

**THE IMPACT OF PUBLIC INVESTMENT ON PRIVATE  
INVESTMENT IN 21 OECD COUNTRIES OVER THE  
PERIOD 2000-2017**

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## **Abstract**

This dissertation analyses the relationship between private and public investment in 21 OECD countries over the period 2000-2017. We estimated an econometric model using panel data methodologies that allow us to study the effects of public investment on private investment. Results suggest a positive effect of public investment on private investment. One percent increase in government investment would yield a 0.18% increase in private investment. To test the robustness of this results, the analysis was extended to subgroups of countries within the 21 countries under analysis, divided by high and low GDP growth rate, and the findings confirm the positive effect of public investment on private investment in both subgroups. This positive effect possibly is due to public sector promoting infrastructures which convert to investment opportunities for the private sector. The impact of public investment on private investment for a larger OECD country sample was done through a different model, compared to previous studies done. Thereby, a contribution to the literature was made.

**Keywords:** Private Investment; Public Investment; OECD; Panel data

**JEL classification:** E22; C23; H54

## **Resumo**

Esta dissertação analisa a relação entre o investimento privado e o investimento público em 21 países da OCDE ao longo do período 2000-2017. Para o desenvolvimento deste estudo, estimámos um modelo econométrico recorrendo a metodologias de dados de painel que nos permite estudar os efeitos que o investimento público tem no investimento privado. Os resultados obtidos sugerem que o investimento público afeta positivamente o investimento privado, um aumento de 1% no investimento público gera um aumento de 0,18% no investimento privado. Para testar a robustez dos resultados obtidos, a análise também foi feita para 2 subgrupos de países entre os 21 em estudo, divididos por superiores e inferiores à média da taxa de crescimento económico, e as conclusões obtidas confirmam o efeito positivo do investimento público no investimento privado em ambos os subgrupos. Este resultado deve-se, possivelmente, às infraestruturas promovidas pelo sector público que se refletem numa oportunidade de investimento para o setor privado. Este estudo contribuí para a literatura existente, na medida em que, através de um modelo diferente estudámos os efeitos do investimento público no investimento privado abrangendo uma amostra maior de países da OCDE comparativamente aos estudos anteriormente feitos.

**Palavras-chave:** Investimento privado; Investimento público; OCDE; Dados de painel

**Classificação JEL:** E22; C23; H54

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## List of abbreviations

<b>OECD</b>	Organization for Economic Cooperation and Development
<b>OCDE</b>	Organização para a Cooperação e Desenvolvimento Económico
<b>VAR</b>	Vector autoregression
<b>SYS-2SLS</b>	System two-stage least squares
<b>FE</b>	Fixed Effects
<b>RE</b>	Random Effects
<b>B-P LM</b>	Breusch-Pagan Lagrange multiplier test
<b>CD</b>	Cross-sectional Dependence

## **1. Introduction**

Investment is a strong element of countries' economic development. Productive investment is needed to raise countries' economic activities and the productive capacity of an economy can be increased through investment effectiveness, i.e. investment in new technologies and education is vital as it will provide optimally production output, value-added and increase the competitiveness of an economy, in the long term. However, investment is very volatile and fluctuating, as it is greatly influenced by the stage of the economic cycle in which it is found. Investment trends have grown, decreased or stagnated over the years because of these different phases of the economic cycle.

There are two sectors that promote investment activities: public and private. Public investment is the investment promoted by governments and arises with the need to guarantee services, goods and infrastructures that are crucial to the proper functioning of countries. On the other hand, private investment is the gross fixed capital formation promoted by the private sector and it is understood as the acquisition of a capital asset that is expected to generate profits and / or create value-add in the future. Because private investment improves the standard of living of the population and creates employment, it has a substantial impact on the development of the economic activities.

How private investment responds to the evolution of public investment has been a hotly debated issue over the years. Regarding the impact of public investment on private investment, we can distinguish two effects, positive and negative. Firstly, public investment favours private investment mainly by creating favourable conditions through the promotion of infrastructures which may be a stimulant for private investment activities (Argimón, Gonzalez-Páramo and Roldan, 1997). Secondly, public investment may undermine private investment mainly by increasing interest rates as a consequence of the demand for funds in the financial markets. The rise of interest rates would reduce the amount of savings available to be used by the private sector and increase the cost of financing (Dash, 2016). However, some previous researchers found mixed effects, crowding in and crowding out effects, among their samples (Afonso and Aubyn, 2008). Briefly, the results of previous analysis on this topic are ambiguous since there is no coherence in the conclusions obtained. There are studies that prove crowding in effects as well as others that conclude crowding out, and this is transverse for both developed



and developing countries. The inconclusiveness of previous studies motivated us to further investigate this topic.

In this study, we analyse the relationship between private investment and public investment empirically. For this purpose, we estimate an econometric model using appropriate panel data methodologies for a set of 21 OECD countries over the period 2000-2017. To test the robustness of the results obtained, the analysis was also performed for two subgroups of countries, namely Lower GDPg and Higher GDPg. The first includes the countries that grow economically at a lower average than the average economic growth of the total sample and the second groups those countries that grow at a higher average.

This study differentiates from the existing literature in four aspects: the study considers a wider group of OECD countries compared to existing studies on the effects of public investment on private investment. Regarding the model used, we applied a fixed effect with Driscoll and Kraay standard errors approach, which contemplates the cross-sectional dependence and to our knowledge it has not yet been used in this subject. Another aspect in which our work differs from existing works is related to the variables used as control variables in the model, we added two new variables, specifically foreign direct investment (FDI) and savings, that had not yet been tested on this theme for OECD countries. Lastly, we divided the sample of 21 OECD countries, based on the average economic growth of the full sample, into two smaller subsamples to check the robustness of the results. Our results suggest that public investment complements private investment, indicating a crowding in effect.

The remaining study is structured as follows: section two outlines the theoretical arguments behind the relationship between private investment and public investment. In section three we present an overview of the theme and some statistical analysis. Section four describes the data and presents the empirical analysis used to assess the effects of public investment on private investment. Section five presents the main findings and the robustness tests of the empirical results. Finally, section six sums up the work done.

## **2. Literature Review**

The impacts of public investment on private investment have been the subject of study in economic literature and the findings are inconclusive, being divided into crowd in or crowd out effects. Different opinions about how public spending should be managed and whether public spending directed towards investment contributes to positive or negative externalities in private investment were presented by several authors. The results are not consensual, and it is not possible to identify a general rule for a given type of economy since the conclusions obtained for samples from similar economies differ from study to study. Indeed, empirical studies show that public investment can both have a positive as well as a negative effect on private investment.

Classical economists defended the view that the economy should act on its own, without the intervention of any other agent, and that the economy itself would tend to equilibrium. According to them, unless public investment is self-financed it undermines private investment because it implies the search for funding contributing towards increasing the value of the interest rate. Contrary to classical economists, Keynesian economists defended that public investment positively affects private investment by increasing the national income. For them, public spending stimulates the economy by promoting employment and the demand for goods and services due to the multiplier effect (Chipaumire, Ngirande, Method, & Ruswa, 2014).

Throughout the last few years, different authors tested whether there is or not a significant relationship between public investment and private investment.

The conclusions obtained by Argimón et al., (1997), Erden and Holcombe (2005), Saeed, Hyder and Ali (2006), Afonso and Aubyn (2008), Andrade and Duarte (2014), Barbosa, Carvalho, and Pereira (2016), Dreger and Reimers (2016), Abiad, Furceri and Topalova (2016), and Carrillo, Pino, and Heredia (2018) indicate that public investment has a significant and positive impact on private investment, thus according to the referred authors, public investment crowds in private investment.

Public investment in infrastructures were the main cause of crowd in effects identified by the several authors. Following their ideas, infrastructures such as airports, seaports, highways, schools, hospitals, and other social infrastructures can stimulate private investment by increasing the private sector productivity, thereby creating business

opportunities. The construction of these infrastructures ensures the availability of public goods and services such as education, health, telecommunications, water supply, sewerage system, all factors that contribute to promote private activities.

Argimón et al., (1997) by the analysis of a sample of 14 countries from the OECD showed that capital expenditure (public investment) crowds in private investment, since, public investment accumulated tends to increase productivity, thus the positive effect is due to a positive impact of infrastructures on private investment productivity. However, they found that current expenditure (public consumption) decreases private investment.

Dreger and Reimers (2016) analysed the long term relationship between public and private investments for a panel of 12 euro area countries. Considering a stock-flow approach, they found a crowding in effect of private investment due to the cointegration between the capital stocks. Nevertheless, they highlight that in the euro area, lack of public investment might restrict private investment.

Abiad et al., (2016) investigated the macroeconomic effects of public investment in 17 OECD countries. They used public investment forecast errors to identify the effects of public investment and their findings suggest that increasing public investment the output raises, crowds in private investment and decrease unemployment. The complementarity between public infrastructures and private investment; the high efficiency of public investment and the public investment being debt-financed were the reasons pointed out to explain the crowding in effect.

Saeed et al., (2006), estimating a VAR model, studied the impact of public investment on private investment distinguishing different industries such as the manufacturing sector, the agriculture sector and the general economy, to understand which private sectors are crowded either in or out by public investment in Pakistan. Their results showed that there is a positive relationship between public and private investment in the agricultural sector due to the added value of real public investment and labour and to the public spending in agricultural infrastructures. Investment in these infrastructures increases the rate of return on investment in the agricultural sector, increasing public investment and consequently rising private investment. However, for the manufacturing sector the evidence indicates that public investment undermines the development of private investment. Concerning the general economy, results did not reveal a relevant impact of public investment on private investment.

Andrade and Duarte (2014) studied the Portuguese economy for the period between 1960 and 2013. Their study confirms that public and private investment are complementary and thus public investment promotes solid conditions for private investment. The results show that public investment affected private investment positively, also contributing to a positive impact on the output of Portugal.

Makuyana and Odhiambo (2016) studied the impact of public and private investments in economic growth for developing and developed countries by surveying conclusions from studies previously done by various authors. Their main conclusions are that in developed economies, public investment is an important factor for economic growth principally when it is focused on infrastructures which encourage private investment. Concerning developing economies, the conclusions reached indicate that both public investment and private investment are an important component of economic growth.

Carrillo et al., (2018) researched the relationship between public and private investments in Mexico. The period of study was between 1993 and 2017 but due to the existence of a divergence between the trend of public investment and of private investment from 2009, an analysis was made for the period 1993-2008 where the two series present an upward trend, and an analysis for the period 2009-2017 where private investment presents an upward trend while for public investment the trend is downward. For this study a time series model was used, and the results of the regression model show that for each period of study there is a statistically significant direct relationship between public investment and private investment, concluding that larger public investment generate greater private investment.

Barbosa et al., (2016) identified how governments can promote private investment through public stimulus. Governments can ensure an adequate political and institutional environment which may reduce uncertainty, and this is important as firms that do not have information about the project, tend to postpone its implementation until acquiring more information about it. To encourage private firms to undertake the project quickly, the government can introduce public incentives such as tax reductions or a subsidizing policy. The threat of public competition can also act put pressure on companies once the public sector shows interest in investing to obtain the same target of the private sector.

Erden and Holcombe (2005) explored the effects of public investment on private investment in 19 developing countries. They used an empirical model based on a flexible

accelerator investment model which allows private investment to be explained through several relevant variables and they found their results through the application of the system two-stage least squares (SYS-2SLS). The empirical findings reveal that if public investment increases in 10% private investment would increase about 2% and this may be due to infrastructures that are complementary to the private sector, due to a stabilizing influence on the economy provided by public investment, or due to public investment providing information about investment productivity for private investors, although the authors identify that uncertainty has a negative impact on private investment.

The multiplier effect is referred by several authors as a positive aspect of public investment. When investing in public goods such as physical infrastructures or services, the government creates an opportunity for companies to invest and an economic cycle of opportunity is generated.

Another strand of the literature emphasises evidence of negative effects on private investment caused by public investment. The drivers of crowding out effects from public investment on private investment are very diversified.

While goods, services, and infrastructures promoted by the public sector can contribute positively to the private sector, they may, on the other hand cause harm, as to promote them tax money may be necessary for the public sector to finance itself. By raising taxes, this reduces private savings and causes a decrease in private investment (Vanhoudt, Mathã & Schmid, 2000).

Higher interest rates increase the cost of loans and consequently decreases investment leading to reduced economic growth. The payment of higher interest rates discourages firms from investing because companies are less willing to risk investing and also because the financial availability is reduced once resources are being spent on the payment of interest rates. Financing public investment implies a higher tax burden or a higher demand of the public sector for funds in capital markets, and this leads to an increase in interest rates which crowds out private investment (Dreger & Reimers, 2016).

Afonso and Aubyn (2008), found mixed effects, once for a sample of 14 countries from the European Union and Japan, Canada and United States between 1960 and 2005, they found a crowding out effects in nine countries, since a positive impulse of public investment leads to a decline in private investment. For the remaining eight countries, a crowding in effect is highlighted. According to them, private investment is discouraged

due to the pressure that public investment causes in interest rates by the demand of financing in financial markets and this decreases private investment because the availability of savings is reduced for private investors and also decrease the expected rate of return of private capital.

Dash (2016) verified that public investment crowded out private investment in India for the period 1970-2013. For him, crowding out effects are resultant of the increase of the cost to obtain financing derived from the increase of interest rates and due to the reduce availability of savings because when the public sector uses national savings, it decreases its accessibility to the private sector. However, he mentioned that investment in infrastructures can promote private investment if the quality of the infrastructure is guaranteed and the financing of infrastructures construction does not condition the availability of bank credit or lending rates.

Voss (2002) in his paper analysed the possible crowd in or crowd out effects in United States and Canada for four decades using a VAR model. He identified innovations to public investment as a negative factor for private investment in both countries and concluded that public investment and private investment were not complementary in US and Canada.

Saeed et al., (2006) referred that policy makers of Pakistan defend the idea that the increase in public investment reduces resources for private investment that leads to competition, increasing interest rates and consequently decreasing private investment.

Erden and Holcombe (2005) with the same empirical model used in the study of developing countries they tested it to a sample of 12 developed economies reaching different results since, for this type of economy, public investment was seen as having a negative effect on private investment because in developed countries the both investments are competitors and due to declining private sector productivity in response to a large public sector. Dreger and Reimers, (2016) also referred that if public and private sector compete for the same resources this may crowd out private investment because costs for private investment increases.

Uncertainty is another aspect mentioned as a negative effect on development of private investment because under these circumstances' firms do not have complete information about the project and they tend to defer the investment until acquiring more knowledge about it. However, the study elaborated by Erden and Holcombe (2005) demonstrate that

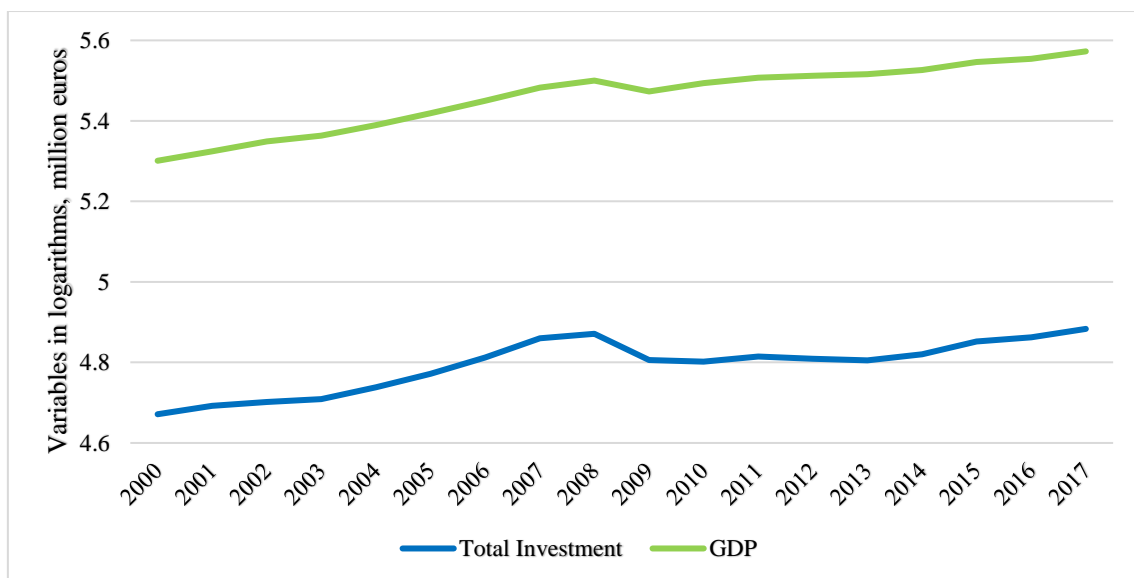
*The impact of public investment on private investment*

for developed economies, contrary to developing economies, uncertainty has an insignificant impact and it does not hamper private investment.

### 3. Overview

In this section we discuss the relation between private and public investments over the period 2000-2017. However, before that, we analyse the trend of total investment over the period, and to better understand its behaviour, we also contextualise the economic environment in which the variable developed. In the following paragraphs, we present the evolution of total investment and of the GDP, and also analyse the effects that the crisis had on public debt and on economic growth of countries and how this influenced investment.

Figure 1 represents the averages of the total investment and GDP variables of the 21 countries and illustrates how total investment and GDP has evolved over the past few years. Over the reporting period, both investment and GDP grow, but with disturbances such as the 2008 crisis. There is a sharp drop in both variables and subsequent recovery from the shock, however the recovery of investment is much slower as it remained stagnant until 2014. The two variables describe a similar trend/behaviour, indicating that investment follows GDP closely. As GDP is an indicator of the state of the economy, it influences the investment decision and, therefore, it is expected that when GDP shows growth this will be reflected in investment as an increase. The opposite is also expected, a fall in GDP can cause a further fall in investment and this may contribute to the subsequent decline in GDP.

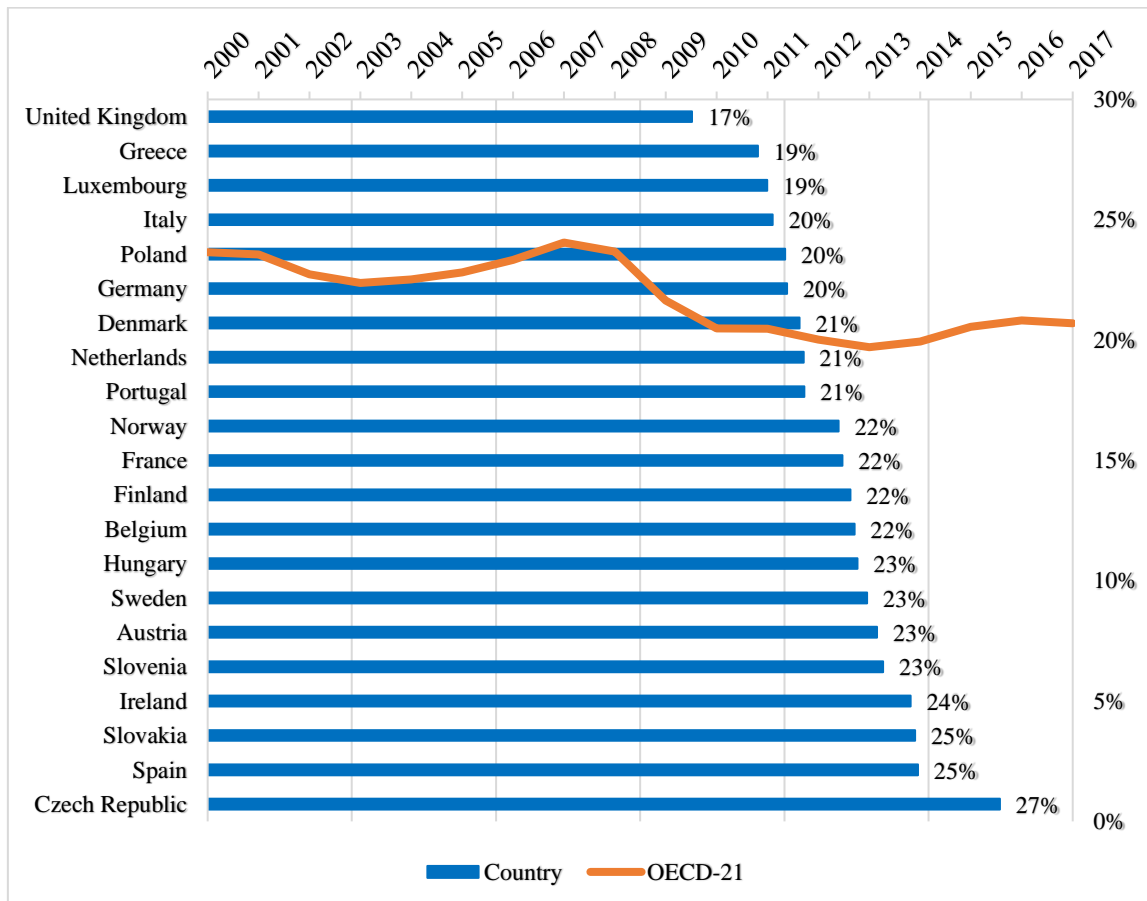


**Figure 1:** Evolution of total investment and GDP over the period 2000-2017, averages of the 21 OECD countries.

Source: Ameco database (Last update Autumn 2018)



Among this sample, investment represented on average about 22% of GDP over these 18 years, however, through Figure 2 we see that this value has fluctuated over time and especially from 2008 to 2013, the weight of investment suffered a significant decrease, slowly recovering after 2014. The Czech Republic is the country displaying the highest average of total investment, accounting to 27% of GDP. On the opposite side, is the United Kingdom with the lowest average share of investment to GDP, about 17%.

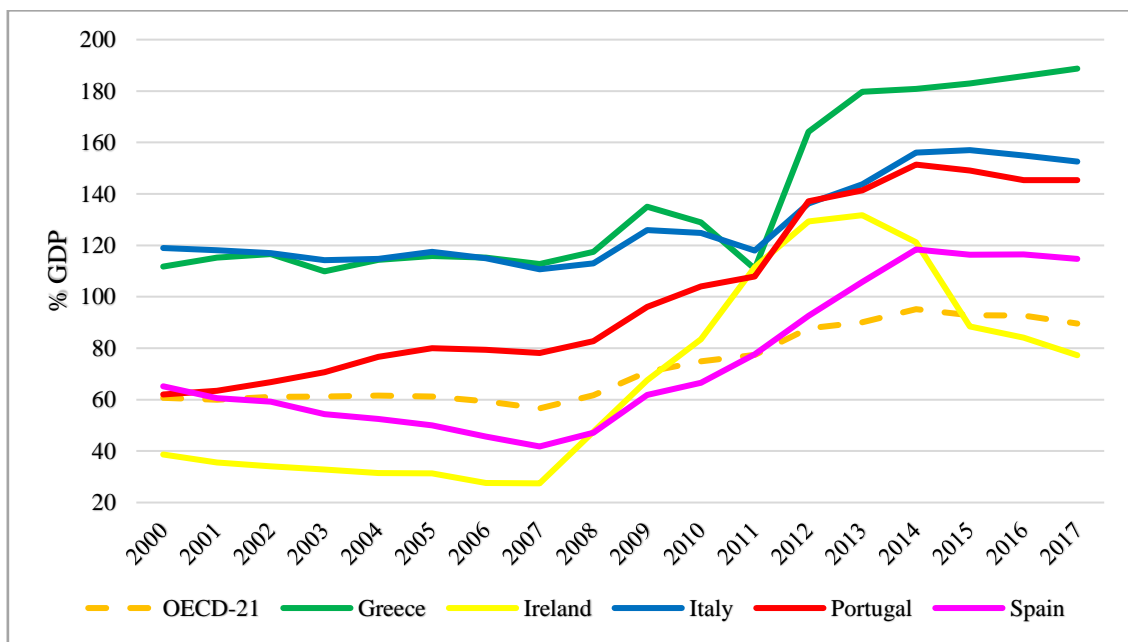


**Figure 2:** Total investment as share of GDP. Average of each country and average of the 21 OECD countries, over the 18 years.

Source: Ameco database (Last update Autumn 2018)

The contextualization of the economic cycles in which the variables developed is fundamental to the understanding the oscillations over time, so it is important to highlight the period of recession that these economies have gone through. If investment declined after the crisis of 2008, the period that precedes the downturn witnessed a noticeable continuous growth of GDP and investment (cf. Figure 1), which demonstrates that the economic environment up to the crisis promoted conditions for these variables to grow and develop positively. The strong global crisis of 2008 unsettled economies on a world scale. As a result, markets became unstable, unemployment, government debt and interest

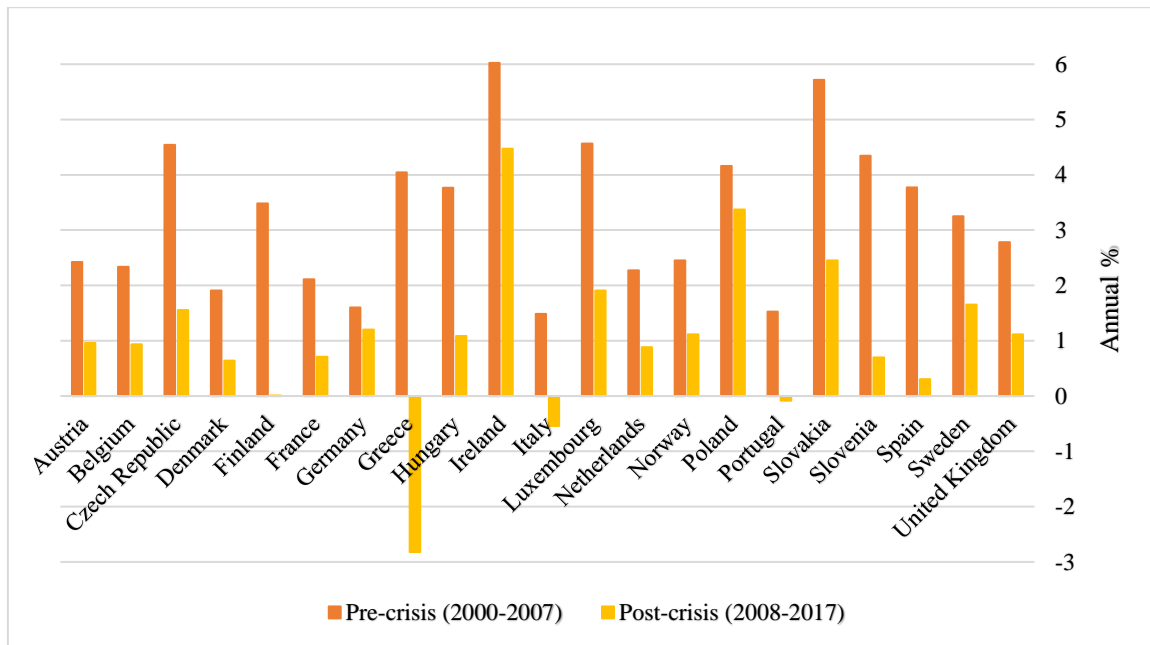
rates increased, and the granting of credit was restricted. Inevitably this was reflected negatively on GDP growth and limited investments, both private and public. Greece, Ireland, Portugal and later Italy and Spain stand out as the group of countries in Europe that were strongly affected by the crisis and had to resort to external financial support. Figure 3 shows the countries whose public debt was heavily affected after 2008. Indeed, these countries show a considerably higher value of public debt to GDP way above the average ratio of public debt to GDP of the 21 countries while a sharp rise in public debt after 2008 is also evident. Also, relatively to the average of the 21 OECD countries it is evident that all countries highlighted in this graph were deeply affected by the crisis.



**Figure 3:** General government debt-to-GDP ratio between 2000 and 2017.  
 Source: OECD database from series General government debt.

To assess how economic growth was disturbed by the crisis, we build Figure 4 which shows the average rate of economic growth by country for the pre and post crisis periods. We easily observe that economic growth was negatively affected in all countries, its average decreasing from one period to another. Apparently, Greece was the country whose economic growth was the most affected, displaying a decrease of almost 7% from the pre-crisis to the post-crisis period. Due to the devastating effects of the crisis and its consequences, the economic growth of Greece, Italy and Portugal was so harmed that it became negative in the post-crisis period. Although, Portugal's variation in economic growth between the two periods is not that evident, as its economic growth before the crisis, was already reduced. Yet, the Czech Republic, Finland, Hungary, Italy,

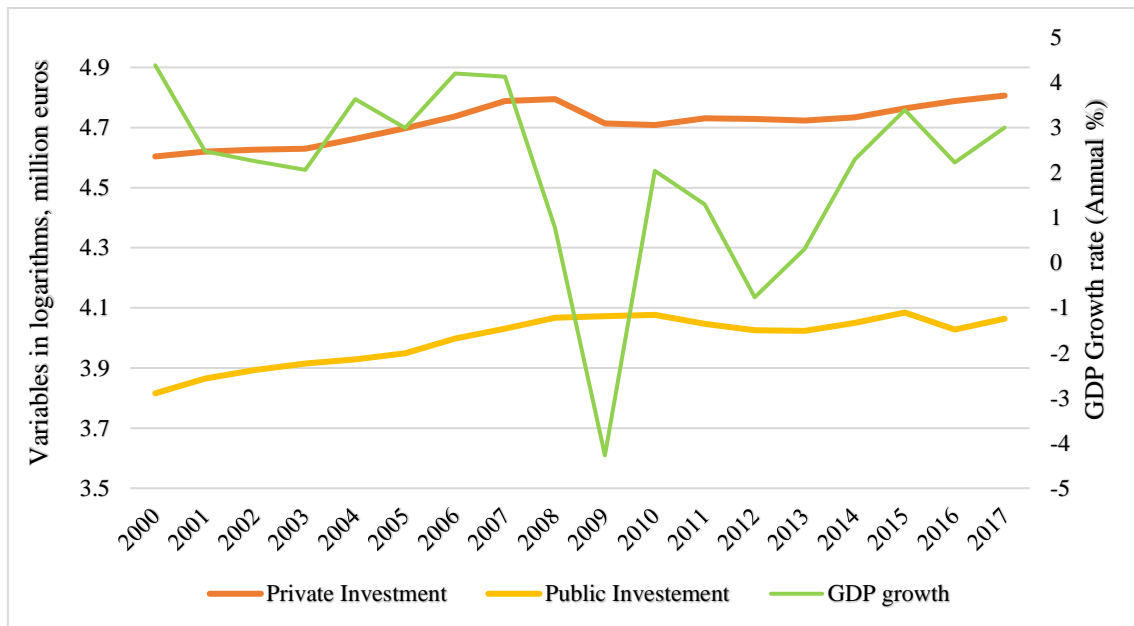
Luxembourg, Slovakia, Slovenia and Spain also show considerable declines in economic growth after being hit by the crisis. On the other hand, economic growth in Germany and Poland appears to have been less affected by the crisis compared to the other countries in this sample.



**Figure 4:** Comparison of economic growth for the pre and post crisis periods.  
 Source: Ameco database (Last update Autumn 2018) and from World Bank database

After studying how total investment has evolved over the period and how it has reacted to changes in the economic environment caused mainly by the effects of the crisis, it is easier to analyse the evolution of public and private investments and discuss their relation, considering that both also underwent the same economic conditions as total investment.

Observing Figure 5, we can understand the way in which private investment has changed over the 18 years in the 21 OECD countries. Through its analysis we realized that it grew until 2008, a year in which there was a fall very likely due to the global crisis, after this break, it remained stagnant, and it was only in 2015 that there was a continuous growth of private investment again.



**Figure 5:** Comparison between private and public investments and GDP growth rate. Average of the 21 OECD countries.

Source: Ameco database (Last update Autumn 2018) and from World Bank database

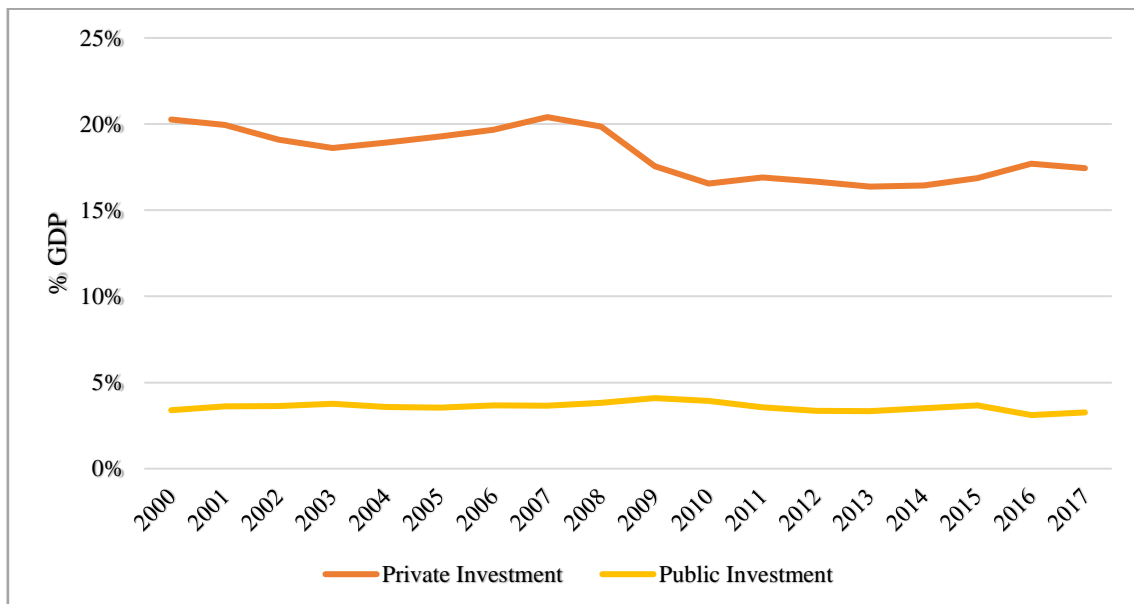
Also, in the same figure, we perceive that public investment did not suffer an immediate break with the crisis, but its growth slowed, and notwithstanding the effects of the crisis were reflected mainly between the years 2010 and 2015, during which there was a considerable increase in public debt and consequently public investment decreases (in Figure 3, we see that since 2011, government debt-to-GDP in the countries where the crisis was most reflected, reaches its peak).

Comparing the two investment variables, we realize that overall, they are apparently interrelated and grow over time. Yet, after the crash, they show a slightly different behaviour; probably given different impact of the crisis on each of them. During 2010-2015, when the level of public investment fell, private investment experienced a stagnation of its growth rate. Both investments suffered a decline that took years to recover, however private investment was more quickly affected by the crisis than public investment, indicating that financial instability had a direct impact on private investment, while the effects on public investment were mostly noticed by the impact it had on the increase of public debt.

Investment is influenced by economic growth, which in turn depends on the influence that investment has on economic activity, so it is expected that the way economic growth evolves will be reflected in investment behaviour. Economic growth (Figure 5) also

suffered a drastic drop after 2008, presenting accentuated ups and downs reflecting an image of an uncertain and volatile economy. Since 2015, the year in which the recovery of the crisis begins to be perceived, public investment follows the evolution of GDP growth, which may indicate that, with the end of austerity, the public sector has more scope to increase its investment. However, the value of public investment has not been very high, which may lead us to conclude that, in Europe the main purpose of the investment promoted by governments is only to meet public needs. Yet, even though government investment is not very high and does not aim to encourage private investment, it still can indirectly act as a stimulus for private investment through creating investment opportunities for the private sector.

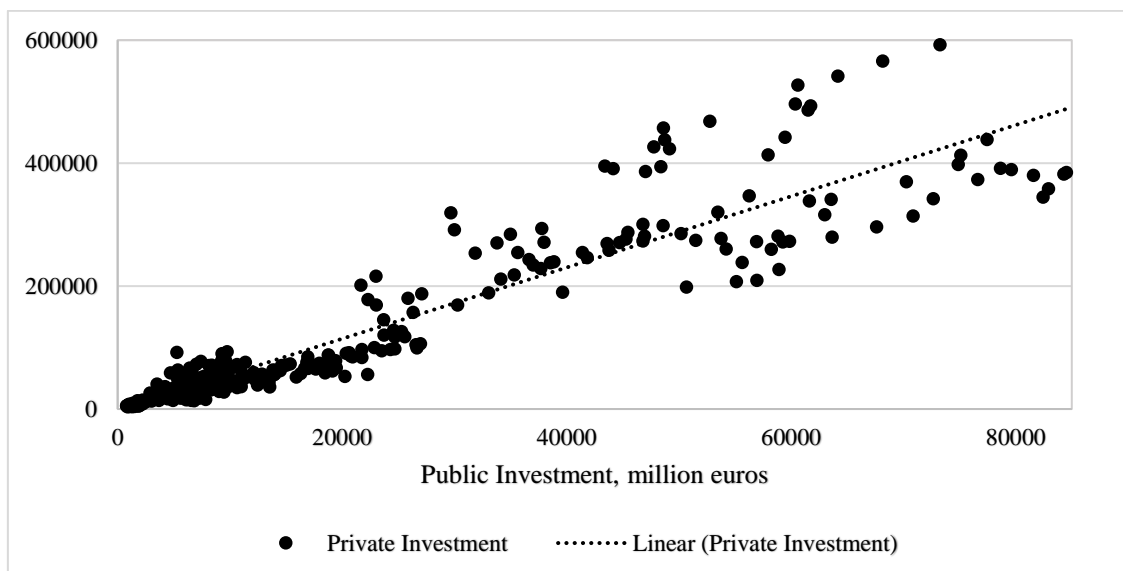
Private investment and public investment in relation to GDP (Figure 6) represents the percentage of investment promoted by the private sector and the public sector, respectively, that contributes to the country's GDP. Regarding private investment, there is a clear decrease during the period presented, in 2000 the average was around 20% while in 2017 it was about 17%, a decrease of 3%. Over the 18 years, on average private investment has represented about 18% of GDP in the 21 countries. Concerning public investment, its share of GDP is apparently constant over the years, on average, it is around 4%, with no major oscillations.



**Figure 6:** Private and public investments as a share of GDP. Average of the 21 OECD countries. Source: Ameco database (Last update Autumn 2018)

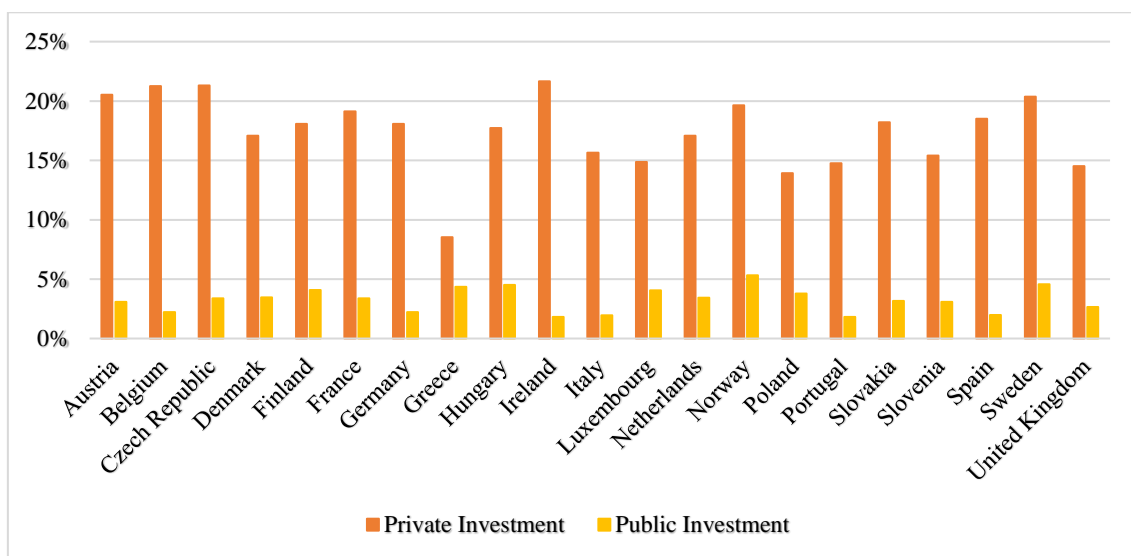
We also constructed graphs like Figure 6 for each of the 21 countries in order to understand the evolution of both types of investment, over the years. These graphs are presented in Appendix A, since their interpretation is similar to Figure 6 and the only difference is each graph represents one of the countries instead of the total sample. Since the conclusions that can be drawn for the total sample are not valid for each country, we discuss those countries that point out the greatest differences from the overall average. In Austria, Belgium, Czech Republic, Ireland, Slovakia, Slovenia, Spain and Sweden, private investment as a share of GDP has been above the average of the total sample, indicating that in these countries private investment contributes, above average, to a better performance of economic activity and it is a stronger component of GDP than in other countries. On the other hand, we find that in some countries, such as the Czech Republic, Greece, Hungary, Ireland, Poland, Portugal and Spain, public investment (% GDP), contrary to the whole sample, has not remained constant and has shown fluctuations throughout the reporting period.

To obtain a visual image of how private investment and public investment relate, we present Figure 7 which describes the correlation between the two variables. The type of relation we can observe in the figure is called a positive linear regression. A positive and strong correlation is verified between both investment variables in a way that as public investment increases, private investment also tends to increase.



**Figure 7:** *Correlation between private and public investments.*  
*Source: Ameco database (Last update Autumn 2018)*

To get a more updated view of how private investment behaves, and as our last year of study is 2017, we will analyse how much the investment contributes to the development of economic activity in this year. In the figure below, we see the total investment, in 2017, divided into its two components, private and public investments. In all countries, private investment is the strongest component, and this is verified for the remaining years of study. We can state that, although a total investment will affect the outputs of economic activities, since this is mostly derived from private investment, a change in private investment will have much more force to influence the economic activity than a variation in public investment.



**Figure 8:** % of private and public investment in relation to GDP, in 2017.

Source: Ameco database (Last update Autumn 2018)

Summarizing, public investment provides the necessary infrastructures for the operation of economic activity and, as such, can be an important determinant of companies' decision to settle on national territory by investing in new opportunities. Europe was severely affected by the crisis 2008, until then, the trend in investment value showed continued growth, which did not happen after this crash. It is evident that, the sovereign debt crisis contracted public investment in Europe. However, if we look at the evolution of the total investment variable, we realize that its behaviour is closer to the evolution of private investment, which indicates that fluctuations in public investment do not link investment trend in Europe, as public investment is a small component of total investment.

The behaviour of private investment, over the years, was influenced by the evolution of public investment and after 2008, as well as by the effects of the crisis. In the pre-crisis

period, the evolution of private investment follows public investment, reflecting the clear idea that investment promoted by government contributed to creating investment opportunities for the private sector in Europe. Regarding the post-crisis period, with this shock, the evolution of private and public investments shows a slightly different trend, nevertheless we associate the slow growth of private investment with the reduction of public investment. However, we cannot say that public investment did not continue to contribute to the development of private investment during this period, because, although public investment was less, the private sector continued to take advantage of the infrastructures already promoted by the government.



## 4. Data and Empirical Methodology

### 4.1. The Model

The empirical model used in this study can be represented with the following regression, where private investment is explained as a function of government investment and  $X$ , the set of control variables.

$$PRIVINV_{i,t} = \beta_0 + \beta_1 GOVING_{i,t} + \beta_2 X_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where  $\begin{cases} i = 1, 2, \dots, 21 \text{ denotes countries} \\ t = 1, 2, \dots, 18 \text{ denotes years} \end{cases}$

Specifically, we want to estimate:

$$\begin{aligned} LOGPRIVINV_{i,t} = & \beta_0 + \beta_1 LOGGOVING_{i,t} + \beta_2 GDPg_{i,t} + \beta_3 INTRATE_{i,t} \\ & + \beta_4 DEBT_{i,t} + \beta_5 CPI_{i,t} + \beta_6 SAVINGS_{i,t} + \beta_7 FDI_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (2)$$

Where  $LOGPRIVINV$  and  $LOGGOVING$  are respectively the natural logarithm of private investment and of public investment,  $GDPg$  is the percentage of GDP growth rate,  $INTRATE$  is the annual percentage of interest rates,  $DEBT$  is the general government debt-to-GDP ratio,  $CPI$  is the consumer price index base 2015=100,  $SAVINGS$  are the gross savings in percentage of GDP and  $FDI$  is the net inflows of foreign direct investment in percentage of GDP. Table B1 in Appendix B resumes information on these variables.

### 4.2. Model variables

This empirical study uses annual observations for the set of 21 OECD countries over the period 2000 to 2017.

In our model, the dependent variable is private investment ( $LOGPRIVINV$ ) in millions of euros<sup>1</sup>. The variable was gathered from the series gross fixed capital formation of the private sector at current prices of the AMECO database and transformed into a logarithm (Dreger & Reimers, 2016).

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<sup>1</sup> Following the approach of Carrillo et al., (2018), which used millions of pesos as unit of measure of investments for their research of the relationship between private investment and public investment in Mexico.

Government investment corresponds to public investment and is the main independent variable. This variable corresponds to the general government gross fixed capital formation at current prices from AMECO database and is measured in millions of euros. We have converted it into a logarithm. The principal goal of our analysis is to determine the sign of this variable coefficient, since, due to the contradictory effects mentioned in the literature, we are unable to infer definite expectations for the impact of public investment on private investment.

The growth rate of GDP in percentage was obtained from The World Bank database. In theory, investment is affected by the rate of economic growth given the accelerator principle. When the business sector expects positive growth of the economy it tends to increase its investment activities. Improving macroeconomic conditions induces the growth of private investment, as it creates new opportunities and generates more stable markets for private firms to invest. The expected sign for this variable coefficient is thus positive.

The annual interest rate, is measured in percentage, and was extracted from OECD Data. Long-term interest rates are one of the most important business determinants and are used to analyse whether high/low interest rates have influence on private investment. In economic literature, high interest rates are sometimes faced as a consequence of public investment financing, because the allocation of resources to the public sector reduces the amount of savings for private investment activities and therefore has a crowding out effect (Afonso & Aubyn, 2008; Dreger & Reimers, 2016). Thus, we expect to find a negative coefficient for this variable. Under neoclassical theory, interest rates are taken as an element of the user cost of capital (Bosco and Emerence, 2016), therefore the investment is discouraged when interest rates rise because the cost of financing is greater.

General government debt in percentage of GDP is another of our control variables. This variable was collected from OECD Database. This ratio can be interpreted as an indicator of an economy's health and it is a significant factor for the sustainability of government finance. Public debt increases the risk of investment and can hinder the growth of private investment, as the cost of financing increases because interest rates rise. Dreger and Brautzsch (1999) argued that an increase in debt can aggravate the country's financial situation by raising interest rates and thus restrict demand. Consequently, the coefficient of general government debt is expected to be negative.

To analyse the relationship between private investment and inflation it is used a consumer price index (2015=100), obtained from OECD Database. Inflation is a very oscillating variable and changes as the economic cycle goes on, accompanying its development, increasing when the economic cycle increases and decreasing when it decreases. In periods of expansion, both investment and inflation increase. As inflation increases, private investment is also expected to increase as this variable is measured in current prices. Rising prices translate into increased revenues for companies increasing the value of funds available and giving them greater flexibility to invest. Therefore, we predict that the signal of this variable coefficient will be positive.

Gross savings in percentage of GDP is an independent variable used in the model to try to understand whether a country's savings influences private investment. Data was gathered from The World Bank database. Gross savings correspond to the sum of savings from the private and public sectors and reflect the portion of disposable income after the realization of liabilities that is available to be invested. Given that, usually, public savings are negative since public expenditures are higher than government's revenues or are neutral when the revenues only cover the expenditures, thus the largest component of gross savings come from to private sector. Therefore, gross savings can be an important element for private investment since public expenditures have already been secured and they are available funds to be invested, thus the expected coefficient is positive.

Finally, the model includes foreign direct investment inspired on Dash (2016) work, extracted from The World Bank database. FDI is part of investment, therefore a higher share of FDI will contribute to increase investment. It is possible that the inflows of FDI reduces a probable crowding out effect of public investment, since *“theoretically, it is expected that an increase in net inflows of foreign direct investment leads to an increase in loanable funds in the domestic financial market and relaxes the domestic financing constraint (Dash, 2016: 300)”*. In our model, the FDI variable reflects the net inflows (new investment inflows minus divestments) from foreign investors in the economy as a percentage of GDP. We used it to assess whether foreign capital invested in the country contributes to the development of private investment through the study of the impact that the net inflows of foreign investment has on GDP. The expected coefficient sign is positive.

To sum up, we can expect the following results for the signs of the coefficients:

1. Government Investment (?)
2. GDP Growth (+)
3. Long-term Interest Rates (-)
4. General Government Debt (-)
5. Consumer price index (+)
6. Gross Savings (+)
7. Foreign direct investment, net inflows (+)

Table 1 summarizes a descriptive statistic of each variable to better understand the results that will be presented later.

<b>Variable</b>		<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>
<b>LOGPRIVINV</b>	overall	4.714249	0.5389172	3.577352	5.772664
	between		0.5422016	3.74681	5.662092
	within		0.0985173	4.409465	5.11933
<b>LOGGOVINV</b>	overall	3.996389	0.5051858	2.908519	4.927047
	between		0.5006621	3.128698	4.865571
	within		0.1259097	3.47079	4.41987
<b>GDPg</b>	overall	2.02279	2.994819	-9.132494	25.55727
	between		1.203172	0.2289796	5.163316
	within		2.754378	-8.091777	22.41674
<b>INTRATE</b>	overall	3.965357	2.267108	0.09	22.4975
	between		1.247462	2.591512	7.528687
	within		1.907759	0.0216697	18.93417
<b>DEBT</b>	overall	73.03698	34.1976	16.54233	188.7342
	between		29.19499	23.60402	138.1172
	within		18.85639	32.96469	138.0309
<b>CPI</b>	overall	89.63267	10.08641	51.96151	105.4917
	between		2.591491	81.59669	94.32561
	within		9.763335	59.99748	110.7883
<b>FDI</b>	overall	7.312905	18.09887	-58.32288	252.3081
	between		9.97541	0.7981337	41.06904
	within		15.41606	-92.07902	218.552
<b>SAVINGS</b>	overall	23.16678	6.462973	4.870592	41.69065
	between		5.736172	12.10744	36.66564
	within		3.081579	10.72127	35.89596

*Table 1: Variables' descriptive statistics*

### 4.3. Methodology

In this section we estimate<sup>2</sup> the impact of public investment on private investment using a panel data of 21 OECD countries and discuss the obtained results with previous studies done.

Starting with the complete set of independent variables, we estimate the regressions using fixed effects (FE) and random effects (RE), and in order to choose the most adequate panel data estimation method we apply the Hausman test and then, estimate several regressions to test robustness.

Since our sample incorporates different countries that are inserted in distinct economic environments, we will divide the full sample into smaller subsamples with more homogeneous economic features in order to obtain a deeper analysis of the results.

#### 4.3.1. Fixed effects vs Random effects

The first step in this estimation is to assess if the regression should be estimated under fixed effects or random effects specification.

To decide between random effects and a simple OLS regression, we used the Breusch-Pagan Lagrange multiplier (B-P LM) test, under the null to run OLS estimation, whose result suggests that the null hypothesis is rejected, and thus random effects regression is the most appropriate. Fixed effects are tested through F test and the null hypothesis ( $H_0$ : *Pooled OLS*) is rejected, concluding that fixed effects are preferred over OLS regression.

After the conclusions of the referred tests we were confronted with fixed effects and random effects, and to assess which we should use in the development of our model we performed the Hausman test whose null hypothesis is random effects. The results shown in Table 2 suggest that we should apply the fixed effects model.

	FE	RE
VARIABLES	LOGPRIVINV	LOGPRIVINV
LOGGOVINV	0.178*** (0.0404)	0.688*** (0.0361)
GDPg	0.00380***	0.00410**

<sup>2</sup> The analysis was performed using Stata 14.

	(0.00139)	(0.00187)
<b>INTRATE</b>	-0.0124***	-0.00270
	(0.00219)	(0.00285)
<b>DEBT</b>	-0.00280***	-0.000351
	(0.000264)	(0.000293)
<b>CPI</b>	0.00625***	0.000752
	(0.000630)	(0.000729)
<b>FDI</b>	0.000523**	0.000618**
	(0.000207)	(0.000279)
<b>SAVINGS</b>	0.00318**	0.00486***
	(0.00124)	(0.00159)
<b>Constant</b>	3.636***	1.809***
	(0.159)	(0.156)
<b>Observations</b>	355	355
<b>Number of id</b>	21	21
<b>R-squared</b>	0.683	0.560
<b>Standard errors in parentheses</b>		
<b>Diagnostics</b>		
<i>Hausman test</i>	0.0000***	
<i>Modified Wald test</i>	0.0000***	-
<i>Wooldridge test</i>	0.0000***	-
*** p<0.01, ** p<0.05, * p<0.1		

Table 2: Fixed effects vs Random effects regressions

#### 4.3.2. Residuals tests

After realizing that we should follow a model with fixed effects condition we applied some tests to this regression to ensure that the estimation is as efficient as possible. The fixed effects regression model invokes the OLS estimator under the classical assumptions, thus this regression admits that the error process is independently and identically distributed and estimates the model assuming homoscedasticity. Although the error process may be homoscedastic within cross-sectional units, its variance might differ across units, which is known as groupwise heteroscedasticity. Therefore, we performed a modified Wald test for groupwise heteroscedasticity in the residuals of the fixed effect regression model under the null hypothesis of homoscedasticity (Baum, 2001). Table 2 shows the result of the modified Wald test. Its interpretation suggests that we should reject the null concluding that the errors reveal groupwise heteroscedasticity.

The serial correlation test should be done on panel data models since autocorrelation changes the standard errors and consequently makes the results less efficient. Thus, to

test the serial correlation in the idiosyncratic errors we performed the Wooldridge test (Drukker, 2003). The null of no serial correlation is rejected at 1% significance level, as we can observe in Table 2, indicating the presence of autocorrelation.

Considering the above results, the residuals of the estimated regression under fixed effects specification present issues of heteroscedasticity and autocorrelation. Thus, we used the cluster option where the standard errors estimated are robust to disturbances that are heteroscedastic and autocorrelated (Hoechle, 2007). Table B2 in Appendix B provides the results under the fixed effects regression with cluster standard errors.

To ensure the validity of statistical results it is important to test if the residuals from the FE estimation of regression model are independent across cross-sections, and for this purpose we computed the CD (Cross-sectional Dependence) test proposed by Pesaran (2004). According to the results of Pesaran's CD test presented in Table 3, the null hypothesis is strongly rejected which indicates that there is cross-sectional dependence. The correlation value indicates the average absolute value (abs) of the off-diagonal elements of the cross-sectional correlation matrix of residuals. This high value (0.363) suggests evidence that there is a presence of cross-sectional dependence in the model under fixed effects specification (Hoyos & Sarafidis, 2006).

<b>Value</b>	<b>p-value</b>	<b>Correlation (abs)</b>
6.944	0.0000***	0.363

**Table 3:** *Cross-sectional dependence test*

*Notes: CD test follows a standard normal distribution assuming the null of cross-sectional independence. \*\*\* Rejects the null at 1% significance level.*

### **4.3.3. Estimator**

Given the previous test results and considering that the cluster option does not contemplate cross sectional dependence, to study the relationship between private investment and the independent variables: government investment; GDP growth; interest rates; general government debt; CPI; FDI and savings, we used a covariance matrix estimator proposed by Driscoll and Kraay (1998) since the residuals of the panel regression are cross-sectionally dependent. The estimator to be used is a fixed effects model with Driscoll and Kraay standard errors, this estimator produces heteroscedastic

and autocorrelated standard errors that are robust to cross-sectional dependence (Hoechle, 2007). A lag length of 2 was used by default.



## 5. Results and Discussion

### 5.1. Entire sample: 21 OECD

Our empirical analysis starts by estimating a panel regression model with all variables that are expected to affect private investment and then we eliminated the least significant variables to test the robustness of the results.

Table 4 shows these regressions and suggest that most of the variables have significant influence on the dependent variable in study and present several levels of significance. In all regressions, the logarithm of private investment is the dependent variable and a positive/negative coefficient means that the independent variable induces an increase/decrease in private investment. In fact, savings is the only variable that does not appear to be relevant to explain private investment (Reg 1), consequently, it was removed, and we obtained regression 2. Given that FDI also contains a private component, this variable was removed to test if without this variable the model would perform better.

In the three regressions the results are consistent and robust, thus our analysis will be based on regression 1 because 68% of the variation of private investment can be predicted from the explanatory variables, as can be seen by the analysis of within R-squared.

	Reg 1	Reg 2	Reg 3
VARIABLES	LOGPRIVINV	LOGPRIVINV	LOGPRIVINV
LOGGOVINV	0.178*** <sup>3</sup> (0.0582)	0.168** (0.0621)	0.165** (0.0616)
GDPg	0.00380** <sup>4</sup> (0.00166)	0.00509*** (0.00124)	0.00539*** (0.00139)
INTRATE	-0.0124*** <sup>4</sup> (0.00400)	-0.0130*** (0.00428)	-0.0128*** (0.00412)
DEBT	-0.00280*** <sup>4</sup> (0.000258)	-0.00273*** (0.000293)	-0.00274*** (0.000299)
CPI	0.00625*** <sup>4</sup> (0.000633)	0.00638*** (0.000567)	0.00645*** (0.000559)
FDI	0.000523** <sup>4</sup> (0.000191)	0.000512** (0.000186)	-
SAVINGS	0.00318 (0.00237)	-	-
Constant	3.636***	3.730***	3.735***

<sup>3</sup> Elastic relationship, both dependent and independent variables are log-transformed.

<sup>4</sup> Dependent variable is in its log-transformed form and the independent variable is in its original metric.

	(0.246)	(0.260)	(0.259)
<b>Observations</b>	355	365	369
<b>Number of groups</b>	21	21	21
<b>Within R-squared</b>	0.6828	0.6546	0.6566
<b>Standard errors in parentheses</b>			
<b>*** p&lt;0.01, ** p&lt;0.05, * p&lt;0.1</b>			

Table 4: Fixed effects regression with Driscoll-Kraay standard errors

Government investment has a positive influence on private investment suggesting that government investment complements private investment, a result that is robust to the three estimations. One percent increase in government investment would yield a 0.18% increase in private investment. This evidence supports the theory that states that public investment crowds in private investment, possibly due to the high complementarity between public infrastructures and private investment. Thus, public sector through the provision of infrastructures can create business opportunities for the grow of private investment as supported by Argimón et al., (1997) and Abiad et al., (2016) that also studied OECD countries.

GDP growth is shown to a positive impact on private investment, a one percentage point increase in its growth rate increasing private investment by 0.38%. This find demonstrates that the improvement of the macroeconomic conditions allows the increase of the private investment. Voss (2002), in his study focused in US and Canada, also found evidences of a positive effect in private investment as a response to innovations to economic growth, pointing out the importance of the accelerator mechanism for investment, however, this effect seems to be slightly higher in US than Canada. Suhendra and Anwar (2014) used this variable and found evidence that private investment is related with the evolution of economic growth and a positive economic growth leads to an increase in private investment. According to them, the positive impact shows that the evolution of economic growth is a factor to be considered when it comes to private investment.

As expected, interest rates affect private investment negatively, an increase of one percentage point in interest rates, contributing to decrease private investment by 1.24%. By conditioning the decision to obtain or not financing for a particular investment operation, the interest rate is a determinant factor of private investment, its increase tending to decrease private investment. Our conclusion is in accordance with the results obtained by Dreger and Reimers (2016) for the euro area, which evidence that interest rates negatively affect private investment causing a decline.

General government debt is found to have a negative relation with private investment, in the sense that when general government debt as percentage of GDP increases by one unit, private investment would decrease in 0.28%. This finding is in line with the thesis that poor financial conditions derived mainly from the increase of the interest rates restrict investment since it is discouraged by the fiscal efforts that firms fear to face (Dreger & Brautzsch, 1999). Our finding is consistent with Huang, Panizza and Varghese (2018), that higher levels of government debt decrease private investment, especially among those firms that need to rely more on external financial resources.

Inflation measured by consumer price index appears to have a positive influence on private investment, which implies that when inflation rises this induces an increase in private investment. For a one unit increase in inflation, private investment increases by 0.63%. Both inflation and investment are pro-cyclical, increasing in the expansionary stages of the economy. Private investment is a nominal variable, meaning that it is not adjusted for inflation; therefore, private investment increases when inflation increases as it is part of investment. In addition, when inflation rises, firms have the possibility of adjusting prices and then they tend to not be afraid of increasing production and thus nominal profits increase, higher profits reflect increased investment as companies have more liquidity/cash to invest. As inflation increases, nominal private investment will also increase because firms increase the availability of funds, as a result of higher prices, and increase their investments.

Lastly, foreign direct investment results also indicate a significant and positive impact on private investment. However, given that FDI is part of private investment, the interpretation of its effects on private investment is not straightforward. Beyond to FDI raising the value of private investment in levels, in this case, we analyse whether FDI promotes conditions to the development of private investment or not through its effects on GDP. FDI can positively affect a country's private investment since it injects money in the country's economy, and this gives the country greater financial slack, by providing economic growth and private companies benefit from these as better economic conditions allows firms to increase their investment. Therefore, the positive impact is interpreted as a result of the positive effect generated by the net inflows of FDI on GDP, so, when FDI contributes to the positive development of GDP, this allows private investment to grow. Our results indicate that when the percentage of FDI on GDP increases by one percentage point, private investment increases 0.05%.

## **5.2. Sub-samples: Lower GDPg and Higher GDPg**

After estimating the model for the entire sample, we want to test the robustness of our results, and therefore divided the 21 countries into smaller subgroups. Tables B3 and B4, in Appendix B, summarizes a descriptive statistic of each subgroup. We already realized how economic growth is an important factor for private investment. In this section, we want to test if the effect that public investment has on private investment is somehow related to their average economic growth performance and to do that we separate our whole sample into two groups of countries, distinguished by their average growth rate during the entire period, splitting them between those that grew above and below the sample economic growth average. From now on, the 2 subgroups are denominated as Lower GDPg and Higher GDPg. The first group comprises the countries whose average of the 18 years of economic growth is lower than the average of the economic growth of the total sample abridging: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Portugal, Spain and United Kingdom. Higher GDPg group includes countries such as: Czech Republic, Hungary, Ireland, Luxembourg, Poland, Slovakia, Slovenia and Sweden, whose economic growth's average is higher than the average of the 21 countries.

For each subgroup we performed the Hausman test to ensure that we can run the regression under fixed effects specification. To test the robustness of the results for the two groups of countries we chose to estimate the previous regression 1 using the same estimator as before and apply it to each subsample, verifying whether the results obtained for Lower GDPg and Higher GDPg groups coincide with the entire model results or not. Table 5 provides the results of fixed effects model with Driscoll and Kraay standard errors for Lower GDPg and Higher GDPg subsamples.

	<b>Lower GDPg</b>	<b>Higher GDPg</b>
<b>VARIABLES</b>	<b>LOGPRIVINV</b>	<b>LOGPRIVINV</b>
<b>LOGGOVINV</b>	0.186** (0.0751)	0.168** (0.0783)
<b>GDPg</b>	0.00246* (0.00122)	0.00437* (0.00230)
<b>INTRATE</b>	-0.0115** (0.00413)	-0.0160** (0.00747)
<b>DEBT</b>	-0.00297*** (0.000369)	-0.00245*** (0.000475)

<b>CPI</b>	0.00660***	0.00569***
	(0.000998)	(0.000911)
<b>FDI</b>	0.000375	0.000489*
	(0.000246)	(0.000241)
<b>SAVINGS</b>	0.00473***	0.00209
	(0.00133)	(0.00422)
<b>Constant</b>	3.781***	3.333***
	(0.304)	(0.378)
<b>Observations</b>	227	128
<b>Number of groups</b>	13	8
<b>Within R-squared</b>	0.6783	0.6955
<b>Standard errors in parentheses</b>		
<b>*** p&lt;0.01, ** p&lt;0.05, * p&lt;0.1</b>		

Table 5: Subgroups estimated under fixed effects regression with Driscoll-Kraay standard errors

Results in Table 5 are in line with the conclusions obtained from the complete group on the relationship between public investment and private investment. Indeed, in both subsamples, government investment has a significant and positive impact on private investment confirming the existing of a crowding in effect of private investment promoted by public investment. Regarding the remaining variables, the magnitude of the effects did not change, at least for the Higher GDPg subgroup.

The Lower GDPg subgroup presents different conclusions regarding FDI and savings. In this group, the FDI is not relevant in private investment, which may indicate that foreign investment is low. Statistical data of this variable confirm its low value in this group. If we compare the average FDI of this group (cf. Table B3 in Appendix B) with that of the total sample (cf. Table 1), we realize that the Lower group FDI value is significantly lower than that of the full sample. The better the economic conditions of the country the more attractive the economy is to foreign investors. The fact that this group represents countries with below average growth may be grounds for low FDI since low economic growth conveys a low return /security image and it is not attractive for investors. On the other hand, the FDI is one of the factors that contributes to the economic development as it generates growth providing better economic environment. Thus, the low FDI can be identified to explain the weak economic growth, which in turn, justifies the unattraction to the FDI, and thus the reduced effect on private investment.

Concerning the savings variable, in this subsample, its effects is relevant and positive for private investment, confirming that the amount of funds available to invest, mostly held

by the private sector, contributes to the increase in private investment. This suggests that companies have the ability to self-finance their investments using savings.

Regarding Higher GDPg group, the results, comparing with the entire model, show more similarities being robust at the level of all variables, thus, we identify that countries from Higher GDPg group are driving our general model.

## **6. Conclusion**

Over the last few years the economies have undergone a severe financial crisis that resulted in an uncontrollable increase in public debt of the countries. Investment is a varying component of GDP and oscillates according to the conditions that financial markets provide. However, it is an important factor for economies to grow and create stability in markets. As investment is very dependent on the surrounding economic conditions it was inevitably affected and suffered a downturn, and this was reflected in both private and public investment.

Private investment, which is promoted by companies and aimed at profit, and public investment, promoted by governments to ensure public needs, were also influenced by the economic environment in which they were inserted, although in different timings. Since private investment and public investment act differently in the economy, they can be complementary or substitutes. Thus, we analysed the impact of public investment on private investment whose opinions in the economic literature are divided into crowding-in and crowding-out effects.

In this thesis, we explored the relationship between private investment and public investment for a sample of 21 OECD countries over the period 2000-2017. For this purpose, we used panel data methodologies, more specifically we applied the estimator proposed by Driscoll and Kraay (1998) that corrects for heteroscedastic, autocorrelation and cross-sectional dependence issues. From the empirical analysis, we observed that public investment induces private investment for the 21 OECD countries. Our finding supports the theory of crowding in effects found in literature, which suggests that public investment promotes private investment mainly due to the provision of infrastructures which create business opportunities for private sector to invest in. Overall, our results imply that a 1% increase in public investment leads to 0.18% increase in private investment.

In order to obtain a deeper analysis of the results and to test the robustness, after estimating the model for the entire sample, we divided the 21 countries into smaller subgroups, namely: Lower GDPg (comprises the countries whose economic growth is lower than the average of the total sample) and Higher GDPg (groups those countries that grow economically at a higher average). The criterion used for the division was based on the average of the economic growth of the whole sample. A positive effect promoted

by public investment on private investment is also verified in both subgroups. However, the results of the independent variables used for model estimation, in the Lower GDPg group are slightly different, specifically for two variables, FDI and savings.

This study confirms that public investment complements private investment and thus contributes to its growth and development. This has been seen in the different groups of countries tested, which further strengthens the theory of crowding-in effects in OECD countries.

With this analysis we realize that public investment, even if not directed at promoting private investment, contributes to its growth. In Europe, monetary policy has been used to stimulate the economy as well as private investment. However, we believe that if governments also focused on encouraging private investment by creating the necessary conditions for private sector act instead just creating opportunities as a consequence of their activity, private investment would benefit as the necessary conditions would be in place for them and companies could invest and start their activity immediately without having to spend resources beforehand to create such conditions, which may be a factor that hinders private investment. As a result, private investment develops and grows faster, contributing towards a better economic environment and is also beneficial to the public sector and its investments.

The major limitation of this study was in gathering data for the model. Initially the sample covered a larger number of countries, and due to the gap in the data of essential variables to the model such as private investment and public investment, the sample was reduced.

For future research, it would be interesting to apply the same methodology used in this work to a similar sample that only includes developing countries to compare the results obtained, thus the results would be unbiased to different methodologies and allowed to understand the difference between developed and developing economies and by subdividing the sample trying to assess the influence of economic growth on private investment in emerging economies. Also, since one of our subgroups has different results regarding to the control variables, it would be interesting to choose a different criterion, for the division the sample, for instances geographical or average unemployment criteria to assess how the variables behave/are influenced depending on the circumstances.

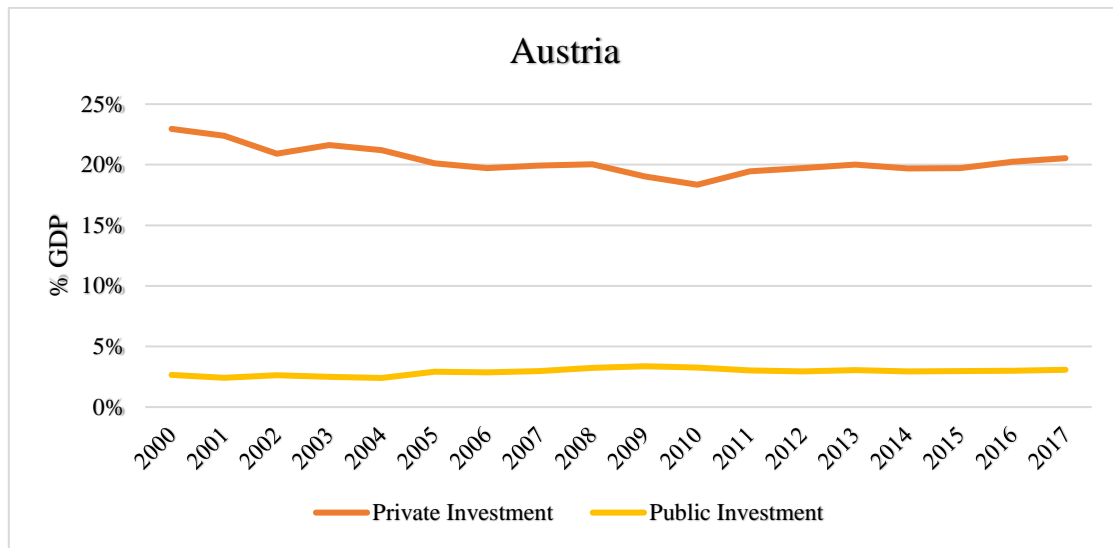


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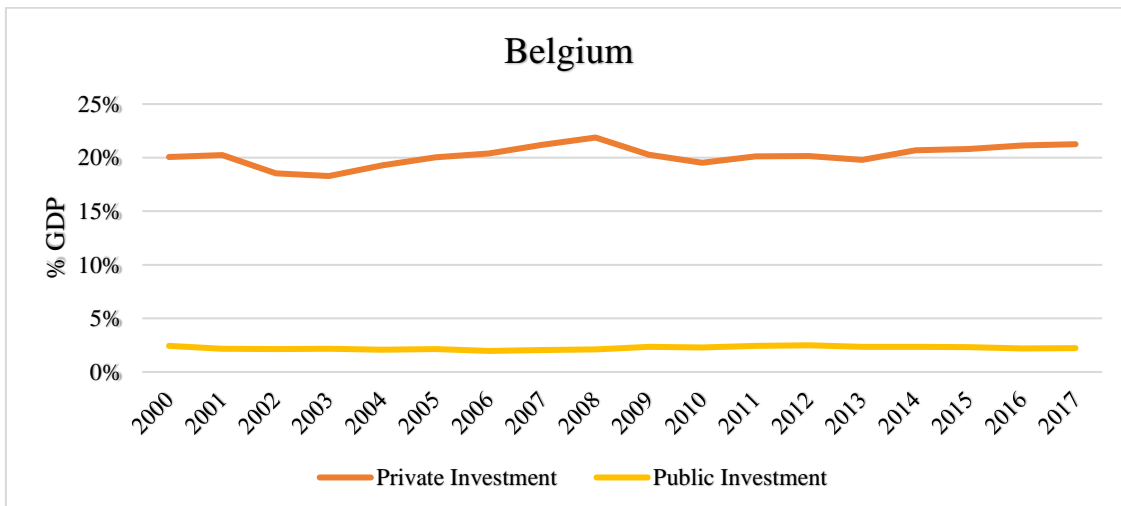
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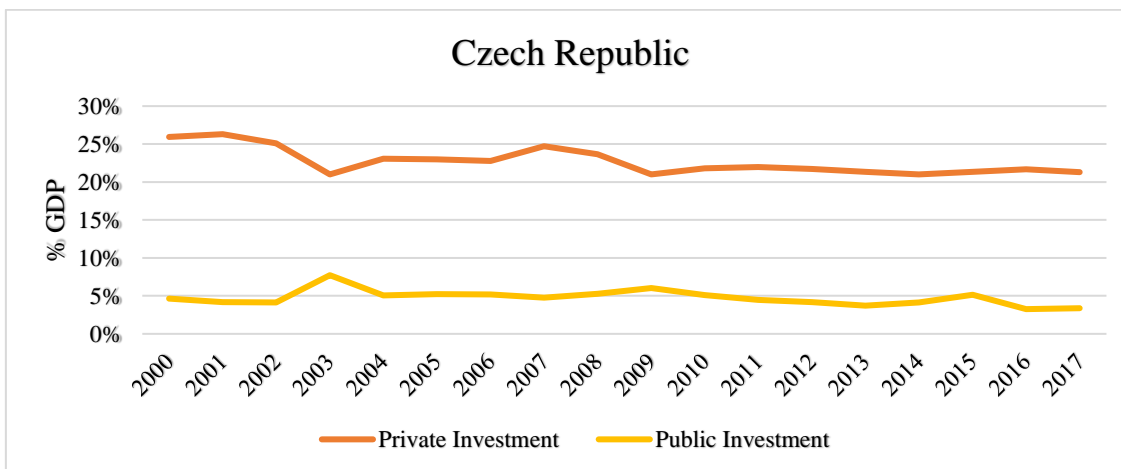
Appendix A: Figures



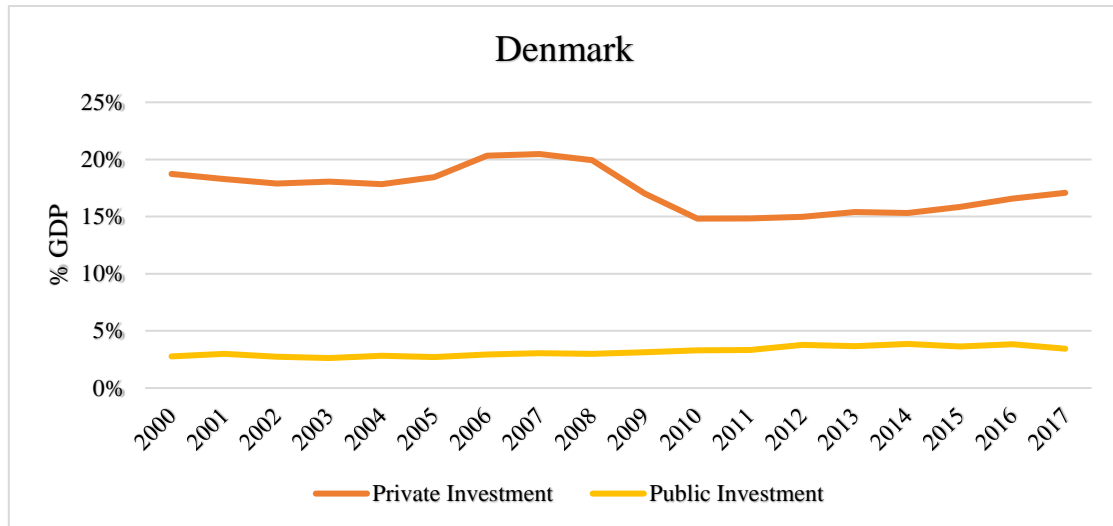
**Figure A1:** Austria - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



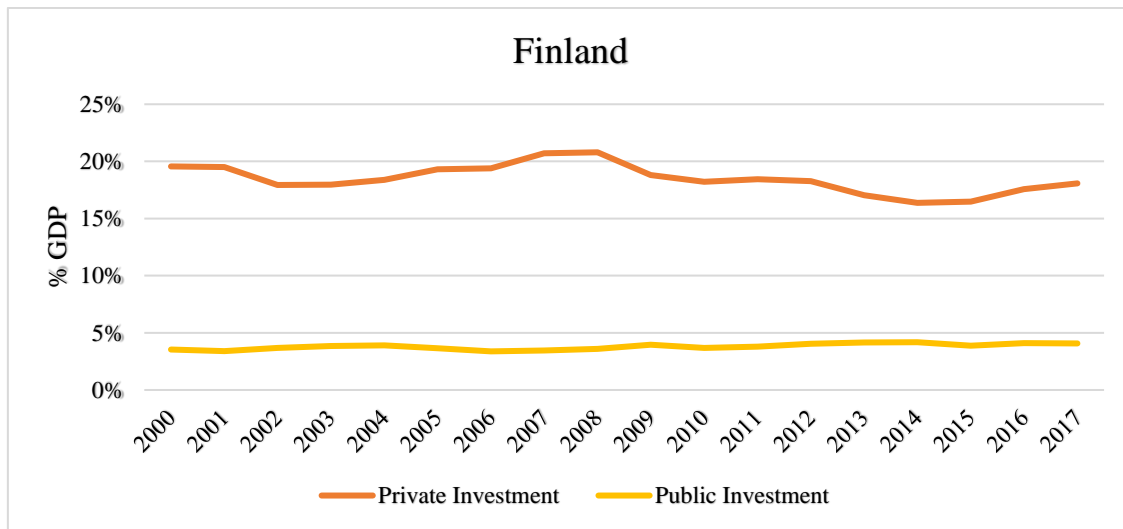
**Figure A2:** Belgium - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



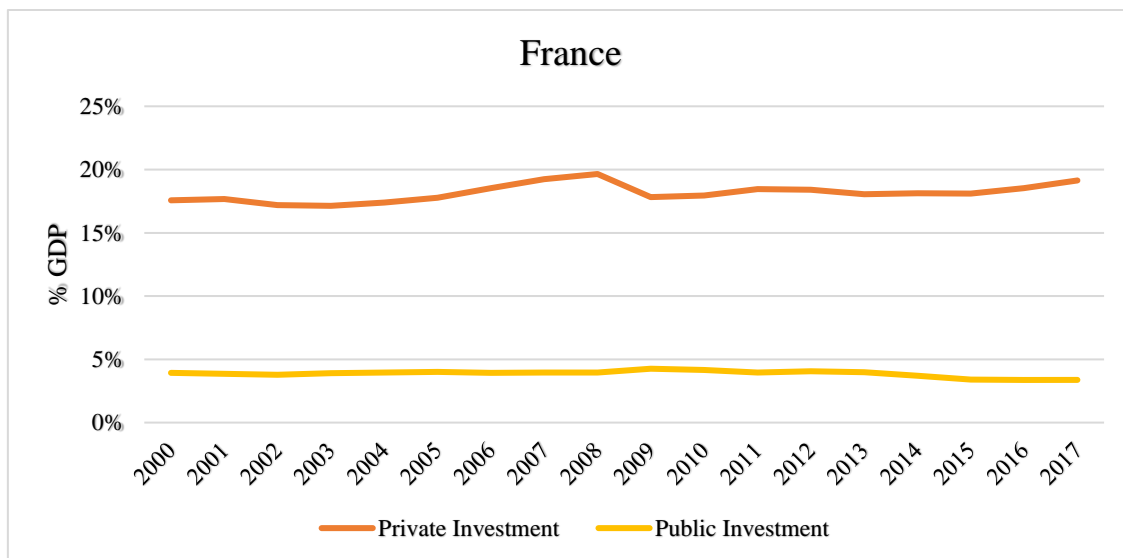
**Figure A3:** Czech Republic - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



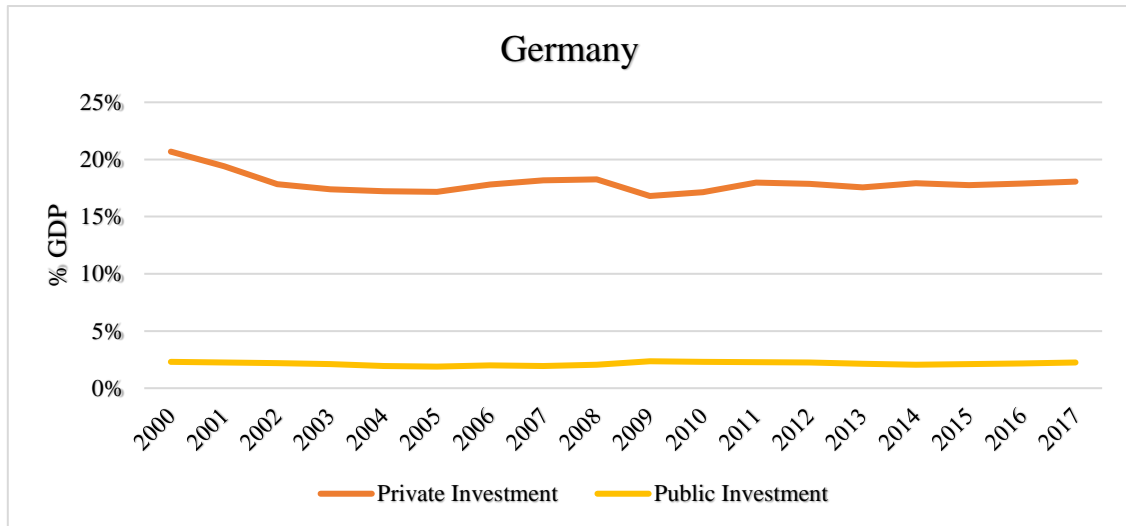
**Figure A4:** Denmark - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



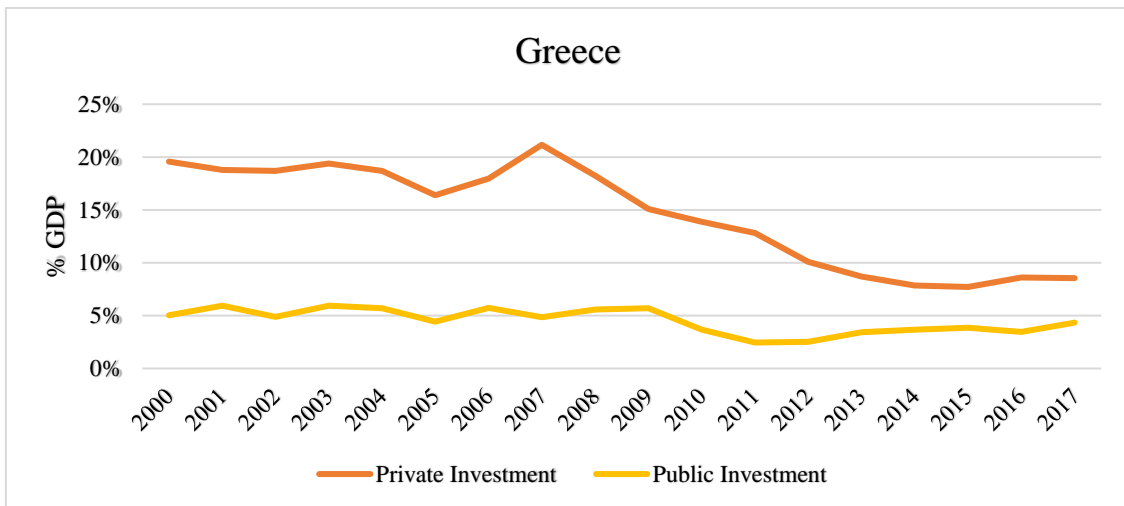
**Figure A5:** Finland - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



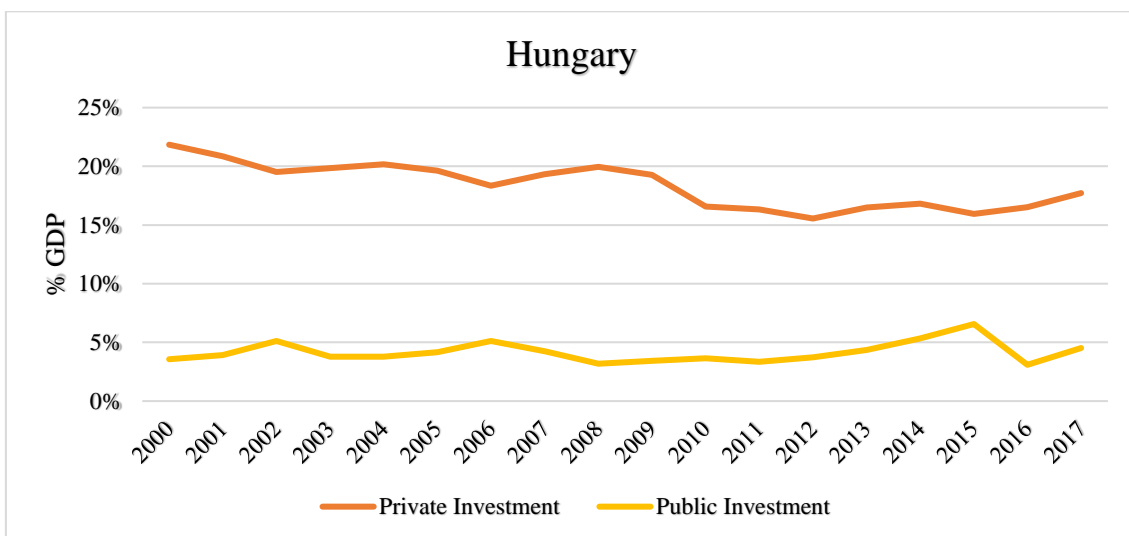
**Figure A6:** France - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



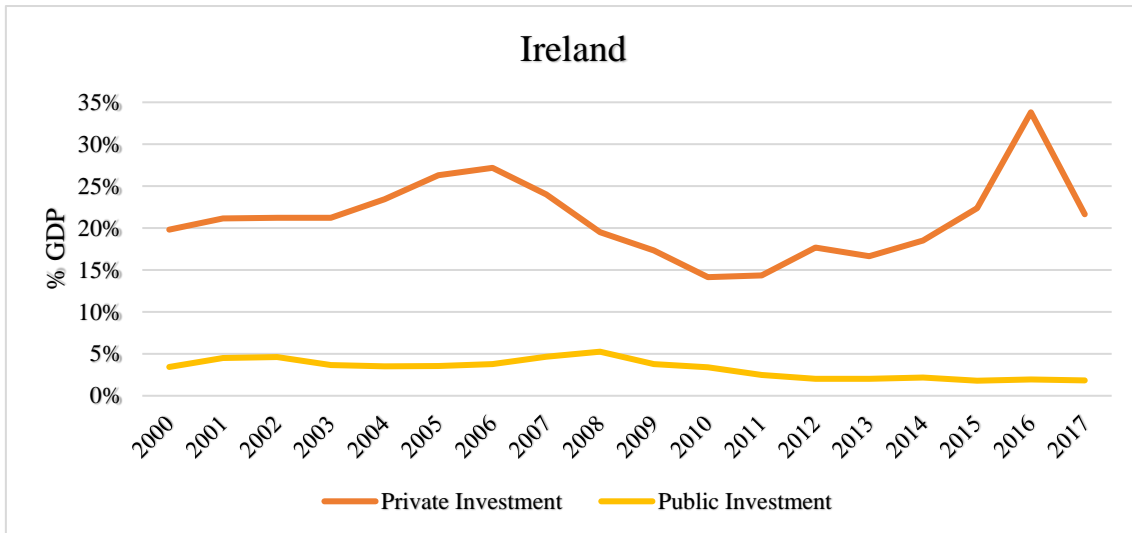
**Figure A7:** Germany - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



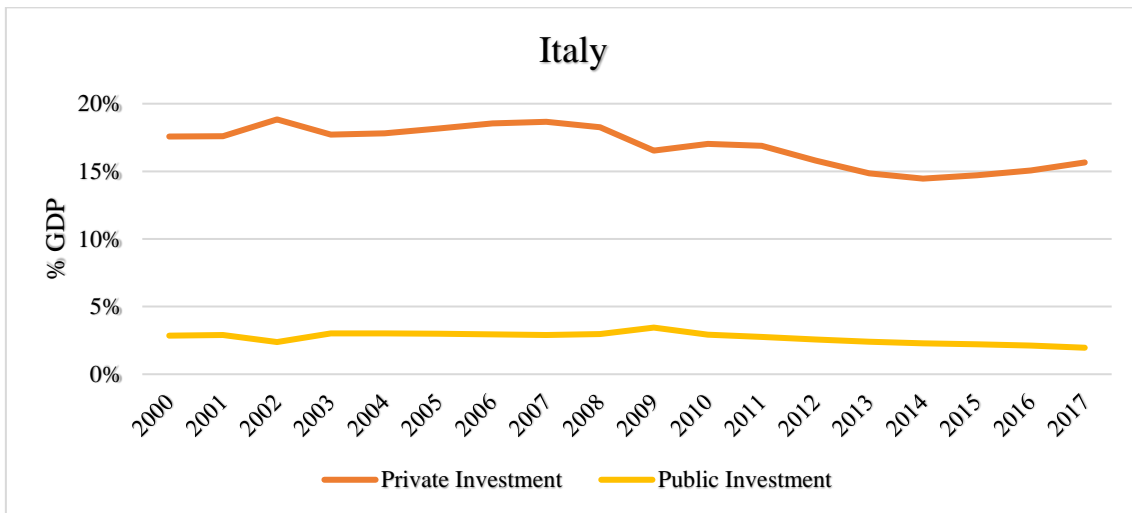
**Figure A8:** Greece - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



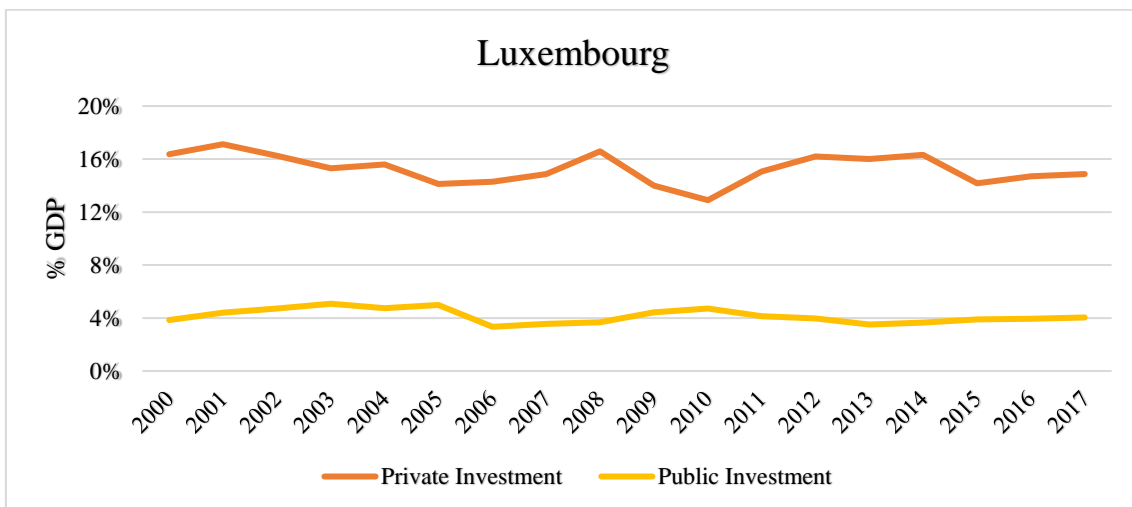
**Figure A9:** Hungary - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



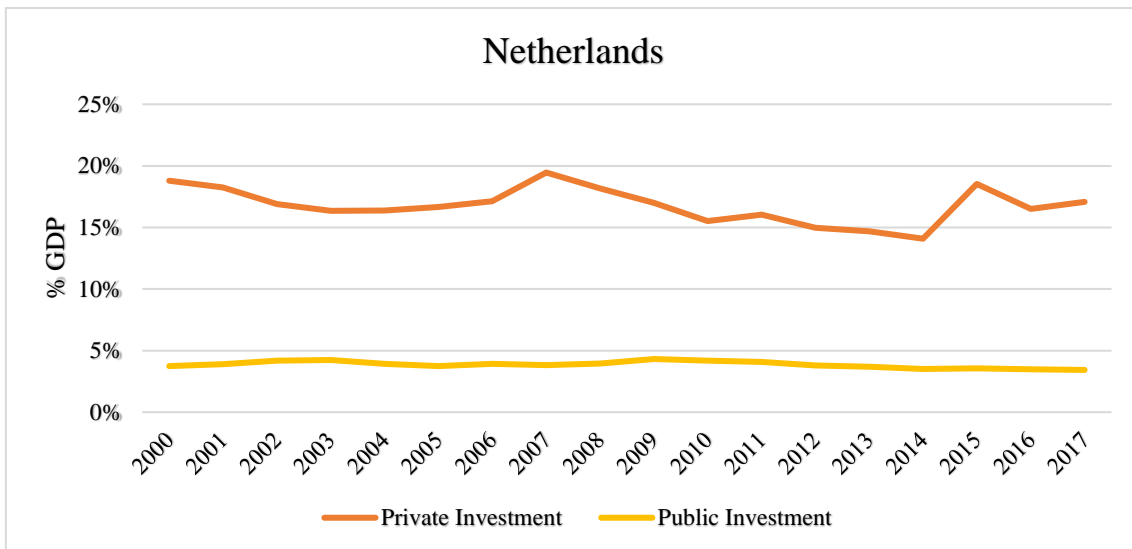
**Figure A10:** Ireland - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



**Figure A11:** Italy - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)

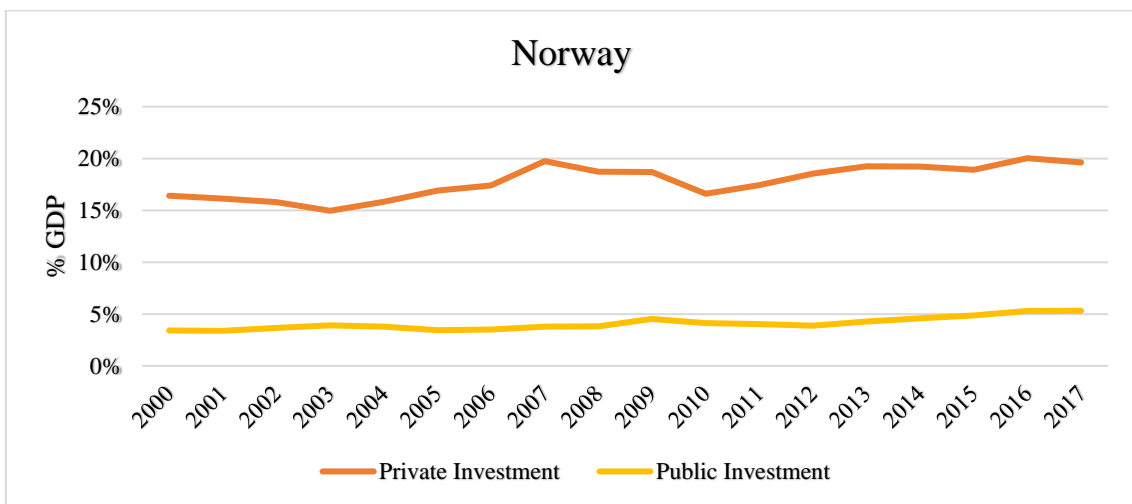


**Figure A12:** Luxembourg - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



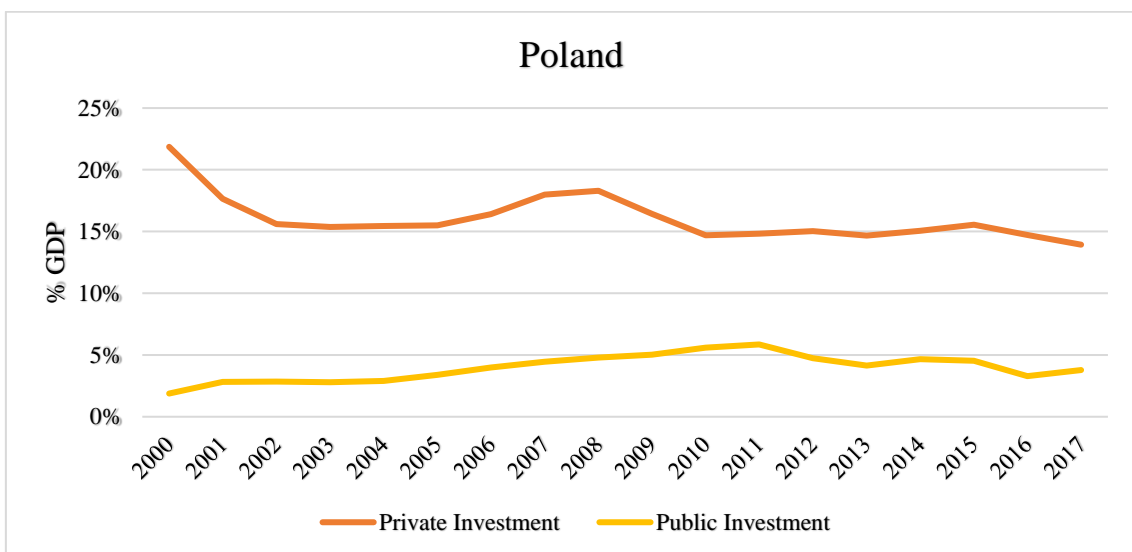
**Figure A13:** Netherlands - Private and public investments as a share of GDP.

Source: Ameco database (Last update Autumn 2018)



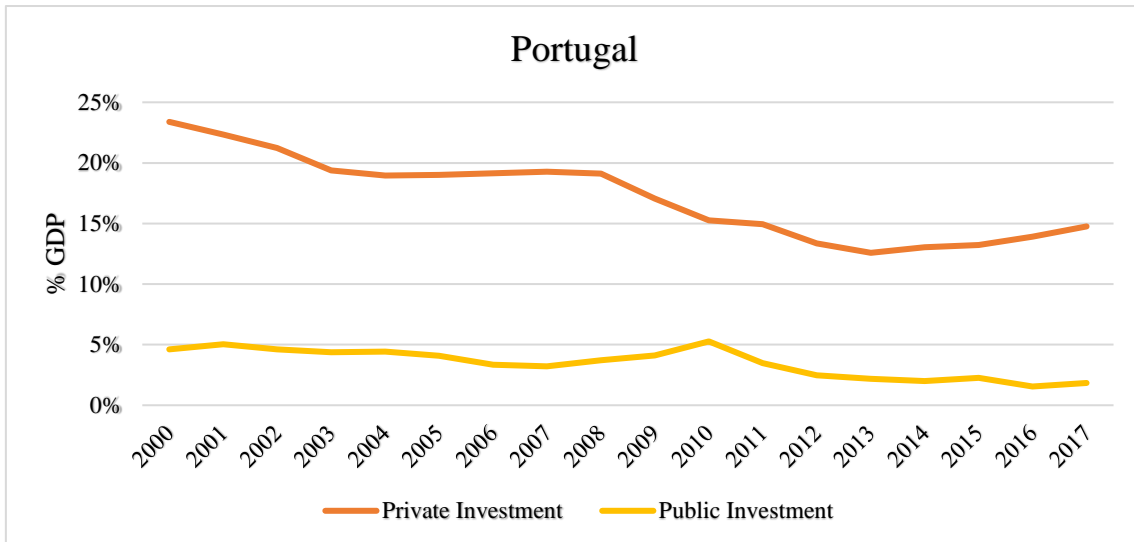
**Figure A14:** Norway - Private and public investments as a share of GDP.

Source: Ameco database (Last update Autumn 2018)

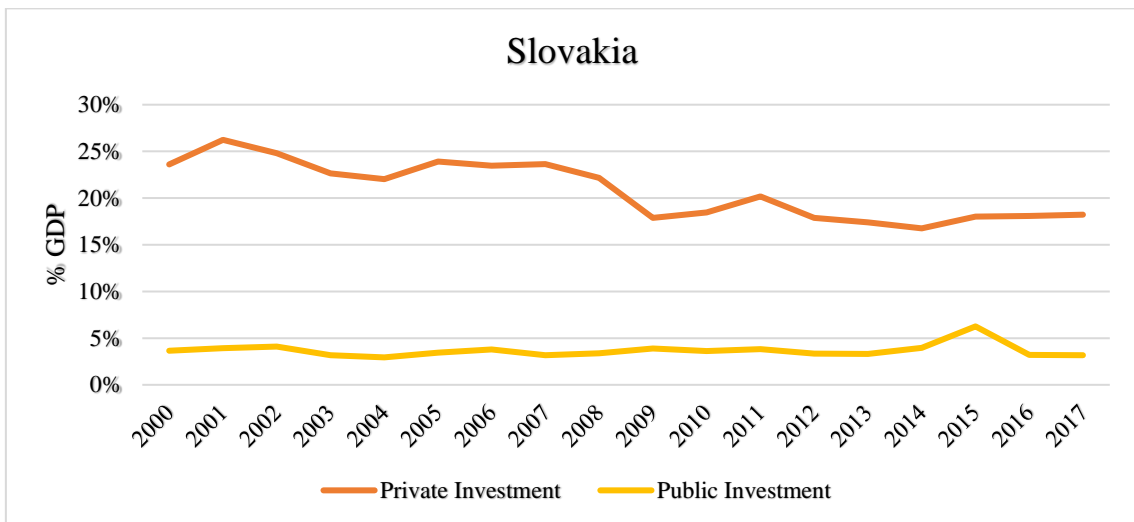


**Figure A15:** Poland - Private and public investments as a share of GDP.

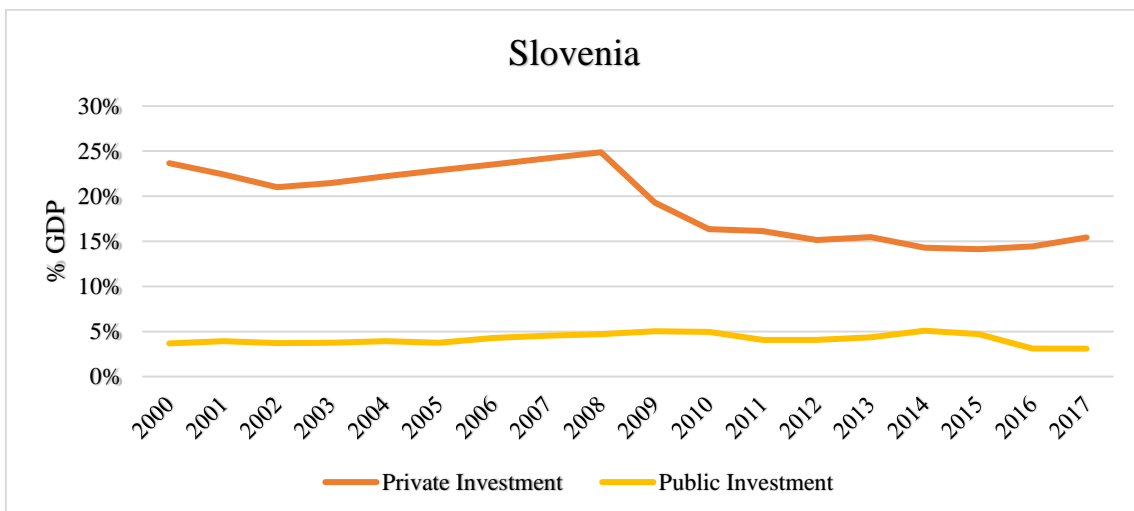
Source: Ameco database (Last update Autumn 2018)



**Figure A16:** Portugal - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)

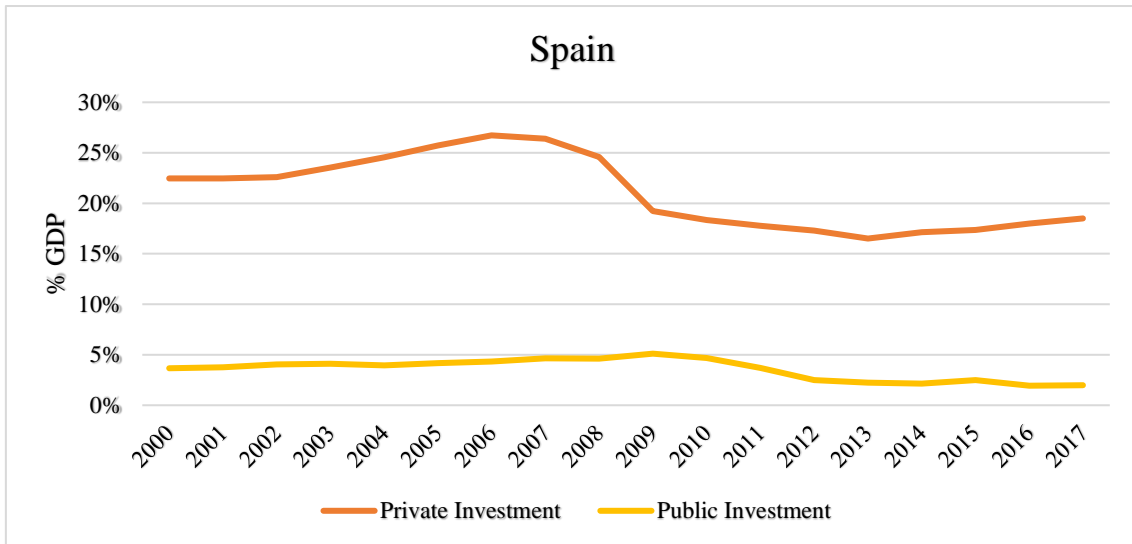


**Figure A17:** Slovakia - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)

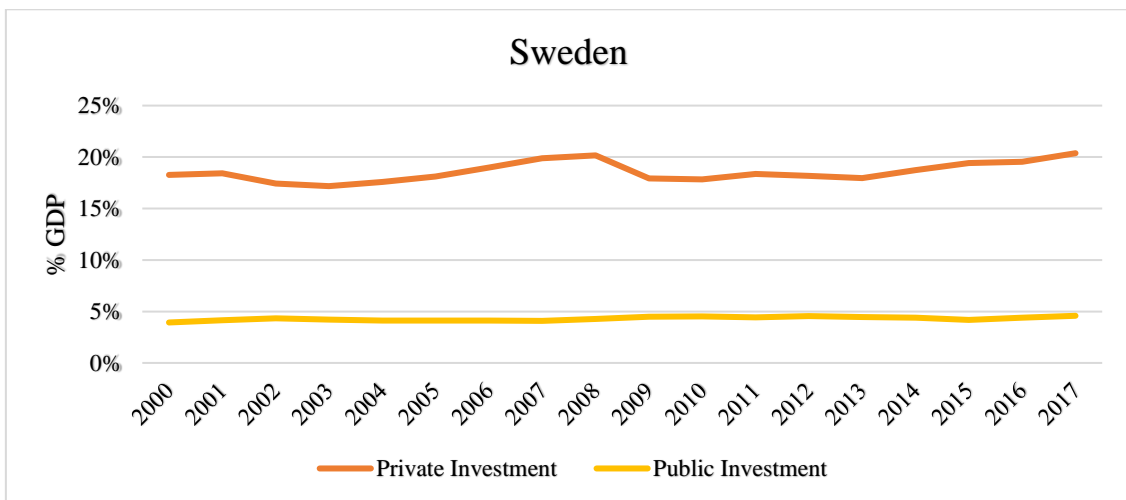


**Figure A18:** Slovenia - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)

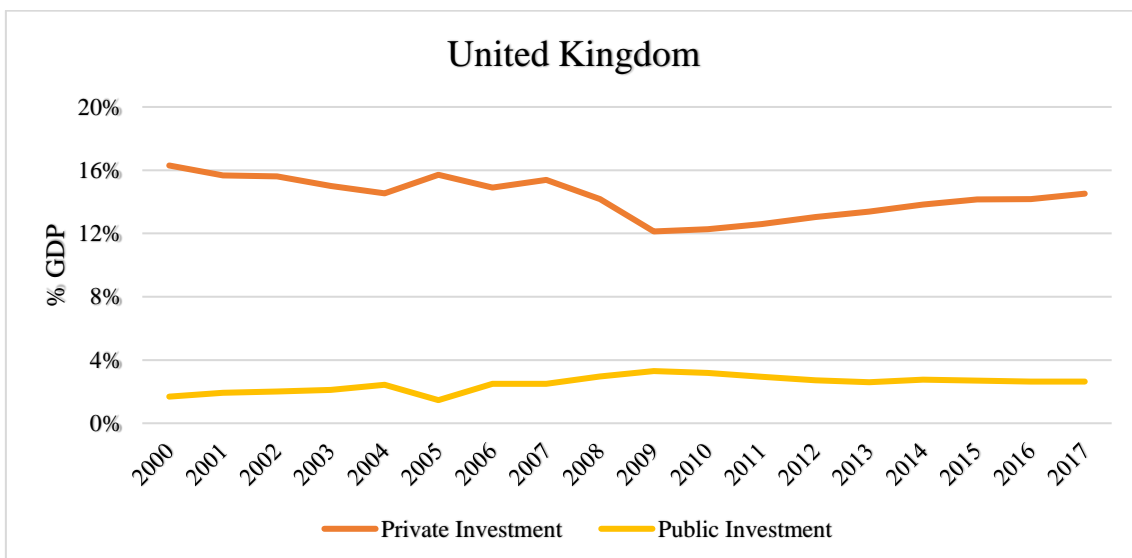




**Figure A19:** Spain - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



**Figure A20:** Sweden - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)



**Figure A21:** United Kingdom - Private and public investments as a share of GDP.  
Source: Ameco database (Last update Autumn 2018)

Appendix B: Tables

Variables	Definitions	Sources
<b>LOGPRIVINV:</b>	The logarithm of gross fixed capital formation (private sector)	AMECO
<b>LOGGOVINV:</b>	The logarithm of gross fixed capital formation (government sector)	AMECO
<b>GDPg:</b>	GDP growth in annual percentage	The World Bank
<b>INTRATE:</b>	Annual nominal long-term interest rates in percentage	OECD
<b>DEBT:</b>	Gross general government debt in percentage of GDP	OECD
<b>CPI:</b>	Consumer price index (2015=100)	OECD
<b>SAVINGS:</b>	Gross savings in percentage of GDP	The World Bank
<b>FDI:</b>	Foreign direct investment, net inflows in percentage of GDP	The World Bank

Table B1: Definition and source variables

<b>Reg 1</b>	
<b>VARIABLES</b>	<b>LOGPRIVINV</b>
<b>LOGGOVINV</b>	0.178** (0.0629)
<b>GDPGROWTH</b>	0.00380* (0.00195)
<b>INTRATE</b>	-0.0124*** (0.00230)
<b>DEBT</b>	-0.00280*** (0.000691)
<b>CPI</b>	0.00625*** (0.00125)
<b>FDI</b>	0.000523** (0.000206)
<b>SAVINGS</b>	0.00318 (0.00439)
<b>Constant</b>	3.636*** (0.286)
<b>Observations</b>	355
<b>Number of Countries</b>	21
<b>R-squared</b>	0.683
<b>Robust standard errors in parentheses</b>	
*** p<0.01, ** p<0.05, * p<0.1	

Table B2: Fixed effects regression and cluster the standard errors at country level

Variable		Mean	Std. Dev.	Min	Max
<b>LOGPRIVINV</b>	overall	4.974716	0.4388624	4.136033	5.772664
	between		0.4470577	4.418971	5.662092
	within		0.0855674	4.691779	5.248083
<b>LOGGOVINV</b>	overall	4.23132	0.4078355	3.460514	4.927047
	between		0.4091724	3.730994	4.865571
	within		0.1054659	3.96084	4.477076
<b>GDPg</b>	overall	1.289551	2.314413	-9.132494	5.794531
	between		0.5427694	0.2289796	1.856057
	within		2.25464	-8.53168	6.855103
<b>INTRATE</b>	overall	3.833254	2.314422	0.09	22.4975
	between		1.244532	2.887407	7.528687
	within		1.980075	-0.1104334	18.80207
<b>DEBT</b>	overall	84.74608	34.39509	31.30664	188.7342
	between		29.44376	42.85468	138.1172
	within		19.47666	44.67379	135.3631
<b>CPI</b>	overall	90.16902	8.840256	71.28364	105.4917
	between		1.213793	87.69444	92.22357
	within		8.762667	70.47086	106.4991
<b>FDI</b>	overall	5.093508	9.679414	-8.013757	87.44259
	between		6.813443	0.7981337	26.34468
	within		7.108892	-17.67676	66.19142
<b>SAVINGS</b>	overall	22.73527	7.04477	4.870592	41.69065
	between		6.798132	12.10744	36.66564
	within		2.409671	15.49842	29.1723

Table B3: Descriptive statistic of each variable (Lower GDPg group)

Variable		Mean	Std. Dev.	Min	Max
<b>LOGPRIVINV</b>	overall	4.29099	0.4005611	3.577352	4.985968
	between		0.4081625	3.74681	4.822324
	within		0.1168663	3.986205	4.696071
<b>LOGGOVINV</b>	overall	3.614626	0.4058854	2.908519	4.347644
	between		0.4001314	3.128698	4.186362
	within		0.153855	3.089027	4.038107
<b>GDPg</b>	overall	3.214303	3.550811	-7.797277	25.55727
	between		1.005014	2.275257	5.163316
	within		3.423198	-6.900265	23.60826
<b>INTRATE</b>	overall	4.194336	2.172077	0.177239	10.68167
	between		1.310145	2.591512	6.641365
	within		1.782648	0.5154703	9.597391
<b>DEBT</b>	overall	54.00968	23.80466	16.54233	131.7296
	between		16.75488	23.60402	79.14927
	within		17.86922	14.72961	119.0036
<b>CPI</b>	overall	88.7611	11.81698	51.96151	103.125
	between		3.906407	81.59669	94.32561
	within		11.23366	59.12591	109.9167
<b>FDI</b>	overall	10.93896	26.30034	-58.32288	252.3081
	between		13.31839	2.14986	41.06904
	within		23.36443	-88.45296	222.178
<b>SAVINGS</b>	overall	23.87148	5.328796	14.66614	39.84083
	between		3.743053	17.72369	29.14967
	within		3.950614	11.42596	36.60066

Table B4: Descriptive statistic of each variable (Higher GDPg group)