

The Effect of Negative Interest Rate Policy on Investment in the Euro Area (2014-2019)

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Abstract. *This study investigates the effect of the Negative Interest Rate Policy (NIRP) on investment spending in the Eurozone over the period 2014-2019 using a panel data approach. The literature on this relation is relatively thin which pinpoints the contribution of this study. Both qualitative analysis and quantitative analysis are adopted. On the econometric side, Kao cointegration test and Fully Modified OLS technique are carried out. Both the descriptive and empirical findings indicate that interest rate after adopting the NIRP has a negative effect on the investment level. This finding is consistent with the neoclassical school of thought.*

Keywords: Negative Interest Rate Policy, Monetary Policy, Investment; Modified Ordinary Least Squares, Panel Data.

JEL Codes: E220, E430, E520.

2. Introduction

Negative Interest Rate Policy (NIRP) has become the latest innovation in central banks' toolkit of unconventional monetary policies, implemented during the last decade after the 2008–09 global financial crisis when traditional interest rate instruments reached the zero lower bound (ZLB)¹ (Brunner & Wu, 2017; Lopez-Penabad et al., 2022). After nearly half a decade with NIRP seemed nearly impossible, it has become rooted as part of the mainstream economic consensus (Randow & Takeo, 2019).

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¹ ZLB refers to an expansionary monetary policy tool, whereby central banks push short-term interest rates to the zero level to stimulate the economy and promote growth.

Before the global financial crisis in 2008–09, interest rate cuts and rises through the nation's central bank would be cyclical and mainly to the tune of the respective recessions and booms that economies go through. As interest rates are the primary tool of monetary policy they are directed to stimulate investment and employment and to contain inflation. The theory states that low interest rates encourage investment and spending, sparked by the opportunity cost effect of insufficient returns offered by savings accounts. The financial crisis has decoupled this relationship and rendered interest rates struggling to stimulate investment spending and economic growth. Since then, the developed world has witnessed an unprecedented period of low-interest rate environments (Borio & Hofmann, 2017).

With conventional policy options proven ineffective in reviving economic damages caused by the crisis and recession (Randow & Takeo, 2019), the European Central Bank (ECB) responded to the crisis with a major additional monetary stimulus through standard and even non-standard measures. Such measures incorporated the reduction of policy rates to levels near the ZLB, targeting longer-term refinancing operations for banks along with large-scale asset purchases equivalent to Quantitative Easing (QE) (Riet, 2017).

In June 2014, the ECB became the first major central bank to cut one of its main policy rates—the deposit facility rate, or Interest Rate paid on Excess Reserves (IOER)—below zero and has subsequently lowered this deposit facility rate to the negative 0.5% as of September 2019 (Brruning & Wu, 2017).

Generally, low-interest rates intend to stimulate the economy by reducing money market rates and bond yields, depreciating the exchange rate, inducing banks and investors to rebalance their portfolios toward riskier assets, and boosting credit to the economy (Hannoun, 2015; Arteta, Kose, Stocker, & Taskin, 2016). A NIRP that effectively taxes banks for holding deposits (that exceed regulatory requirements) at the central bank, increases banks' incentives to reduce these excess reserves through bank lending or purchases of alternative assets. Overall, NIRP provides an environment where banks and investors may be more sensitive to both conventional and unconventional monetary policy accommodations that encourage them to rebalance their portfolios toward riskier investments/assets with higher yields. This raises a question regarding whether NIRP constitutes simply a continuation of conventional interest rate instruments or if it causes a fundamental change in the monetary policy transmission mechanism (Brruning & Wu, 2017). In other words, while positive interest rates represent the incentive that drives investors to risk their money by lending, negative rates remove the incentive (and even punish) those who are averting risk by hoarding cash (Randow & Takeo, 2019).

The new era of negative rates has recently been the subject of a debate about whether the policy adopted by the ECB was able to achieve its goals to ward off the threat of deflation (or a spiral of falling prices that could have deepened economic distress), jolt lending, stimulate investment spending, and reinvigorate economic growth in the Euro-zone countries or on the contrary has caused a distortion in financial markets and crippled banks and investors (Randow & Takeo, 2019).

This paper contributes to this debate by focusing on the empirical investigation of the effect of negative interest rates on investment spending in Euro-zone countries for the period 2014-2019 using a panel data model. The selection of this period meant to tackle the period during which NIRP was adopted in the Euro-zone area while excluding the COVID-19 pandemic period starting in 2020 that could have affected the relationship between NIRP and investment, especially with the tendency of advanced central banks to tighten their monetary policy after the pandemic.

The paper is organized as follows. Section 2 provides the theoretical framework behind the relationship between the interest rate and investment with a focus on the theoretical background of NIRP, along with a review of the empirical literature that investigates this relation. Section 3 analyses in detail the economic environment of the Euro-zone countries correlated with the adoption of negative rates by the ECB and proceeds with a qualitative analysis of their effect on investment. Section 4 provides an econometric analysis to further investigate the relationship between the two variables for the Euro-zone countries throughout the period 2014-2019. Finally, Section 5 presents the conclusion of this study.

3. Research Elaborations

3.1. Theoretical framework:

NIRP once existed in literature as an anarchistic theoretical fantasy that has now become a part of the mainstream economic consensus. Although NIRP may appear relatively new, it represents a continuation of pre-Keynesian, neoclassical macroeconomic reasoning that regained ascendancy in the late 1970s, and has been shaping macroeconomic policies for over four decades. This continuation could be highlighted through the focus on interest rates as a critical tool for stimulating investment and consumption in a demand-driven recession, as well as for stabilizing the economy and ensuring full employment in a deflationary environment (Ilgmann & Menner, 2011). This part of the paper presents a concise review of the theoretical origins of NIRP and the theoretical debate regarding its role in stimulating investment in the economy (Ilgmann & Menner, 2011; Palley, 2016a; Palley, 2016b).

3.1.1. Loanable funds theory of interest:

The classical theory of interest rate and investment presented by David Ricardo, A.C. Pigou, Marshall, Walras, Taussig, Cassels, and Knight, sets an inverse relationship between interest rate and investment. Interest rate is the price of investment or cost of borrowing, so a high interest rate reduces investment and a low interest rate encourages higher investment. According to this classical theory, the interest rate is determined by equilibrating the goods market through equating demand for investment and supply of household savings in the goods market. This theory is also known as the real theory of interest rate as it only takes into consideration real factors affecting goods markets like productivity and thrift without taking into consideration relevant monetary factors (Pal, 2018).

The old classical model was reformulated by the neoclassical school in the 19th century to incorporate and account for monetary factors in addition to the real determinants of saving and investments. The new formulation is called the loanable funds theory of interest. This theory is associated with the names of Wickells and several other Swedish economists. It is considered the core economic theory behind NIRP and ZLB economics of the contemporary mainstream economic consensus (Palley, 2016a; Pal, 2018). While in the classical theory, only saving from current income is available for investment, the loanable funds theory of interest includes disinvestment, dis hoarding, bank loans, and

bank credit² as other sources of funds available for investment to the borrowers. So, the loanable funds theory is often referred to as both the real and monetary theory of interest (Pal, 2018). According to the loanable funds theory, the real interest rate is the critical mechanism, that adjusts to coordinate saving and investment in the goods market and ensure that aggregate demand (AD) equals aggregate supply (AS). This equilibrium, according to the monetary overinvestment theories, occurs when the Natural Rate of Interest (NRI) equals the policy interest rate in the loanable funds market (Palley, 2016a; Hoffmann and Schnabl, 2016).³

Afterwards, Neo-Keynesian economists added a twist to the canonical neoclassical macro model. That twist is a central bank that is responsible for interest rate targeting. In this contemporary formulation, the neo-classical interest rate adjustment mechanism is managed by the central bank's nominal interest policy (Palley, 2016a). Thus, whereas the loanable funds market sets the interest rate in the classical model, the central bank in the Neo-Keynesian model takes over the interest rate setting function (Palley, 2019). The central bank sets the nominal interest rate targeting an inflation rate that is consistent with the aforementioned belief regarding the required loanable funds' real interest rate through a four-step procedure (Palley, 2016a). First, it announces a credible inflation target, Second, it estimates NRI, third, it sets a nominal interest rate target that equals the estimated NRI plus the inflation target, and fourth, the central bank adjusts the nominal interest rate targeting NRI (Palley, 2019).

An economic downswing occurs when the NRI exceeds the internal interest rate of investment projects, so investment turns out unprofitable (Klausinger, 2011). The fall in the investment of some firms negatively affects the investment of other firms as expected returns fall, causing further disinvestment (cumulative downward process). This leads to a downward shift in the investment curve, making a policy interest rate above the NRI. Thus, credit supply is restricted further such that saving is higher than investment. In this situation, the central bank should cut its base rate to contain the downward spiral (Hoffmann and Schnabl, 2016). However, problems arise for the central bank when the nominal interest rate approaches the zero level, which minimizes the effectiveness of conventional monetary policy (Palley, 2019).

The ZLB becomes relevant when the nominal interest rate cannot adjust to deliver the NRI needed to clear the loanable funds and the goods markets. This occurs when the NRI (full employment interest rate) is below the negative inflation rate, at a nominal interest rate equal to zero, (i.e. since real interest rate = nominal interest rate – inflation rate). Consequently, both the goods market and the loanable funds market are in excess supply at the prevailing real short-term interest rate (RI) (Palley, 2016c).

3.1.2. ZLB economics:

The idea of removing ZLB was first suggested by Silvio Gesell at the beginning of the 20th century via taxing money. However, it was shortly forgotten in the literature until it was renewed with the Japanese financial crisis in the early 1990s. This crisis rendered monetary policy ineffective in fighting recession and deflation when reaching the ZLB. This has revived discussions regarding the implications

² Disinvestment means the sale or liquidation of assets. While dishoarding is the activity of investing money or selling gold, silver, etc. after a period during which investors have saved them. Bank credit is an amount of funds that a person or business can borrow from a bank. Or money that banks have lent or have available to lend.

³ According to the overinvestment theories, the natural interest rate is the one that balances the demand for capital (investment) and supply (saving).

of ZLB and possible remedies. The ZLB economics was first introduced by Krugman, Dominquez, & Rogoff (1998) who originally developed it to explain Japan's stagnation after the collapse of its asset price bubble in 1991. However, as the majority of developed countries had enjoyed a period of stable growth previous to the global financial crisis of 2008-09, the risk of nominal rates hitting the zero floor was considered very small, especially in the light of high inflation rates. Thus, the ZLB was not considered an important issue for mainstream economists (Ullersma, 2002; Buiter, 2005; Ilgmann & Menner, 2011). The global financial crisis of 2008-09 followed by global recession and stagnation along with the unresponsiveness of the economy to the massive monetary and fiscal stimulus, has prompted a search for a theoretical explanation. An explanation was then provided by new Keynesian economists; Eggertsson and Krugman (2012). Their analysis is based on the ZLB to nominal interest rates that supposedly obstructed the clearing of the loanable funds market for attaining full employment savings and investment.

The Eggertsson–Krugman approach is part of the new Keynesian consensus that considers the economy as a full employment system that only fails as a result of rigidities and market imperfections. ZLB economics adds the nominal interest rate to the list of these rigidities (Eggertsson & Krugman, 2012; Palley, 2016c; 2019). Eggertsson and Krugman (2012) deleveraging hypothesis argued that after the global financial crisis, some households tried repairing their balance sheets by paying back their debt and deleveraging. This process caused an increase in the supply of savings (loanable funds), initiating a fall in the NRI. However, that fall was blocked by the ZLB, causing an excess supply of loanable funds. Eliminating that excess supply resulted in a contraction of income and employment that lasted through the deleveraging process (Palley, 2016c).

3.1.3. Unconventional monetary policy recommendations:

As the central bank's base rate approaches zero, conventional monetary tools become ineffective in guiding or stimulating the economy, so scholars and economists have been searching for and suggesting unconventional monetary tools to escape ZLB. Bernanke (2016) suggests that with the base rate near zero, the central bank could next turn to a "forward guidance" approach that is, communicating the US Federal Reserve policy plans to markets and the public. If the central bank can convince market agents that short-term rates will remain low for some time, it can reduce longer-term rates, which are more important to investors, consumers, and businesses. Bernanke ensures that forward guidance can be very effective, and rate cuts along with guidance might be sufficient.

Another approach was presented by Gregory (2009). According to Gregory (2009), the central bank should commit itself to producing significant inflation. Since the RI equals the nominal interest rate minus expected inflation, a higher inflation rate lowers the RI. Thus, people will have the incentive to borrow and are confident that they can repay their debt in devalued money. The goal of such a policy is to induce enough inflation until the RI is sufficiently negative; however, this policy exposes the economy to the adverse effects of price instability.

Some ZLB economists argue that this goal can be achieved with monetary authority by driving up inflation expectations. However, Palley (2016a) argues that inflation expectations primarily are predetermined by expectations of real economic conditions rather than pronouncements by the monetary authority.

Another monetary policy tool that has been implemented by the US Federal Reserve in 2008 - and others – is to stimulate investment and encourage lending in the market by QE which refers to massive purchases of assets for the central bank's portfolio, financed by the created reserves in the banking system (Bernanke, 2016). Like the previously discussed monetary tools, QE aims to reduce longer-term interest rates encouraging borrowing, investment, and spending. Bernanke (2016) stated that, while QE has helped support the US recovery, central banks might be reluctant to apply it due to the market resistance to terminate it afterwards. So central banks should consider other options before undertaking QE (Bernanke, 2016). Thus, NIRP becomes the next policy of choice following simple extrapolative logic (Palley, 2016a).

3.1.4. Negative interest rate policy (NIRP):

NIRP has been presented on the macroeconomic level as an unavoidable last measure of monetary policy. In principle, the monetary authority can implement this strategy directly by setting its lending rate below zero, or it can adopt non-standard tools such as charging commercial banks for their deposits with the central bank using its base rate (official reserve rate) (Palley, 2016a).

In practice, this means that commercial banks are being charged on the reserves above a certain threshold instead of receiving interest on the reserves they hold with the central bank. Banks are expected to shift to other short-term assets, in response, driving down the yields on those assets as well. Ultimately, the efforts of banks and investors aiming to avert negative returns on short-term assets should cause declines in a broad range of long-term interest rates such as corporate bond yields and mortgage rates (Bernanke, 2016).

According to the reasoning embodied in ZLB economics (Palley, 2016a), such action would encourage business investment and consumer spending; making exports more competitive. Besides, it would lower the value of a country's domestic currency, increase the value of other risky assets; and increase expectations of future inflation, which can induce people to spend more now (Irwin, 2016).

The idea of negative interest rates still fascinates scholars, professional economists, and the public. As conventional wisdom states nominal interest rates earned on investments never go below zero because investors could alternatively hoard currency. Yet there are costs for holding currency, that are represented in the –huge cost to safeguard in large amounts, and the difficulty of using it for remote and large transactions, as it might be subject to physical destruction or theft (Anderson & Liu, 2013). McAndrews (2015) formulates this by stating that "different economic agents will be more or less willing to invest in negative rate investments to the extent that diseconomies of scale make their costs of handling currency higher or lower than others". He then readjusts his proposition to account for other dynamic considerations involving innovative actions to avoid negative rates, to be "different economic agents will be less willing to invest in negative rate investments over time to the extent that innovations reduce the costs of handling currency or make available other zero, or near-zero, interest rate economic arrangements".

Some scholars went even further seeking to fully remove the ZLB, liberating conventional monetary function which requires levying negative interest rates on the whole monetary base. They came up with various schemes for removing the zero bound via negative interest rates, where Buiter (2009) suggests separating the role of currency as a unit of account and the means of payment function, this follows the idea presented by Gaitskell et al. (1969), but was initially introduced by Eisler (1932) with the motivation

of shielding the economy from the negative effects of inflation. Nonetheless, the most commonly thought method for removing the ZLB is taxing money which was first introduced by Silvio Gesell at the beginning of the 20th century and revived by Gregory (2009) in his article in the New York Times, concerning periodic taxation or partial confiscation of base money, with both components of the monetary base subject to this tax, simple arbitrage will be supposedly sufficient to ensure that all components of the money supply will also yield negative nominal interest (Ilgmann & Menner, 2011).

3.2. Empirical Review:

Regarding the topic of the relationship between negative interest rates and investment, the majority of studies that tackle negative interest rates do not present a direct relationship between such variables and investment. Instead, the studies that discuss negative interest rates focus more on the relationship between such variables and their effect and implementation on the banking sector and equity markets. The contribution of this study is shown by conducting empirical evidence in the 19 countries of the Euro-zone from 2014 to 2019; the aim shall be to fill the gap in the literature between NIRP and investment. However, there is an abundance of empirical studies that tackle the relationship between positive interest rates and investment from which the majority state a negative relationship between the interest rate and investment. Besides, some studies find a positive relationship between the two variables in question. The following results summarize different studies conducted within this field based on the main empirical findings.

As an example, for the studies that investigate the effect of NIRP on banks' profitability, risk-taking, and stock prices, Boungou (2019) conducted research using a panel dataset of 2442 banks operating in 28 EU countries over the period from 2011 to 2017. The study investigates the effects of NIRP on bank profitability and risk-taking. Boungou (2019) found that NIRP has contributed to a reduction in banks' risk-taking. In addition to stating that, the effects of NRIP on the banks' profitability and risk-taking differ among banks, depending on their balance sheet characteristics.

Also, according to Jurkšas (2017), the impulse-response functions of the created VAR model for the European Union (EU) from 2000 to March 2017 confirm the following results: an interest rate reduction decreases borrowing, deposit rates, and net interest margins but positively affects confidence, bond, and equity prices, leading to higher expectations of economic growth and inflation in the longer term.

3.3. Descriptive analysis:

3.3.1. Overview of the NIRP in the Euro-zone:

The period of ultra-low and negative interest rates in Europe started when the ECB was battling the global financial crisis of 2008-09. The immediate financial shocks related to these crises have been resolved. But a decade later their effects on the real economy, including low inflation and subdued growth, continued to rank, requiring further unconventional policies such as NIRP. The ECB was the second bank in the world that implement a negative interest rate after Denmark in June 2014. The goal is to maintain the inflation rate under 2%. Also, it is designed to relatively weaken the euro to provide some assistance to Euro-zone exporters (Wang, 2017).

The ECB started by lowering the remuneration on its deposit facility to 0.10 percent in June 2014. Subsequently, during September 2014, December 2015, and March 2016, there were four additional steps of 10 basis points cuts. In September 2019, the ongoing rate of – 0.50 percent was reached (Eisenschmidt

& Smets, 2019). The decision to adopt NIRP was part of a more comprehensive monetary policy easing package, which eventually also included the introduction of targeted long-term refinancing operations and a large-scale Asset Purchase Program (APP) of private and public sector bonds. The sole motivation for the ECB's decision to set rates below zero was the desirability to provide additional monetary easing to the whole economy in response to the emerging deflation risks. Given the ECB's focus on providing additional monetary policy accommodation with its negative deposit facility rate, raises a question about the effectiveness of the NIRP (Eisenschmidt & Smets, 2019).

While the transmission of NIRP to financial market rates is complete, a different picture arises when looking at rates paid by banks for household and Non-financial Corporations (NFC) deposits. Comparing the distribution of deposit rates through a representative sample of Euro-zone banks in June 2014 and June 2019, it is obvious that these two types of deposit rates have declined during the NIRP period, with both distributions having most of their value at zero. This accumulation of deposit rates at zero suggests the existence of a ZLB for bank deposits, although some banks do report rates below zero for their NFC deposits and households (Eisenschmidt & Smets, 2019).

While the effect of NIRP on investment spending is yet to be examined, some scholars claim that NIRP has put European banks into a spiral of declining margins and instability in their business models. As it drove down to what banks earned on the money they lent, they still, and to a great extent had to pay customers for their deposits. The resulting profit compression left many European banks complaining that the ECB was making it harder for them to lend, not easier (Randow & Takeo, 2019). Besides, banks have paid the ECB more than €20 billion in negative interest fees, providing a tangible demonstration of its crippling effects.

To consider the consequences of such a policy, there is a need to look at the portfolio investments outflowing the countries with higher real interest. The financing entities, which do not want to make a loss, withdraw their capital from the financial companies and retain them. Furthermore, keeping the money outside the financial system in which the necessary audits and controls are done causes an increase in the number of unrecorded transactions, which means that, it will affect investment and also growth (Yilmaz & İçellioğlu, 2016).

However, many other factors affect the investment environment such as investment costs, financing conditions, price expectations, profit possibilities, and uncertainties. Also, the effectiveness of a NIRP depends on whether there will be an uptrend from savings to investments or not.

3.3.2. Initial Assessment of Euro-zone Data:

This section highlights the initial assessment of the relationship between NIRP and investment in a more descriptive way. The analysis is conducted using the data of the Eurozone regarding the two variables of interest to indicate the relationship between them. The first variable is nominal interest rate and the other one is Gross Fixed Capital Formation as % of GDP (GFCF). The coming graph plots the two variables under study together to have initial interpretations of the relationship.

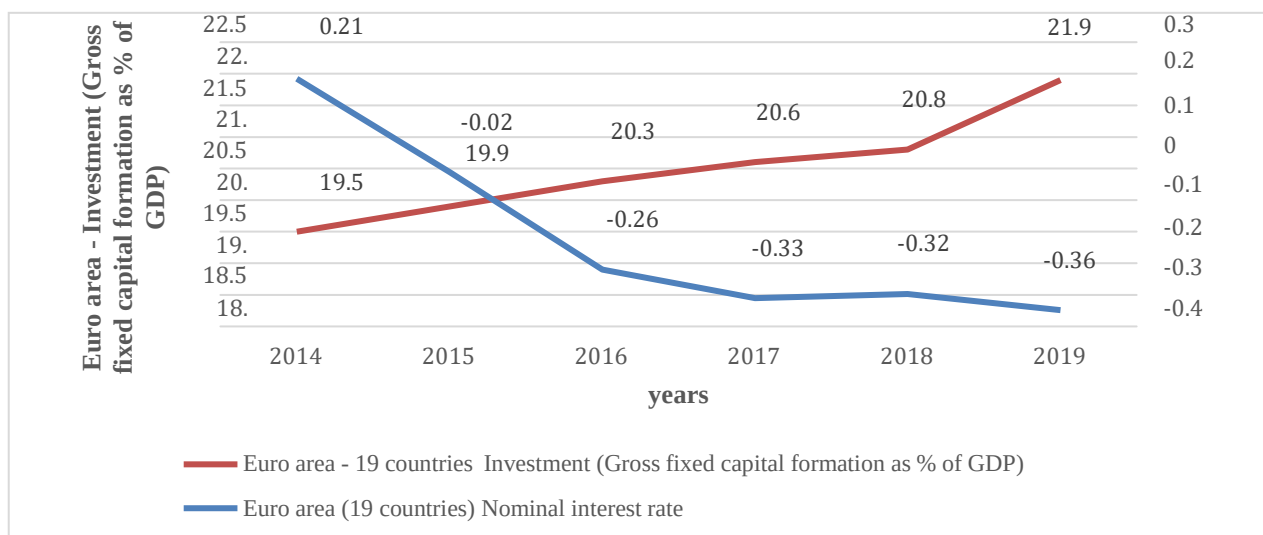


Fig. 1: Interest rate and gross fixed capital formation in the Euro-zone from 2014 to 2019
 (Source: done by the researchers based on data from Eurostat & OECD, 2020)

It can be concluded from Figure (1) that while the nominal interest rate has been experiencing a sharp fall starting from 2014, the GFCF is showing a nearly constant upward slope with almost no fluctuations. It is worth mentioning that the two variables nominal interest rate and GFCF are integrated in the first order as mentioned later in the next section. Therefore, to be able to comment on the correlation, the First difference between the two variables is plotted together against time in Figure (2).

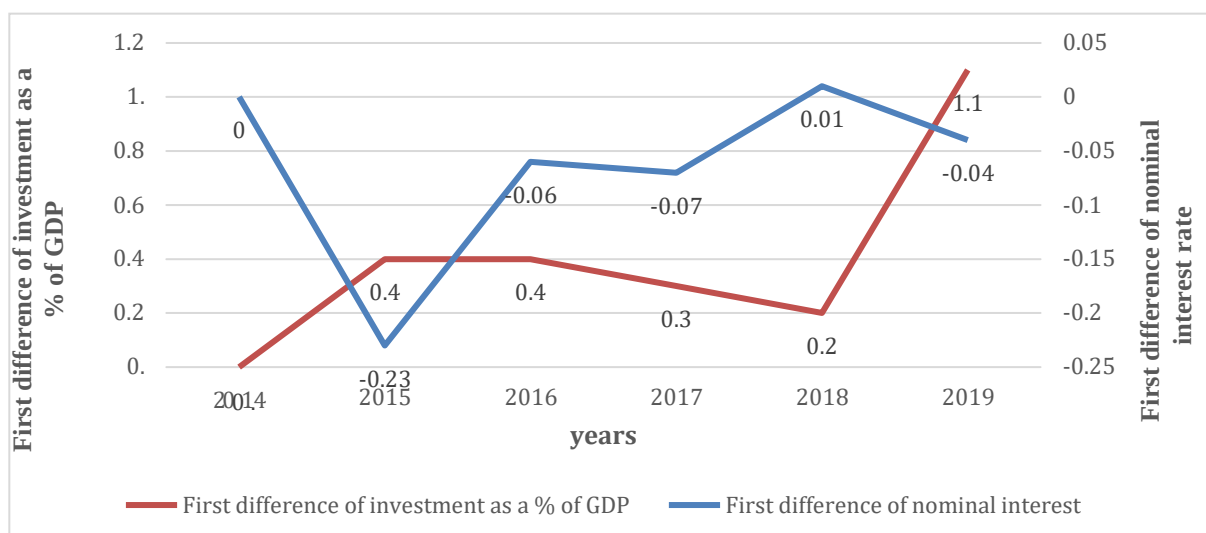


Fig. 2: The first difference of both interest rate and gross fixed capital formation in the Euro-zone (2014 - 2019)
 (Source: done by the researchers based on data from Eurostat & OECD, 2020)

From Figure (2), it can be observed through the transition from 2014 to 2015 that there is a slight negative correlation between the two variables in question. But starting from 2016, it can be stated that there is nearly no correlation between both variables. Besides the correlation coefficient between both variables is estimated to be (-0.1415) which indicates a weak negative correlation between variables.

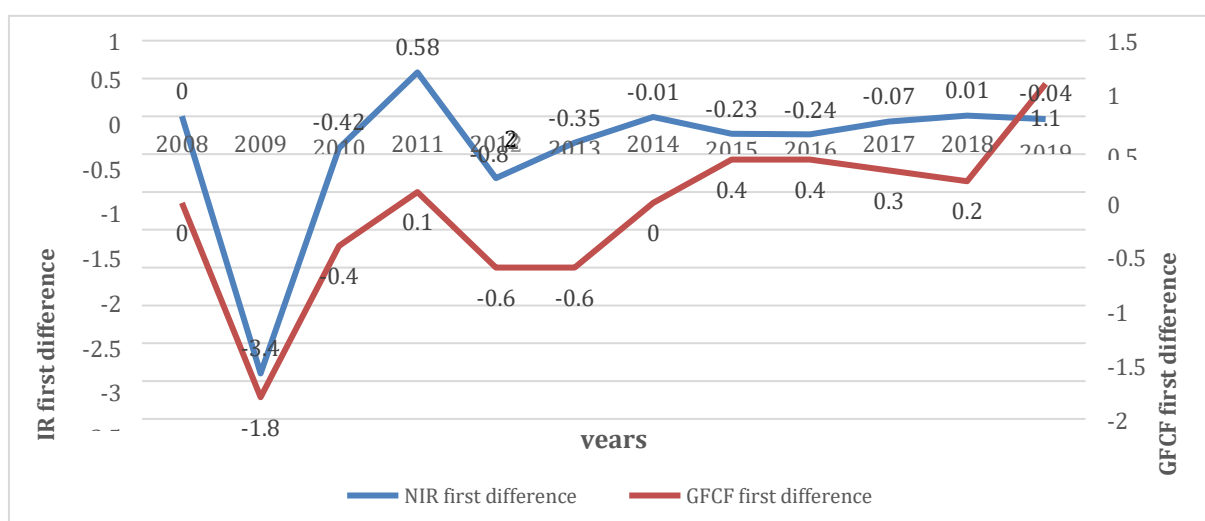


Fig. 3: the first difference of negative interest rate and gross fixed capital formation in the Euro-zone (2008 - 2019)
 (Source: done by the researchers based on data from Eurostat & OECD, 2020)

To further identify whether such a weak negative correlation between interest rate and investment is triggered by the adoption of NIRP or not, the study investigates the correlation between the two variables since 2008 (i.e. before the adoption of the NIRP in the Euro-zone) (as depicted in Figure 3). It is obvious from Figure 3 that throughout the period from 2008 to 2013, there has been a near-perfect positive correlation between the two variables. The calculated correlation coefficient between the two variables from 2008 to 2013 is (0.9792). However, since 2014, a significant change occurred not only in the strength of the correlation between the two variables but even in its direction, producing a sharp sudden change in the trend that dominated the previous period which presents an adjustment in the relationship between the two variables under study. This observation is consistent with ZLB economics' claim that the adoption of NIRP and going below the ZLB would have revived the effectiveness of monetary tools (including interest rates) to operate according to their conventional functions. However, stating that the adoption of NIRP was the only cause for such change would be an inaccurate assessment, as the decision to adopt NIRP was accompanied by other easing measures such as the APP, which had a significant downward effect on long-term bond yields, and the program targeting long-term refinancing operations, which provided long-term funding to banks at negative interest rates under certain conditions (Eisenschmidt & Smets, 2019).

Also, this could be interpreted by the recovery of the economies from the 2008-09 financial crisis and its ramifications and repercussions that lasted till 2013. So, the degree to which the adopted NIRP

contributed to reshaping the relation could be impossible to determine accurately using the aforementioned descriptive analysis.

3.4. Empirical Analysis:

3.4.1. Data and Variables

In an attempt to study the relationship between NIRP and investment for the 19 countries of the Euro-zone, annual data for the period 2014-2019 is applied using the panel data econometric technique. The variables employed are GFCF as a percentage of GDP as a proxy for investment, real per capita gross fixed product (RPGDP), real short-term interest rate, and Financial Development Index (FDI). All data are extracted from the online services of Eurostat, OECD, and International Financial Statistics reported by the International Monetary Fund and World Bank data services (Ucan, 2014).

The definitions of the incorporated variables are as follows:

- **The Gross Fixed Capital Formation as a percentage of GDP (GFCF):** it is used as a proxy for the investment level and it consists of resident producers' acquisitions, less disposals, of fixed tangible or intangible assets. This covers in particular machinery and equipment, vehicles, dwellings, and other buildings (Eurostat, 2020).
- **The real per capita GDP (RPGDP):** it is calculated as the ratio of real GDP to the average population of a specific year. GDP measures the value of the total final output of goods and services produced by an economy within a certain period. It includes goods and services that have markets (or which could have markets) and products that are produced by general government and non-profit institutions (Eurostat, 2020).
- **The real short-term interest rate (RI):** it is used as a proxy for the real interest rate which is calculated according to the Fisher equation; by subtracting the inflation rate from the nominal interest rate. The nominal short-term interest rate is the rate at which short-term borrowings is affected between financial institutions or the rate at which short-term government paper is issued or traded in the market. Short-term interest rates are mainly averages of daily rates, measured as a percentage. Short-term interest rates are based on three-month money market rates where available. Typical standardized names are "money market rate" and "treasury bill rate" (OECD, 2020).
- **Financial development index (FDI):** it is an index that summarizes how developed the financial institutions and financial markets are in terms of their depth (size and liquidity), access (the ability of individuals and companies to access financial services), and efficiency (the ability of institutions to provide financial services at low cost and with sustainable revenues and the level of activity of capital market) (Svirydzenka, 2016).

2.3.2 Model specification:

According to the neoclassical theory, the investment level is mainly determined by the interest rate, besides other variables such as GDP and the level of financial development (Pal, 2018). Consequently, in this paper, the GFCF is the dependent variable. The independent variables incorporate RPGDP, RI, and FDI. The following functional form is used in the analysis:

$$GFCF_{it} = f \left(\begin{matrix} RPGDP_{it} & RI_{it} & FDI_{it} \\ (+) & '(-)' & (+) \end{matrix} \right) \quad (1)$$

4. Results and Discussions

4.1. Empirical findings:

4.1.1. Test for stationarity:

There are different methods for testing the unit root of the variables. Particularly, the unit root test using Levin, Lin & Chu (LLC), Augmented Dickey-Fuller test (ADF), and Phillips-Perron Fisher Chi-square (PP) methods are used for the different variables to guarantee the accuracy of the results (Maddala & Wu, 1999). The test results are shown in Table (1)

Table (1): LLC, ADF & PP test results:

Variable	At level			At first difference			Result
	LLC	ADF	PP	LLC	ADF	PP	
GFCF	17.0610	10.7663	11.5140	-5.8387***	102.688***	98.6910***	I(1)
RPGDP	14.2143	0.20104	0.15316	-4.0514***	51.0976*	52.4805**	I(1)
RI	0.41020	23.4998	24.0053	-7.0013***	80.6363***	79.7031***	I(1)
FDI	0.65547	38.7794	42.7195	-10.632***	146.794***	146.751***	I(1)

1. Newey-West bandwidth selection using Bartlett kernel.
2. Common effects for LLC and Individual Effects for both ADF and PP
3. (***) represent variables significant at 1%, (**) represent variables significant at 5%, (*) represent variables significant at 10%.

(Source: done by the researchers based on the empirical findings on the model)

The lag length used in this unit root test is zero according to Schwarz information criteria. Table (1) shows that all variables are integrated in the first order. Since at level, the P-value of all variables is greater than 10% and at the first difference, the P-value of each one of them is less than 10% which induces rejecting the null hypothesis of unit root at first difference.

4.1.2. Co-integration test:

Since all the variables are non-stationary and have the same order of integration, the cointegration test can be performed to examine the existence of any long-run equilibrium relationship between the variables. The test used is the Kao panel cointegration test with the null hypothesis of no cointegration (Kao, 1999).

Table (2): Kao panel cointegration test:

	t-Statistic	Prob.
ADF	-5.728927	0.0000

1. Newey-West bandwidth selection using Bartlett kernel.
2. Lag length is zero based on SIC.

(Source: Done by the researchers based on the empirical findings on the model)

In Table (2), since the P-value is 0 which is less than 5%, thus the null hypothesis will be rejected indicating that there is a long-run relationship between the variables.

4.1.3. Fully modified ordinary least square model (FMOLS):

To test the long-run relationship between the variables, a fully modified ordinary least square (FMOLS) model for heterogeneous cointegrated panels is estimated (Pedroni, 2000).

Table (3): FMOLS model:

Variable	Coefficient	Prob.
RPGDP	0.000745***	0.0000
RI	-0.057414***	0.0000
FDI	23.57917***	0.0000

(Source: Done by the researchers based on the empirical findings on the model)

From Table (3), the FMOLS equation is:

$$GFCF_{it} = 0.000745 RPGDP_{it} - 0.057414 RI_{it} + 23.57917 FDI_{it} \quad (2)$$

According to Table (3), all the variables have a significant effect on GFCF since their P-value is equal to 0 which is smaller than 5%. The recorded coefficients in Table (3) represent long-run coefficients. The PRGDP has a positive effect on the GFCF and increasing it by 1 % would increase the investment level as a percentage of GDP by 0.0745%. The real interest rate has a negative effect on the GFCF and increasing it by 1 % would decrease the investment level as a percentage of GDP by 0.057% which goes along with the theory that expects that there is a negative relationship between the interest rate and investment level. The financial development index -which summarizes the level of development of the financial institutions and financial markets- has a positive effect on the investment level.

5. Conclusion:

The purpose of this paper is to empirically investigate the relationship between the interest rate and investment level after adopting the NIRP. The study was conducted on a panel of the 19 countries of the Euro-zone over the period 2014 to 2019. To achieve this goal, first, a descriptive analysis of the variables under question is conducted then an econometric analysis is carried out.

The descriptive analysis is conducted over two periods to assess the effect of the NIRP on the investment level and conclude if there are any changes in this relation after adopting the NIRP in 2014. From 2008 till 2013, the descriptive analysis suggests a strong positive relationship between the interest rate and investment level in the Eurozone. This positive relationship could be attributed to the existence of the financial crisis in 2008-09, which negatively affected the investment levels in the Euro-zone (Ksantini & Boujelbène, 2014). Despite all the consecutive declines in the interest rate by the ECB, the investment levels continued their decreasing trend. Leaving the ECB with no other choice rather to adopt an NIRP that contributed to adjusting the relationship between those two variables. Specifically, during the period from 2014 to 2019, there was a negative but weak correlation between NIRP and investment levels which is following the expected

theoretical direction as presented by the neoclassical school of thought. Consequently, the adoption of NIRP was inevitable to rebuild this relationship.

Then an econometric analysis is performed to investigate the relationship between those variables. Kao panel co-integration test is employed. The cointegration analysis suggests that incorporated variables, namely, gross fixed capital formation, real per capita GDP, financial development index, and the negative interest rate, are cointegrated. To quantify this relationship, FMOLS technique is employed. The model suggests that all the explanatory variables within the study have a significant impact on the investment level. It concludes that both real per capita GDP and financial development index have a positive effect on the investment level, while the interest rate, after adopting the NIRP in the Euro-zone, has a negative effect on the investment level. This relation is consistent with the results of the descriptive analysis which are all in harmony with the neoclassical theory.

The implications of this study are crucial for central banks. Given the tendency of central banks to adopt the NIRP post the global financial crisis as one of the unconventional monetary policy tools employed to revive the economy. Investigating the impact of the NIRP on investment and assessing its success in simulating growth could guide central banks and policymakers about the effectiveness of this policy and whether it could be employed in the future or not.

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