarding the determinants of investment as well as the nature of the economic environment conducive to economic growth. Although investment is generally recognized as the key variable to promote economic growth and reduction of unemployment; nevertheless the precise nature of the investment decisions remains a puzzling and still largely unresolved question in economic theory and that little progress has been achieved. Of course, we know that the investment decisions are motivated by profit, but the precise modelling of a well behaved investment function with profitability as the principal independent variable remains an open question, inasmuch as in this function enter arguments such as uncertainty and expectations which are very hard to quantify let alone theorize.

Given the above outlined difficulties, this paper makes no claims to deal with the hard theoretical questions determining investment decisions and its purpose is restricted to the use of a much more modest theoretical framework within which empirical investigation may be carried out. More specifically the objective of this paper is twofold in a sense that it attempts on the one hand to explore the conditioning factors of investment decisions, and on the other hand attempts to shed some light on the relative importance of these factors in both the short and the long-run. Our data set consists of 13-EU countries which for the purpose of our investigation is split into two clusters: the core economies (Belgium, Denmark, France, Netherlands, Austria, Finland, Sweden, UK) and peripheral (Portugal, Italy, Ireland, Greece and Spain) economies which share some commonality in economic environments and became historically known as PIIGS. Our endeavour is primarily focused on the extent to which there is a significant difference between the respective clusters of our sample in terms of the determination of investment. In passing, it should be stressed that the envisaged contribution of this study is on the empirical treatment of the investment function at hand.

The remainder of the paper is organized as follows: Section 2 reviews the relevant literature and examines the rationale behind the specification of the empirical model. Section 3 introduces the variables that will be used in the econometric specification and pays particular attention to the profitability variable and the rationale for its use. Section 4 sets out the econometric methodology adopted for the estimations. Section 5 presents and discusses the results of our econometric analysis. Finally, Section 6 concludes by delineating some policy implications.

2. Review of Literature

Investment activity is undoubtedly a source of economic growth, well-being and economic stability. Over the years, various theoretical frameworks have been put forward in an attempt to effectively explain variations in investment activity. It is well documented that investment expenditure is one of the key components of aggregate demand that conditions, through the introduction and diffusion of new technology, economic activity and hence, employment.

The standard neoclassical theory emphasizes the importance of interest rate and prices in general in the determination of investment decisions. On the other hand, the Keynesian and many heterodox economists place particular emphasis on the accelerator type of models and in so doing tend to downplay the role of prices and in particular the rate of interest. The neoclassical idea is that the rate of interest implies an investment demand schedule and that the equality of savings and investment is attained through variations in the rate of interest and that full employment level of output can be established assuming that there is enough price flexibility. Furthermore, the investment demand schedule and the associated with it trade off between investment and rate of interest leads to the measurement of capital whose consistency with the requirements of the neoclassical theory of value necessitates the hypothetical one-commodity-world economy.[1] Eatwell and Millgate (2011) cast doubt on the alleged inverse relationship between investment and interest rate on the following grounds "[i]n neoclassical theory, investment is reduced to an element within the theory of value and distribution, the function relating investment to the rate of interest being confronted with a function relating saving to the rate of interest in order to determine the equilibrium volume of saving and investment. As the capital theory debates have shown, this view of investment is logically untenable" (Eatwell and Millgate, 2011, p. 168). Investment decisions in this perspective cannot be fully

[1] For the discussion of the famous capital theory controversies we recommend the readings conveniently collected in Eatwell, et al. (1993).

theorized, yet we can make some general remarks and select important variables such as demand growth - which is central in regulating investment decisions - but in no way these variables will they become part of a general theory of uncertainty-ridden investment decisions. This however by no means does it indicate that profitability and the interest rate are not linked to the investment decisions. On the contrary, investment decisions are governed by profitability and interest rate, but the inherent linkage should be assessed and understood within the process of capital accumulation (see also Eatwell and Milgate, 2011, pp. 168 and 228).

Despite the theoretical lacuna with respect to uncertainty characterizing the investment decisions, the old classical economists and Marx thought that the difference between the rate of profit and the rate of interest (i.e., the net rate of profit or "the rate of profit of enterprise" according to Marx) is a crucial determinant of investment. The same is true with Keynes (1936) whose investment decisions i.e., "the supply price of capital" depend on the difference between the marginal efficiency of capital (Keynes's definition of profitability) and the rate of interest. In similar fashion Kalecki (1968, pp. 96-99) emphasizes the net rate of profit as the key variable in the investment function and by doing so shares the view of profit-driven capital accumulation (see also Sawyer, 1985, p. 95).

In most of the early studies, investment expenditure is taken as the dependent variable either in absolute terms and measured in constant prices or as a percentage of the capital stock (i.e. the rate of capital accumulation). Junankar (1972) in his important study derived that the accelerator is a by far more important influence on investment than the rate of interest. This view is consistent with the ideas of Keynesian and post-Keynesian economists of the 1960s and 1970s, who downplayed the view that investment decisions of firms are regulated by the (real) rate of interest (assumed to be equal to the rate of profit) and that the level of demand is by far the most crucial variable in shaping these decisions. In this respect, it is interesting to note that Junankar (1972) who is apparently influenced by the capital controversies of the 1960s, is blatantly clear on issues relating to the measurement of aggregate capital stock in a way which is consistent with the tenets of the neoclassical theory. More specifically, he contends that problems relating to capital measurements can be surmounted by measuring capital in terms of actual markets prices. In the following years, a number of studies, utilising time-series econometric methodologies, provided evidence that prices may have a significant effect on investment decisions (see for instance Bean, 1981 and Catinat, *et al.,* 1987). In reviewing the past empirical studies of investment behaviour Chirinko (1993) reached the following general conclusion according to which neither the profit rate nor the interest rate (i.e., the price variables) prove to be statistically important in the investment decisions. He notes that "the response of investment to price variables tends to be small and unimportant relative to quantity variables" (Chirinko, 1993, p. 1906).

3. Price Variables and the investment flows

Although the past econometric literature deemphasized the importance of the so called price variables, this may be explained partly by the lack of reliable and long-run time series data; partly by the econometric techniques which suffered from a number of problems that now we can cope with using panel unit root tests and panel cointegration; finally, the econometric specification usually was not the most appropriate to capture the price variables. In our econometric specification, we take the growth rate of investment as the appropriate index which essentially indicates the acceleration or deceleration of capital accumulation. As independent variables, we include the incremental rate of profit as an index of profitability, the real prime interest rate as an index of financial conditions, the growth rate of real GDP as our proxy for the demand conditions or acceleration effects and we also use lags of the dependent variable to capture the possible cumulative and diffusion of technology effects of past investment activity. The major advantage of such econometric specification is that in our measure of profitability, we dispense altogether with the capital stock and the difficulties, theoretical and empirical, associated with its measurement as produced (means of production) goods. As a consequence, the gross investment expenditures, used in our profitability variable (see below), have the advantage that their measurement is straightforward and common across countries and also over the years.

The profitability conditions are captured by the incremental rate of profit (IROP), that is, the change in real gross profits over the real gross investment of the last period. The idea is that the economy-wide average rate of profit commonly used in investment or capital accumulation econometric specifications is a weighted average of all firms operating in all industries and it is not necessarily the rate of profit that actually becomes the magnet or repeller of the bulk of investment activity. Thus, the decisions to invest are motivated by the profitability of the leading firms (called "regulating capitals") activated in each industry.

The underlying principles of the IROP are described in Shaikh (1995) according to which investment is attracted more by the recent returns on investment rather than on returns on all past investment. Thus, starting from the current period flow of profits (Π_t) derived from two sources: first from the profits on most recent investment (I_{t-1}) multiplied by a markup (ρ) to be determined and second from the profits that accumulate to a firm from all other past investments (Π^*). Thus we may write:

$$\Pi_t = \rho I_{t-1} + \Pi^*$$

If we subtract profits of the previous period from both sides of the above equation we get:

$$\Pi_t - \Pi_{t-1} = \rho I_{t-1} + (\Pi^* - \Pi_{t-1}) \text{ or } \Delta\Pi_t = \rho I_{t-1} + (\Pi^* - \Pi_{t-1})$$

The term in parenthesis in the above equation is expected to be small, much smaller when compared to the term ρI_{t-1} which is another way to say that its total effect is negligible and for all practical purposes the profits of all past periods may be safely ignored (Shaikh, 1995; Elton, *et al.* 2003, ch. 18, p. 448). Vaona (2012) and Bahçe and Eres (2012) also argue that the term in the parenthesis is not only relatively small, but also mean (zero) reverting. Moreover, current profits are loaded with so many ephemeral elements, and we do know that abnormally high (or low) profits attract (or repel) investment flows. Thus, it is reasonable to assume that expectations about future returns to investment are not far sighted and so the current rate of return on new investment will be:

$$\rho \approx \frac{\Delta\Pi_t}{I_{t-1}}$$

that is, the ratio of the current change in gross real profits to gross real investment lagged by one period. This ratio is called the incremental rate of profit (IROP) and it provides us with a practical guide to identify indirectly the profitability on the leading firms (or the regulating capitals) of an industry over the years. The IROP refers to short-run profitability, i.e., profits derived from the most recent investment, as a more immediate regulator of the investment activities, whereas the average rate of profit is derived from profits of all (recent and past) investment is a rather long-run regulator of investment flows shaping more or less the general psychology (optimism or pessimism) of the business community.

This does not mean that the average rate of profit is of no significance to the investment decisions. It just means that the average rate of profit, r, being the average of all firms in the economy does not really capture the ebbs and flows of investment activity. In effect, the average rate of profit, r, and the IROP are strictly related to one another and this relation can be seen starting from the definition of profits $\Pi = r \cdot K$, whose total differential in discrete time will be

$$\Delta\Pi \approx r\Delta K + K\Delta r$$

By dividing by $\Delta K \neq 0$ we get:

$$\frac{\Delta\Pi}{\Delta K} \approx r + \frac{\Delta r}{\Delta K}K$$

or

$$\rho \approx r\left(1 + \frac{\Delta r}{\Delta K}\frac{K}{r}\right)$$

where the term in the parentheses is a kind of a markup that makes the IROP a variable characterized by turbulent dynamic behaviour, a feature which is a reflection of the short-term nature of excess profits and losses which really act as magnets of inflows of new investment expenditures. It is worth stressing that this characteristic feature is not specific to classical approach but rather is shared by all contending approaches (Mejorado and Roman, 2014, p. 191).

It is important to stress that the notion of IROP is also connected to the marginal efficiency of capital (MEK), a short run Keynesian index of profitability (Tsoulfidis and Tsaliki, 2012). We start from the well known formula of the internal rate of return,

$$I_{t-1} = \Pi_t \cdot (1+d)^{-1} + \Pi_{t+1} \cdot (1+d)^{-2} + \cdots.$$

where *d* is the interest rate or the internal rate of return on investment. Differentiation of investment with respect to *d* gives:

$$\frac{\mathrm{d}I_{t-1}}{\mathrm{d}d} = -\Pi_t \cdot (1+d)^{-2} - 2\Pi_{t+1} \cdot (1+d)^{-3} \ldots.$$

Assuming equality of profits in all periods, it follows that the longer the time horizon, the more negative the profits. Thus, having to choose between short term and long term projects, entrepreneurs opt for the former rather than the latter, and in particular

$d = \Pi_t \cdot (I_{t-1})^{-1} - 1$ (Scherer and Ross, 1990 and Tsoulfidis and Tsaliki, 2012). Since investment and profits are strictly related to each other it follows that both ρ and d are neither too far, nor unrelated to each other.

The financial conditions, so important for both, the upturn as well as the current depression are reflected in the movement of the prime real interest rate, RIR. This suggests that an increase in interest rates dampens planned investment expenditures, reduces productive capacity growth and potential output and undercuts the need for labour to produce the lower output, thereby increasing the unemployment rate. It should be stressed that neither the IROP nor the RIR should be thought of as the key factors responsible for equilibrating saving and investment. The IROP and the RIR should be seen in a broader classical perspective according to which the rate of interest is a derived (from the total profits or surplus value produced) variable which in relation to the relevant rate of profit govern the process of capital accumulation.

Finally, the growth in demand elicits changes in investment expenditures. This is the accelerator principle that Keynesian economists give a lot of weight to and in the first empirical studies of investment behaviour, this was the variable that turned out to be perhaps the single most important.

With the passage of time, data are more easily accessible but moreover extend to a much longer period of time and are selected in a more or less uniform way for a number of countries. Meanwhile the econometric techniques that have been developed allow tests with more definitive results. Thus the combination of longer time series and more homogenous data sets across countries together with more advanced econometric techniques have, from a practical point of view alone, changed fundamentally the way that we look at variables and the way that investment decisions are shaped.

4. Model Specification

This section considers the empirical determinants of investment. The empirical specification of the investment regressions is a variant of the standard investment specifications encountered in the literature (see for instance Keynes (1936), Kalecki (1968), Sawyer (1985), Alexiou (2010), Tsoulfidis and Tsaliki (2014)).

The dataset used (subject to availability) spans over the period 1980 to 2013, consisting of N cross-sectional units, denoted $i = 1,\ldots,N$ observed at T time periods, denoted $t = 1,\dots,T$. More specifically, y is a ($TN\times1$) vector of endogenous variables, x is a ($TN\times k$) matrix of exogenous variables, which does not include a column of units for the constant term. In this context, we collated data for the two country clusters namely the core cluster (comprising 9 countries: Belgium, Denmark, France, Netherlands, Austria, Finland, Sweden, UK) and the peripheral cluster (comprising 5 countries: Ireland, Greece, Spain, Italy, Portugal)[2]. The main data provider was AMECO database.

The generic linear econometric form of the model utilized can be expressed as follows:

$$y_{it} = \alpha_i + \beta_i X_{it} + \varepsilon_{it}, \qquad (1)$$
$$\varepsilon_{it} \sim i.i.d.\ (0, \sigma_i^2).$$

where y_{it} is the dependent variable, α_i is the intercept term, β_i is a $k\times1$ vector of parameters to be estimated on the explanatory variables, and X_{it} is a $1\times k$ vector of observations on the explanatory variables, $t = 1, \dots, T$, $i = 1, \dots, N$, and ε_{it} is a random term, assumed to satisfy the normal requirements.

In this context, we estimate various specifications of model (1) the explicit form of which is expressed as follows:

$$RINV_{it} = a_0 + a_1 IROP_{it} + a_2 RGDP_{it} + a_3 RIR_{it} + \varepsilon_{it} \qquad (2)$$
$$\varepsilon_{it} = v_i + u_{it}$$

where (RINV) is real gross capital formation, (IROP) stands for the incremental rate of profit which is defined as the change in current real net profits over real net investment,[3] (RGDP) is real gross domestic product, (RIR) denotes real interest rates, ε_t is the disturbance term, v_i captures the unobserved country-specific effect while u_{it} is the idiosyncratic error. This is a one-way error component regression model, where $v_i \sim$ IIN $(0, \sigma^2)$ and independent of $u_{it} \sim$ IIN $(0, \sigma^2)$.

4.1 Methodology

Cointegration analysis provides the platform upon which our methodological endeavour unfolds.

[2] It should be stressed that we have deliberately left out Germany due to inconsistencies associated with data collection prior to German unification in 1990.
[3] As indexes of profitability we also tried the average rate of profit and the Keynesian MEK data that are available in the AMECO database, however, both variables did not give better results compared to the IROP.

Panel unit roots

DF (Dickey-*Fuller) or ADF (Augmented Dickey Fuller) tests have been traditionally used to test for the presence of unit roots in univariate time series. The aforementioned tests however, have been proven to suffer from low power in rejecting the null hypothesis of a non-stationary series as well as limiting distributions which are complicated and not well-defined. In recent years, further unit root tests have been developed - such as those by Levin, Lin and Chu, (2002), Im, Pesaran and Shin, (2003) and Hadri, (2000) – which are shown to be more powerful than the unit root tests applied to individual series. While these tests are commonly termed 'panel unit root' tests, theoretically speaking, they are simply multiple-series unit root tests that have been applied to panel data structures (where the presence of cross-sections generates "multiple series" out of a single series). In this study we utilized both common root tests - Levin, Lin, Chu (LLC) - and individual root tests - Im, Pesaran, Shin (IPS), Fisher - ADF, Fisher - PP, and Hadri. Common root indicates that the tests are estimated assuming a common AR structure for all of the series; "Individual root" is used for tests which allow for different AR coefficients in each series.

4.2. Cointegration

Cointegration methodology is primarily used to investigate whether spurious estimation results are evident in the event of non-stationary time series. If such a stationary linear combination exists, the non-stationary time series are said to be *cointegrated*. The stationary linear combination is called the *cointegrating equation* and may be interpreted as a long-run equilibrium relationship among the variables. In other words, if two variables are integrated of the same order and these appear to be converging in the long-run, then their extant relationship will produce errors which are stationary. In order to determine whether such a long run relationship exists, panel cointegration techniques advanced by Pedroni (1999) are utilized. Pedroni essentially builds on the two-step residual-based strategy of Engle and Granger (1987) to develop his own tests. On the basis of this approach seven different statistics that test for panel cointegration are generated. Four are based on a within-dimension and three on the between-dimension. It is in this sense that the within-dimension based statistics are referred to as panel cointegration statistics, whilst the between-dimension based statistics are termed as group mean cointegration statistics. These tests are based on the null of no cointegration and work with the assumption of heterogeneous panels.

The proper formulation for all seven tests is expressed as follows:

$$y_{it} = \alpha_i + \beta_1 X_{1,i,t} + \beta_2 X_{2,i,t} + \ldots\ldots + \beta_n X_{n,i,t} + \mu_{it} \quad (3)$$

where $X_{i,t}$ are the regressors for n cross sections. A regression is then performed on the residuals resulting from equation (3):

$$\mu_{i,t} = \zeta_i \mu_{i,t\text{-}1} + z_{i,t} \qquad (4)$$

The preceding estimation process generates seven different statistics namely the Panel-v, panel-rho, panel non-parametric-t and panel parametric-t (the within dimension), and group-rho, group non-parametric-t and group parametric-t (the between dimension of the panel). In the within-dimension framework, the null of no cointegration and the alternative of cointegration are tested as follows:

H_0: $\mu_i = 1$ for all i,

H_1: $\mu_i = \mu < 1$ for all i.

This stands at stark contrast to the between dimension framework where the alternative hypothesis states that H_1: $\mu_i < 1$ for at least one i.

Note that, the between-dimension test is less restrictive and allows for heterogeneity across members. In the case of the within dimension test, a common value for all cross sections is imposed, i.e. $\mu_i = \mu$. As the purpose of this paper is far from getting bogged down to technicalities, details of the technical aspects of the respective unit root and cointegration tests can be sought in the original papers.

4.3 Panel Fully Modified OLS (FMOLS)

Once cointegration has been established, we then proceed to estimating the model using the Fully Modified Ordinary Least Squares (FMOLS) techniques for heterogeneous cointegrated panels proposed by Pedroni (1996, 2000). According to Pedroni (2000), standard OLS estimation of a panel will produce an asymptotically biased estimator. He argues that only in the case of exogeneity of the regressors and homogenous dynamics across the individual members of the panel, is it possible for the OLS estimator to be unbiased.

The FMOLS estimates are superior to OLS estimates in a sense that they are able to account for both serial correlation and potential endogeneity problems. In addition, FMOLS methodology allows for the country-specific fixed effects to be heterogeneous while estimating long-run relationships. Pedroni (2000) also contends that t-statistics for group mean panel FMOLS offers more flexible alternative hypothesis than pooled panel FMOLS because the former are based on the between-dimension as opposed to within-dimension of the panel; thus it estimates the cointegrating vectors for a common value under the null hypothesis, while under the alternate hypothesis the values for the cointegrating vectors are allowed to vary across groups. The latter is of great significance in the context of Pesaran and Smith's (1995) finding that under heterogeneous cointegrating vectors across different countries, group mean estimators give consistent estimates of the sample mean of cointegrating vectors while pooled within dimension estimators fail to do so.

In view of the above, the resulting FMOLS model assumes the following form:

$$y_{i,t} = \alpha_i + \beta x_{i,t} + \mu_{i,t} \qquad (5)$$

$$x_{i,t} = x_{i,t-1} + \xi_{i,t} \qquad (6)$$

where, α_i allows for the country specific fixed effects, β is a cointegrating vector given that $y_{i,t}$ is $I(0)$. The vector error process $\varepsilon_{i,t} = (\mu_{i,t}, \xi_{i,t})$ is therefore a stationary process too. Note that Pedroni (2000) shows that the group-mean FMOLS estimator is consistent and that the test statistic performs reasonably well even in small samples as long as the time period under consideration is not smaller than the number of cross sections.

The final step in the empirical procedure is the estimation of a panel error correction model (ECM) that will provide the short-run as well as long-run dynamics between the variables in the system.

5. Estimations results

The analysis commences with an assessment of the integration properties of the variables incorporated in the model. As we indicated earlier, three different datasets are considered. One set of estimations deals with the presence of unit roots and cointegration in the entire dataset, one assesses the existence of unit roots and cointegration in the core economies whilst the third one deals with the data set consisting of the peripheral economies. Table 1 below reports the panel unit roots test estimates for the respective datasets.

Table 1. Panel unit roots test

	Core Economies									
	Levels					First difference				
	LLC	IPS	ADF-F	PP-F	Hadri	LLC	IPS	ADF-P	PP-F	Hadri
RINV	0.87	2.84	2.61	3.1	8.71*	-6.06*	-7.96*	90.4*	41.2*	-1.23
IROP	-8.55*	-5.38	57.1*	54.6*	6.56*	-14.6*	-14.5*	82.6*	97.5*	2.14
RGDP	-2.35	-4.26*	35.6*	27.9	3.70*	-5.50*	-5.61*	60.1*	65.1*	1.98
RIR	-2.82	-2.10	25.9	26.1	11.8	-14.8*	-11.8*	80.5*	97.9*	1.67
	Peripheral Economies									
RINV	-1.91	-1.04	11.7	5.26	4.37*	-4.20*	-4.35*	37.2*	24.1*	-0.17
IROP	-4.48*	-3.65	6.73	26.5*	5.79*	-16.1*	-18.2*	40.1*	92.1*	0.49
RGDP	0.54	0.65	4.48	3.48	4.53*	-2.98*	-3.36*	27.8*	27.9*	3.26*
RIR	-0.97	-1.34	13.3	13.4	1.71*	-13.8*	-11.8*	85.1*	87.2*	-0.49

Notes: (*) denotes significance at the 5% level of significance. The models have been specified with individual effects. The Null hypothesis for LLC, IPS, ADF-F and PP-F is that of a unit root whilst the respective Null hypothesis for Hadri's test is that of stationarity –Hadri's z-statistics are reported.

An inspection of Table 1 suggests that all variables when used in levels form appear to be non-stationary. A closer look however suggests that a number of these tests regarding the variables *IROP, RIR* and *RGDP* have turned out to be rather inconclusive. Evidently, when the first differences are taken, all variables are found to be integrated of order 1 i.e. $I(1)$. It should be noted that the tests were also performed with individual effects and individual linear trends - not reported in this Table 1 due to economy of space - but no significant differences were observed.

5.1 Cointegration analysis

Even though it is well documented in the existing literature that it is not possible for two series integrated of different orders to form a cointegrated series, it is less acknowledged that it is possible that the combination of more than two series which are integrated of different orders can form a cointegrated series of lower order of integration. In other words, if $x_t \sim I(1)$ and $y_t \sim I(0)$, then x_t and y_t cannot be cointegrated. However, if $x_t \sim I(2)$, $z_t \sim I(2)$ and $y_t \sim I(1)$, then x_t and z_t can cointegrate to form an $I(1)$ series which can then cointegrate with y_t to give a $I(0)$ series (see Pagan and Wickens, 1989). Harris (1995) indicates that there can be up to n-1 linearly independent cointegrating vectors, where n is the number of variables. In view of the latter, even if some of our tests for the order of integration are inconclusive, it is still possible to come up with multiple cointegrating vectors which can then form a linear combination to generate an $I(0)$ series. Table 2 below reports the panel cointegration estimates for all samples.

Table 2. Pedroni's Cointegration Test Results

	Core Economies	Peripheral Economies
	Panel statistics (Within Dimension)	
v-statistics	-0.14	-0.48
ρ-statistics	-5.25*	-2.36**
pp-statistics	-7.15*	-5.67*
ADF-statistics	-1.82**	1.93**
	Group statistics (Between Dimension)	
ρ-statistics	-4.54*	-3.87**
pp-statistics	-8.05*	-7.67*
ADF-statistics	-1.36***	2.98**

Note: Pedroni (2004) residual cointegration tests. The null hypothesis is no cointegration. The models have been specified with deterministic intercept and trend. (*), (**) and (***) denote rejection of the null hypothesis of no cointegration at 1% , 5%, and 10% level respectively.

All the reported statistics in the Table 2 above suggest that there is evidence of a strong cointegrating relationship among the variables, when the dependent variable is investment. We also performed Kao's Residual Cointegration test and found a strong cointegrating relationship across all datasets. More specifically, Kao's test rejected the null of no cointegration at the 1% level of significance.

5.2 FMOLS estimation results

Having established the existence of a cointegrating relationship, we then proceed to estimating the long run parameters of our equation. Table 3 below reports the estimates generated using the Fully Modified OLS (FMOLS) estimator for all three respective samples.

Table 3. FMOLS estimates

Long-run estimates: Dependent variable is investment		
	Core Economies	Peripheral Economies
IROP	0.92(15.56)*	0.61(1.66)
RGDP	0.14(4.53)*	0.20(6.14)*
RIR	-4.07(-20.67)*	-0.64(-3.02)*

Note: The models include common time dummies. (*), (**) and (***) denote significance at 1% , 5%, and 10% significance level respectively. t-statistics are given in parenthesis.

A quick inspection of Table 3 reveals that in all samples the coefficients of the underlying variables bear the expected signs. In particular, the long-run cointegration results suggest that real interest rates as well as demand growth exert a significant effect on investment, whilst IROP is highly significant in the case of the core economies and marginally insignificant in the case of the peripheral cluster of economies. Further in to the analysis we can also establish that demand-side management policies are thought to positively affect investment, and therefore enhance the economic environment where employment creation can be nurtured across the region.

Table 4. Error Correction estimates

	Core Economies	Peripheral Economies
c	-0.19(-0.64)	0.01(0.10)
$\Delta RINV_{t-1}$	0.52(5.49)*	0.68(8.38)*
$\Delta RINV_{t-2}$	0.04(0.45)	0.15(1.96)**
$\Delta IROP_{t-1}$	1.16(1.86)***	0.19(2.21)**
$\Delta IROP_{t-2}$	-0.49(-1.01)	-0.10(-1.55)
$\Delta RGDP_{t-1}$	1.46(4.43)*	0.98(5.71)*
$\Delta RGDP_{t-2}$	-1.42(-1.75)	-0.95(-6.21)*
ΔRIR_{t-1}	-1.17(-3.12)*	-0.84(-9.35)*
ΔRIR_{t-2}	-0.25(-1.06)	-0.03(-0.47)
EC_{t-1}	-0.25(-5.59)*	-0.13(-4.05)*

Note: The values in parentheses denote the t-statistics. (*), (**) and (***) indicate statistical significance at 1% , 5% and 10% levels, respectively.

The short run evidence derived from the error correction model is consistent with the expected theoretical framework thus, indicating a speedy convergence as this is reflected by the EC coefficient. In achieving convergence, IROP is statistically significant in both sets of economies lending support to the view that the IROP is potentially bound up with the short-term investment decisions. In the long run, however, the results suggest that investment decisions are more prone to be affected by the overall state of the economy as this is reflected by the growth of demand and the rate of interest. The latter ever since the 1980s has served as means of conducting monetary policies and is also considered to be responsible for restoring profitability in the 1980s up until the onset of the great recession in 2007.

Given the dynamic process through which the error correction ensures that equilibrium is attained, it is worth emphasizing that such an attainment instead of eliminating any of the existing disparities, it rather drives a wedge between the EU core and peripheral countries.

6. Concluding Remarks

Our empirical endeavour has generated evidence consistent with our theoretical exposition in terms of the signs and the statistical significance of the coefficients. All variables turned out to be statistically significant for the core economies apart from the peripheral ones, where the long run estimate of IROP was only marginally insignificant. The implication of the latter might be that the existing austerity policies implemented in the peripheral economies do not have the expected long-run stimulating impact on investment activity. In particular, the outright wage reductions in conjunction with an indiscriminate hike in income tax might have temporarily stifled economic activity. Recently, an argument, that appears to be shared by a significant number of both academics as well as policy makers, states that increasing wages, i.e. dwindling profitability, in the core economies might be the right policy to reduce existing disparities across EU countries.

In the case of demand growth, the results are more straightforward, thus, suggesting that in both clusters of our countries demand-expansion policies may exert a significant effect on investment across countries. A result which is in line with the early studies of investment decisions where the role of accelerator was important.

The real rate of interest is in all cases statistically significant but its coefficient is by far larger in the core economies than in the peripheral ones. Thus we may say that the policies of ECB of targeting interest rates benefit, in terms of attracting investment activity, more the core than the peripheral EU countries. It can also be deducted that the generated evidence suggests that continuation of the austerity programmes in the long run are likely to worsen the existing disparities amongst core and peripheral countries of the EU.

Future research may extent the scope of this analysis by introducing more variables into the econometric specification, such as for example, risk (on measure might be the difference between the prime interest rate and EURIBOR), flows of lending funds from the financial system or more sophisticated variables capturing demand growth effects such as for example the growth of capacity utilization (see Semmler and Franke, 1995). Finally, for profitability one could also use as a possible variable the Tobin-Q. Such experimentation however, would call for an empirical treatment utilizing quarterly time series data.

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