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ORIGINAL ARTICLE

Revisiting the Classical Theory of Investment: An Empirical Assessment from the European Union

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Abstract

In alignment with classical investment theory, this study explores the enduring relationships and causal linkages among total private investment, profit rate, unit labour costs, and demand growth within the European Union throughout the period spanning from 1961 to 2019. The empirical approach adopted involves the use of advanced econometric techniques designed to address cross-sectional dependence and slope heterogeneity. As a first stage, we examine stationarity and cointegration by employing second-generation panel unit root and cointegration tests. Subsequently, we estimate long-run equations through estimators intended to control for cross-sectional dependence and slope heterogeneity. As a further step, we use the Dumitrescu-Hurlin procedure to examine potential bidirectional causality between the variables and detect whether there exists endogeneity in the data. Finally, we apply the dynamic common correlated effects estimator mean group with instrumental variables to control for the potential presence of endogeneity. The outcomes of the analysis underscore a positive association between private investment and the profit rate, unit labour costs, and demand growth, thus providing robust empirical support for the classical theory of investment.

Keywords Investment · European Union · Heterogeneity · Cross-sectional dependence · Causality

JEL Classifications B12 · C33 · C52 · E10 · E22

The slow growth of developed economies over the last decade has led to a renewed interest in studying the determinants of private investment from a classical political

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economy standpoint. Given the consensus on the centrality of capital accumulation to economic growth, recent studies have used different econometric strategies based on panel data analysis to elucidate whether classical political economy theory provides a satisfactory framework for assessing the factors that influence firms' investment decisions (Alexiou 2010; Alexiou et al. 2016; Arestis et al. 2012; Arestis and González-Martínez 2016; Boundi Chraki 2022). In this vein, their findings demonstrate the importance of profitability and aggregate demand in private investment, supporting the classical approach to capital accumulation empirically.

However, the existing studies on investment and its determinants from a classic framework have not paid enough attention to bias and inconsistent estimates that stem from the presence of cross-sectional dependence and slope heterogeneity.[1] While some of the first generation of unit root and cointegration tests allow for heterogeneity (Im et al. 2003; Pedroni 2004), the econometrics literature highlights that standard panel cointegration techniques are not adequate when all cross-sectional units are correlated (Baltagi and Pesaran 2007; Chudik et al. 2016; Chudik and Pesaran 2015; Pesaran 2006, 2007).

Since cross-sectional dependence arises when assessing macroeconomics and financial data (Banerjee and Carrion-i-Silvestre 2017; Urbain and Westerlund 2006), the first generation of unit root and cointegration tests often encounters the so-called size distortion problem, potentially leading to misleading inference and over-rejection of the null hypothesis (Banerjee et al. 2005; Dąbrowski et al. 2018; Pesaran 2007). Therefore, it is essential to examine both slope heterogeneity and cross-sectional dependence while working with panel data that includes numerous countries or sectors over extended periods.

With the above concerns in mind, we aim to analyse the classical investment theory for the European Union (EU) over the period 1961–2019, considering the presence of cross-sectional dependence and slope heterogeneity. To our best knowledge, this study contributes to the literature by empirically examining classic investment theory, employing for the first time the second generation of panel unit root tests and cointegration tests (Pesaran 2007; Westerlund 2007) in combination with the common correlated effects mean group estimator (CCEMG) (Pesaran 2006) and the augmented mean group estimator (AMG) (Eberhardt and Teal 2010).

Another significant contribution involves investigating the causal relationship between total private investment and its determinants by using the Dumitrescu and Hurlin (2012) panel Granger non-causality test, as previous studies have not taken into account the potential mutual interactions that may disclose endogeneity concerns through simultaneous relationships. As a third noteworthy contribution to the literature, we apply the dynamic common correlated effects estimator mean group with instrumental variables (DCCEEMG-IV) developed by Chudik and Pesaran

[1] With the notable exception of Arestis and González-Martínez (2016, p. 40), who assess the existence of cross-sectional dependence by employing the Breusch and Pagan LM test and the Pesaran test. In order to control for cross-sectional dependence, they make use of the standard error estimator by Driscoll and Kraay. However, according to footnote 25, they checked the null hypothesis of nonstationarity by applying the first generation of unit root tests that assume cross-sectional independence.

(2015). This approach not only allows us to control for both cross-sectional dependence and endogeneity in our research but also addresses potential endogeneity in the data.

The outline of this research is as follows: Sect. "Theoretical Framework" explains the theoretical framework. In Sect. "Hypotheses, Data and Preliminary Analysis", we define the hypotheses, present the econometric model, and conduct preliminary data analysis. Sect. "Empirical Analysis" tests the theoretical hypotheses and discusses the results. The final section summarizes and concludes.

Theoretical Framework

Classical political economy, represented by Adam Smith (1776), Ricardo (1821), and Sismondi (1821), anticipated Keynes's (1936) *General Theory* by revealing that saving is a residual that depends on investment. In such a framework, capital accumulation increases income faster than consumption (Smith 1776, pp. 330–349), implying a significant part of firms´ investment is self-financed through their profits (Ricardo 1821, pp. 110–127), thereby uncovering that the rate of saving is an endogenous variable (Sismondi 1821, pp. 90–95).

Thus, the classical political economists dismissed the idea that the interest rate was the adjustment variable between investment and saving. According to classical political economists, investment is driven by both realised and future profitability, calculated by firms as the ratio between profits and advanced capital. That is, the level of investment (INV_t) is positively related to realised and expected profits (π_t and $\Delta\pi_t$) but negatively associated with the increase in capital stock (ΔK_t):

$$INV_t = f\left(\pi_t, \Delta\pi_t, \Delta K_t\right) \tag{1}$$

However, as noted by Sismondi (1821, p. 369), output growth derived from new investments implies changes both in profits and in the capital stock, which will influence profitability. In this vein, Sismondi points out that the question is whether the new investments will generate a profit rate that is higher than, lower than, or equal to the actual profit rate. From a classical political economy standpoint, the causal relationship between investment and profitability is bidirectional.

It should also be emphasised that Smith (1776, pp. 72–81) and Ricardo (1821, pp. 89–92) contend that capital accumulation is not a voluntary act, insofar as competition compels firms to increase their investment, even though the level of profitability is declining. As McNulty (1968, p. 649) highlights, the classical economists conceived competition as a guiding force expressed in unit labour costs cutting.[2] As Smith (1776, pp. 77–78) notes, given that competition is the struggle for obtaining extraordinary profits, firms will try to reduce their production costs by increasing

[2] Ricardo (1821, p. 19) referred to unit labour costs as the real value of wages, expressing the relation between wages and gross output. As Kurz (2016, pp. 134–135) points out, Ricardo studied several types of technical progress and considered the possibility of "technological unemployment" as "the progressive replacement of labour by fixed capital is a characteristic feature of modern economic development".

labour productivity. In that way, investment in fixed capital assets will tend to reduce the unit labour costs in the long run.

Ricardo adds that if unit labour costs are increasing and the level of profit rate is low, firms will be forced by competition to invest in new and better production techniques in order to improve their cost-competitiveness.[3] In this vein, Ricardo (1821, p. 163) discloses that capital accumulation produces an increased competition, whereas an increased competition spurs private investment. Consequently, the causal relationship between investment, profitability, and competition runs both ways.[4] Based on the above, function Eq. (1) can be extended by including the changes in unit labour costs (ΔUlC_t) as a proxy of competition effects on private investment:

$$INV_t = f\left(\pi_t, \Delta\pi_t, \Delta K_t, \Delta ULC_t\right) \quad (2)$$

On the other hand, Keynes (1936) and Kalecki (1954), who agreed with the assumption that profitability leads to investment,[5] contributed to classic theory by incorporating the accelerator principle by Aftalion (1927) and Clark (1917) with substantial modifications. In its simplest form, the accelerator principle establishes a positive linear relationship between current investment and the increase in aggregate demand (ΔY_t), which can be expressed as follows:

$$INV_t = \Delta K_t = \Delta Y_t \quad (3)$$

Despite its simplicity, Baghestani and Mott (2014) show that this version of the accelerator principle is not empirically successful, because it assumes that all productive capacity (i.e., existing or installed fixed capital) is fully utilised and investment is immediately realised. In the literature, this version is known as the flexible accelerator or the capital-stock adjustment model (Baghestani and Mott 2014).

It is not surprising that both Keynes and Kalecki criticised this version since in the presence of large reserve capacities (i.e., the output gap) production may increase without expanding productive capacity. In other words, the increased aggregate demand does not produce an increased net investment in capital assets immediately,[6] revealing that the accelerator principle in its simplest form is not adequate to explain firms'

[3] Note that classical political economists treated technological change as an endogenous process determined by competition.

[4] It is worth mentioning that the investment-profitability-competition nexus revealed by the classical political economists is consistent with the (later) Schumpeterian notion of the process of creative destruction. Schumpeter (1942, pp. 81–86) maintains that the destruction of capital due to tough competition plays a central role in investment decisions, insofar as it implies a massive devalorisation of fixed assets concerning the profits. The increase in firm bankruptcies would affect mainly those firms whose rate of profit is lower than average profitability. Thereby, the most efficient firms will drive economic growth, while the average profit rate will increase, stimulating investment demand.

[5] Keynes identified the marginal efficiency of capital (MEC) as the measure of profitability, which is negatively related to the interest rate. From a Keynesian standpoint, a greater gap between the MEC and the interest rate encourages firms to invest productively. In this research, we prefer using the profit rate as the profitability measure.

[6] Kalecki claims that the time lag between investment decisions and aggregate demand would be more than one period.

investment decisions in the short run. It should be emphasized, however, that Kalecki solves this problem by invoking changes in inventories.

Although an increase in both production and sales does not produce changes in inventories *ipso facto*, Kalecki (1954, p. 107) points out that investment in inventories will be related to the level of aggregate demand and the rate of changes of this level, given a certain time lag. By adding the equations of investment in fixed assets and investment in inventories, Kalecki (1954, pp. 107–108) illustrates that total private investment will depend on both the level of economic activity and its changes. Following Kalecki's formula for total investment, the importance of the accelerator principle can be measured by including growth in aggregate demand (ΔY_t) in function Eq. (2):

$$INV_t = f\left(\pi_t, \Delta\pi_t, \Delta K_t, \Delta ULC_t, \Delta Y_t\right) \tag{4}$$

Nevertheless, Keynes (1936, pp. 129–144) states that the new investments provoke multiplier effects that spur an increase in aggregate demand, thereby disclosing that expanded production contributes to generating income and consumption. In this regard, Samuelson (1939) and Fiorito and Vernengo (2009) expose that Clark was aware of the mutual interaction between the accelerator principle and the investment multiplier. Assuming that the time lag is more than one period, Clark (1917) contended that private investment -through the multiplier- and aggregate demand -through the accelerator principle- interact with each other generating cumulative processes.

These reciprocated relationships are in line with circular and cumulative causation posited by Myrdal (1957) and Kaldor (1970). According to Myrdal and Kaldor, the regions with the highest level of private investment are those whose conditions of profitability are the most advantageous. In this way, economies of agglomeration arise, reducing unit labour costs and reinforcing regional competitive advantages. The increased competition and aggregate demand encourage private investment, depressing economic growth in their regional neighbours.

Nevertheless, the rapid investment in fixed capital assets can have a diminishing effect on profit rates, prompting firms to contemplate adopting new production methods or relocating to regions offering greater profitability. Myrdal-Kaldor's notion of circular and cumulative causation emphasizes the intricate interplay among these variables, where they continuously influence and respond to one another over time.

This interconnectedness underscores a critical consideration in econometrics: the potential for endogeneity. Given the complex web of causation elucidated by Myrdal and Kaldor, addressing endogeneity becomes imperative when conducting econometric analysis. In the following section, we will define our hypotheses and perform a preliminary data analysis.

Hypotheses, Data and Preliminary Analysis

The research aims to test two hypotheses based on the theoretical framework, namely: (1) there exists a positive long-run relationship between total private investment, the rate of profit, the unit labour costs, and the accelerator principle; (2) the causal relationships between the variables are bidirectional.

Table 1 Sample countries

EU-28			
EU-15		CEEU	
Austria (1961–2019)	Italy (1970–2019)	Bulgaria (1996–2019)	Malta[a] (1996–2019)
Belgium (1970–2019)	Luxembourg (1990–2019)	Croatia (2001–2019)	Poland (1996–2019)
Denmark (1971–2019)	Netherlands (1970–2019)	Cyprus[a] (1996–2019)	Romania (1996–2019)
Finland (1961–2019)	Portugal (1961–2019)	Czechia (1996–2019)	Slovakia (1996–2019)
France (1961–2019)	Spain (1970–2019)	Estonia (1996–2019)	Slovenia (1996–2019)
Germany (1961–2019)	Sweden (1970–2019)	Hungary (1996–2019)	
Greece (1961–2019)	United Kingdom (1961–2019)	Latvia (1996–2019)	
Ireland (1970–2019)		Lithuania (1996–2019)	

[a]Cyprus and Malta are Mediterranean countries both culturally and geographically. However, they were included within CEEU to maintain analytical consistency

To test the hypotheses, we make use of the panel data analysis because of its numerous advantages over time series and cross-sectional data (Hsiao 2007). We organise the data into three unbalanced panels that comprise the 28 EU state members (EU-28) before the United Kingdom's (UK) withdrawal, the 15 original EU members (EU-15), and the Central and Eastern European member countries (CEEU), covering the period from 1961 to 2019[7] (see Table 1). All the information is gathered from the European Statistical Office (henceforth Eurostat) database. To maintain the statistical consistency among the EU countries, the variables are measured by the national currency-euro exchange rate.

Total private investment ($INV_{i,t}$) is computed by adding the gross fixed capital formation ($GFKF_{i,j}$) at constant prices (base year = 2015) plus the change in inventories and net acquisition of valuables ($\Delta IAV_{i,t}$) at constant prices (base year = 2015) from the private sector. The rate of profit ($G_{i,t}$) is the ratio between net operating surplus (π_t) and the net stock of fixed capital measured at historical cost[8] (K_{t-1}) from the private sector. The unit labour costs ($ULC_{i,t}$) are calculated as the ratio between labour compensation ($w_{i,t}$) and the domestic product ($Y_{i,t}$) measured by the income approach -*i.e.*, total gross value added-.

[7] Extending the analysis beyond 2019 into the post-COVID-19 era could introduce significant challenges and uncertainties that may compromise the integrity and relevance of the study. The COVID-19 pandemic has disrupted economies worldwide, leading to significant fluctuations and unprecedented events in economic indicators, specially, private investment. Likewise, the COVID-19 pandemic represents a profound structural break in the global economy, whose impact on investment decisions and economic variables is unlike anything seen in recent history. Including the post-pandemic data would require accounting for these structural changes, which can be complex and challenging. It might require modeling approaches different than those we use in this research, making it difficult to compare with the pre-pandemic data.

[8] The advantages and disadvantages of the historical cost method *vis-á-vis* the replacement current method for computing the net stock of fixed assets are exposed and discussed in Basu (2013).

Table 2 Correlation matrix

	LOG(INV)	LOG(G)	LOG(GDP)	LOG(GDP)
EU-28				
LOG($INV_{i,t}$)	1.000			
LOG($G_{i,t}$)	– 0.296	1.000		
LOG($ULC_{i,t}$)	0.263	– 0.513	1.000	
LOG($GDP_{i,t}$)	0.992	– 0.297	0.270	1.000
EU-15				
LOG($INV_{i,t}$)	1.000			
LOG($G_{i,t}$)	– 0.062	1.000		
LOG($ULC_{i,t}$)	0.193	– 0.450	1.000	
LOG($GDP_{i,t}$)	0.989	– 0.055	0.209	1.000
CEEU				
LOG($INV_{i,t}$)	1.000			
LOG($G_{i,t}$)	0.017	1.000		
LOG($ULC_{i,t}$)	– 0.339	– 0.515	1.000	
LOG($GDP_{i,t}$)	0.977	– 0.009	– 0.376	1.000

The gross domestic product ($GDP_{i,t}$) at constant prices (base year = 2015) measured by the expenditure approach -i.e., aggregate demand- is used to estimate the accelerator principle effects on the dependent variable. The long-run relationship between total investment, the rate of profits, the unit labour costs, and growth in aggregate demand represents the following functional equation:

$$INV_{i,t} = f\left(G_{i,t}, ULC_{i,t}, GDP_{i,t}\right) \tag{5}$$

By taking natural logarithms (*LOG*), the econometric model is written as:

$$LOG(INV_{i,t}) = \beta_0 + \beta_1 LOG\left(G_{i,t}\right) + \beta_2 LOG\left(ULC_{i,t}\right) + \beta_3 LOG\left(GDP_{i,t}\right) + \varepsilon_{i,t} \tag{6}$$

where the subscripts denote the *i*-th EU country member at year *t* between 1961 and 2019, whereas β_0 is a constant, β_1 to β_3 are the coefficients of interest, and $\varepsilon_{i,t}$ is the error term. We evaluate whether the independent variables in our regression model are correlated by employing the correlation matrix and the multicollinearity test based on the variance inflation factor (henceforth, VIF). Table 2 shows that the correlation coefficients among the explanatory variables are moderate and smaller than 0.8 (Wooldridge 2016), suggesting that our regression may not suffer from multicollinearity problems. The results of the VIF test outlined in Table 3 support that the explanatory variables are not correlated because the VIF values are much smaller than 5 (Wooldridge 2016).

On the other hand, Urbain and Westerlund (2006) emphasise that in the macroeconomic and financial analyses, the hypothesis of cross-sectional independence cannot be warranted when the variables are strongly related. Since our theoretical framework states that the variables are mutually linked, the cross-sectional dependence may arise, making the standard panel cointegration methods

Table 3 Multicollinearity test (VIF)

Variable	EU-28 VIF	EU-15 VIF	CEEU VIF
LOG($G_{i,t}$)	1.39	1.26	1.44
LOG($ULC_{i,t}$)	1.41	1.31	1.68
LOG($GDP_{i,t}$)	1.12	1.05	1.23
Mean VIF	1.30	1.20	1.45

unsuitable for testing the hypotheses. To avoid bias and inconsistencies in our empirical assessment, we control the cross-sectional dependence by using the second generation of panel cointegration methods.

We start testing the null hypothesis of cross-sectional independence by applying the cross-sectional dependence (CD) test developed by Pesaran (2021). This test is based on the Lagrange multiplier (LM) by Breusch and Pagan (1980), including essential modifications that solve the bias and inconsistencies in which the LM test incurs (Pesaran 2007, pp. 6–10). As shown in Table 4, the Pesaran CD strongly rejects the null hypothesis of cross-sectional independence, except for the LOG($ULC_{i,t}$) of the CEEU panel. Likewise, the simple average of the pairwise correlation coefficients is large for LOG($GDP_{i,t}$) and moderate for the rest of the variables. In a nutshell, the statistical evidence points out that we should consider the cross-sectional dependence in our empirical assessment.

In this regard, it is worth mentioning that slope heterogeneity across the panel might arise in the presence of cross-sectional dependence. Pesaran and Smith (1995, p. 80) remark that ignoring slope heterogeneity leads to biased results and inconsistent estimates of the parameters. Hence, the further step in our econometric analysis consists of testing the null hypothesis of slope homogeneity by using the Pesaran and Yamagata (2008) and Blomquist and Westerlund (2013) tests. As noted by Bersvendsen and Ditzen (2020, pp. 2–6), the Pesaran-Yamagata test standardizes the Swamy (1970) method, thereby allowing for testing the null hypothesis of slope homogeneity for panel data with large N and T. In contrast, the Blomquist-Westerlund test is a HAC consistent extension of Pesaran-Yamagata.

Table 5 shows that the null hypothesis can be rejected for the three unbalanced panels, indicating that there is slope heterogeneity across the three panels. The results outlined in Table 6 support the existence of slope heterogeneity across the EU-28 and EU-15 panels, though the Blomquist-Westerlund test fails to reject the null hypothesis for the CEEU panel. According to Bersvendsen and Ditzen (2020), the Blomquist-Westerlund lacks power with small samples, which could explain the discordance between the results of the tests for the CEEU panel. Thus, the statistical evidence is supportive of the slope heterogeneity existence, disclosing that we should take it into account in our empirical analysis.

Given that the first generation of panel unit root tests assume cross-sectional independence, Baltagi and Pesaran (2007) state that they are not suitable in the presence of neglected cross-section dependence, leading to substantial size distortions and misleading results. The cross-sectional augmented Im, Pesaran, and

Table 4 Pesaran (2021) CD test

Variable	EU-28				EU-15				CEEU			
	CD test	p value	Corr	Abs (corr)	CD test	p value	Corr	Abs (corr)	CD test	p value	Corr	Abs (corr)
LOG($INV_{i,t}$)	70.40	0.000[a]	0.649	0.681	56.71	0.000[a]	0.789	0.800	29.05	0.000[a]	0.683	0.683
LOG($G_{i,t}$)	15.60	0.000[a]	0.137	0.372	15.69	0.000[a]	0.215	0.363	7.76	0.000[a]	0.183	0.432
LOG($ULC_{i,t}$)	16.08	0.000[a]	0.126	0.387	25.35	0.000[a]	0.349	0.467	1.01	0.314	0.022	0.362
LOG($GDP_{i,t}$)	96.86	0.000[a]	0.909	0.909	69.46	0.000[a]	0.972	0.972	39.94	0.000[a]	0.936	0.936

[a]Denotes rejection at 1%. The *xtcd* command by Eberhardt (2011a) was applied

Table 5 Pesaran and Yamagata (2008) test

	EU-28		EU-15		CEEU	
	Delta	p value	Delta	p value	Delta	p value
	7.628	0.000[a]	8.770	0.000[a]	1.758	0.099[c]
Adj	8.328	0.000[a]	9.339	0.000[a]	2.069	0.053[c]

[a]Denotes rejection at 1%

[c]Denotes rejection at 10%. The *xthst* command by Bersvendsen and Ditzen (2020) was implemented

Table 6 Blomquist and Westerlund (2013) test

	EU-28		EU-15		CEEU	
	Delta	p value	Delta	p value	Delta	p value
	5.859	0.000[a]	7.266	0.000[a]	− 0.524	0.600
Adj	6.396	0.000[a]	7.737	0.000[a]	− 0.617	0.537

[a]Denotes rejection at 1%. The *xthst* command by Bersvendsen and Ditzen (2020) was implemented

Shin (CIPS) test developed by Pesaran (2007) overcomes the limitations of the first generation by representing those unobservable processes leading cross-sectional dependence through a single common factor (Gregori and Giansoldati 2020). By applying the CIPS, we can test whether the variables are nonstationary in level and integrated I(1).

As we can observe in Table 7, the null hypothesis of nonstationary will be rejected or not depending on the number of lags and whether a trend is included. It is noteworthy, however, that in most cases, we find that the CIPS cannot reject the null hypothesis of nonstationarity, suggesting that they are integrated I(1). Moreover, most of the results propose that the variables in their first difference become stationary and integrated I(0).

The last step of the preliminary data analysis involves determining whether the variables are cointegrated computing the panel cointegration and the error correction model (ECM) cointegration tests by Westerlund (2007). The purpose of this test is to determine whether there is cointegration in a panel dataset, considering the long-term equilibrium relationship and short-term dynamics. In Table 9, the statistics G_t and G_a are used to evaluate the presence of cointegration. G_t is a panel statistic that tests the null hypothesis that there is no long-term or stable relationship, while G_a tests the null hypothesis that there is no cointegration across the panel. Concretely, G_t is focused on the presence of any long-term relationship, whether stable or not, while G_a specifically checks for cointegration.

P_t and P_a statistics also test for cointegration but with different procedures. P_t tests the null hypothesis that there is no cointegration across the panel, while P_a tests the null hypothesis that the cointegrating vector is the same across entities. These tests help to determine whether variables in panel data exhibit a stable long-term

Table 7 Pesaran (2007) CIPS test

Lags	Without trend				With trend			
	LOG(INV)	LOG(G)	LOG(ULC)	LOG(GDP)	LOG(INV)	LOG(G)	LOG(ULC)	LOG(GDP)
EU– 28								
0	– 0.052 (0.479)	– 4.949 (0.000[a])	– 0.803 (0.211)	– 5.299 (0.000[a])	– 0.992 (0.161)	– 4.676 (0.000[a])	0.008 (0.503)	0.395 (0.653)
1	– 0.305 (0.380)	– 3.654 (0.000[a])	– 0.725 (0.234)	– 2.560 (0.000[a])	– 3.112 (0.001[a])	– 3.408 (0.000[a])	– 0.894 (0.186)	– 0.607 (0.272)
2	0.915 (0.820)	– 1.135 (0.128)	0.670 (0.748)	– 2.117 (0.017[b])	– 0.544 (0.293)	– 0.441 (0.330)	– 0.012 (0.495)	0.361 (0.641)
3	1.887 (0.970)	– 1.461 (0.072[c])	1.448 (0.926)	1.494 (0.932)	0.266 (0.605)	– 0.612 (0.270)	– 0.414 (0.339)	2.098 (0.982)
4	2.754 (0.997)	– 0.384 (0.350)	2.292 (0.989)	2.010 (0.978)	0.772 (0.780)	1.876 (0.970)	2.289 (0.989)	2.728 (0.997)
EU– 15								
0	– 0.823 (0.205)	4.694 (0.000[a])	– 2.646 (0.004[a])	1.805 (0.964)	– 0.064 (0.474)	– 6.880 (0.000[a])	– 1.378 (0.084[c])	2.314 (0.990)
1	– 0.267 (0.395)	– 2.316 (0.010[a])	– 2.724 (0.003[a])	1.952 (0.975)	– 0.169 (0.433)	– 4.214 (0.000[a])	– 2.069 (0.019[b])	1.847 (0.968)
2	0.661 (0.746)	– 0.233 (0.408)	– 1.802 (0.036[b])	2.469 (0.993)	1.285 (0.901)	– 2.001 (0.023[b])	– 1.207 (0.114)	2.275 (0.989)
3	1.655 (0.951)	0.811 (0.791)	– 1.110 (0.134)	3.717 (1.000)	2.756 (0.997)	– 0.555 (0.289)	– 0.695 (0.244)	2.816 (0.998)
4	0.983 (0.837)	– 0.163 (0.435)	– 0.028 (0.489)	4.451 (1.000)	2.314 (0.990)	– 0.616 (0.269)	0.198 (0.578)	4.233 (1.000)
CEEU								
0	– 1.913 (0.028[b])	– 2.826 (0.002[a])	0.469 (0.681)	– 3.153 (0.001[a])	– 2.629 (0.004[a])	– 1.967 (0.025[b])	1.600 (0.945)	– 1.151 (0.125)
1	– 0.808 (0.209)	– 3.106 (0.001[a])	– 0.113 (0.455)	– 2.642 (0.004[a])	– 1.227 (0.110)	– 2.657 (0.004[a])	0.607 (0.728)	– 1.064 (0.144)
2	0.486 (0.686)	0.154 (0.561)	1.322 (0.907)	– 1.082 (0.140)	0.516 (0.697)	1.060 (0.855)	2.616 (0.996)	– 0.970 (0.166)
3	– 0.016 (0.494)	– 2.700 (0.003[a])	1.370 (0.915)	0.955 (0.830)	0.554 (0.710)	– 0.247 (0.403)	2.015 (0.978)	2.265 (0.988)
4	2.225 (0.987)	– 0.646 (0.259)	2.726 (0.997)	1.552 (0.940)	1.618 (0.947)	2.560 (0.995)	4.029 (1.000)	0.883 (0.811)

Table 7 (continued)

First difference

Lags	Without trend				With trend			
	LOG(INV)	LOG(G)	LOG(ULC)	LOG(GDP)	LOG(INV)	LOG(G)	LOG(ULC)	LOG(GDP)
EU– 28								
0	– 17.723 (0.000[a])	– 20.891 (0.000[a])	– 17.828 (0.000[a])	– 14.058 (0.000[a])	– 15.812 (0.000[a])	– 19.819 (0.000[a])	– 16.778 (0.000[a])	– 12.695 (0.000[a])
1	– 13.272 (0.000[a])	– 15.354 (0.000[a])	– 11.184 (0.000[a])	– 9.239 (0.000[a])	– 11.567 (0.000[a])	– 13.764 (0.000[a])	– 9.540 (0.000[a])	– 7.722 (0.000[a])
2	– 9.420 (0.000[a])	– 10.964 (0.000[a])	– 8.148 (0.000[a])	– 7.595 (0.000[a])	– 7.750 (0.000[a])	– 9.703 (0.000[a])	– 6.728 (0.000[a])	– 6.179 (0.000[a])
3	– 5.603 (0.000[a])	– 8.480 (0.000[a])	– 5.799 (0.000[a])	– 5.808 (0.000[a])	– 3.858 (0.000[a])	– 8.471 (0.000[a])	– 3.499 (0.000[a])	– 5.226 (0.000[a])
4	– 3.533 (0.000[a])	– 3.748 (0.000[a])	– 2.801 (0.003[a])	– 2.436 (0.007[a])	– 0.215 (0.415)	– 1.808 (0.035[b])	0.379 (0.648)	– 0.592 (0.277)
EU– 15								
0	– 16.690 (0.000[a])	– 18.215 (0.000[a])	– 16.893 (0.000[a])	– 15.149 (0.000[a])	– 15.854 (0.000[a])	– 17.827 (0.000[a])	– 16.107 (0.000[a])	– 14.487 (0.000[a])
1	– 13.046 (0.000[a])	– 15.109 (0.000[a])	– 12.515 (0.000[a])	– 10.043 (0.000[a])	– 11.520 (0.000[a])	– 13.787 (0.000[a])	– 11.222 (0.000[a])	– 9.306 (0.000[a])
2	– 10.446 (0.000[a])	– 12.401 (0.000[a])	– 9.380 (0.000[a])	– 7.696 (0.000[a])	– 8.727 (0.000[a])	– 10.932 (0.000[a])	– 8.004 (0.000[a])	– 6.272 (0.000[a])
3	– 7.189 (0.000[a])	– 8.846 (0.000[a])	– 7.099 (0.000[a])	– 7.867 (0.000[a])	– 5.396 (0.000[a])	– 7.025 (0.000[a])	– 5.286 (0.000[a])	– 6.257 (0.000[a])
4	– 5.486 (0.000[a])	– 6.849 (0.000[a])	– 5.627 (0.000[a])	– 4.322 (0.000[a])	– 3.762 (0.000[a])	– 5.121 (0.000[a])	– 3.820 (0.000[a])	– 3.021 (0.001[a])
CEEU								
0	– 8.985 (0.000[a])	– 11.380 (0.000[a])	– 8.705 (0.000[a])	– 6.489 (0.000[a])	– 7.086 (0.000[a])	– 10.173 (0.000[a])	– 7.449 (0.000[a])	– 4.677 (0.000[a])
1	5.915 (0.000[a])	– 7.531 (0.000[a])	– 4.209 (0.000[a])	– 3.406 (0.000[a])	– 4.623 (0.000[a])	– 6.320 (0.000[a])	– 2.337 (0.010[a])	– 1.392 (0.082[c])
2	– 2.295 (0.011[b])	– 3.399 (0.000[a])	– 1.592 (0.056[c])	– 3.773 (0.000[a])	– 0.727 (0.234)	– 2.880 (0.002[a])	0.153 (0.561)	– 2.605 (0.005[a])
3	– 1.683 (0.046[b])	– 3.165 (0.001[a])	0.068 (0.527)	– 0.571 (0.284)	– 0.009 (0.497)	– 3.736 (0.000[a])	1.472 (0.930)	0.762 (0.777)
4	– 0.648 (0.259)	0.288 (0.613)	1.906 (0.972)	– 1.156 (0.124)	3.885 (1.000)	0.442 (0.671)	3.325 (1.000)	3.533 (1.000)

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. p values are reported within parentheses. The *multipurt* routine by Eberhardt (2011b) based on Lewandowski's (2007) *pescadf* was used

Table 8 Westerlund (2007) panel cointegration test

	EU-28		EU-15		CEEU	
	Without trend	With trend	Without trend	With trend	Without trend	With trend
Variance ratio	− 4.258	− 4.1980	− 2.513	− 1.166	− 1.371	− 0.440
p value	0.000[a]	0.000[a]	0.006[a]	0.122	0.085[b]	0.330
Panels	28	28	15	15	13	13
Avg. number of periods	39.25	39.25	52.8	52.8	23.62	23.62

[a]Denotes rejection at 1%

[b]Denotes rejection at 10%. The *xtcointtest westerlund* command was applied

relationship and how this relationship varies across entities. Both the Westerlund (2007) panel cointegration test and ECM panel cointegration test are appropriate in the presence of cross-sectional dependence and slope heterogeneity.

According to results shown in Table 8, the panel cointegration test rejects the null hypothesis of no cointegration for all panels when we do not include a trend. Conversely, when a trend is included, the test cannot reject the null hypothesis for the EU-15 and CEEU panels.

The results from Table 9 reveal that G_t strongly rejects the null hypothesis of no cointegration for all panels data, whereas G_a fails to reject the null hypothesis for the EU-15 panel. On the contrary, P_t and P_a can reject the null hypothesis for all the panel models. The findings support the hypothesis of a stable long-term relationship among the four variables -i.e., the variables share a common trend in the long-run. Having been established that our variables are cointegrated, in the next section we proceed to examine the long-run equations and the causal relationships.

Empirical Analysis

In this section, we estimate the long-run equations and the causality relationships between the variables using techniques that control cross-sectional dependence and slope heterogeneity. The literature points out that the group mean estimators are more suitable in the presence of slope heterogeneity than those methods based on pooled or weighted estimators (Eberhardt and Teal 2010; Pedroni 2000; Pesaran 2006; Pesaran and Smith 1995; Phillips and Moon 1999). In the light of the above, we begin our empirical assessment implementing the group mean fully modified ordinary least square (GM-FMOLS) and the group mean dynamic OLS (GM-DOLS) developed by Pedroni (2000, 2001).

As we can observe in Table 10, the rate of profit, the unit labour costs and the growth in GDP have, in the long run, positive and statistically significant correlations with total private investment. The GM-FMOLS suggests that a 1% increase in the rate of profit expands total private investment by between 0.517% (CEEU) and 0.281% (EU-15). The GM-DOLS reports that profitability improves

Table 9 Westerlund (2007) ECM panel cointegration test

	EU-28			EU-15			CEEU		
Statistic	Value	Z value	Robust p value	Value	Z value	Robust p value	Value	Z value	Robust p value
G_t	− 3.190	− 7.648	0.000[a]	− 3.225	− 5.731	0.000[a]	− 3.149	− 5.069	0.000[a]
G_a	− 7.582	0.194	0.090[c]	− 7.480	0.205	0.283	− 7.845	− 0.020	0.021[b]
P_t	− 19.907	− 9.872	0.000[a]	− 9.882	− 3.648	0.011[b]	− 14.863	− 7.717	0.000[a]
P_a	− 12.154	− 6.606	0.001[a]	− 10.142	− 3.601	0.016[b]	− 7.191	− 1.668	0.015[b]

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. Test is performed by setting the Bartlett kernel window ≈ 3 and robust p values with 800 bootstrap replications. The Akaike information criterion (AIC) was used to select the optimal lags. The *xtwest* command developed by Persyn and Westerlund (2008) was used

Table 10 GM-FMOLS and GM-DOLS

Dependent variable: LOG(INV)	EU-28		EU-15		CEEU	
Variables	FMOLS	DOLS	FMOLS	DOLS	FMOLS	DOLS
LOG ($G_{i,t}$)	0.417	0.327	0.281	0.301	0.574	0.357
	(0.042)	(0.067)	(0.048)	(0.056)	(0.073)	(0.129)
	[9.846][a]	[4.881][a]	[5.886][a]	[5.398][a]	[7.893][a]	[2.766][a]
LOG ($ULC_{i,t}$)	0.938	0.811	0.457	0.693	1.492	0.947
	(0.179)	(0.282)	(0.217)	(0.257)	(0.293)	(0.529)
	[5.249][a]	[2.879][a]	[2.111][b]	[2.696][a]	[5.100][a]	[1.790][c]
LOG ($GDP_{i,t}$)	0.925	0.795	0.952	1.036	0.893	0.517
	(0.032)	(0.046)	(0.028)	(0.032)	(0.061)	(0.093)
	[29.056][a]	[17.177][a]	[34.146][a]	[32.459][a]	[14.753][a]	[5.580][a]
Observations	1071	1029	777	753	294	276
Countries	28	28	15	15	13	13

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. Standard errors are enclosed in parentheses, and statistics are provided within brackets. One lag is selected as optimal based on the AIC for both estimators. Estimations were performed using Eviews 11

total private investment by between 0.357% (CEEU) and 0.301% (EU-15). It is interesting to note that these results are in line with that of Alexiou et al. (2016), whose GM-FMOLS informs that a 1% increase in profitability improves investment by approximately 0.91% for the EU core economies[9] over 1980–2013.

Concerning the effects of competition, the GM-FMOLS reveals that a 1% increase in the unit labour costs provokes an increase of total private investment by between 1.492% (CEEU) and 0.457% (EU-15). The GM-DOLS suggests that a 1% increase in the unit labour costs has a positive impact on total private investment of between 0.947% (CEEU) and 0.693% (EU-15). Lastly, the GM-FMOLS indicates that a 1% increase in the growth of aggregate demand stimulates the dependent variable by between 0.953% (EU-15) and 0.893% (CEEU). When we employ the GM-DOLS, a 1% increase in the growth of aggregate demand increases total private investment by between 1.036% (EU-15) and 0.517% (CEEU).

Although Alexiou et al. (2016) also report a positive relationship between investment and the accelerator principle in the EU, their GM-FMOLS shows coefficients smaller than those we have obtained. Concretely, these authors find that a 1% increase in GDP stimulates investment by between 0.20% (peripheral economies[10]) and 0.14% (core economies). Given that the bias of an estimator tends to be smaller

[9] The core economies are Belgium, Denmark, France, the Netherlands, Austria, Finland, Sweden, and the UK.

[10] The peripheral economies comprise Ireland, Greece, Spain, Italy, and Portugal.

as the sample size increases, our results could be considered more robust than theirs because our sample comprises the 28 EU countries covering the period 1961–2019.

It should be noted, however, that both the GM-FMOLS and GM-DOLS do not consider the issue of cross-sectional dependence, which means that these findings should be interpreted with caution. As a robustness check and in order to deal with misleading results derived from the presence of cross-sectional dependence, we apply the mean group (MG) by Pesaran and Smith (1995), the correlated effects MG (CCEMG) by Pesaran (2006), and the augmented MG (AMG) developed by Eberhardt and Teal (2010). Since the MG estimator does not control for cross-sectional dependence, its outcomes are quite like those reported by the GM-FMOLS and GM-DOLS (see Table 10).

Therefore, robustness testing is focused on CCEMG and AMG estimators, because they account for both slope heterogeneity and cross-sectional dependence (Dąbrowski et al. 2018; Saqib 2022; Sharma and Pal 2021). In this regard, it should be highlighted that CCEMG and AMG estimators have several advantages over FM-FMOLS, GM-DOL, and MG estimator (Eberhardt 2012; Eberhardt and Teal 2010; Pesaran 2006).

Since classical investment theory involves the study of long-run relationships and the factors that determine private investment over extended periods, CCEMG and AMG estimators are well-suited for analysing such long-term dynamics, as they consider both time-series and cross-sectional dimensions of the data. In this vein, it should be noted that the CCEMG estimator allows for a more efficient estimation of the parameters, as it combines individual estimates with common effects, hence capturing the underlying relationships more accurately than GM-FMOLS, GM-DOLS, and MG estimators.

CCEMG and AMG estimators are consistent and asymptotically efficient under more general conditions, making them appropriate for small samples, whereas GM-FMOLS and GM-DOLS might require larger samples to achieve consistent estimates. Furthermore, CCEMG and AMG are robust in the presence of structural breaks and nonstationary unobserved common factors (Ahakwa 2023; Boundi Chraki 2022).

Lastly, both CCEMG and AMG can account for differences between countries and regions, which is crucial for understanding how classical investment theories apply in the European Union context. In summary, the application of CCEMG and AMG estimators in the assessment may enhance the comprehension of the long-run relationship between total private investment and its determinants in the context of classical investment theory.

For the EU-28 panel, a 1% increase in the rate of profit brings about a long-term increase of total private investment by 0.197% (CCEMG) and 0.198% (AMG) (see Table 10). In contrast, if we only consider the 15 original EU countries, the CCEMG and AMG estimations indicate that the relationship between the profit rate and total private investment is not statistically significant. The CCEMG and AMG applied for the CEEU panel display that a 1% increase in profitability improves total private investment by 0.368% and 0.439%, respectively. Interestingly, these results are very similar to those we obtained with the estimators that do not control for cross-section dependence.

As far as competition is concerned, the CCEMG and AMG estimate that a 1% rise in the unit labour costs generates an increase in the dependent variable by between 0.536% and 0.408% in the 28 EU countries. As for the EU-15 panel, the CCEMG and AMG indicate that the relationship between total private investment and the unit labour costs is not statistically significant. Furthermore, the sign of the coefficients is the opposite of that suggested by the theoretical framework. There could be several reasons for this difference. We need to consider whether changes in the economy, limitations in the data, or unaccounted variables are affecting the relationship in ways not addressed by the theoretical framework. Furthermore, it is possible that the economic structure of EU-15 countries results in a different type of competition than what classical political economy suggests. For example, there may be a focus on competitive strategies like product differentiation rather than traditional price warfare and cost reduction. Additionally, the results might be influenced by labour market rigidities that exist in many EU-15 countries and a significant decline in the importance of manufacturing sectors in the overall output, as suggested by recent empirical evidence (Liboreiro 2023; Liboreiro et al. 2021). Concerning the CEEU panel, the results obtained with the CCEMG and AMG are like those of GM-FMOLS, GM-DOLS, and the MG reported in Table 10 and the first column of Table 11.

We now turn to analyse the relationship between total private investment and growth in aggregate demand. According to our findings, the long-run impact of the accelerator principle on the dependent variable is noticeably stronger than the one reported by the GM-FMOLS, GM-DOLS and MG estimators. This evidence appears to suggest that the accelerator principle is the variable that affects total private investment with the greatest strength in the long-run. It is consistent with the findings by Arestis et al. (2012), who contend that the expected growth of aggregate demand is the crucial determinant of capital accumulation.

Moreover, Arestis and González-Martínez (2016) point out that weak aggregate demand may discourage firms from investing in fixed assets. In this vein, it suffices to recall that our theoretical framework posits that increased aggregate demand spurs both rises in profitability and competition. In turn, the new investments in fixed capital assets may improve both aggregate demand and the profit rate, as well as increase competition.

In addition, Myrdal-Kaldor's concept of circular and cumulative causation indeed has implications for endogeneity in econometric analysis. Circular and cumulative causation refers to a situation in which various economic factors, such as demand and supply, reinforce and amplify each other's effects, leading to a self-reinforcing cycle of economic change. This concept implies that economic variables are interrelated and can have mutually reinforcing effects over time.

Endogeneity, in the context of econometric analysis, arises when an independent variable in a regression model is correlated with the error term, violating the assumption of exogeneity (Wooldridge 2016, Chapter 15). In the case of circular and cumulative causation, the endogeneity issue may emerge

Table 11 MG, CCEMG, and AMG

Dependent variable: LOG(INV)	EU-28			EU-15			CEEU		
Variables	MG	CCEMG	AMG	MG	CCEMG	AMG	MG	CCEMG	AMG
LOG($G_{i,t}$)	0.345	0.197	0.198	0.265	0.024	0.012	0.451	0.368	0.439
	(0.075)	(0.067)	(0.081)	(0.082)	(0.051)	(0.049)	(0.130)	(0.120)	(0.113)
	[4.690][a]	[2.950][a]	[2.460][b]	[3.240][a]	[0.500]	[0.240]	[3.470][a]	[3.060][a]	[3.890][a]
LOG($ULC_{i,t}$)	0.842	0.438	0.408	0.527	− 0.084	− 0.007	1.335	1.119	1.387
	(0.252)	(0.271)	(0.334)	(0.265)	(0.360)	(0.307)	(0.434)	(0.594)	(0.401)
	[3.330][a]	[1.760][c]	[1.620][c]	[1.990][b]	[-0.230]	[-0.002]	[3.080][a]	[1.880][c]	[3.460][a]
LOG($GDP_{i,t}$)	0.866	1.116	1.393	0.933	1.412	2.062	0.886	1.888	0.996
	(0.078)	(0.086)	(0.116)	(0.058)	(0.134)	(0.147)	(0.211)	(0.388)	(0.184)
	[11.050][a]	[12.980][a]	[12.03][a]	[16.090][a]	[10.490][a]	[14.000][a]	[4.190][a]	[5.170][a]	[5.410][a]
CDP			1.022			0.943			1.012
			(0.176)			(0.095)			(0.343)
			[5.810][a]			[9.950][a]			[2.950][a]
Intercept	0.417	− 0.434	− 2.844	− 0.504	0.388	− 7.090	0.912	1.075	0.392
	(0.699)	(0.816)	(0.853)	(0.440)	(0.730)	(0.913)	(1.263)	(1.987)	(1.169)
	[0.600]	[− 0.530]	[− 3.330][a]	[− 1.150]	[0.530]	[− 7.690][a]	[0.720]	[0.540]	[0.340]
Observations	1099	1099	1099	792	792	792	307	307	307
Countries	28	28	28	15	15	15	13	13	13
Wald chi2 (3) (p-value)	148.58 (0.000[a])	179.74 (0.000[a])	255.64 (0.000[a])	273.22 (0.000[a])	110.28 (0.000[a])	237.22 (0.000[a])	39.11 (0.000[a])	32.32 (0.000[a])	111.05 (0.000[a])
CD-test (p-value)	16.05 (0.000[a])	− 1.010 (0.312)	− 0.810 (0.418)	11.840 (0.000[a])	− 1.18 (0.060[b])	− 3.18 (0.001[b])	6.05 (0.000[a])	− 1.39 (0.165)	− 2.49 (0.013[b])

Table 11 (continued)

Dependent variable: LOG(INV)	EU-28			EU-15			CEEU		
Variables	MG	CCEMG	AMG	MG	CCEMG	AMG	MG	CCEMG	AMG
Root Mean Squared Error (sigma)	0.109	0.067	0.094	0.093	0.064	0.062	0.141	0.071	0.106

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. Standard errors are enclosed in parentheses, and statistics are provided within brackets. For the MG and CCEMG estimators, the coefficient averages were calculated as outlier-robust means. For the AMG estimator, the coefficient averages were computed as unweighted means; likewise, a common dynamic process (CDP) is included. Cross-sectional averaged regressors are omitted because they are not relevant for the assessment. The *xtmg* command by Eberhardt (2012) was used

because the economic factors involved are not truly exogenous but are influenced by each other.

To test these potential feedback loops between the variables, we employ the Dumitrescu and Hurlin (2012) panel Granger non-causality test. Dumitrescu and Hurlin (2012, pp. 1450–1451) state that their approach is a simple Granger non-causality test for heterogeneous panel data that uses a block bootstrap procedure for controlling for cross-sectional dependence. In this way, the Dumitrescu-Hurlin test can obtain results more robust than the original Granger (1969) non-causality test in the presence of both slope heterogeneity and cross-sectional dependence (Akram and Rath 2019). The results outlined in Table 12 indicate that there exist bidirectional causal relationships between the variables, exception made for LOG($GDP_{i,t}$) and LOG($G_{i,t}$) in the case of the CEEU panel. The confirmation of these bidirectional causal relationships underscores the importance of addressing endogeneity and employing appropriate econometric methods in our analysis.

To mitigate the detected endogeneity while ensuring robust results, we apply the dynamic common correlated effects estimator mean group with instrumental variables (DCCEMG IV) developed by Chudik and Pesaran (2015). As noted by the literature, this approach yields estimations that are more efficient in presence of cross-sectional dependence and slope heterogeneity compared to other methods (Kim 2022; Mamba and Ali 2022). The dynamic specification involves incorporating the lagged dependent variable into Eq. (6):

$$\begin{aligned} LOG(INV_{i,t}) = \beta_0 + \gamma LOG(INV_{i,t-1}) + \beta_1 LOG\left(G_{i,t}\right) + \beta_2 LOG\left(ULC_{i,t}\right) \\ + \beta_3 LOG\left(GDP_{i,t}\right) + \varepsilon_{i,t} \end{aligned} \tag{6.1}$$

In Eq. (6.1), γ represents the coefficient for the lagged dependent variable, thus capturing the dynamic relationship, as the other terms have been defined earlier. According to the literature which analyses the relationship between investment and growth, the endogeneity may be tackled by using lagged explanatory variables as instruments (Caselli et al. 1996; Durlauf et al. 2005; Temple 1999). Following the procedure developed by Ditzen (2018), we include the first two lags of regressors as instruments in Eq. (6.1) to control for potential endogeneity.

According to Table 13, in the three regressions (EU-28, EU-15, and CEEU), a negative coefficient is observed, suggesting that past values of LOG($INV_{i,t}$) have a significant negative effect on the current value. The t-statistics are highly significant, indicating the robustness of this relationship and suggesting a strong persistence effect in the dependent variable; a decrease in the previous period is associated with a decrease in the current period. The magnitude of this effect varies slightly between the regions, with the EU-28 showing the largest effect and the CEEU region showing the smallest one. The coefficient estimates for the variables LOG($G_{i,t}$), LOG($ULC_{i,t}$), and LOG($GDP_{i,t}$) exhibit similar patterns in all three regions, with varying magnitudes and significance levels.

Specifically, ceteris paribus, a 1% increase in profitability (LOG($G_{i,t}$)) has a positive impact on LOG($INV_{i,t}$) ranging from 0.177% (EU-15) to 0.427% (CEEU), which is similar to the results summarized in Tables 10 and 11 for the other estimators. However, the most interesting outcomes pertain to the

Table 12 Dumitrescu-Hurlin (2012) Granger non-causality test

	EU-28			EU-15			CEEU		
Null hypothesis	W-Stat	Zbar-Stat	Prob	W-Stat	Zbar-Stat	Prob	W-Stat	Zbar-Stat	Prob
LOG($G_{i,t}$) does not Granger cause LOG($INV_{i,t}$)	4.433	4.959	0.000[a]	5.355	5.738	0.000[a]	2.302	2.486	0.013[b]
LOG($INV_{i,t}$) does not Granger cause LOG($G_{i,t}$)	6.268	8.997	0.000[a]	6.803	8.286	0.000[a]	4.205	6.469	0.000[a]
LOG($ULC_{i,t}$) does not Granger cause LOG($INV_{i,t}$)	7.697	12.143	0.000[a]	10.291	14.428	0.000[a]	1.988	1.829	0.067[c]
LOG($INV_{i,t}$) does not Granger cause LOG($ULC_{i,t}$)	7.393	11.473	0.000[a]	6.091	7.034	0.000[a]	5.782	9.770	0.000[a]
LOG($GDP_{i,t}$) does not Granger cause LOG($INV_{i,t}$)	11.826	21.229	0.000[a]	11.243	16.104	0.000[a]	4.097	6.242	0.000[a]
LOG($INV_{i,t}$) does not Granger cause LOG($GDP_{i,t}$)	3.960	3.919	0.000[a]	3.550	2.559	0.010[a]	2.901	3.739	0.000[a]
LOG($ULC_{i,t}$) does not Granger cause LOG($G_{i,t}$)	10.026	17.269	0.000[a]	8.556	11.374	0.000[a]	3.035	4.019	0.000[a]
LOG($G_{i,t}$) does not Granger cause LOG($ULC_{i,t}$)	8.025	12.864	0.000[a]	10.110	14.109	0.000[a]	3.812	5.646	0.000[a]
LOG($GDP_{i,t}$) does not Granger cause LOG($G_{i,t}$)	7.780	12.325	0.000[a]	8.156	10.669	0.000[a]	3.760	5.537	0.000[a]
LOG($G_{i,t}$) does not Granger cause LOG($GDP_{i,t}$)	3.853	3.682	0.000[a]	3.641	2.720	0.007[a]	0.796	-0.666	0.506
LOG($GDP_{i,t}$) does not Granger cause LOG($ULC_{i,t}$)	9.065	15.152	0.000[a]	8.419	11.132	0.000[a]	4.129	6.309	0.000[a]
LOG($ULC_{i,t}$) does not Granger cause LOG($GDP_{i,t}$)	4.993	6.192	0.000[a]	5.279	5.603	0.000[a]	3.588	5.177	0.000[a]

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. For the EU-28 and EU-15, we impose two lags. For the CEEU panel, we use one lag. Estimations were performed using Eviews 11

Table 13 DCCEMG-IV

Dependent variable: LOG($INV_{i,t}$)			
Variables	EU-28	EU-15	CEEU
LOG ($INV_{i,t-1}$)	− 0.602	− 0.355	− 0.732
	(0.118)	(0.085)	(0.150)
	[− 5.110][a]	[− 4.160][a]	[− 4.880][a]
LOG ($G_{i,t}$)	0.425	0.177	0.427
	(0.164)	(0.056)	(0.235)
	[2.590][a]	[3.150][a]	[1.820][c]
LOG ($ULC_{i,t}$)	1.018	0.256	1.461
	(0.852)	(0.581)	(0.528)
	[2.130][b]	[2.000][b]	[1.960][c]
LOG ($GDP_{i,t}$)	1.127	0.372	1.714
	(0.411)	(0.180)	(0.723)
	[2.590][a]	[2.060][b]	[2.730][b]
Intercept	3.205	1.896	1.277
	(0.651)	(0.719)	(0.853)
	[1.050]	[1.610][c]	[0.380]
Observations	1099	792	307
Countries	28	15	13
CD-test (p value)	− 0.05 (0.583)	− 2.070 (0.038[b])	− 1.440 (0.150)
Root mean squared error (sigma)	0.09	0.05	0.07

[a]Denotes rejection at 1%

[b]Denotes rejection at 5%

[c]Denotes rejection at 10%. Standard errors are enclosed in parentheses, and statistics are provided within brackets. Endogenous variables include LOG($G_{i,t}$), LOG($ULC_{i,t}$) and LOG($GDP_{i,t}$). Exogenous variables consist of LOG($G_{i,t-1}$), LOG($ULC_{i,t-1}$), LOG($GDP_{i,t-1}$), LOG($G_{i,t-2}$), LOG($ULC_{i,t-2}$), and LOG($GDP_{i,t-1}$). The *xtdcce2* command by Ditzen (2018) was applied, which supports estimations of instrumental variables by using the ivreg2 package developed by Baum, Schaffer, and Stillman (2010)

relationship between LOG($INV_{i,t}$) and LOG($ULC_{i,t}$). In contrast to CCEMG and AMG, DCCEMG-IV reports that a 1% increase in LOG($ULC_{i,t}$) results in a 0.256% increase in LOG($INV_{i,t}$) in EU-15 countries, suggesting that competition, based on efforts to reduce prices and costs, remains a significant factor in the most advanced European countries.

Furthermore, in the case of both EU-28 and CEEU, the impact of competition is more pronounced than what is observed when using estimators that do not account for endogeneity. To be specific, *ceteris paribus*, a 1% increase in LOG(*ULCi,t*) results in an expansion of private investment by approximately 1.018% (EU-28) and 1.461% (CEEU). Lastly, it is worth highlighting that according to the DCCEMG-IV results, the accelerator principle appears to be a crucial factor in driving long-term private capital accumulation. That is, the beta coefficients suggest that a 1% increase in aggregate demand leads to an investment improvement of about 0.372% (EU-15) and 1.714% (CEEU). Overall, the empirical assessment has provided evidence that supports the hypotheses based on the theoretical framework.

Summary and Concluding Remarks

In this research study, we have revisited the classical approach to investment both theoretically and empirically. The classical theory of investment posits that capital accumulation is a dynamic process governed in the long term by profitability, competition, and the accelerator principle, where these variables interact mutually, thereby generating circular and cumulative causations.

Utilizing a sample that comprises the 28 EU countries over the period from 1961 to 2019, we tested hypotheses inspired by the theoretical framework using econometric techniques that can control for both cross-sectional dependence and slope homogeneity. This represents the primary contribution of our investigation to the literature, as previous studies analysing the classical theory of investment with panel data methods either neglect cross-sectional dependence (Alexiou 2010; Alexiou et al. 2016) or their samples do not cover all EU countries (Alexiou et al. 2016). It should be clarified, however, that our findings do not contradict these investigations but rather complement them, as we achieve similar results that support the empirical validity of the classical theory of investment even when considering cross-sectional dependence.

Furthermore, both the estimators that do not account for cross-sectional dependence and those that control for it provided sufficient evidence to support the theoretical hypotheses. In this context, it is interesting to note that the CCEMG and AMG estimators reported that the long-run relationship between investment and the accelerator principle is stronger than the one suggested by the GM-FMOLS, GM-DOLS, and MG estimators. This finding appears to reinforce the hypothesis that the accelerator principle is the key determinant of private investment in the long term (Arestis et al. 2012; Arestis and González-Martínez 2016).

Nevertheless, given that the Dumitrescu-Hurlin non-causality test indicates potential feedback loops between the variables, it is not easy to establish which is the chief determinant that drives private investment in the long run. This can also be considered another valuable contribution to the existing literature since recent investigations have not explored the causal relationships between investment and its determinants in the context of panel data analysis. For this reason, the DCCEMG with instrumental variables was implemented to mitigate endogeneity, thus obtaining results more robust in supporting the empirical validity of the classical investment function. Although other investigations have used methods that control for endogeneity, such as dynamic panel system generalized method of moments (GMM) or instrumental variable fixed effects (IV FE) estimators, these techniques often neglect cross-sectional dependence (Banerjee and Carrion-i-Silvestre 2017).

While our study primarily focused on the fundamental aspects of classical investment theory, we do acknowledge that further research should assess the effects of credit, foreign trade, capital mobility among countries, the institutional framework, and sectoral composition on capital accumulation, both in the short and long term. For this purpose, other methods that effectively control for cross-sectional dependence and slope heterogeneity should be applied.

Last but not least, the results obtained have significant economic policy implications. Given that GDP growth appears to be a pivotal factor in driving private capital accumulation, policymakers should prioritise the implementation of measures aimed at bolstering the domestic market and improving local firms' competitiveness to capture foreign markets. This may include increasing public investment in economic infrastructure, fostering a business-friendly environment to attract both domestic and foreign investment, and promoting initiatives that enhance the competitiveness of domestic industries. This approach could enhance profitability conditions and stimulate private investment through the presence of new competitors driven by foreign investment.

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Code Availability The data that support the findings are freely available from Eurostat and from the corresponding author upon reasonable request.

Declarations

Conflict of Interest No potential conflict of interest was reported by the authors.

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