The Accelerator Effect in Portugal

Francisco Malhado

Universidade de Évora

49075: MAEG

Abstract

This paper examines the accelerator effect in the Portuguese economy by testing the relationship between **real GDP growth** and **Private Investment**. According to the accelerator principle, investment decisions are driven by changes in output, with higher growth leading to higher investment. Using quarterly data on Gross Fixed Capital Formation (GFCF) and real GDP from official sources, this study estimates a simple linear regression model in logarithmic first differences, which approximate quarterly growth rates. The results confirm a statistically significant and positive relationship between GDP variation and investment, supporting the existence of a short-run accelerator effect. The analysis further demonstrates that the model performs well in explaining the dynamics of investment without relying on lagged or forward-looking variables. These findings reinforce the role of output growth, driven by aggregate demand, as a key determinant of private investment in Portugal, and underscore the importance of GDP stabilization policies to support sustained capital accumulation. This has relevant implications for macroeconomic policy, particularly during recessionary periods.

Keywords: Accelerator Principle, GFCF, GDP, Portugal, Aggregate Demand

Author Note

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Introduction

This paper investigates whether the accelerator effect is present in the Portuguese economy by analyzing the relationship between the quarterly GDP growth and quarterly growth in private investment. According to the accelerator principle, private investment growth is a function of changes in output: when output increases, firms tend to invest more to expand their productive capacity. The central research question of this paper is whether changes in real GDP can statistically explain variations in private investment over time in Portugal, using official macroeconomic data.

The topic is relevant because private investment plays a crucial role in long-term economic growth, and understanding its determinants helps policymakers design better counter-cyclical strategies. The accelerator effect, despite being a classic theory, has seen renewed interest in the context of post-crisis recovery and fiscal stimulus programs. In the case of Portugal, studying this mechanism offers insights into how the economy reacts to demand-side fluctuations, especially during recessionary periods such as the 2008 financial crisis or the COVID-19 pandemic.

To address this question, we use quarterly data on real Gross Fixed Capital Formation (GFCF) and real GDP from Banco de Portugal. A linear regression model in logarithmic first differences is estimated, allowing us to approximate quarterly growth rates and assess the short-run relationship between output and investment. The results confirm the presence of a statistically significant accelerator effect in Portugal, with strong implications for macroeconomic policy.

Literature Review

Mourão and Popescu (2023) explore the interaction between the accelerator effect and macroeconomic competitiveness across several European countries, including Portugal, over the period 2000–2021. Using panel data regression models, they analyze how output growth influences private investment, while accounting for structural economic differences between countries. The study finds that real GDP growth is a statistically significant driver of investment, although the magnitude of the accelerator effect varies depending on factors such as trade openness and fiscal policy constraints. In the case of Portugal, the results suggest that investment decisions remain sensitive to short-term fluctuations in output, confirming the presence of a moderate accelerator mechanism. The authors argue that while the accelerator effect is not the dominant force behind investment dynamics, it plays an important role in amplifying cyclical trends, particularly in economies with limited external competitiveness.

The accelerator effect is typically framed within a demand-driven perspective, where short-run output growth is driven by fluctuations in aggregate demand components such as consumption, government spending, and net exports. It is this demand-led output expansion that creates incentives for firms to invest in additional productive capacity.

Data: Sources and Review

To examine the presence of the accelerator effect in the Portuguese economy, this study employs quarterly macroeconomic data spanning from the first quarter of 1977 to the fourth quarter of 2023. The objective is to evaluate whether short-run changes in output can explain fluctuations in private investment. The data were retrieved from official sources, namely the **Banco de Portugal** (via the *BP – Long Series 2024*). Two key macroeconomic aggregates were selected:

(i) **Real Gross Domestic Product (GDP)**, chained to 2016 prices, as a proxy for economic activity.

(ii) (ii) **Gross Fixed Capital Formation (GFCF)**, also at constant prices, as a proxy for private investment.

Both variables are expressed in millions of euros and were converted into natural logarithms. To capture the dynamics of growth, **first logarithmic differences** were applied. This transformation provides a close approximation of **quarterly percentage growth rates**, while also helping to stabilize the variance and ensure stationarity in the series.

A summary of the descriptive statistics is presented below:

Table 1. Descriptive Statistics for Real GDP and Private Investment (Levels)

Variable (EUR Millions)	Mean	Std. Error	CV (%)
Real GDP	39277.5	9571.34	24.37
GFCF	7672.62	2236.76	29.14

Table 2. Quarterly Growth Rates of Real GDP and GFCF (Logarithmic Differences)

Variable (EUR Millions)	Mean	Std. Error	CV (%)
Δ log GDP (%)	0.5103 %	1.88	3.68
Δ log GFCF (%)	0.5023 %	3.40	6.77

The descriptive analysis provides a first empirical insight into the behavior of real GDP and private investment in Portugal. Table 1 shows that, in absolute terms, the average quarterly level of real GDP was approximately €39.3 billion, with a standard deviation of €9.57 billion. Gross Fixed Capital Formation (GFCF), used as a proxy for private investment, recorded a mean value of €7.67 billion and a standard deviation of €2.24 billion. These figures reflect a higher absolute volatility in investment relative to output, which is further emphasized by their respective coefficients of variation, 29.14% for GFCF versus 24.37% for GDP.

To further understand the short-run dynamics, we analyze the growth rates derived from the logarithmic first differences of both variables. As reported in Table 2, the average quarterly growth

rate of real GDP is 0.5103%, with a standard error of 1.88%. In contrast, investment presents a similar average growth rate of 0.5023%, yet with a substantially higher standard error of 3.40%. The coefficient of variation of GFCF in this transformed scale (6.77%) is nearly double that of GDP (3.68%), indicating that investment is considerably more volatile even when measured in relative terms.

These descriptive patterns reveal meaningful differences in the behavior of GDP and private investment over time. While average growth rates are similar, investment exhibits greater dispersion around its mean. This difference will be further explored through visual analysis, where graphical representations illustrate the temporal co-movements and the sensitivity of investment to output changes, consistent with the accelerator effect.

To complement the statistical overview, these visualizations help identify the temporal co-movements between the two variables and shed light on the responsiveness of investment to fluctuations in output, which is central to the accelerator hypothesis.

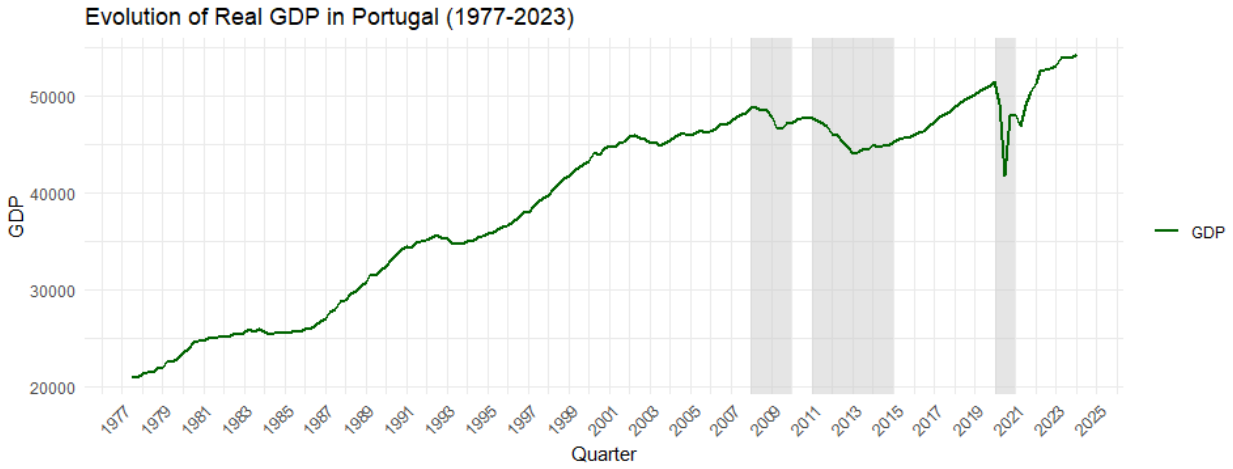

Figure 1 illustrates the quarterly evolution of real GDP (at constant 2016 prices).

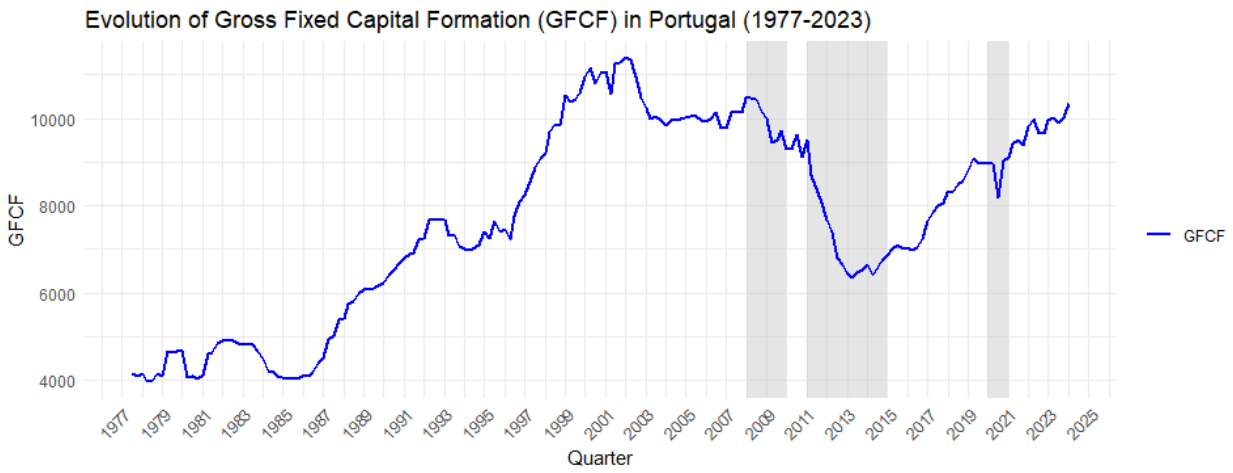

Figure 2 illustrates the quarterly trend of Gross Fixed Capital Formation (GFCF) in Portugal.

The graphical comparison between real GDP (Figure 1) and Private Investment (Figure 2) reveals periods of strong co-movement between the two variables. Both follow a broadly similar long-term trajectory, interrupted by major downturns during episodes of economic distress. Notably, the 2008 global financial crisis and the 2020 COVID-19 pandemic are associated with sharp contractions in GDP, mirroring even deeper and more prolonged declines in GFCF. During the 2011-2013 sovereign debt crises, GDP stagnated while investment dropped more significantly, suggesting that Private Investment is particularly vulnerable to economic shocks. While the alignment is not perfect across all periods, the visual evidence supports the idea that changes in aggregate demand carry significant weight in explaining short-run fluctuations in GFCF, particularly during recessions.

To evaluate this further, Figure 3 displays the quarterly percentage change in both real GDP and GFCF, based on logarithmic first differences. This visualization offers a more granular perspective of the short-run dynamics between the two variables, highlighting how investment responds to fluctuations in output at a higher temporal resolution.

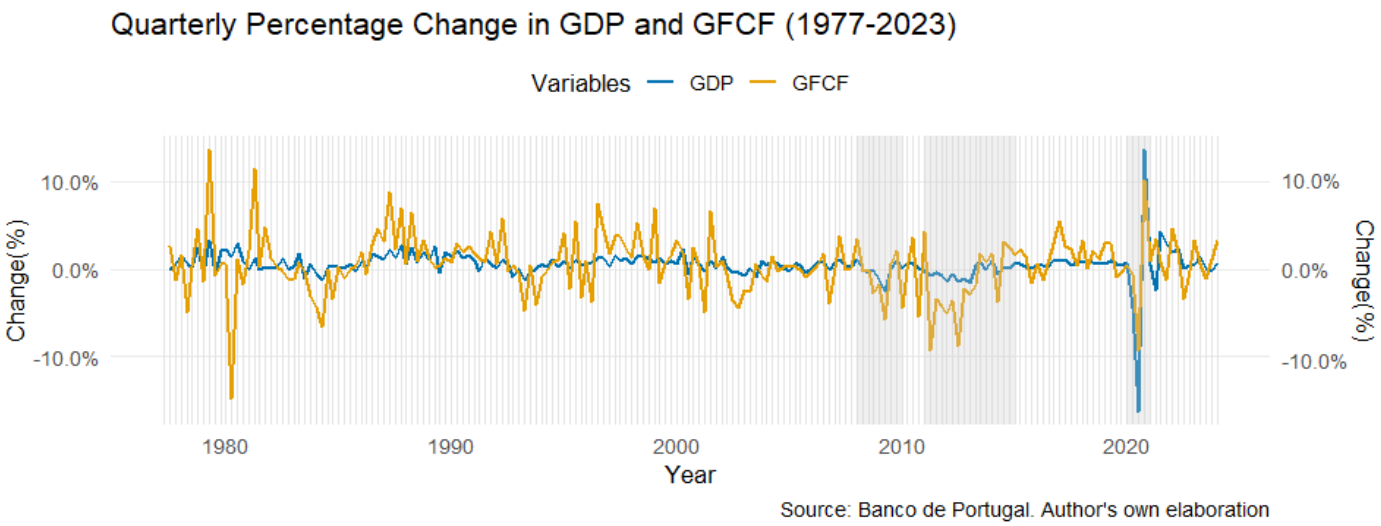

Figure 3 Quarterly Percentage Change in Real GDP and GFCF (1977–2023)

As shown in Figure 3, the two variables exhibit visible co-movements in their quarterly growth rates, particularly during the periods of economic turbulence. Investment growth appears to react more strongly to both positive and negative changes in output, often amplifying the direction of GDP movements. For instance, during the sharp decline in 2008, GFCF registered even more pronounced negative spikes. In contrast, the 2020 COVID-19 shock resulted in a sharper drop in GDP than in investment, suggesting that exceptional policy responses, including fiscal support and investment incentives, such as the European Central Bank's decision to lower the EURIBOR to near zero levels, may have mitigated the contraction in private investment. In the other hand, in recovery periods investment tends to accelerate in tandem with GDP. This behavior reflects the short-run mechanism of the accelerator effect, where changes in aggregate demand exert significant influence on investment decisions. The heightened responsiveness of GFCF supports the idea that private investment plays a reinforcing role in the economic cycle.

Overall, the descriptive and visual analysis of GDP and private investment data reveals that, while investment often follows the dynamics of output, the strength and direction of this relationship can vary across time. These findings provide empirical context for the econometric modelling that follows, where the accelerator effect is formally tested.

Methadology

To evaluate the accelerator effect in the Portuguese economy, we estimate a simple linear regression model that links the quarterly growth rate of private investment (measured by Gross Fixed Capital Formation – GFCF) to the growth rate of real output (measured by real GDP). The model is specified in logarithmic first differences to approximate percentage changes and ensure stationarity of the time series.

The final model follows the form:

$$\Delta \log(GFCF_t) = \beta \cdot \Delta \log(GDP_t) + \varepsilon_t$$

Where:

$\Delta \log(GFCF_t)$, is the quarterly growth of private investment,

$\Delta \log(GDP_t)$, is the quarterly growth of real GDP,

β, captures the marginal responsiveness of investment to output changes.

The intercept term was excluded from the final model after being found statistically insignificant in preliminary estimation ($p = 0.0995$), and because its inclusion slightly reduced the model's performance. The specification without an intercept yielded a higher adjusted R-squared (0.33) and a lower Bayesian Information Criterion (BIC = -811.66) compared to the version with an intercept (BIC = -809.20). As such, the final specification includes only the slope coefficient, capturing the short-run responsiveness of investment to output variation.

Several alternative models were tested, including regression with lagged and forward-looking values of GDP growth. However, while adding complexity, these specifications did not consistently improve the model's explanatory power. The final model was estimated after excluding four influential observations based on Cook's distance. In addition, standard diagnostic tests were performed to ensure the validity of the Ordinary Least Square (OLS) assumptions. Specifically, the Breusch-Pagan test was used to assess heteroscedasticity, and residual plots confirmed that the error terms displayed constant variance and no major violations of normality assumptions.

Results and Discussion

The final model estimated a statistically significant relationship between the quarterly growth rates of GDP and private investment in Portugal. The regression output produced a slope coefficient of **$\beta = 1.5604$** ($p < 2e\text{-}16$), indicating that, on average, a 1% increase in real GDP would result in a 1.56% increase in GFCF in the same quarter. The adjusted R-squared of 0.33 suggest that approximately one third of the variation in private investment is explained by changes in GPD growth alone.

This result supports the existence of a short-run accelerator effect, as originally proposed in Keynesian and post Keynesian investment theory. The magnitude of the coefficient is consistent with the idea that investment amplifies economic cycles, reacting proportionally more than output to variations in aggregate demand.

Figure 4 illustrates the predicted values of GFCF growth against the observed values in the data. While some dispersion remains, the predicted values follow the general pattern of the observed data, confirming that the model captures a relevant portion of the investment dynamics.

These findings align with those of Mourão and Popescu (2023), who estimated accelerator coefficients between 1.2 and 1.7 across European countries. The slightly higher value observed in

the Portuguese case may reflect stronger sensitivity of investment to output shocks in small open economies.

It is worth noting, however, that the explanatory power remains moderate ($R^2 = 0.33$) suggesting that other factors, such as interest rates, expectations or policy uncertainty also play important roles in shaping investment decisions. Moreover, the exclusion of outliers and the intercept term were necessary to improve model performance but may also limit the model's capacity of generalization to extreme conditions.

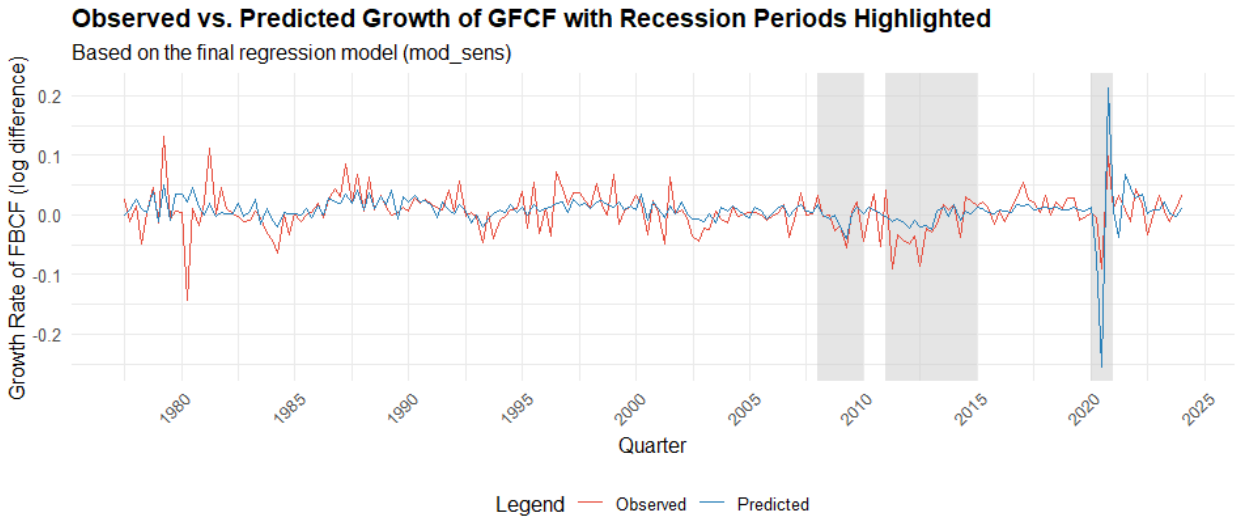

Figure 4 Observed vs Predicted Growth of GFCF (1977-2023)

Conclusion

This study set out to examine whether the accelerator effect is empirically observable in the Portuguese economy. The analysis confirms that there is a statistically significant and positive relationship between quarterly GDP growth and private investment growth, with an estimated coefficient of 1.56. This implies that, on average, a 1% increase in real GDP is associated with a 1.56% increase in GFCF in the same period. The model explains approximately 33% of the variation in investment, providing moderate but relevant explanatory power.

The results proved to be more robust and statistically clearer after removing four influential observations identified through Cook's distance. This adjustment improved model fit and strengthened the estimated relationship between GDP and investment growth, further supporting the presence of the accelerator effect.

Several alternative specifications incorporating lagged and forward-looking values of GDP growth were tested. Although some of these variables appeared to be statistically significant, their inclusion consistently resulted in higher BIC and AIC values. Therefore, the penalty introduced by the added complexity was not justified, reinforcing the suitability of the simpler model that relies solely on contemporaneous quarterly GDP growth.

While the model is intentionally simple and focuses on the core theoretical mechanism, future research could expand upon it by incorporating additional explanatory variables, such as interest rates, fiscal policy indicators or business confidence measures. Nevertheless, the evidence presented here supports the idea that private investment in Portugal is sensitive to short-run changes in output, consistent with the accelerator hypothesis.

References

Mourão, P. R., & Popescu, A. (2023). *Investment, growth and competitiveness: The multiplier accelerator in the 21st century*. Journal of Competitiveness, 15(3), 100–117