Investment, growth and competitiveness: The multiplier-accelerator in the 21st century

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Abstract

This paper advances understanding of multiplier-accelerator interaction in European countries in the 21st century. More than eight decades from the contributions of Keynes and Samuelson, multiplier-accelerator interaction has spawned rich and interesting literature. In this study, we examined the relationship between investment, consumption, and economic growth for European Economic Area (EEA) countries, with data observed between 2000 and 2021. We found evidence for both multiplier and accelerator effects. However, for most European economies, the multiplier effect is stronger than the accelerator effect, helping to explain the profile of economic cycles. These results present two emerging policy implications. First, investment made in Europe reacts to the rates of economic growth observed in recent periods. Investment dynamics have long been highlighted as promoters of economic growth and competitiveness. Economic agents use investments to improve their strategic position as agents of long-term socioeconomic development. Second, the estimated effects are not uniform over time; investments react in the same direction as the economic growth observed in the previous years. This nonlinearity of effects obliges all decision-makers to duly anticipate these reactions as well as obliges the academic community to further study the subject. The existence of spatial competition in the distribution of investments leads to strategic behaviours by which competing countries ensure long term national competitiveness.

Keywords: *multiplier-accelerator (M-A), supermultiplier, investment, competitiveness, business cycle, European Economic Area (EEA)*

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1. INTRODUCTION

Recently, understanding the relationship between competitiveness and the macroeconomic environment has become an important area of research. National competitiveness is influenced by various factors that contribute to a country's ability to achieve sustainable economic growth, attract investments, create jobs, and improve the standard of living for its citizens. While the specific factors can vary depending on the context, some of the main factors that stimulate national competitiveness include economic policies and institutions, infrastructure development, human capital, innovation and technology, access to finance, trade openness, and environmental sustainability (Schwab & Zahidi, 2021).

However, stable macroeconomic conditions represent the basic premise for fostering competitiveness. Along these lines of thought, the dynamic relationship between national income, investment, and consumption has preoccupied economists since the beginning of economic science. Investment depends on the output and revenue of the community because it is part of the total expenditure. Wealthier and more prosperous communities make greater investments. Wealthier and more prosperous areas construct more dwellings, public structures, and infrastructure. However, investment is at the same time a factor of future production on its

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own. Today's investments help us produce more tomorrow, which increases our income, and thus leads to the increase of the investment asset base.

The relationship between national product, investment, and consumption was masterfully captured by Samuelson (1939a, 1939b) in a model that incorporates the interplay between the principle of acceleration and the multiplier. The principle of acceleration refers to the fact that an increase in the demand for goods will tend to cause a more than proportionate increase in the demand for productive assets. The multiplier effect refers to the fact that an increase in spending determines an increase in national income and consumption greater than the initial amount spent. Furthermore, the interaction of the accelerator with the multiplier generates, under certain circumstances, continuous cyclical fluctuations. The combined effects of accelerator and multiplier on national income propagation generate various types of economic cycles with mild, damped, or explosive fluctuations, of varying amplitude and periodicity.

Although simple in essence, the multiplier-accelerator model proposed by Samuelson (1939a, 1939b) has generated an overwhelming interest in such models. The Samuelsonian model has been continuously refined by scholars who have turned their attention to accelerator – multiplier theory and models to investigate various problems related to the financial crisis, business / trade / economic cycles, monetary and fiscal policies, environmental impacts, or technological developments. However, the majority of scholars have developed theoretical models tested with numerical or stochastic data.

A clear empirical gap exists in the scientific literature on multiplier-accelerator models. Few studies in economic literature propose an empirical validation of the Samuelson (1939a, 1939b) model. We found that these studies showed mixed results in terms of the multiplier-accelerator interplay and their combined effect on national income. For instance, Blanchard (1981) argued that a change in output (especially a decrease) will not lead to a change in consumption but may lead to a significant change in investment. In particular, empirical studies on the macroeconomic dynamics of growth using Samuelsonian multiplier-accelerator models are lacking for European countries. These economies are inserted in a competitive dynamism which involves other European areas. So, realizing the magnitude of these effects – accelerator and/or multiplier ones – is relevant for properly managing the European economies' competitiveness.

In this paper, we examine the relationship proposed by the original model of the accelerator-multiplier effect and discuss the findings and the implications for public policy. Our econometric investigation provides evidence that, over the period considered, there is a short-term and procyclical reaction between investment and the growth of the aggregate economy for European countries. But, there is a countercyclical behaviour of investment in view of what was observed in the economy two and three periods prior. Thus, if in two lagged periods the economy had negative growth rates, investment tends to react positively at the time of observation. In economies with stationary movements in economic growth, the expected effect of economic growth on investment is positive. If there were high rates of economic growth in the previous two or three periods and, meanwhile, the economic growth rates in the previous period or the observation period are significantly lower, this may lead to lower induced investment. We found evidence for both multiplier and accelerator effects in European economies. However, the multiplier effect is stronger than the accelerator effect for most European economies, helping to explain the profile of economic cycles.

The remainder of the paper is organised as follows. Section 2 provides an investigation into the origin, development, and practical relevance of the multiplier-accelerator models. Section 3 provides information on the methodology and describes the data collection and data analysis method. In Section 4, we present the findings of our research. They are further discussed in Section 5. Finally, the last section concludes.

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2. THEORETICAL BACKGROUND

2.1. Competitiveness, investment, and economic growth

Discussion over investment, economic growth and competitiveness has long permeated economic research studies. Investment has been acknowledged as a prominent source of growth (Afonso & Rodrigues, 2023). Investment spending stimulates the economy in the short term through income and multiplier effects that boost economic growth. In this sense, it raises the stock of productive capital and long-run total factor productivity. Accordingly, investments provide two effects, namely Keynesian demand increase in the short run and neoclassical supply stimulus in the long run (Afonso & Rodrigues, 2023; Ramey, 2020).

The relationship between economic growth and national competitiveness is complex and multifaceted. There is an ongoing debate among economists about the causality between national competitiveness and economic growth. Some argue that competitiveness drives economic growth, while others contend that economic growth leads to increased competitiveness.

On one hand, competitiveness depends on the level and dynamics of the economic growth. The conditional effect of macroeconomic factors has a significant impact on national competitiveness (Khyareh & Rostami, 2022). However, the dynamics of competitiveness may be different depending on the level of economic development and the macroeconomic environment (Fyliuk et al., 2019; Simionescu et al., 2021). An extensive body of research has investigated empirically the relationship between economic growth and competitiveness. Recent studies found a positive relationship between the level of national competitiveness and economic growth for EU member states (Gama et al., 2020; Boikova et al., 2021; Simionescu et al., 2021; Terzić, 2021; Vîrjan et al., 2023).

On the other hand, national competitiveness can contribute to economic growth. Characterized by factors such as efficient institutions, infrastructure, skilled workforce, innovation, and favourable business environment, competitiveness at the national level can create conditions that stimulate economic growth. Competitiveness can attract investments, promote productivity gains, foster innovation, and entrepreneurship, and enhance a country's ability to participate in global markets (Schwab & Zahidi, 2021). Economic growth itself can also impact national competitiveness. Higher levels of economic growth can generate resources that can be invested in improving competitiveness factors such as education, infrastructure, and technological capabilities (Fagerberg et al., 2007; Hausmann & Hidalgo, 2014). This tends to create a positive feedback loop between competitiveness and economic growth.

While national competitiveness can contribute to economic growth, it is not the sole determinant (Barro & Sala-i-Martin, 2004). Macroeconomic stability plays a significant role in driving economic growth. Therefore, the investigation of macroeconomic stability becomes of major importance for national competitiveness policy and research. The relationship between national competitiveness and economic growth is context-specific and can vary across countries and time periods. Different countries may have distinct strengths and challenges that influence their economic growth trajectories. Factors that drive economic growth in one country may not have the same impact in another. Considering the interplay between investment, consumption, and economic growth, the Samuelsonian multiplier-accelerator model provides solid explanations and answers to the current problems of economic cycles and the macrodynamics of economic growth (Mourao & Popescu, 2022) and can be used to investigate differences in macroeconomic conditions across countries.

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2.2. The development of the multiplier-accelerator model

Since 1936, the "General Theory of Employment, Interest, and Money" (Keynes, 2018) has probably been the most relevant work in economics. In this cornerstone work, Keynes (2018) discussed the basic conditions for investment and consumption, among others. Private investment occurs when companies adjust their production capacity to the expected total demand for consumption. Therefore, the investment decision is based on the expectation that there will be a demand for consumer goods produced with these capital goods. There must be enough investment spending to cover the difference between production at full capacity and total consumption in order to justify a particular level of employment. Additionally, as the experience of current consumption serves as a major basis for expectations of future consumption, a decline in the former is likely to have a negative impact on the latter (Keynes, 2018, p. 210).

We see in Keynes's (2018) seminal work two effects that impact the dynamics of economic growth, namely the accelerator and the multiplier. However, the accelerator effect had already been discussed by Carver (1903) and Aftalion (1909). Their research suggested that a rise in the demand for commodities will typically result in an increase in the demand for productive assets that is greater than commensurate. The acceleration principle states that changes in the demand for consumer goods can generate larger changes in the demand for investment goods used for their production. Thus, induced investment depends on the pace of growth in economic activity (accelerator effect). Later, the acceleration principle was introduced by Clark (1917) in his theory of the derived demand for capital equipment. The multiplier effect comes from Keynes (2018) and collaborators (Kahn, 1931; Keynes & Henderson, 1929). According to the original model, a change in private investment increases economic activity and increases income until savings equal the initial investment. Thus, the marginal propensity to consume determines the size of the investment multiplier.

However, the two effects were considered conceptually distinct and discrete until Samuelson (1939a, 1939b) integrated them into the same analysis framework. To analyse the business cycle, Samuelson (1939a) proposed a model in which cyclical fluctuations arise as a consequence of the interplay between the accelerator and the multiplier. Considering both accelerator and multiplier effects and their relation, his model was better able to capture the complexity of fluctuations in national economies.

Samuelson's multiplier-accelerator model has a Keynesian foundation. Keynesian macroeconomics saw the interest rate as a stabilizing mechanism for both savings and investment. In addition, the notion of effective demand is included in the dynamic analysis by the acceleration principle, a theory of investment. Samuelson's model emphasizes the realities on the demand side, specifically, the fact that investment follows the expected increase in demand and that consumption is affected by the level of economic activity.

The original model proposed by Samuelson (1939, p.76) in discrete time is based on the following assumptions.

National income at time *t*, Y_t, can be written as the sum of three components: (i) governmental expenditure, G_t, (2) induced private investment, I_t and (3) consumption expenditure, C_t, where G_t was kept constant (G_t=1) by Samuelson (1939a, 1939b).

$$Y_t = G_t + I_t + C_t \quad (1)$$

Consumption C_t at time *t* depends on the previous income (Y_{t-1}) and on the marginal propensity to consume, modelled by a parameter α, which is the multiplier coefficient, where $0< \alpha <1$:

$$C_t = \alpha Y_{t-1} \quad (2)$$

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Induced private investment I_t depends on changes in consumption (C_t-C_{t-1}) and on the accelerator factor β, where $\beta > 0$:

$$I_t=\beta\ (C_t-C_{t-1}) \tag{3}$$

Therefore, the national income can be written as follows:

$$Y_t= G_t+ \beta\ (C_t-C_{t-1})+ \alpha\ Y_{t-1}= G_t+\alpha\ \beta\ Y_{t-1} - \alpha\ \beta\ Y_{t-2} + \alpha\ Y_{t-1}= G_t+ \alpha\ (\beta +1)\ Y_{t-1} - \alpha\ \beta\ Y_{t-2} \tag{4}$$

According to (4), having known the national income for two consecutive periods and selecting the values for the accelerator and the multiplier, we can deduce the national income for a country. This model, with constant government expenditure, becomes a second-order linear equation capable of producing oscillations converging to the equilibrium value of the national income considering a two-fold causal relationship between the national income and investment. However, in certain situations, the original model generates damp or explosive oscillations. According to Dassios et al. (2014), this is the major shortcoming of the model - its inability to produce a stable path for national income when realistic values for multiplier and accelerator parameters are considered.

In particular, three works originating in Samuelson (1939a, 1939b) have marked the development of multiplier-accelerator models: Kaldor (1940), Hicks (1950), and Goodwin (1951). Based on them, many interesting multiplier-accelerator models have emerged, either linear or nonlinear, giving rise to a nascent family of multiplier-accelerator models or "supermultiplier" models, a term coined by Hicks (1950).

Kaldor (1940) proposed the first nonlinear business cycle model by introducing nonlinear investment and saving functions. The system can produce long-term cyclical fluctuations with amplitude determined by endogenous factors. Based on the Kaldorian model, several versions of the model were proposed in the macroeconomic literature (e.g., Dana & Malgrange, 1984; Herrmann, 1985; Lorenz, 1992, 1993; Grasman & Wentzel, 1994; Dohtani et al., 1996; Nadiri & Prucha, 1996; Krawiec & Szydłowski,1999; Bischi et al., 2001; Agliari et al., 2007; Wu, 2011). For example, Grasman and Wentzel (1994) assumed that the current change in the stock of capital equals the investment minus the depreciation of the capital stock and calculate the change in the gross product considering a sufficiently large parameter that allows one to obtain a stable equilibrium or "relaxation oscillations."

Hicks (1950) extended the Samuelson (1939) model in discrete time with the introduction of "floor" (investment lower bound) and "ceiling" (full employment bound) to temper the explosiveness of oscillations generated by the original model. These limits were subsequently discussed by Rau (1974), Gandolfo (1985), Hommes (1991), Bischi and Lamantia (2012) and Bischi et al. (2012). Even with bounds, Hommes (1995) argued that the system was unstable, leading to explosive oscillations when the equilibrium is unstable. He showed that a chaotic attractor can occur. In his version of the model, Hommes (1995) introduced consumption and investment delays distributed over several periods. Consumption lags one period behind income, whereas investments are included in the immediately following period in which the income change occurs. Goodwin (1951) transposed the original model in continuous time. He replaced the piecewise linearity with a smooth nonlinearity in the investment function, by including an investment delay and nonlinear accelerator. The equilibrium position of the system is still unstable in his model, but a stable limit cycle can be generated.

2.3. Multiplier-accelerator models in recent times

Multiplier-accelerator models have undergone continuous development. In what follows, we provide a brief theoretical review of recent works, followed by a discussion of practical relevance in present time.

https://doi.org/10.7441/joc.2023.03.04

Ensuring the stability of the system has been the main objective of model development. In this sense, Puu et al. (2005) considered a floor that is linked to the capital stock through a depreciation rate, while Puu (2007) considered a ceiling that is linked to the capital stock through an income-capital ratio. Sushko et al. (2010) considered both the previously mentioned bounds, and showed that periodic, quasiperiodic and aperiodic cycles can be generated by their model. Westerhoff (2006) included investor sentiment in the model by making investment depend on a nonlinear mix of extrapolative and regressive expectation formation rules to predict the evolution of the national income. He argued that the sentiment of investors is directly related to fluctuations in economic activity and investment level. A similar approach is used in Lines and Westerhoff (2006), but this time the model uses a weighted average of extrapolative and reverting expectations formation rules to predict changes in national income. The Goodwin (1951) model was fine-tuned by Matsumoto and Szidarovszky (2010, 2015), who included consumption and investment delays. Matsumoto and Szidarovszky (2015) considered an S-shaped functional form of investment and a linear consumption function. Their system can produce cycles, and equilibrium repeatedly occurs when one of the delays increases while the other is kept positive and constant. Other studies that developed the Goodwin (1951) model are Lorenz and Nusse (2002), Matsumoto (2009), Li et al. (2011), Flaschel (2015), and Matsumoto et al. (2018).

Furthermore, notable recent discussions and developments regarding multiplier-accelerator models are to be found in the contributions of the following: Day and Chen (1993), Day (1999), Puu (2000), Rosser (2000), Puu (2003), Gallegati et al. (2003), Sushko et al. (2003), Hommes (2013), Bischi (2014), Naimzada and Pecora (2017), Bischi et al. (2019), Barros and Ortega (2019), and Tramontana and Gardini (2021). Markovian jump linear systems with H∞ methods from control theory based on multiplier-accelerator models (Caravani, 1995; Song et al., 2017; Chen et al., 2012) have also been proposed.

By its very early nature, the multiplier-accelerator mechanism was designed to analyse the effects of fiscal policy. However, few studies have examined the effects of the introduction of the monetary sector in multiplier-accelerator models. We mention here the early contributions of Smith (1963) and Lovell and Prescott (1968). More recently, a study by Karpetis and Varelas (2012) developed a linear, discrete-time multiplier–accelerator model with a money market and a balanced government expenditure rule to analyse the stability of such an economic system.

The most recent global economic and financial crisis (mid-2007 to early-2009) brought the multiplier-accelerator effect back into the spotlight. In their attempt to investigate how speculations in the financial market are transmitted to the real market and how the real market marks the evolution of the financial market, Cavalli et al. (2017) developed a Samuelsonian discrete time model with an incorporated stock market.

To the best of our knowledge, the number of empirical studies using multiplier-accelerator effects is small, showing a clear gap in the literature. Our literature search on the main academic search engines for academic publications (i.e., Web of Science and Scopus) revealed only six empirical publications out of more than 100 publications on multiplier-accelerator models (Christensen & Knudsen; 1992; Aguiar-Conraria & Wen, 2007; Pérez-Montiel & Erbina, 2020; Silvestrov et al., 2022; Kosov et al., 2022; Kopczewska, 2006).

However, none of the empirical studies in European countries incorporated multiplier-accelerator effects to investigate macroeconomic dynamics. Consequently, there is a clear empirical gap in the scientific literature on multiplier-accelerator models. On the one hand, empirical studies on the macroeconomic dynamics of growth are lacking for European countries. On the other hand, existing studies showed mixed results in terms of the multiplier - accelerator interplay and their combined effect on national income. More so, Blanchard (1981)

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argued that a change in output (especially a decrease) will not lead to a change in consumption but may lead to a significant change in investment. He concluded that "the multiplier is dead and the accelerator alive" (Blanchard, 1981, p. 154).

Additionally, studies on investment optimization at the national level are largely absent. Investment decisions are made based on the impact of investment on income, which can be measured by the multiplier effect. Several studies concern the investment made by central authorities (e.g., Kosov et al., 2022; Kopczewska, 2006), but there is still a gap for private investment. Interestingly, Erden and Holcombe (2006) found that the impact of an investment in an economy (i.e., the multiplier) may be different depending on whether investment is made by the public or private sector. Furthermore, previous studies on the relationship between public and private investment and GDP growth showed that private investment may "crowd in" (e.g., Seitz, 1994; Pereira, 2001) or "crowd out" (e.g., Voss, 2002; Zou, 2006; Cavallo & Daude, 2011). These mixed results require further investigation of the interaction between macroeconomic determinants of economic growth. The next section will contribute to filling this gap.

3. METHODOLOGY

In this study, we used a quantitative research approach. For the purpose of this empirical estimation, we constructed a panel of all countries of the European Economic Area (EEA). The panel consists of 27 E.U. countries and Iceland, Liechtenstein and Norway, which are also part of the European Union's Single Market. Specifically, the investigated countries are Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and Switzerland. We selected EEA countries for studying this interaction because they have similarities in terms of economic development as compared to the rest of the world, but their performance in terms of national competitiveness varies largely due to differences in innovation performance and macroeconomic conditions.

The variables are national income, investment, and consumption. Data were collected from Eurostat, the E.U. statistical office. For income we used the 'gross domestic product' at market prices in million euro (Eurostat table NAMA_10_GDP) (Eurostat, 2023a) as in the standard literature for economic development (Li et al., 2016; Boubtane et al., 2016; Omran & Bilan, 2022). For investment, we used 'gross fixed capital formation' at current prices in million euro (Eurostat dataset TIPSNA20) (Eurostat, 2023b). For consumption, we used 'final consumption' at current prices in million euro (Eurostat table NAMQ_10_FCS) (Eurostat, 2023c). Data were collected for the period 2000-2021. A total of 680 observations were included in the analysis.

We estimated a dynamic panel data model. We recurred to the System of Generalized Method of Moments (GMM) for exploring the dynamics of variables' lags. GMM is the "predominant estimation technique for empirical models with endogenous variables, in particular lagged dependent variables, when the time horizon is short" (Kripfganz, 2019). The consistency of the GMM estimator relies on the validity of the instruments and the assumption that the error terms are not correlated. To ensure the consistency of the GMM estimator, we tested the residual characteristics by using conventional tests: AR2; Hansen/Sargan and the Hansen test of overidentification of restrictions.

4. EMPIRICAL MODEL AND RESULTS

Considering a simple empirical formalization (Puu, 2004), this model considers that national income (Y) is equal to the sum of consumption (C) plus investment (I). Thus, for a given period

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t, $Y_t=C_t+I_t$. Investment at a moment *t* is composed of the investment of substitution (a fixed value, usually neglected in the dynamic solution) and of the induced investment, defined as a fraction of the most recent growth rate of income ($\Delta Y=Y_{t-1} - Y_{t-2}$), that is $I_t = a*\Delta Yt\text{-}1$. Consumption is defined as a proportion of the income of the previous period: $C_t = c*Y_{t-1}$. Therefore,

$$Y_t = (a+c)*Y_{t-1} - a*Y_{t-2} \quad (5)$$

Depending on the magnitudes of the accelerator effect (*a*) and of the multiplier effect (*1/(1-c)*), the model can have various paths for the projected income at leads *t+1, t+2,* etc. (Samuelson, 1939a). For instance, if the accelerator is small relative to the multiplier, the oscillations of the economic cycle become increasingly weaker; at the end, this leaves income constant at its central value. In a different scenario, high values of the accelerator and low values of the multiplier give rise to explosive fluctuations, the cycles becoming each time increasingly pronounced.

Thus, we analyse, for 31 European economies, the relationship proposed by the original model of the accelerator-multiplier effect. In Table 1, we present the descriptive statistics for the logs of the variables: GDP (million euro); household consumption (million euro); and gross fixed capital formation (million euro). We have also obtained the GDP growth rates for these European economies, and the respective statistics are in Table 1.

Tab. 1 - Descriptive Statistics. Source: own research

Variable	N	Mean	Standard Deviation	Minimum	Maximum
GDP (million euro)	660	453777.6	704119.2	4394.88	3601750
Household Consumption (million euro)	680	243743.1	384560.9	3283.4	1717921
Gross Formation of Capital Fixed (million euro)	650	96445.25	143438.5	792.3	783804
GDP (million euro), log	660	11.88047	1.644	8.3882	15.09693
Household Consumption (million euro), log	680	11.29181	1.5791	8.0966	14.35663
Gross Formation of Capital Fixed (million euro), log	650	10.395	1.6059	6.67494	13.57191
GDP, yearly growth rate	628	0.0437	0.0618	-0.26028	0.2986

Let us start by studying the relationship between investment and economic growth, that is, investment as depending on current and past growth rates. Table 2 exhibits the estimates of this fundamental equation of the accelerator-multiplier effect estimated for 31 European economies in the period 2000-2021. We considered both the log of investment and the absolute value of it (in million euro).

Tab. 2 - Results for the Investment Equation. Source: own research

	Investment (log)				Investment (absolute values)			
	Coefficient	Std. Err.	Z	P>|z|	Coefficient	Std. Err.	Z	P>|z|
I_t-1	0.940	0.016	58.98	0.000	0.965	0.032	29.62	0.000
ΔY_t	1.456	0.059	24.50	0.000	16479.45	8969.835	1.84	0.076
ΔY_t-1	0.283	0.059	4.71	0.000	10338.652	4343.971	2.38	0.011
ΔY_t-2	-0.208	0.067	-3.10	0.002	-11091.27	8444.76	-1.31	0.199

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ΔY_t-3	-0.183	0.062	-2.94	0.003	-13769.78	8694.134	-1.58	0.124
Arellano-Bond test for AR(1) in first differences (p-value)				0.000				0.012
Arellano-Bond test for AR(2) in first differences (p-value)				0.446				0.121
Sargan test of overid. Restrictions (p-value)				0.000				0.000
Hansen test of overid. Restrictions (p-value)				0.000				0.000

Note: Difference-in-Hansen tests of exogeneity were performed and are available upon request.

Table 2 shows that, following the theoretical debate (Samuelson 1939a; Samuelson, 1939b; Keynes, 2018), current levels of investment depend on their first lags, but also on the growth rates of national production. Here, we call attention to these challenging insights:

- The current growth rate of the economy exerts a significant and positive effect on the level of investment;
- The first lag of the growth rate of the economy also exerts a significant (and not so high) effect on the level of investment;
- The second and third lags of the growth rates of the economy tend to exert significant but negative effects on the actual levels of investment in European countries.

We consider these insights as challenging for the following reasons.

In terms of the investment cycle in European economies, these results show that there is a short-term and procyclical reaction between investment and the growth of the aggregate economy. Therefore, we expect investment to grow when there were positive growth rates in the past period and when there are positive growth rates associated with the current period. We also expect investment to decline when the economy experienced negative growth rates in the previous period or in the current period.

When we look at the second group of columns in Table 2, we also see that, in absolute values, there is also a reaction of investment in European economies in relation to GDP growth rates. In this case, we find that the growth rates of the previous period encourage increases in investment in the previous period. Instead of the first group of columns in which the dependent variable was the logarithm of the investment, making it possible to identify the estimated coefficients with elasticities between the investment and the growth rate of the product, Table 2, column 6 allows for a different reading. Here, the estimated coefficient provides an estimate of the expected effect of a one-percent increase in the rate of GDP growth relative to observed investment in the economy in the subsequent period. There is also a high persistence effect (visible in the estimated coefficient for the first investment lag, 0.965).

In the last lines of Table 2, the statistical values of several tests are exposed: the Arellano-Bond test for AR(1) and for AR(2) in first differences, the Sargan test of overidentification of restrictions, and the Hansen test of overidentification of restrictions. The p-values allow us to

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reject the null hypotheses of residual autocorrelation in the first differences (AR-2) and to accept the validity of the over-identifying restrictions. We also ran additional tests, namely difference-in-Hansen tests of exogeneity of instrument subsets. These tests are available upon request.

We also wanted to test the implications of this discussion on the original formalization of the GDP for European economies. Table 3 reveals these estimates, in which we regress both the logarithm of GDP and the absolute values for each economy. Recall, according to our review of the literature, the equation 1 ($Y_t = c*Y_{t-1} + a*\Delta Y_{t-1}$).

Tab. 3 - Results for the Effect of the Accelerator-Multiplier. Source: own research

	GDP (log)				GDP (absolute values)			
	Coefficient	Std. Err.	Z	P>|z|	Coefficient	Std. Err.	Z	P>|z|
Y_t-1	0.950	0.025	37.48	0.000	0.9842	0.0206	49.72	0.000
ΔY_t	0.165	0.065	2.51	0.012	10554.2	2401.3	4.395	0.000
ΔY_t-1	0.106	0.063	1.68	0.093	-8615.474	79104.32	-0.11	0.914
ΔY_t-2	-0.068	0.052	-1.31	0.191	-60502.86	45316.75	-1.34	0.192
ΔY_t-3	-0.062	0.058	-1.07	0.286	-27265.74	70904.09	-0.38	0.703
Arellano-Bond test for AR(1) in first differences (p-value)				0.000				0.056
Arellano-Bond test for AR(2) in first differences (p-value)				0.226				0.240
Sargan test of overid. Restrictions (p-value)				0.843				0.482
Hansen test of overid. Restrictions (p-value)				0.532				0.225

Note: Difference-in-Hansen tests of exogeneity were performed and are available upon request.

On the one hand, we confirmed the high persistence of income over the observed time. This fact confirms the consumption multiplier hypothesis. But, on the other hand, we also confirmed the importance of the growth of the product in the past periods in the current values observed. Specifically, current and past period rates tend to positively stimulate the logarithmic value of the GDP, while rates of two- and three-lagged periods were not recognized as having significant estimated coefficients.

Let us now read the results of the estimations, in an integrated way. Two lines of readings can be highlighted. The first concerns the agreement of the results obtained with the implications of the model studied, which is based on the accelerator-multiplier effect. Thus, our results showed the dependence of aggregate income values on lagged values (multiplier principle) but also on lagged values of growth rates (accelerator principle). The second reading, with important implications for the present, shows that the value of the multiplier is significantly greater than the value of the accelerator. This evidence confirms the trend towards economic growth rates converging with core values (the so-called 'steady state' theory), revealing that investment tends to react more to short-term growth rates.

https://doi.org/10.7441/joc.2023.03.04

5. DISCUSSION

Previous empirical studies that assessed the impact of investment on economic growth found mixed results, ranging from robust positive to negative impacts on economic growth (Warner 2014; Whalen & Reichling, 2015; Van Elk et al., 2019; Afonso & Rodrigues, 2023). Our results showed that there tends to be a differentiated relationship depending on whether the stimuli come from more recent periods or from more lagged periods.

In economies with stationary movements in economic growth (with growth rates of national production with nonsignificant differences between the various periods), the expected effect of economic growth on investment is positive. For example, if in 4 periods (t,…,t-3) the economic growth rate was always 1%, then the effect of this economic growth on investment, estimated by our model in Table 2, was 1,456+0,283-0,208-0,183=1,348. But these results also show that European investment reacts to accelerated growth or decline in the economy. If there were high rates of economic growth in the previous two or three periods and, meanwhile, the economic growth rates in the previous period or the observation period are significantly lower, this may lead to lower induced investment. Previous research found that a change in output (especially a decrease) will not lead to a change in consumption but may lead to a significant change in investment (Blanchard, 1981).

These results show that there is a countercyclical behaviour of investment in view of what was observed in the economy in two and three periods before. Thus, if in two lagged periods the economy had negative growth rates, investment tends to react positively at the time of observation. Motivations for this reaction have already been studied – from the effect of public intervention policies in terms of investment to the reaction arising from the responses of private investors in the face of lower costs as well as the inflow of foreign direct investment – there are plenty of explanations for this fact. This influences the competitiveness of European economies.

National competitiveness has become a major issue of international macroeconomic research and policy. The conceptual delimitation of competitiveness at the macroeconomic level is still controversial. However, several macroeconomic indicators have been taken into consideration as usual measurements for competitiveness by recent studies. Our research is in line with the approaches that considered the following determinants of competitiveness at the national level, namely the investment indicators (e.g., public investment, foreign direct investment, gross fixed capital formation) (Meyer & Sinani, 2009; Kim & Li, 2014; Khyareh & Rostami, 2021), consumption indicators (e.g., final consumption expenditure of households) (Boikova et al., 2021), and output indicators (e.g., gross domestic product, economic growth rate) (Khyareh & Rostami, 2021).

6. CONCLUSION

The relationship between investment and income and production is complex. In this article, we have reiterated the accelerator-multiplier model that was developed by economists such as Keynes, Samuelson and Hicks. This model advocates that, depending on the intensity of the relationship between investment expenditure in the present period and the growth rates of production in previous periods, different economic cycles may appear. If, for example, the effect of the multiplier is greater than that of the accelerator, then business cycles will tend to be smooth and converge towards a 'steady-state' value. If the accelerator effect is greater than the multiplier effect, showing a large reactivity of investment to production growth rates, then the cycles will tend to be pronounced.

These models of the accelerator-multiplier effect were popular in the economic literature until the 1970s, but have recently gained a new lease of life. In addition to institutional and political dimensions, macroeconomic studies have realized that structural dimensions persist in the

https://doi.org/10.7441/joc.2023.03.04

economy that influence the economic cycle of each country. Therefore, in this work we studied the relationship between investment and economic growth for 31 economies, with data observed from 2000 onwards. We conclude that there is evidence in favour of the presence of multiplier effects but also accelerator effects. Our results show that the empirical effort has detailed the long-term relationship that previous debates advocated for the response of investment to economic growth. For most European economies, the multiplier effect is stronger than the accelerator effect, helping to explain the profile of economic cycles.

This study advises decision makers and provides evidence for the national competitiveness strategists. Two emerging policy implications emerge directly from this research study. The first shows that investment made in Europe reacts to the rates of economic growth observed in recent periods. As such, in moments of convergence of growth rates to stationary values, it is necessary to develop policies in favour of investment in order to counteract its dependence on observed rates, which are, for Europe in general, low rates in these first decades of the 21st century. The second implication shows that the estimated effects are not uniform over time – investment reacts in the same direction as the economic growth observed in the previous year and in the penultimate year; but we also observed that investment reacts in the opposite direction of the growth observed 3 and 4 years ago. This nonlinearity of effects obliges all decision-makers to duly anticipate these reactions as well as obliges the academic community to further study the subject.

Future research avenues that emerge following this investigation open new opportunities for exploration and development of national competitiveness empirics. This work enables three emerging lines of investigation. The first line concerns the possibility of deepening the non-linear relationship found between investment and economic growth, namely by exploring alternative methodologies (such as time series analysis). The second line of research concerns the possibility of exploring the formalization of other accelerator-multiplier models, developed by several of the current researchers, with the inclusion of the interconnection between macroeconomic variables and institutional dimensions. Finally, there is a third line of investigation, which proposes the possibility of extending the data observed here to more countries and to periods before 2000.

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