Investment dynamics in Portugal

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Abstract

This paper studies the dynamics of Portuguese investment throughout the past years. This important economic variable has been decaying since the beginning of the century. The magnitude of this development was amplified by the Global Financial Crisis and subsequent European Debt Crisis. This paper starts by summarizing relevant stylized facts, a to describe pertinent developments on investment dynamics. Besides studying aggregate dynamics, we decompose investment into different sectors and assets, in order to understand their role in recent dropout. The results point that part of this investment slowdown is probably explained by output dynamics. Other important determinants as uncertainty, financial fragmentation, high leverage and market structure are proven to influence investment over the span of the analysis.

1.Introduction

Portuguese private and public investments have fallen significantly in the wake of the crisis, as in other countries heavily hit by the crisis (European Commission, 2017). For the particular case of Portugal, the Global Financial Crisis contributed to increase the impact of the negative trend in investment that started in the beginning of the century. Although there are signs of a recovery, investment still remains below the levels registered before the crisis.

The intensity and duration of the slowdown in investment suggests that this negative trend may not be just an effect of the crisis but could be a more structural development. The study of this hypothesis is of special interest, as economic theory suggests that investment is a crucial source of productivity and economic growth, providing workers with more capital that increases labor productivity and raises living standards. For this reason, it is important to study the dynamics and determinants of this slowdown, as to provide a strong and reasoned foundation for economic policy work.

Chapter 2 presents stylized facts summarizing important investment developments in Portugal over the last years. The analysis is complemented with a decomposition of investment for both sectors and asset classes.

Chapter 3 provides a complete analysis to this decomposition, which hopefully will help to identify the sectors (and asset classes) that contributed to the fall of aggregate investment. In this chapter it is conducted a shift-share analysis that breaks down the change in total investment in three different effects: within-sector, redistribution and dynamic shift effects. Ultimately, it is done a distinction between tradable and non-tradable sectors, as to evaluate the efficiency of the Portuguese resource allocation in the global economic system.

After a comprehensive characterization of the Portuguese investment developments, chapter 4 reviews the main approaches for modeling investment developments and its main determinants.

Chapter 5 develops an empirical analysis of the determinants behind the slowdown in investment. Firstly, it is developed a baseline accelerator model, which analyzes the explanatory power of output developments alone. Secondly, non-output variables are fed into the model.

The final section is reserved to stress the main conclusions taken from the analysis developed, to point possible extensions to this investigation and to recommend potential policy applications.

2. Investment Dynamics

In order to study the investment dynamics for the Portuguese economy, we must seek a broad and representative set of economic indicators. Over this characterization it will be done a comparison between the Portuguese evolution and the one of its main partners. The most interesting benchmarks for the Portuguese case are Spain, Greece, Italy and Ireland, as they went through similar processes and conditions over the last years, with special regard to the years following the Global Financial Crisis. It is also helpful to evaluate the performance within the European context, looking at the European Union (EU28) average and also two of the best-performing economies: Germany and France.

Table 1 – Average growth rate of GFCF at 2010 prices (%)

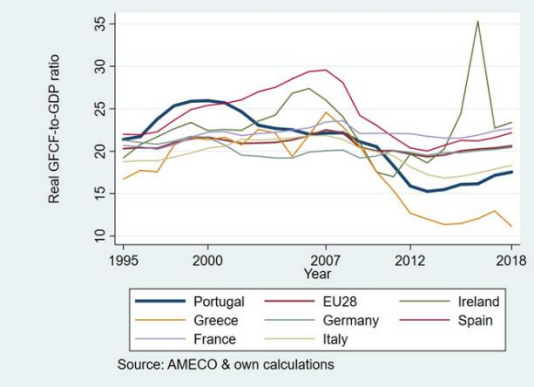
Country	1995/2000	2001/2007	2008/2013	2014/2018
Portugal	6.8	-1.2	-7.3	4.3
EU28	3.5	2.7	-2.4	2.9
Italy	3.1	1.7	-4.8	2.7
Ireland	29.6	6.6	-3.9	11.6
Greece	7.3	5.3	-14.6	0.2
Spain	5.9	5.1	-6.9	3.9
Germany	1.8	0.7	-0.1	2.1
France	3.7	2.3	-1	2.2

Source: Eurostat & own calculations

Over the last lustrum of past century, Portugal presented one of the highest average nominal growth of Gross Fixed Capital Formation (6.8%), only surpassed by Greece (7.3%) and Ireland (29.6%). This evolution virtually doubled the European average (3.5%) and was significantly higher than the ones of its main economic partners (see Table 1). This situation is antithetical relatively to the following period, with Portugal presenting a negative average growth rate (- 1.2%) between 2001 and 2007, contrary to what happened in other European economies, whose average growth rate decreased but stood positive. This situation worsened after the Global Financial Crisis and the consequent debt crisis, with the average nominal growth rate of GFCF of Portugal peaking at -7.3%. The magnitude of the fall in investment in Portugal in this period was widely higher than for the European average (-2.4%) and it was only surpassed by Greece (-14.6%). The evolution of investment between 2014 and 2018 in Portugal was positive, with the average growth rate of GFCF getting closer to 1995/2000 figures (6.8%) and presenting higher values than the European average and relevant economic partners.

In sum, Portugal departed as one of the countries which presented higher investment rates between 1995 and 2000. The shortfall of investment rates started well before the global economic crisis, with worrisome levels during the first years of the century. The evolution of the last five years points to a recovery of this indicator, with Portugal outperforming its main partners.

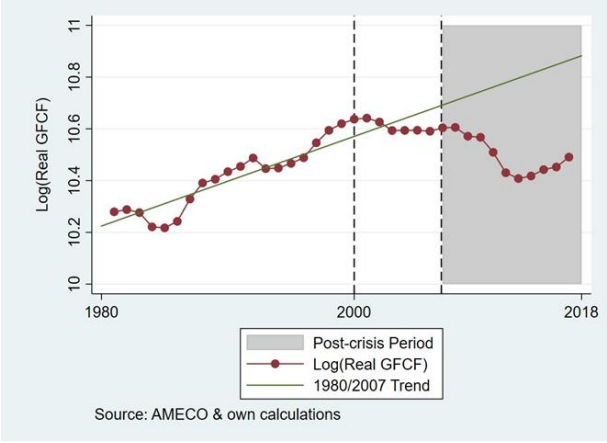
Figure 1 – Dynamics of GFCF at 2010 prices



For a better perspective on investment dynamics, it is interesting to analyze the evolution of the real GFCF-to-GDP ratio (Figure 1). The investment effort of Portugal until 2000 was the highest between the countries in analysis, with a clear positive divergence from the European average. By year 2000, Portugal's GFCF-to-GDP ratio was set at 26%, while the European average was 21.6%. The convergence process began with the decline in the investment rates of early 2000s, with both ratios pairing around 2007 (at approximately 22%). From this point on, the Portuguese ratio negatively diverged, peaking at 15.2% in 2013, while the European ratio decreased at a slower rate (19.3%). The positive evolution of the investment rates between 2013 and 2018 started a new convergence process to the European average. By 2018, Portugal's GFCF-to-GDP ratio was 17.5% while the European average was set at 20.6%.

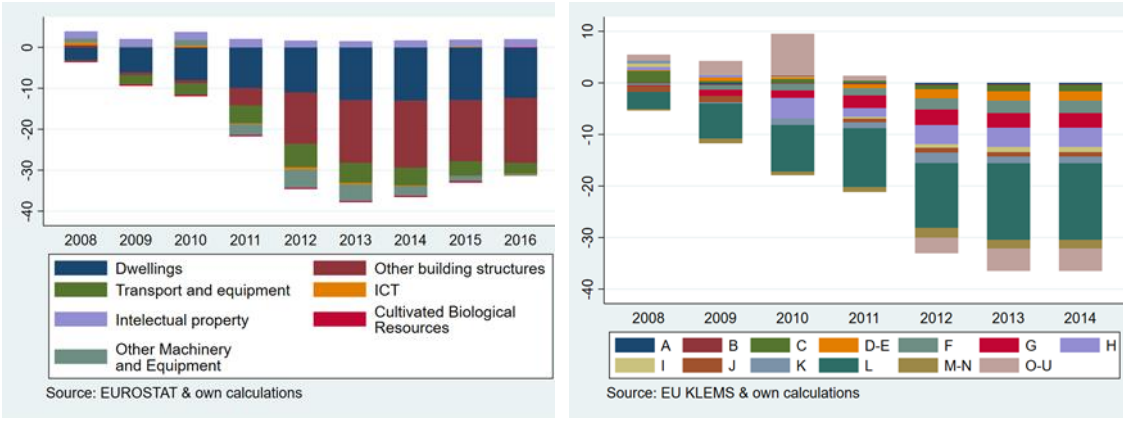
At this point it is convenient to study the particular evolution and drivers of Portuguese investment indicators. Figure 2 plots the dynamics of GFCF, complemented with its trend be- tween 1980 and 2007. As it has been introduced, the beginning of the century marked a shift on the evolution, as GFCF started to decay. Between 2003 and the sprout of the global Financial Crisis, this indicator stagnated. The shaded area represents the post-crisis period, where it can be perceived the dramatic effects of the crisis on investment in Portugal.

Figure 2 – GFCF Dynamics - Portugal



A specially relevant period that should be studied to understand this shift is 2007-2016. In order to understand the impact of the crisis on the economy and to understand the main drivers of the investment decline, it was conducted an analysis on the main asset classes and sectors driving the decline in GFCF.

Figure 3 – Drivers of the decline in GFCF



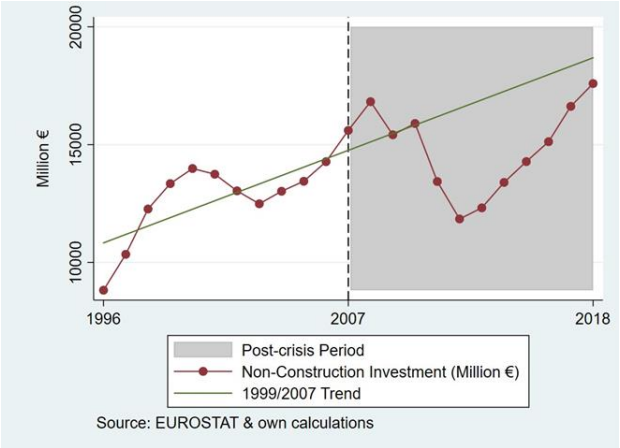
(a) Asset Classes (b) Sectors

Starting with the analysis for asset classes, figure 3a presents a decomposition of the cumulative variation relatively to 2007. Generally, investment declined in all asset classes, with special regard for investment in infrastructures. Investment in intellectual property was an exception, as its evolution was positive for all years following the crisis.

The time frame for analysis of economy' sectors[1] (figure 3b) was reduced, as data was only available until 2014. By 2014, the cumulative variation relative to 2007 was negative for all sectors in the economy. The main sector driving the decline was Real Estate Activities (L), followed by Transportation and Storage (H).

One of the main objects of study throughout this article will be business investment. As a proxy for it, we will use real Non-Residential Investment (ECB 2016), which represents the gross fixed capital formation adjusted for construction (i.e. disregarding dwellings and residential investment). Figure 4 provides evidence regarding the impact of the Global Financial

Figure 4 – Non-Construction Investment dynamics



Crisis on the business side of the economy. Business investment dynamics were fairly positive between 1996 (8800 million e) and 2008, when it peaked at around 16820 million e. However, the Global Financial Crisis interrupted this positive trend and decaying business investment was registered between 2008 and 2013 (around 12320 million e). After 2013, business investment appears to be recovering at a faster rate than the one presented for the 1999/2007

[1] For a clarification on sectoral classification, remit to subsection 3.1 on page 8.

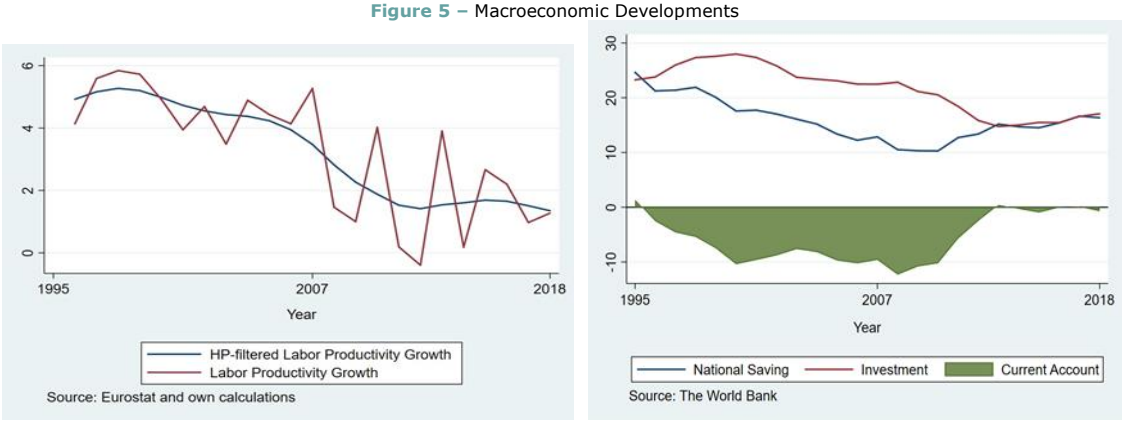
period. In 2018, Non-Residential Investment recorded in Portugal surpassed the maximum value presented before the financial crisis hit the Portuguese economy (17600 million e), which confirms the recovery path of business investment.

Basing the following points on economic theory assumptions, there are some macroeconomic developments directly linked to the previously described fall in investment that should be pointed out.

For instance, a fall in investment is expected to lead to a reduction in the capital-to-labor ratio, which would imply a decline in labor productivity[2]. Indeed, as it can be perceived in Figure 5a, Portugal's labor productivity growth has plummeted over the period in analysis. Effectively, labor productivity growth was set at 4.92% in 2000, conversely to the average growth rate of 1.59% of the 2008/2018 period.

Additionally, recalling accounting identities[3], a fall in investment is expected to lead to an increase in the Current Account Balance, assuming constant aggregate savings. As it can be perceived in Figure 5b, between 1995 and 2000, the growth in investment was tied to a fall in national savings, which led to a current account deficit of around 10% of GDP in 2000. The fall in aggregate savings was continued until around 2010, which explains the current account deficit oscillating around 10% of GDP between this period. However, the reaction to the Global Financial Crisis led to a increase in national saving, which translated in the expected surge in the current account balance. The current account balance finally stabilized around 0% between 2013 and 2018.

Figure 5 – Macroeconomic Developments



(a) Productivity (b) Current Account

3. Sectoral perspective on Investment Dynamics

Throughout this section it will be delivered a breakdown analysis of the investment dynamics between different sectors, as to understand specific trends and as to point out the main sectors driving investment slowdown. In order to understand the role of each sector in the fall of aggregate investment in Portugal, it will be analyzed the evolution of each sector's share of total gross value added and sectoral investment rates[4] over the last two decades. A shift-share analysis be used in order to decompose sectoral investment rates between three different effects: within-sector, redistribution and dynamic-shift effect. Additionally, in order to gain

[2] First of all, a slowdown in investment (I) would imply a fall in the capital stock (K): $K_t = I_t + \delta * K_{t-1}$. As a result, the fall in capital stock would imply the degradation of labor productivity, which is assumed as the output-to-labor ratio:

$$\frac{Y}{L} = A\left(\frac{K}{L}\right)^{\alpha}.$$

[3] Current Account Balance = Saving – Investment.

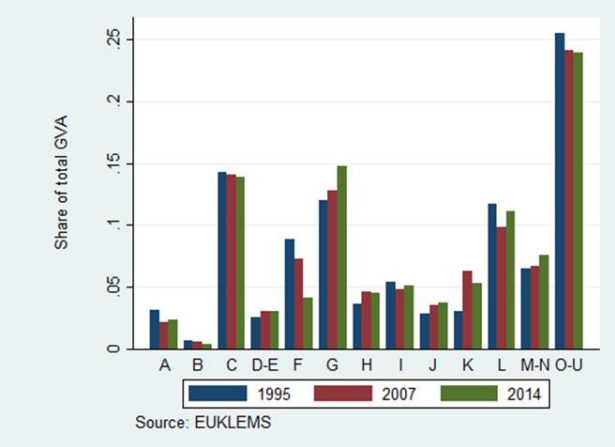
[4] For each sector j: $ij = \frac{Ij}{GVA_j}$

important insights regarding the economy's resource allocation, the sectors will be classified as tradable or non-tradable.

3.1. Sectoral Investment Rates and Share of GVA of different sectors

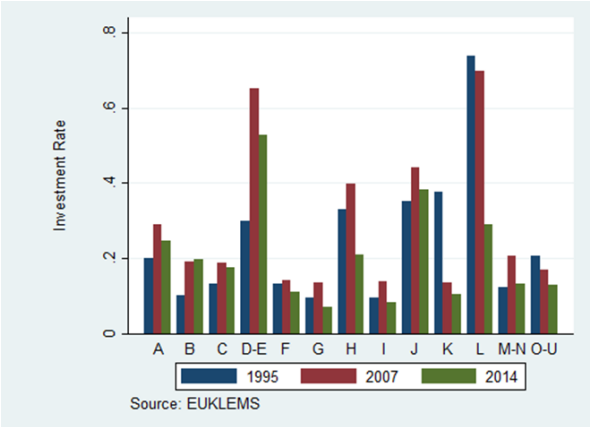
The analysis was conducted using sectoral data (NACE-Rev.2) retrieved from EU KLEMS Database. It was used annual data from 1995 to 2014 (last year available for sectoral GFCF and GVA data) for the following sectors: Agriculture, Forestry and Fishing (NACE sector A), Mining and Quarrying (B), Manufacturing (C), Electricity, Gas and Water supply (D-E), Construction (F), Wholesale, Retail Trade, Repair of Motor Vehicles and Motorcycles (G), Transportation and Storage (H), Accommodation and Food Service activities (I), Information and Communication (J), Financial and Insurance activities (K), Real Estate activities (L), Professional, Scientific, Technical, Administrative and Support Service Activities (M-N) and Com- munity Social and Personal Services (O-U).

Figure 6 – Share of GVA by sector



At a first stage, it will be analyzed the dynamics of the sectoral investment rates and the share of total GVA of the different sectors. This analysis is essential, as the interplay between sectoral investment rates and the weight of each sector in total economy will influence and ex- plain the dynamics of investment rates. Effectively, the fall in investment rates is often pointed to be related with a reallocation of investment, characterized by a shift towards less investment-intensive sectors, mainly focused to the services sector[5]. Hopefully, the following analysis will help to understand if that is the case for the Portuguese economy.

Figure 7 – Sectoral Investment Rates



[5] See EC 2017

Figure 6 shows the evolution of each sector' share in total GVA. The share of services (J-U) in total GVA has increased from 50% in 1995 to 52% in 2014. However, this evolution was not homogeneous between sectors, as real estate activities and community social and personal services reduced their respective shares of total GVA between this period. Supporting the servicification hypothesis introduced before, in addition to the wide share of services in total GVA, there is evidence of a contraction on both Agriculture (A) and Construction (F) sectors (from 3% to 2% in the first case and from 9% to 4% in the second).

Figure 7 shows the evolution of investment rates by sector. There is evidence of declining rates in almost every sector. It is interesting to highlight that all sectoral investment rates fell between 2007 and 2014, with the exception of Mining and Quarrying sector.

All in all, although the previous analysis shows relevant trends, it is not possible to reach a general conclusion within the determinants of the fall in general investment rate in recent years. Thus, a more focused analysis is necessary to study the effect of reallocation between sectors with regard to investment dynamics.

3.2. Shift-Share Analysis

In order to perform a wider analysis on the dynamics of the investment-to-output ratio, it was performed a shift-share analysis. We start by defining investment as the gross fixed capital formation (GFCF). Assuming j different sectors and formalizing the investment rate (i) as the ratio between total investment (GFCF) and the economy's gross value added (GVA), it is possible to decompose the ratio the following way:

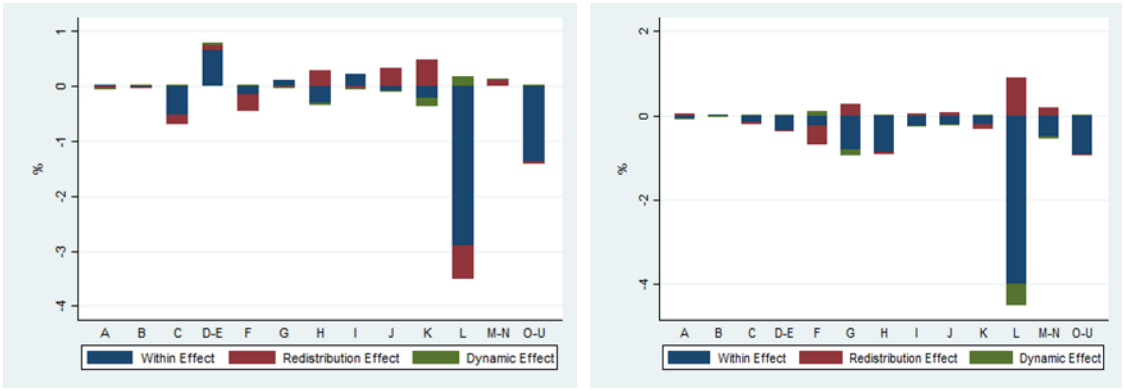
$$i = \frac{I}{GVA} = \sum_j \frac{I_j}{GVA_j} * \frac{GVA_j}{GVA} = \sum_j i_j * s_j$$

Departing from a discrete perspective and basing our analysis in the methodology followed by EC(2017), the change in total investment rate between two different periods can be decomposed further in three driving effects:

$$i_1 - i_0 = \sum_j (i^1_j - i^0_j)s^0_j + \sum_j (s^1_j - s^0_j)i^0_j + \sum_j (s^1_j - s^0_j)(i^1_j - i^0_j)$$

Effectively, each sector's contribution in the change in total investment rate can be decomposed in three effects. The first term of the previous equation represents the within-sector effect, which accounts for changes in investment within each sector under the assumption that there are no variation in each sector's GVA between the two periods. Moving to the second term of the equation, the Redistribution effect represents the impact explained by changes in the economy's structure, measuring variations in each sector's share in aggregate output. Hence, it is this effect that we have to analyze when studying the servicification of the economy. Last, the third term represents the dynamic shift effect, which delivers an approximation to the joint effect of changes in sectoral investment rates and variation in sectoral representation in the economy, accounting for a fall (rise) in investment rates for sectors that have been contracting (expanding).

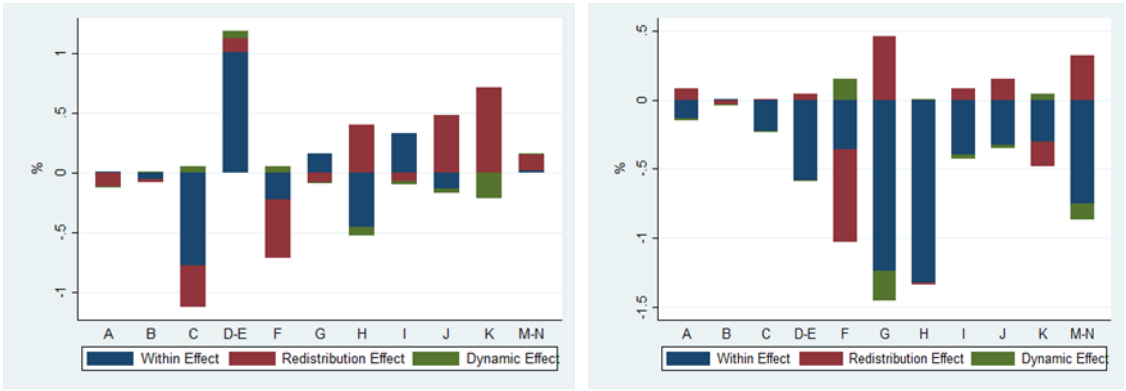
Figure 8 – Shift-Share Analysis, All sectors



(a) 2000/2007 (b) 2007/2014

The analysis was first conducted for all sectors and for two different time horizons. Firstly, it was studied the period 2000/2007, as to capture the first downturn on Portuguese investment. Secondly, the time horizon was changed as to describe the evolution between 2007 and 2014, capturing relevant dynamics triggered by the Global Financial Crisis and the European Debt Crisis.

Figure 9 – Shift-Share Analysis, excluding sectors L & O-U



(a) 2000/2007 (b) 2007/2014

Starting by the decomposition between 2000 and 2007 for all sectors, the GFCF-to-GVA ratio declined by 4.51%. The main driver of this evolution was the within effect (-4.57 pp), followed by the redistribution effect (-0.01 pp). On the other hand, the dynamic effect had a positive impact (although almost negligible) in the dynamics of the GFCF-to-GVA ratio (0.07 pp). Furthermore, when analyzing figure 8(a), it is possible to conclude that there are sectors as D-E, G, J and K that present positive investment dynamics, but these are counterbalanced by negative dynamics in other sectors, mainly L and O-U. When analyzing the redistribution effect by sectors, the information regarding the presence of the servicification effect is not clear[6] Under this data setting, the fall in investment rates was mainly explained by negative dynamics within sectors. The picture worsens when considering the period 2007/2014, where all sectors experienced negative dynamics (Figure 8 (b)). In this period, the GFCF-to-GVA ratio decreased 8.43%. This was mainly explained by within effect (-8.63 pp) and dynamic effect (-0.59 pp), while redistribution effect registered a positive variation (0.78 pp). While the servicification effect was not directly observable on the preceding period, the latest sub-sample appears to support the hypothesis of a structural transformation to the services sector, as it can be seen from the positive redistribution effect on sectors L and M-N.

[6] Recall that sectors J to U are the ones that are treated as services.

A robustness check was conducted, keeping the same data frame setup but excluding sectors L and O-U. These sectors suffered extreme transformations, which were mainly explained by the financial crisis, hence not representing structural changes. In particular, sectors O-U are mainly characterized by public investment. By excluding them we are avoiding the interpretation of effects derived from the application of austerity policies right after the Global Financial Crisis. Under this setting, the total variation of the GFCF-to-GVA ratio between 2000 and 2007 (figure 9 (a)) was slightly positive (0.4%). This was mainly explained by the redistribution effect (0.72 pp), while the dynamic effect (-0.17 pp) and the within effect (-0.14 pp) negatively contributed to this variation. When considering the 2007/2014 frame, the GFCF-to-GVA ratio reduced 5.63%. This variation was mainly driven by within-sector dynamics (-5.63 pp) and dynamic effects (-0.2 pp), while the redistribution effect was positive (0.24 pp).

The restricted analysis points to the existence of the previously unveiled hypothesis of servicification. For both periods in analysis, sectors J and M-N experienced positive redistribution effect. Although some non-service sectors registered positive redistribution effects (D-E and H between 2000/2007 and A, G and I between 2007/2014), the combined effect of all sectors in both periods is negative.

The following table summarizes the previously characterized decomposition:

Table 2 – Effects (%)

Effect	00/07, Total	07/14, Total	00/07, Reduced	07/14, Reduced
Within	-4.57	-8.63	-0.14	-5.63
Redistri-	-0.01	0.78	0.72	0.24
Dynamic	0.07	-0.59	-0.17	-0.2
Total	-4.51	-8.43	0.41	-5.59

3.3. Tradable and non-tradable sectors

Economic theory suggests that in order to maintain a continuous and sustainable growth path, the economies should efficiently allocate their resources. Following this assumption, the aim of this subsection is to analyze the investment dynamics of the Portuguese tradable and non-tradable sectors, complementing the analysis that we have conducted so far.

For the coming analysis we will proceed to a categorization of sector between tradable and non-tradable, following the methodology implemented by GPEARI (2018), which differentiated sectors based on their exposure to international competition. The authors postulate that the sector should be classified as tradable if their trade-to-output ratio[7] exceeds 10%. Under this setting, we will follow the authors approach for Portuguese sectors A to N. Due to lack of disaggregation, sectors O to U will be classified following IMF's and AMECO's designation.

[7] Trade-to-Output ratio = $\frac{Imports+Exports}{GrossValueAdded}$

Table 3 – Sectoral classification: Exposure to international competition

Sector	IMF	AMECO	GPEARI (2018)	Our approach
A	NTR	TR	TR	TR
B	TR	TR	TR	TR
C	TR	TR	TR	TR
D-E	NTR	TR	Note [1]	TR [2]
F	NTR	NTR	NTR	NTR
G	NTR	TR	NTR	NTR
H	NTR	TR	TR	TR
I	NTR	TR	TR	TR
J	NTR	TR	TR	TR
K	NTR	NTR	TR	TR
L	NTR	NTR	NTR	NTR
M-N	NTR	TR	TR	TR
O-U	NTR	Note[3]	Note[4]	NTR [5]

1 D: TR; E: NTR
2 Given that we are using D-E as a group, the classification remits to the one of sector D as it systematically reports higher GVA than sector E.
3 O-Q: NTR; R-S: TR; U: Not Considered.
4 O-Q and U: Not considered; R-S: TR.
5 Following IMF and AMECO classification for the most representative sectors in the subgroup O-Q.

Figure 10 shows both the investment rate and the share of total GVA in both types of sectors. Starting by analyzing the evolution of the investment rate, there is a clear decrease on the investment effort in non-tradable sector, which changed substantially between 1995 (27.9%) and 2014 (14.6%). On the other hand, the investment rate of the tradable sector presented a positive variation between 1995 (18.9%) and 2007 (25.5%). The aftermath of the GFC shifted this trend, with the investment rate of 2014 (19.7%) considerably close to the one presented in 1995.

At the same time, the weight of the tradable sector has been growing over the last two decades, departing from 41.9% in 1995 to 46% in 2014. Nonetheless, the non-tradable sector continues to be the most representative type of sector of the Portuguese economy in 2014.

Figure 10 – Tradable vs Non-Tradable sectors: Share of GVA & Investment Rates

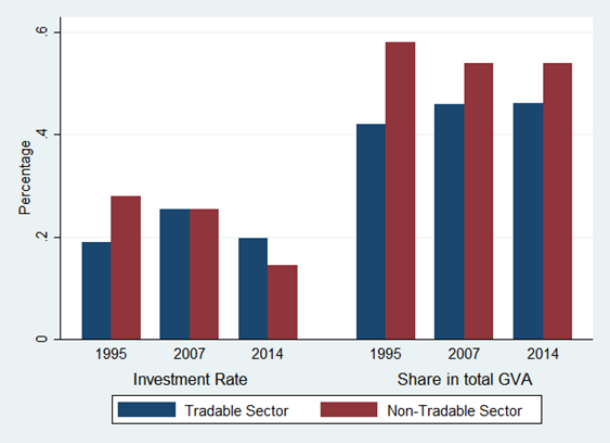
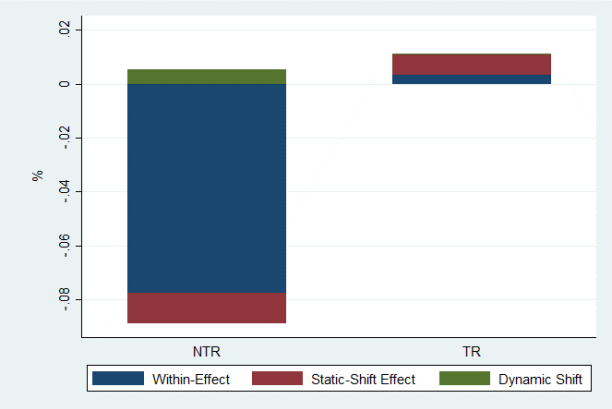


Figure 11 – Shift Share Analysis by exposure to international competition - 1995-2014



A shift-share analysis was conducted, following the methodology used in the previous sub-section. Figure 11 shows that the decline of 7.2% in the GFCF-to-GVA ratio was mainly driven by within-sector developments, which were responsible for a 7.4 pp fall on the ratio (Where the NTR sector effect was -7.7 pp against the positive variation of 0.3 pp on the TR sector). The redistribution effect slightly contributed to the negative variation [0.07 pp (TR) - 1.1 pp (NTR)= -0.04 pp], while the overall effect was vaguely counterbalanced by the dynamic-shift effect [0.003 pp (TR) - 0.054 pp (NTR) = 0.06 pp].

As noted on the previously explained factors[8], there is evidence of a favorable reallocation towards the TR Sector. While the sector's share of total GVA has been increasing, the sectoral investment rate has not presented a consistent upward trend. It would be interesting to have more recent data as to understand if the decrease in the investment effort between 2007 and 2014 was explained by the Global Financial Crisis. The shift-share analysis illustrates that the fall in investment to GVA ratio was mainly explained by negative dynamics within the NTR sector. The dynamics of the TR sector, although positive, were almost insignificant.

4. Determinants of Investment Slowdown

The determinants of investment have been studied throughout the years by economists, providing an important set of literature and empirical approaches to this subject. Oliner et. al. (1995) stresses over the multiple models that have been employed on modern empirical research. From between a multiple set of frequently applied models as Tobin's Q, neoclassical and different formulations of the Euler Equation, the authors present a model where investment is influenced by lagged desired changes in capital stock, which are expected to be a function of output growth-the Accelerator model. This model was previously postulated by Clark (1917) and Jorgenson (1971).

Focusing on this concept, important research has been delivered by the IMF (Lee and Ra- banal (2010), Barbku et. al. (2015), IMF (2015), Poghosyan (2018)), EC (EC (2017)) and ECB (ECB (2017)).

While Lee and Rabanal (2010) used the accelerator model assumptions to forecast non- residential investment in the US, IMF (2015) provides empirical evidence to the importance of output dynamics when explaining changes in Gross Fixed Capital Formation. Barkbu et. al.

[8] In any case, it is important to notice that the results of the analysis are highly dependent on the assumptions followed. For an analysis with a tighter classification criteria (trade-to-output ratio should exceed 15%) see Alexandre et. al. (2017).

(2015) also support this evidence, pointing that changes in output explained investment vulnerabilities, principally before the European Debt Crisis. These findings are further supported by Poghosyan (2018), who studied Denmark's investment slowdown. In a like manner, EC(2017) and ECB(2017) reach equivalent conclusions.

An important finding of the aforementioned literature is that output dynamics are not always sufficient when explaining investment fluctuation. In effect, this proved to be true specially when trying to model investment dynamics on the aftermath of the GFC. In this line, additional variables have been studied and proved to influence aggregate investment dynamics:

- **Uncertainty:** Uncertainty has been proved to be an important determinant of firms' in- vestment behavior (Baum et. al. 2008). Bloom (2009) highlights the ability of uncertainty shock to cause short sharp recessions and recoveries. In fact, uncertainty may hold investors back as expected profits and overall conditions depend on future economic conditions that are not known a priori. Hence, uncertainty has a major role when balancing risk and expected return (IMF 2015; Barkbu et. al. 2015; Poghosyan 2018).
- **Indebtedness:** Private leverage has been rising. Kuchler (2015) points that this factor reduced the ability of private firms to raise funding for investment projects, with special regard to small and medium-sized ones.
- **Financial Constraint:** After the Global Financial Crisis, firms' access to credit became more difficult, as the value of collaterals had depreciated throughout that period. Following this line, the lack of funding resources may help to explain the barriers to firm's investment. Supporting this idea, Barkbu et. al. (2015) point financial constraints as negatively associated with investment for Portugal.
- **Interest Rates**: Economic theory suggests that with lower interest rates, it is expected higher investment. Interest Rates are a specially interesting variable to consider when studying investment barriers, as it is one of the main policy instruments of monetary authorities throughout the global financial system.
- **Competition and Labor Market Regulations:** Investment incentives may be jeopardized by some specific market structures. Greater market concentration and reduced competition reduces willingness to invest and future profits prospect for firms investment, who may face barriers to entry and unbearable technological barriers. The legal framework regarding labor market is another important feature of market' structure.

4.1. Empirical Analysis

In this section it will be used the accelerator model to explore the role of output and non-output factors when explaining investment dynamics. The empirical approach will be similiar to the one employed by Lee and Rabanal (2010) and later by Barkbu et.al. (2015).

Throughout the following sections, it will be studied the behavior of Portuguese Non- Residential Investment, which is used as a proxy for business investment. In a first stage it will be estimated a baseline accelerator model, which will be used to understand the explanatory value of changes in output when studying investment dynamics. In the second stage the model will be augmented, adding the previously stressed additional explanatory factors.

4.1.1. Accelerator Model

As mentioned, the baseline accelerator model will be used to asses if variations in investment can be explained by changes in output.

Departing from the idea initially postulated by Clark (1917) and Jorgenson (1971), the accelerator model relates the current investment (It) to lagged changes (up to N periods) in the desired level of capital stock ($Kt*$) and to the capital depreciation rate (δ). Additionally, it is

postulated a proportional relationship between changes in the desired stock capital and changes in output[9]:

$$I_t = \alpha + \sum_{j=0}^{N} \omega \Delta K^*_{t-j} + \delta K_{t-1} = \alpha + \sum_{j=0}^{N} \beta_j \Delta Y_{t-j} + \delta K_{t-1} \quad (1)$$

An empirical common procedure is to divide the previous equation by the lagged capital stock, adding an stochastic error term (et):

$$\frac{I_t}{K_{t-1}} = \frac{\alpha}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta Y_{t-i}}{K_{t-1}} + \delta + e_t \quad (2)$$

where I represents Private Non-Residential Investment, K is the total capital stock and Y is real GDP[10]. For the scaled equation, the current value of GDP is excluded as to avoid endogeneity concerns.

For the estimation we will implement heteroskedasticity and autocorrelation consistent (HAC) estimators, reporting Newey-West standard errors that control for serial correlation in the residuals. The bandwidth (i.e. the number of lags specified for the residuals) will be set up to 12 lags. The results of the estimation of the second equation are reported in table 4.

All 12 lagged output variables are individually and jointly significant, at least at 10% level. Furthermore, also the α and the δ terms are significant. Additionaly, the results of the Ramsey test indicate that the model is correctly specified. This results support the hypothesis of the importance of output developments when explaining investment dynamics. By analyzing the actual vs fitted plot in figure 12, we can point that the residuals of the baseline accelerator model become mainly negative after the developments of the Debt Crisis, which suggests that a part of investment dynamics were not captured by output developments.

Table 4 – Baseline accelerator model

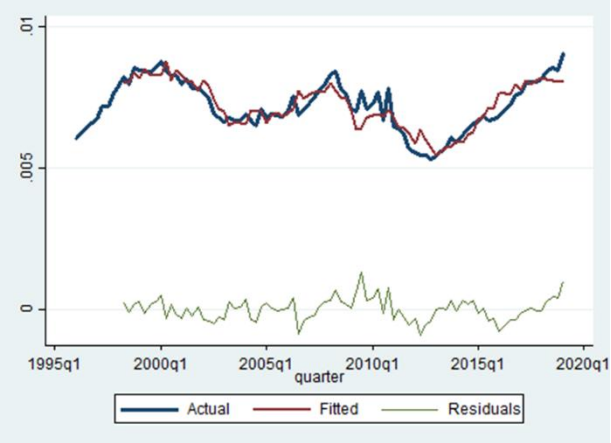
	Coefficient	Robust Std. Err.
α	-2,043.50***	541.80
β_1	0.40***	(0.09)
β_2	0.28**	(0.11)
β_3	0.30***	(0.07)
β_4	0.19***	(0.07)
β_5	0.21***	(0.06)
β_6	0.25***	(0.05)
β_7	0.25***	(0.06)
β_8	0.13*	(0.07)
β_9	0.19**	(0.08)
β_{10}	0.15*	(0.08)
β_{11}	0.17***	(0.05)
β_{12}	0.27***	(0.09)
δ	0.01***	(0.00)
Observations	84	
R-squared	0.81	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[9] ΔK^*_t = cΔYt

[10] All data definition and sources can be found in the appendix

Figure 12 – Actual/Fitted/Residuals



4.1.2. Accelerator Model+

As it has been previously explained, besides output developments there are other important macroeconomic variables that may support our endeavor to explain investment downturn. In this subsection there are presented the results of several augmented accelerator models. For the estimation of these models, it was used the same specification as in the baseline model. The additional controls are in line with the review in the beggining of this chapter and an extensive description can be found in Annex A. The model (1) column of Table 5 shows the results of the estimation of our augmented accelerator model (where all additional variables are considered):

$$\frac{I_t}{K_{t-1}} = \alpha \frac{}{K_{t-1}} + \sum_{i=1}^{N} \beta_i \frac{\Delta Y_{t-i}}{K_{t-1}} + Uncertainty_{t-1} + FinCons_{t-1} + \quad (3)$$

$$+ Indebtedness_{t-1} + InterestRate_{t-1} + PRM_{t-1} + EPL_{t-1} + \delta + e_t \quad (3)$$

Models (2) to (7) provide estimations where each non-output variable was individually added to the model, as to study their individual explanatory power. Control variables as Financial Constraints, Indebtedness and Product Market Barriers proved not to be individually significant when added one by one to the regression.

When considering the wide set of estimations and basing on the R-squared while trying to avoid multicolinearity issues in the regressors[11] (see table 6), Model (8) represents the specification that proved to better capture investment dynamics for Portugal in the time in analysis. The additional control variables seem to be significant (at least at 10% level). When analyzing Model (8) column in Table 5, it is important to highlight:

- Indebtedness, which is proxied by total credit to private non-financial sector as a share of GDP, presents a positive and significant effect on investment dynamics. This may reflect the fact that credit effectively channeled to investment, but one must not forget that extreme leverage may compromise future access to credit and therefore to investment.
- Contrary to what was expected, uncertainty has a positive and significant effect on investment dynamics, although it's magnitude is considerably small.
- Interest Rate has a negative significant effect on investment. This supports the idea that higher interest rates can be faced as a barrier to investment.

[11] According to the literature, having multicolinearity in the control variables is not a problem as long as the variables of interest are not affected. If it is the case, the coefficients of the variables of interest are not affected. Please see" A Summary of Introductory Econometrics By Wooldridge."

- In line with the findings of Félix (2018), Financial Constraints have a negative and significant effect. Following this, this variable should be regarded as a factor holding back investment.
- Employment Protection Legislation, which serves as a proxy to labor market barriers, has a positive and significant effect on investment. This result goes against the idea that the decision whether to investment or not considers the capacity of the firm to adjust its labor structure over time.

Figure 13 provides the plot of the fitted model compared to the actual variable. It can be retrieved that the residuals of this model point that the added variables help to capture investment dynamics, as the recurrent positive residuals after the crisis appear to be smoother and closer to zero, when compared to figure 12.

Table 5 – Accelerator model+

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
α	9,019.04	-1,538.80***	-1,333.74	-1,770.79**	-1,688.16***	-2,267.17**	-2,034.68***	-1670.891
	(5,665.31)	(536.43)	(988.61)	(811.41)	(450.58)	(970.24)	(657.04)	(1,760.9)
β_1	0.07	0.18**	0.37***	0.40***	0.32***	0.39***	0.36***	0.05
	(0.18)	(0.08)	(0.11)	(0.10)	(0.07)	(0.09)	(0.10)	(0.18)
β_2	-0.13	0.08	0.13	0.29***	0.23**	0.27**	0.23**	-0.16*
	(0.09)	(0.08)	(0.16)	(0.08)	(0.09)	(0.11)	(0.11)	(0.08)
β_3	0.09	0.15*	0.26***	0.30***	0.27***	0.28***	0.26***	0.04
	(0.20)	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.05)	(0.08)
β_4	0.01	0.13**	0.18***	0.18**	0.17***	0.17**	0.16*	0.01
	(0.07)	(0.06)	(0.06)	(0.07)	(0.06)	(0.07)	(0.08)	(0.08)
β_5	0.10	0.19***	0.17**	0.19***	0.19***	0.19***	0.17**	0.11
	(0.09)	(0.06)	(0.08)	(0.06)	(0.06)	(0.06)	(0.07)	(0.09)
β_6	0.05	0.21***	0.25***	0.25***	0.23***	0.23***	0.20***	0.06
	(0.12)	(0.04)	(0.09)	(0.07)	(0.05)	(0.05)	(0.06)	(0.01)
β_7	-0.04	0.18***	0.15**	0.27***	0.23***	0.23***	0.23**	-0.06
	(0.09)	(0.06)	(0.07)	(0.08)	(0.06)	(0.06)	(0.09)	(0.09)
β_8	0.21**	0.13**	0.15*	0.13*	0.14**	0.10	0.12*	0.18**
	(0.08)	(0.06)	(0.08)	(0.07)	(0.06)	(0.07)	(0.07)	(0.07)
β_9	0.19**	0.20***	0.21**	0.17*	0.19***	0.16*	0.19**	0.15**
	(0.07)	(0.07)	(0.10)	(0.10)	(0.07)	(0.09)	(0.09)	(0.06)
β_{10}	0.08	0.15**	0.13	0.13	0.14**	0.12	0.15*	0.1
	(0.11)	(0.07)	(0.09)	(0.09)	(0.07)	(0.08)	(0.08)	(0.09)
β_{11}	-0.02	0.16***	0.19***	0.17***	0.15***	0.15***	0.14***	0.001
	(0.09)	(0.04)	(0.06)	(0.05)	(0.04)	(0.05)	(0.05)	(0.09)
β_{12}	-0.03	0.23**	0.26***	0.27***	0.24***	0.24***	0.22**	0.02
	(0.06)	(0.10)	(0.09)	(0.09)	(0.08)	(0.08)	(0.09)	(0.06)
Uncertainty	0.00003***	0.00003***						.00003**
	(0.000007)	(0.00001)						(0.00001)
Fin. Cons.	-0.01		-0.01					-0,01*
	(0.01)		(0.01)					(0.005)
Indebtedness	0.002			0.0002				0.001*
	(0.001)			(0.001)				(0.001)
Interest Rate	-0.01***				-0.01***			-0.06*
	(0.003)				(0.002)			(0.003)
PMR	-0.01*					0.0004		
	(0.003)					(0.0004)		
EPL	0.002***						0.001*	0.001***
	(0.0006)						(0.0003)	(0.0001)
δ	-0.03**	-0.004	0.01***	0.01***	0.01***	0.01***	0.01***	-0.01
	(0.01)	(0.005)	(0.002)	(0.003)	(0.001)	(0.001)	(0.002)	(0.01)
Observations	41	84	65	83	84	80	60	41
R-squared	0.90	0.83	0.78	0.82	0.83	0.82	0.82	0.90

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 13 – Actual/Fitted/Residuals - Model (8)

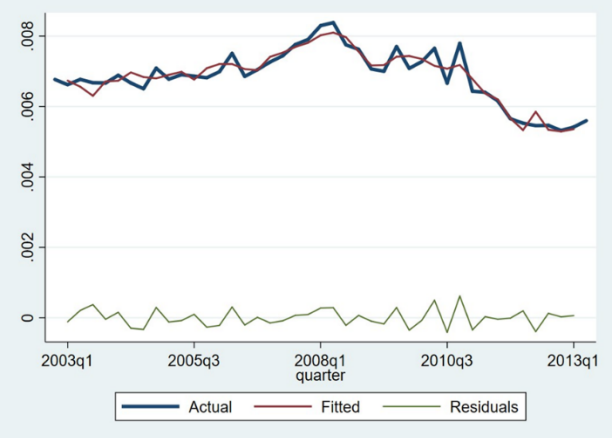


Table 6 – Testing for multicolinearity - Variance Inflaction Factor

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
σ	706.2	4	1.95	8.13	1.34	11.62	6.02	16.88
β_1	5.86	3.02	1.75	1.78	1.77	1.56	1.93	5.31
β_2	5.62	2.79	2.02	1.8	1.84	1.59	1.78	3.52
β_3	7.19	2.32	1.94	1.86	1.83	1.69	1.82	3.21
β_4	7.87	1.82	1.82	1.82	1.79	1.72	1.78	2.31
β_5	7.48	1.77	1.77	1.83	1.73	1.77	1.86	2.19
β_6	7.24	1.74	1.7	1.81	1.67	1.7	1.8	2.39
β_7	7.51	1.88	1.65	1.89	1.58	1.76	1.76	2.3
β_8	6.14	1.78	1.61	1.84	1.66	1.79	1.65	1.79
β_9	4.9	1.77	1.64	1.8	1.61	1.78	1.59	1.53
β_{10}	4.59	1.74	1.56	1.77	1.59	1.75	1.54	1.51
β_{11}	3.07	1.65	1.44	1.66	1.56	1.67	1.48	1.63
β_{12}	3.01	1.66	1.43	1.65	1.33	1.66	1.58	1.83
Uncertainty	11.29	6.71						10.54
Fin. Cons.	2.83		2.96					2.93
Indebtedness	44.84			18.41				29.93
Interest Rate	22.04				1.64			5.68
PMR	1021.08					9.93		
EPL	66.5						2.48	7.99
Mean VIF	75.04	2.48	1.8	3.43	1.64	3	2.08	5.75

5. Conclusions

The slowdown registered in Portuguese private and public investment since the beginning of the century cannot be completely explained by output dynamics. Although the latter explains a considerable share of the variation, there are other factors that contribute to a more accurate fit, specially after the Global Financial Crisis. Our empirical analysis suggests that factors as political uncertainty, indebtedness, market restrictions and interest rates enhance the fitness of the baseline accelerator model.

The magnitude and duration of the investment slowdown in Portugal justified a profound analysis of important developments on economy' sectors and asset classes. There was a general decay in investment on all asset classes (except intellectual property), with investment in infrastructures recording the worst performance in the group. The shift-share analysis identified that the fall in sectorial investment rates was mainly explained by negative dynamics within sectors. There appears to be a shift to less investment-intensive sectors, as services.

A wide share of the fall in investment during the period in analysis can be explained by negative dynamics within the Non-Tradable group of sectors. Further research must be conducted in order to understand whether these negative dynamics may indicate a structural inefficiency on the resource allocation of the Portuguese economy in the global economic system.

A future extension to this study should focus on firm-level data. Given the wide and rich micro-data available for the Portuguese economy, it would be interesting to study the role of financial constraints and indebtedness, specifically in SMEs. It would also be important to de- compose investment between private and public investment, in order to better understand the differences in the dynamics of the two since the surge of the slowdown.

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Data definition, sources and overview

Accelerator Model

Business Investment: Investment data is retrieved from EUROSTAT quarterly national accounts. The data used is expressed in real terms (2010 prices) and seasonally and calendar adjusted. Following ECB (2017) and using data broken down by main asset classes, total investment is adjusted for construction (Non-Construction Investment). This adjusted variable will be used as a proxy for business investment, covering investment in transport, information and communication technology (ICT) equipment, other machinery and equipment, weapon systems, intellectual property products and agricultural products.

Capital Stock: The capital stock series was retrieved from AMECO at a yearly frequency and expressed in real terms (2010 prices). Linear interpolation is used to transform the series into quarterly frequency, with the capital stock in the last quarter of the year corresponding to the annual figure.

Gross Domestic Product: Data on real GDP (2010 prices) was taken from EUROSTAT quarterly national accounts.

Financial Constraints: The data is from European Commission's Business and Consumer Survey, at a quarterly frequency and seasonally adjusted. It expresses the percent of correspondents from manufacturing sector listing financial constraints as a factor limiting production.

Uncertainty: To proxy uncertainty it was used European Commission's economic sentiment indicator for Portugal. Monthly frequency was transformed into quarterly by taking the simple average of the economic sentiment indicator for the months of each quarter. (Natural log of uncertainty*100).

Indebtedness: It is used total credit to private non-financial sector as a share of GDP, for all sectors at market value and adjusted for breaks. The series was retrieved from Bank for International Settlements.

Product Market barriers: This variable is used as a proxy of barriers to investment in the product market. The data is retrieved from OECD's index of product market regulations (Overall PMR Indicator) - for 1998, 2003, 2008, 2013 and 2018. Linear interpolation was used to compute the quarters in between.

Labor Market barriers: Data is retrieved from OECD's indicator for employment protection legislation (EPL) - Regular contracts, including additional provision for collective dis- missals Indicator (Version 1). Yearly data ranging from 1985 to 2013 was linearly interpolated as to have quarterly data.

Interest Rate: It was used EUROSTAT's quarterly data regarding long-term lending rate (Maastricht criterion interest rate).

Data overview

Table 7 – Data overview

Variable	Range	Unit	Nr. Obs.	Mean	Std. dev.	Min.	Max.
GDP	1995q1 to 2019q1	Million e	97	42358.46	3106.069	33766	46579
GFCF	1995q1 to 2019q1	Million e	97	8830.154	1467.908	6302.1	11191.3
Capital Stock [1]	1975q1 to 2018q1	Million e	173	362159.4	139637.1	147801.1	545755.9
NCI	1996q1 to 2019q1	Million e	93	3461.04	532.8	2082.4	4732.5
Financial Constraints	2003q1 to 2019q1	Ratio	65	0.0793	0.02	0.036	0.131
Uncertainty [2]	1987q1 to 2019q1	natural log *100	129	461.54	11.05	433.3	484.6
Indebtedness	1975q1 to 2018q4	Ratio	176	1.419	0.474	0.768	2.315
PRM [1]	1998q1 to 2018q1	0 to 5 scale	81	1.77	0.42	1.29	2.59
EPL [1]	1985q1 to 2013q1	0 to 6 scale	113	4.53	0.359	3.18	5
Interest Rate	1986q1 to 2019q1	Rate/100	133	0.076	0.046	0.015	0.166

[1] After linear interpolation
[2] After transformation