GOSPODARKA NARODOWA

5
(291)
Rok LXXXVII/XXVIII
wrzesień–październik
2017
s. 51–72

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The Impact of the European Central Bank's Interest Rates on Investments in the Euro Area

Abstract: The main objective of this paper is to examine the impact of the central bank's interest rates on investments in the euro area. The results of the analysis indicate that in 1999–2016 the European Central Bank's main interest rate lagged by two quarters had an inversely proportionally and statistically significant influence on the level of investment outlays in the euro area. The disturbances that euro-area economies were experiencing in the analysis period due to the recent financial crisis considerably weakened the monetary policy's effect on the real economy. However, the relationship between the ECB's main interest rate and investment outlays was statistically significant, implying that the interest rate played a role in the central bank's influence on investments.

Keywords: central bank, interest rate, investments, euro area, VAR

JEL classification codes: E22, E43, E52, E58, F33

Artykuł nadesłany 8 sierpnia 2016 r., zaakceptowany 27 września 2017 r.

Introduction

The relationship between interest rates and investments has been studied by numerous economists for various countries and different economic conditions. The efficiency of monetary policy and the amount of time its impulses take to influence the real economy through the transmission mechanisms depend

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on a variety of structural factors. In empirical research, separating the effect of monetary policy on investments from other factors is not a straightforward exercise. A major factor in the transmission of the central bank's monetary policy, associated with the level of investment activity, is the user cost of capital**.** It is also notable that variations in investment demand frequently affect interest rates, a process that is difficult to distinguish from the impact interest rates have on investments. According to Mahadeva and Sinclair, the examination of how investments and interest rates interact is frequently problematic because investment assets (machinery, stocks) are also influenced by exchange rates, foreign money and other factors [Mahadeva, Sinclair, 2004]. The recent financial crisis also had an impact on the decisions of the European Central Bank (ECB) for interest rates in the euro area. Therefore, when analysing the relationship between the real reference rate (main refinancing operation rate) of the ECB and gross fixed capital formation (investment outlays or expenditures) in the euro area, one has to bear in mind that investments depend on many different factors that are beyond the control of the monetary authorities.

The paper provides an analysis of the 1999–2016 period, when economies were affected by recession and a financial crisis. The formulated research hypothesis is as follows: the central bank's reference rate has an inversely proportional and statistically significant influence on investment outlays in the euro area. In order to test the hypothesis, the authors applied an econometric model.

The structure of the paper is as follows: Section 2 provides a review of theoretical and empirical studies in the relevant literature, Section 3 sets out the research data and methodology, and Section 4 presents the empirical results and a discussion. The paper concludes with Section 5.

Theoretical Framework

The concept that the central bank's interest rates can influence investments in the economy is controversial. J. Taylor and M. Keynes considered the relationship important, while Bernanke and Gertler [1995] argued that, in making investment decisions, enterprises are guided less by the cost of capital than by wages and prices. Erceg and Levin [2002] and Kuttner and Mosser [2002] measured the impact of interest rates on particular components of investments. According to their study, interest rates have a stronger influence on residential development projects and a weaker impact on investment companies. The analysis of investments in the context of interest rates has to allow for a variety of factors that reflect the central bank's impact on investment companies. However, Kuttner and Mosser [2002] stressed that an increase in nominal interest rates is followed by an increase in real interest rates and the user cost of capital, which causes investment spending to decline. Taylor [2001] demonstrated empirically that interest rates exert a significant impact on investment expenditures via the cost of capital. Guiso [Guiso *et al.*, 2002] used microeconomic data to analyse the investments of individual enterprises. The impact of interest rates on the user cost of capital he obtained using accurate cost estimates was more powerful than in studies utilising aggregated data for all enterprises.

In considering the central bank's impact on the economy, particularly on investments, the strategy and objectives of monetary policy[1] as well as conditions determining the proper activities of the ECB in the euro area, are important. The ECB operates under greater uncertainty than individual central banks because it is responsible for a multinational currency area [Issing, 2006]. Its monetary policy has to consider many different factors such as the degree of its effectiveness and the quality of monetary policy instruments, in addition to the behaviour of business organisations and their adaptability to ECB decisions [Vlad, 2008].

Official interest rates influence consumption and investments via a monetary policy transmission mechanism. The traditional pattern of how monetary policy is transmitted to the real economy based on interest rate control draws on the IS-LM paradigm and its modifications [Rotemberg, Woodford, 1997; Clarida *et al*., 1999]. According to the paradigm, a reduction in the money supply leads to higher interest rates, consequently reducing investment activity [Gerdesmeier, 2009]. Boivin, Kiley and Mishkin [2010] underline that the neoclassical channels—direct interest rate effects on investment spending, wealth and intertemporal substitution effects on consumption, and trade effects through exchange rates—are the main channels in macroeconomic modelling. The literature on time variations in the strength of these channels does not suggest any major changes over time.

The results of research conducted by Chatelain, Generale, Hernando, von Kalckreuth and Vermeulen [2003] indicate that interest rates and lending constitute the main channels through which shifts in monetary policy influence investments. Boivin, Kiley and Mishkin [2010] argue that the large number of substantial changes in the legislation of many countries had major implications for the transmission of monetary policy actions to residential development projects. This shows that such projects are more determined by interest rates than by the availability of loans [Boivin *et al*., 2010]. On the other hand, investment activity seems to be more sensitive to banking sector liquidity in

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1 The European Central Bank (ECB) adopted a strategy of direct inflation targeting. It aimed to maintain the HICP annual index of consumer prices (*Harmonized Index of Consumer Prices*) below 2% over the medium term. Altavilla and Ciccarelli indicate that the stabilisation of inflation is important for the whole economy, including the level of investments [Altavilla, Ciccarelli, 2007]. Borio and Lowe confirm that low and stable inflation contributes to financial stability as opposed to unexpected fluctuations in the rate of inflation, which usually increase the economy's susceptibility to crises [Borio, Lowe, 2002]. Using monetary policy instruments, the central bank controls short-term money market interest rates, which also affect other interest rates and financial quantities [Tobin, 1978]. According to Cecchetti, the task of monetary policy makers is to change interest rates and provide knowledge of how the economy affects the maintenance of steady economic growth and stable prices [Cecchetti, 2000].

periods of contractionary monetary policy. According to Peersman and Smets [2002], the impact of monetary policy tightening on output is greater during a recession than economic booms because of asymmetries in its transmissions. On the whole, the heterogeneous responses of bank interest rates to market rates offer a better understanding of how the monetary authorities' decisions are transmitted to the real economy [Gambacorta, 2004].

B. Bernanke and A. Blinder [1992] found that a restrictive monetary policy significantly reduces the supply of bank loans and consequently has a negative impact on economic activities. On the other hand, an expansionary monetary policy may increase the supply of loans either directly from banks or by improving borrowers' net worth, which reduces agency costs [Maddaloni *et al.*, 2008]. Gambacorta and Marques-Ibanez [2011] argue that low interest rates may even boost bank lending in the long term (the risk-taking channel hypothesis). Moreover, non-standard central-bank measures may stimulate bank lending. Ehrmann, Gambacorta, Martinez-Pages, Sevestre and Worms [2001] concluded that a tightened monetary policy reduces overall bank lending in most euro-area countries.

In the context of the monetary transmission mechanism, Tobin's q-model providing an important link between stock prices and investment spending is notable [Tobin, 1969]. The model shows that an expansionary monetary policy leads to a rise in stock prices, thus stimulating investment spending, and that the balance-sheet channel works through the effect of stock prices on the balance sheets of companies and finally on their investment spending.

Finally, let us note that the interest rate on loans depends positively on the level of real GDP and inflation. Better economic conditions contribute to an increased number of viable projects (with a promising net present value), thus stimulating the demand for bank loans [Kashyap *et al.*, 1993]. The volatility of the main interest rates has a significant impact on bank interest rates. Interest rates on loans are more affected by interbank interest rate volatility than by interest rates on deposits. This information is crucial, particularly during financial crises [Gambacorta, 2004]. Cukierman [2013] argues that investment, consumption and credit market decisions are mainly based on expectations about an uncertain future. Optimism about future economic indices is an important factor that encourages companies to lend in order to increase consumption and investment. Berger, Ehrmann and Fratzscher concluded that market expectations have a major effect on the mechanism transmitting monetary impulses to the real economy. Changing ECB interest rates affect market interest rates, and market expectations cause changes in the interest rate. On top of that, the ECB is in a difficult position since it has to operate in a heterogeneous environment and take account of possible consequences of its decisions for individual euro-area countries that have diverse economic opportunities. All in all, a financial crisis is a difficult time to make investment decisions.

The financial crisis that erupted in the United States in mid-2007 following the mortgage market subprime crisis quickly spread across the global economy, especially after the collapse of Lehman Brothers in September 2008 [Mallick, Sousa, 2013]. It hit international financial markets, contributing to many problems in the real sector of the global economy and exposing links between the financial system, the housing sector, banking and the credit market. This rapid contagion from the financial sector to the real economy, which in many countries caused a sharp decline in domestic industrial output and investment rates, coupled with a reduction in GDP, is indicative of a significant relationship between monetary stability and financial stability [Castro, 2010; Granville, Mallick, 2009; Sousa, 2010a, 2010b]. It is noteworthy that many studies making assessments based on the Taylor rule suggest that an excessively expansionary monetary policy was the main reason[2] for the financial exuberance and financial crisis [Taylor, 2007; Jorda *et al*., 2015; Brunnermeier, Schnabel, 2014; Hoffmann, Schnabl, 2008, 2011]. Selgin [2014] and Howden and Salerno [2014] blame the macroeconomic instability of the central banks. Meanwhile, De Grauwe and Ji argue that the risk of a debt crisis comes from the basic characteristics of the monetary union that cannot fully control the debt currency. Consequently, euro-area countries are faced with uncertainty in the financial markets. Investors, concerned about payment difficulties because of factors such as a recession, choose to dispose of government bonds, which contributes to the growth of the interest rates and leads to a liquidity outflow [De Grauwe, Ji, 2013].

Because of the events that took place during and after the financial crisis, discussions started in many euro-area countries and beyond about the so-called zero lower bound on nominal interest rates[3], which is widely believed to affect the effectiveness of monetary policy when inflation is low or when there is deflation. For some authors, however, whether a zero lower bound on nominal interest rate can really restrict the monetary authorities' freedom of running a monetary policy is doubtful. The zero-lower-bound phenomenon is indicated to lead to a liquidity trap as discussed by Keynes [Błaszczyk, 2010].

The problem with a zero lower bound on nominal interest rates is that when the rates are close to zero the central bank cannot use them to influence the economy. Another problem is the probable emergence of a liquidity trap when a deflationary shock is strong enough to bring down the general level of prices and create long-term deflationary expectations. According to Svensson, the liquidity trap occurs when a monetary policy becomes ineffective because the economy is abundant with liquidity and the nominal interest rate is zero [Svensson, 2000].

In response to the most recent financial crisis, the ECB adopted a quantitative easing policy with interest rate cuts and purchases of financial assets.

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2 Crises in the contemporary global economy are frequently explained with Minsky's model [1986]. Minsky observed that a financial crisis can be induced by economic stability boosting market optimism that subsequently leads to higher expectations of profitability in some areas, resulting in a large number of investment projects and more intense lending activity [Nawrot, 2009].

3 Since 16 March 2016 the main refinancing operations rate in the euro area has been 0.00%.

The policy improved commercial-bank liquidity but failed to increase the volume of lending in the economy. It did not succeed in boosting real investments and economic growth. Euro-area commercial banks increased their lending activity only slightly, showing that the ECB is not very effective in improving the efficiency of the credit channel [Pyka, 2014]. Giannone, Lenza, Pill and Rechlin [2012] argue, however, that the ECB's non-standard measures significantly and positively influenced commercial-bank lending as well as economic activities in the euro area [Giannone *et al.*, 2012]. The ECB's anti-crisis measures were probably why the decline in the banks' lending activity proved less drastic than feared [Sum, 2016].

Hoffmann and Schnabl [2016] attribute the drop in investments in fixed assets to the incentive effects of an asymmetric monetary policy on different types of investments. During a financial crisis the abundance of central bank liquidity helps stabilise the financial markets (therefore, an asymmetric monetary policy constitutes an implicit insurance mechanism). Interest rate cuts and an unconventional monetary policy can stop or even reverse the fall in asset prices. Interestingly, when the prices of some asset classes (e.g. Japanese stocks) fall, the prices of other asset classes (for example U.S. stocks) go up, compensating for the losses related to the asset classes affected by the crisis. In contrast, returns on real investments drop relative to financial investments primarily because of a likely decline in the marginal efficiency of investment, but also due to the unavailability of a public insurance mechanism against risks involved in individual innovations, product lines or new production processes, and, last but not least, growing uncertainty. As the amplitudes of the boom-and-crisis cycles in financial markets grow larger, long-term investment decisions in the real sector tend to be influenced by growing uncertainty, and the increasing risk reduces the expected return from real investments. Hoffmann and Schnabl's [2016] final point is that ultra-loose monetary policies originating in large, advanced economies can discourage investment. According to Salachas, Laopodis and Kouretas, monetary policy can significantly determine the term structure of interest rates regardless of whether conventional or unconventional measures are used. The authors also argue that the change in predictability during the pre- and post-crisis years can be explained by referring to the market risk effect on the term structure of interest rates in the latter period [Salachas *et al*., 2016].

Malinowska [2016] found that the monetary policy stance of national central banks in EU countries, or of the ECB in the case of the euro area, had no effect on the investment decisions of non-financial private companies in 1999–2014. This was probably due to how central banks in advanced economies responded to the global financial crisis. The crisis entailed interest rate cuts and the adoption of extraordinary expansionary measures to prevent an economic downturn.

The cited studies show that the researchers take an interest in the impact of the central banks' interest rates on the real economy, particularly on investments, and analyse it on many levels and from different angles. This paper is a contribution to the discussion about the impact of the ECB's interest rate policy on gross fixed capital formation in the euro area, including the "special period" of the financial crisis. Studies show that the crisis may have considerably reduced the influence of the ECB's main interest rates on investment outlays in the euro area.

Data and Methodology

An important stage in the testing of the research hypothesis was the examination of the relationship between investment activity and the ECB's reference rate and the effect of the latter on the real economy. The mechanism underlying this process is complex and there are many factors that can distort the effect of explanatory variables on the dependent ones. Therefore, to make sure that the research results are as reliable as possible, an econometric modelling approach making use of a vector autoregressive (VAR) model was applied. The model's parameters were estimated using the least squares method.

Early econometric studies of the investment process considered the need for enlarging the productive apparatus to handle the expected increase in demand for products. After a time, it was realised that rising demand for fixed assets did not necessarily have to involve the enlargement of the productive apparatus, because it could also be handled by an improved use of the available machinery and equipment. The neoclassical theory holds that, in modelling investment activities, profitability, understood as the difference between return and costs, is also important. Particular significance is attributed to the cost of servicing loans and taxes (user costs). Hall and Jorgenson [1967] demonstrated the importance of investment costs (consisting of the principal amount borrowed to purchase an asset and interest on the loan) in the investment function. An investment model should take account of the fact that investment cycles usually extend beyond the observed periods. It should also consider the occurring delays.

The numerical data used in the econometric models and statistical calculations were sourced from the OECD National Accounts database (www.oecd.org). They were converted into real values using the Harmonized Index of Consumer Prices (HICP) and shown as 2016q4 prices.

IR – real *interest rate* – the main refinancing operations rate representing the reference rate (in real terms using the HICP).

IT – (*total investment outlays* – gross fixed capital formation) total real investments (2016q4).

GDP – Gross Domestic Product, in real terms, 2016q4.

Gross fixed capital formation is analysed in line with the recommendations of the ESA 95 (European System of Accounts). Gross fixed capital consists of expenditures increasing the value of fixed assets, including amounts spent on property, plant, equipment, intangible and legal assets, and on the repairs of fixed assets. The value of tangible fixed assets is represented by expenditures made to acquire them, to produce fixed assets for own purposes, and related to fixed assets under construction and improvements.

The data on nominal interest rates were sourced from the Statistical Data Warehouse, Reports, Monthly Bulletin, and Euro Area Statistics Online made available by the ECB, as well as from monetary policy statistics. The empirical research was based on the ECB's nominal interest rates that were in force at the end of each quarter of the year.

In contracts with customers, banks use nominal interest rates. The real interest rate is calculated by subtracting the inflation rate from the nominal rate. In this paper, the following formula was applied to calculate the real interest rate: Ir = [(1 + In)/(1 + i)] –1, where: Ir – a real interest rate; In – a nominal interest rate; i – the rate of inflation.

Empirical verification of the impact of the central bank's reference rate on investment outlays

To test the research hypothesis, a VAR model was used. The VAR models are multi-equation models developed by C. Sims, in which each variable is explained by its delays and by delays in other explanatory variables. The relationships between individual equations in the VAR model are only evident in the relationships between the random components of these equations. VAR models are usually utilised to create dynamic forecasts, to study relationships between variables, to test the general economic theory, and to carry out multiplication analyses and cointegration studies [Kusideł, 2000].

The VAR model built for the euro area accounted for the following variables: increments of the logarithms of gross fixed capital formation (investment outlays in real prices), first differences of the ECB's reference rate, and increments of the logarithms of gross domestic product. The parameters of the VAR model were estimated by the least squares method. The VAR model used in the study is presented below.

Equation 1. The vector-autoregressive model

$$x_t = A_0 D_t + A_1 x_{t-1} + A_2 x_{t-2} + \ldots + A_k x_{t-k} + e_t$$

where:
x_t – vector of observations of all n variables in the model,
D_t –vector of equations' deterministic components,
A_0 – matrix of parameters with variables of vector D_t,
A_i – matrices of parameters with delayed variables of vector x_t,
e_t – vectors of stationary random components.

The results of the model were subjected to statistical tests to find out how well they explained a given problem.

It is important for the variables used in the vector-autoregressive model to be stationary. Hence, before the parameters of the VAR model were estimated, the selected variables were tested for stationarity. As the augmented

Dickey-Fuller test showed, all the variables were non-stationary (their p-values exceeded the accepted significance level of 0.05). To deal with this problem, the following conversion procedure was applied:

- gross fixed capital formation → increments of the logarithms of gross fixed capital formation,
- gross domestic product → increments of the logarithms of gross domestic product,
- ECB reference rate → first differences of the ECB reference rate.

The testing of increments of the logarithms and first differences of the three variables made it possible to reject the null hypothesis (H0) about the presence of a unit root (variables are non-stationary) in favour of its alternative H1 stating otherwise (variables are stationary).

The stationary series having been obtained, the appropriate lag order ensuring the smallest loss of information was selected for the model. The results of the Akaike information criterion (AIC) and the Hannan-Quinn criterion (HQC) pointed to a third-order lag. In the next step the parameters of the VAR model were estimated.

Estimation and statistical verification

The parameters of the VAR (3) model were estimated using the OLS method. The parameter estimates, basic statistics and test results are shown in Tables 1, 2 and 3. Because variable *const* proved not significant, the estimation procedure was run again without that variable. All the equations were tested for the ARCH (Auto-Regressive Conditional Heteroskedasticity) effect and autocorrelation. As neither was found, there was no reason to reject the null hypothesis (H0 – ARCH effect is not present and H0 – autocorrelation is not present).

As the data in Table 1 (in Annex 1) show, in the analysed period, the first differences of the ECB's main interest rate were statistically significantly influenced by the rate's first differences lagged by one, two and three quarters. The ECB's main interest rate was also statistically significantly determined by increments of the logarithms of investment expenditures lagged by one and two quarters and by increments of the logarithms of GDP lagged by one quarter. Therefore, the ECB's interest rates were also influenced by lagged investments and lagged GDP.

Table 2 (in Annex 1) shows that the increments of the logarithms of GDP were statistically significantly determined by the first differences in the ECB's main interest rate lagged by two quarters and by increments of the logarithms of GDP lagged by one quarter. The increments of the logarithms of the euro-area GDP were also statistically significantly determined by the first differences in the ECB' main interest rate lagged by one and three quarters**.**

According to Table 3 (in Annex 1), the increments of the logarithms of investment expenditures in the euro area were statistically significantly shaped by the first differences in the ECB's main interest rate lagged by two quarters and increments of the logarithms of GDP lagged by one quarter. The increments of the logarithms of IT were statistically significantly influenced by the increments of the logarithms of investment expenditures lagged by one and three quarters respectively. The influence of the ECB's main interest rate lagged by one and three quarters on investment outlays proved statistically insignificant.

The minus sign of the coefficient for explanatory variable d_IR_2 (–0.01149) indicates that the dependence between the ECB's reference rate lagged by 2 quarters (d_IR_2) and investments (ld_IT) was economically appropriate. Equation 2 shows that in the analysis period the ECB's main refinancing rate (d_IR_2) was statistically significant for investment activity in the euro area (ld_IT).

The study of impulse responses carried out as a part of the analysis of interactions between variables yielded interesting findings. The results obtained for investment outlays in the euro area are shown in Graph 1. Annex 2 presents the results for GDP and the ECB's interest rate.

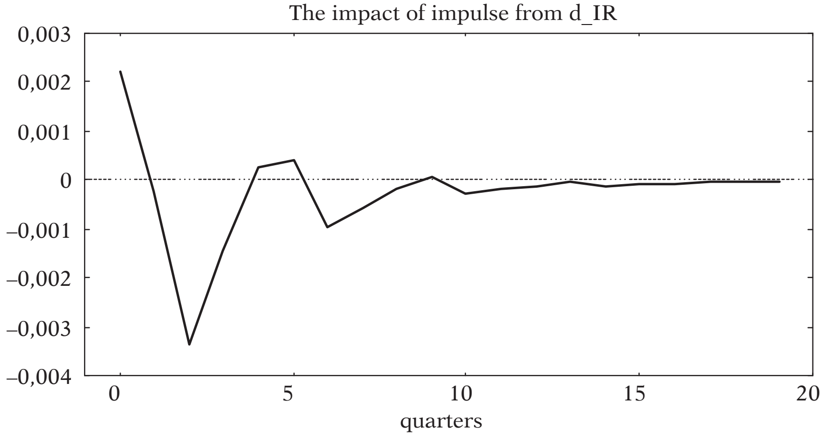
The impulse analysis shows that:

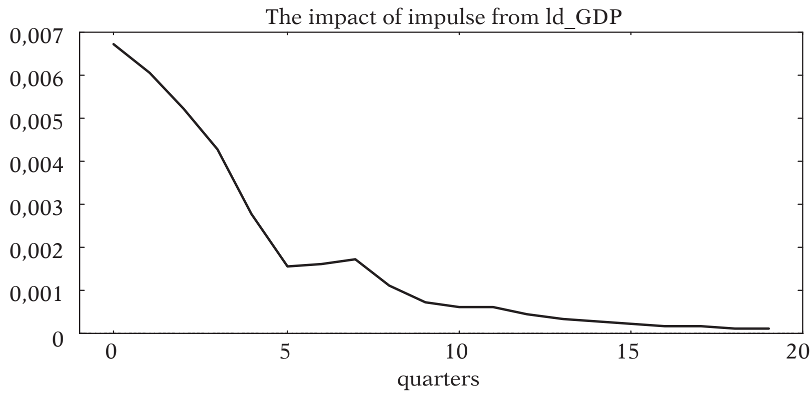
1. The impulse impact on investment outlays in the euro area (see graph 1):
   a. expires after slightly more than 13 quarters from the shock onset when coming from the ECB's interest rate,
   b. starts to expire after less than 5 years when coming from GDP,
   c. takes more than 5 years to expire when coming from fixed capital formation;
2. The impulse impact on GDP (see Annex 1, graph A):
   a. expires shortly after 3 years when coming from the ECB's interest rate,
   b. expires shortly after 4 years when coming from GDP,
   c. does not expire before 20 quarters when coming from fixed capital formation;
3. The impulse impact on the ECB's reference rate:
   a. expires after around 3 years from the shock onset when coming from the ECB's interest rate,
   b. expires after 17 quarters when coming from GDP,
   c. expires in less than 20 quarters when coming from fixed capital formation.

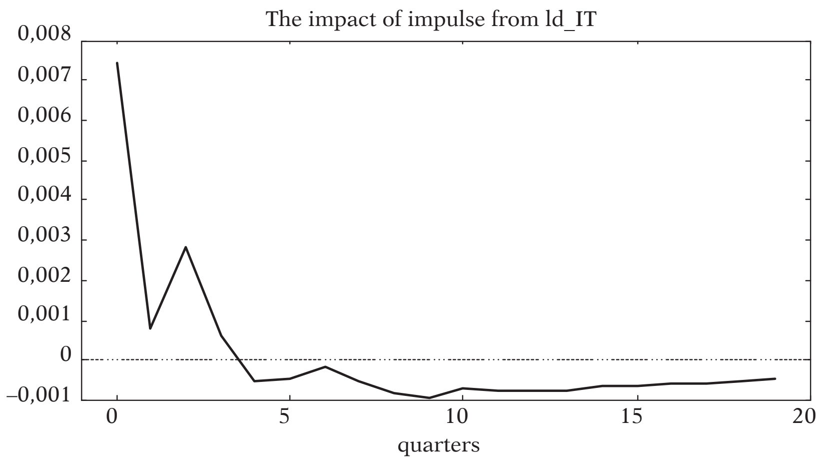
The results obtained for impulse responses of ld_GDP and ld_IT are shown in Annex 1.

In the next step, the share of each variable's prediction error variance determined by its own values and by the values of other variables was estimated. As the data in Table 4 show, the shares tend to stabilise after three years. In the case of the ECB's reference rate, 75% of its error variance is explained by its own values. As for gross fixed capital formation, 60% of its error variance is explained by GDP and 29% by its own values. The shares estimated for GDP are 68% for its own values and 21% for gross fixed capital formation.

Graph 1. The d_IT response to impulses from d_IR, ld_GDP and ld_IT







Source: calculated by the authors using OECD data and the GRETL programme.

Table 4. The prediction error variance of model variables

	Shares in prediction error variance for d_IR			Shares in prediction error variance for ld_GDP			Shares in prediction error variance for ld_IT		
period	d_IR	ld_GDP	ld_IT	d_IR	ld_GDP	ld_IT	d_IR	ld_GDP	ld_IT
1	100	0	0	7.0236	92.9764	0	4.7392	42.9314	52.3294
2	88.2108	0.0163	11.7729	6.3291	93.6317	0.0392	3.5366	57.468	38.9954
3	77.8065	10.7623	11.4312	12.9474	86.3468	0.7058	8.666	57.6624	33.6715
4	76.9054	11.093	12.0016	12.2291	85.7291	2.0418	8.8147	60.6393	30.5461
5	77.4126	10.4183	12.1691	11.4367	81.7847	6.7786	8.5219	61.9238	29.5543
6	76.4882	10.2407	13.2711	11.0165	80.0244	8.959	8.4794	62.2458	29.2748
7	75.9044	10.9355	13.1601	11.0543	78.5961	10.3497	8.7603	62.4213	28.8184
8	75.7611	10.9012	13.3378	10.8551	77.1254	12.0195	8.7578	62.7463	28.4959
9	75.7308	10.8762	13.393	10.5293	75.4109	14.0599	8.6939	62.744	28.5622
10	75.6628	10.8477	13.4896	10.3124	74.0595	15.6282	8.6445	62.5995	28.756
11	75.6082	10.9079	13.4839	10.1737	73.0343	16.792	8.6457	62.5054	28.8489
12	75.6026	10.8888	13.5086	10.0552	72.1445	17.8004	8.6218	62.3995	28.9788
13	75.5817	10.8934	13.5249	9.9284	71.3222	18.7494	8.5999	62.2734	29.1267
14	75.5788	10.8877	13.5334	9.8314	70.6546	19.514	8.574	62.1321	29.294
15	75.5679	10.8937	13.5384	9.7558	70.1173	20.1268	8.5607	62.0252	29.4141
16	75.5699	10.8896	13.5405	9.6962	69.6793	20.6245	8.5451	61.9256	29.5292
17	75.5629	10.8907	13.5463	9.6428	69.3053	21.0519	8.5336	61.8403	29.626
18	75.5639	10.8896	13.5465	9.6003	69.002	21.3976	8.5214	61.7611	29.7175
19	75.5605	10.8901	13.5494	9.5659	68.7552	21.6789	8.5133	61.6991	29.7877
20	75.5615	10.8893	13.5492	9.5386	68.5564	21.9049	8.5054	61.6449	29.8496

Source: calculated by the authors using OECD data and the GRETL programme.

There are several conclusions that can be drawn from the above analysis. First, the ECB's reference rate seems to be more independent than GDP and gross fixed capital formation. The latter is more sensitive to changes in GDP than in the ECB's reference rate. Apart from that, this analysis confirmed the order of equations in the model.

The main research hypothesis tested in this paper is the following: the influence of the central bank's reference rate on investment outlays in the euro area is inversely proportional and statistically significant. The econometric model estimates obtained for the Eurosystem prove the hypothesis to be true.

Because of the context of this research it is necessary to note that business organisations make investment decisions under uncertainty about future demand for products, future costs (interest on loans or taxes), and future profits. Decisions on seeking funds to finance projects therefore depend on how organisations view long-term business prospects. More sophisticated econometric investment models consider capacity utilisation rates, the utilisation of fixed assets, foreign direct investment, and labour and investment costs.

A fact to be considered is that the level of investment outlays is affected by many economic factors and that investment cycles take a long time to complete, so delays in their implementation must be taken into account.

In designing its interest rate policy, the central bank considers various factors. Its interest rates influence banks' interest rates on business loans (an important element of investment costs). The banks' reaction to monetary policy largely depends on factors such as the liquidity of the banking sector, the level of competition in the financial services sector, the preferred maturity of credit arrangements, the diversity of interest rates, and risk premium or administrative costs. In general, many factors affect the effectiveness of central bank monetary policy by acting simultaneously on bank lending rates, and then on the real economy (including investments). This shows how important it is to study the relationship between the economic operators' investments and the central bank's reference rate.

The analysis of the monetary policy in the euro area showed that the banking sectors comprising the Eurosystem use different operational solutions relevant to their specific liquidity. The fact that euro-area countries are at different points of the economic cycle, and are therefore affected by asymmetric shocks, hinders the use of monetary policy tools such as a common interest rate and common exchange rate policy [Lorenzoni, 2010].

Conclusions

Many economists agree that the financial crisis brought long- and short-term interest rates down to historically low levels. In the wake of the crisis, central banks sharply cut their interest rates and introduced non-standard measures: ultra-low interest rates and large-scale asset purchases, also known as quantitative easing. In many cases, their intention was to exert downward pressure on long-term rates and risk premium. Many researchers expected the decisions would trigger a slow but steady improvement in the world economy [Danthine, 2013]. It turned out, however, that the low cost of capital was confronted by an aversion to investment caused by the financial crisis. Different assumptions adopted by researchers and different sample periods resulted in disparate conclusions being drawn about the impact of the central bank's interest rate on investment activity.

The financial crisis may have significantly reduced the ECB main interest rates' effect on investment outlays in the euro area. It is notable that in 1999–2016 only the ECB interest rate lagged by two quarters statistically significantly determined investment outlays in the euro area. This was despite some strong interference from factors influencing investment decisions and remaining outside the control by the monetary authorities (e.g. the financial crisis). The ECB reference rates lagged by one and three quarters proved statistically insignificant because investment decisions are determined by the expectations of real economic growth, the price of capital (Q-Tobin), corporate profits, the expected cost of capital, the amortisation of assets, and many other variables.

Summing up, the use of an econometric model made it possible to test the main research hypothesis stating that the ECB's reference rate (main refinancing operations interest rate) had an inversely proportional influence on investment outlays in the euro area in 1999–2016 and that this influence was statistically significant. As stated, the relationship between these two variables continued to be statistically significant, notwithstanding the impacts of a range of non-monetary factors. The results of this research investigating the impact of the ECB's interest rates on gross fixed capital formation in the euro area show that, although the rates can have a statistically significantly influence on investment outlays in the euro area, the influence and therefore the monetary policy's effect on the real economy can be largely reduced by factors uncontrolled by the central bank.

In view of the presented discussion, further research based on econometric investment models is strongly recommended. It should consider factors such as capacity utilisation rates, the utilisation of fixed assets, foreign direct investment, labour costs, and investment costs.

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Annex 1

Table 1. OLS estimation; N=68 observations from 2000:1–2016:4; lag order 3; dependent variable: d_IR

Variable	Coefficient	Standard error	t-Student	p-value	
d_IR~_1	–0.61726	0.118271	–5.219	2.44E-06	***
d_IR~_2	–0.5916	0.131564	–4.497	3.29E-05	***
d_IR~_3	–0.5777	0.119422	–4.837	9.81E-06	***
ld_GDP~_1	–36.6731	15.7163	–2.333	0.0231	**
ld_GDP~_2	0.139543	16.9252	0.008245	0.9934	
ld_GDP~_3	–15.2972	16.9615	–0.9019	0.3708	
ld_IT~_1	22.0104	6.88242	3.198	0.0022	***
ld_IT~_2	17.8991	7.16755	2.497	0.0153	**
ld_IT~_3	11.655	7.48154	1.558	0.1246	

R-square: 0.499019,
Adjusted R-square: 0.431089
F(9,59) 6.529869 P-value for F test: 2.13e-06
Residuals autocorrelation – rho1: 0.139393
Durbin-Watson Statistic: 1.717813
null hypothesis: the ARCH effect is not present
test statistics: LM = 2.72418
p-value = P(Chi-square (2) > 2.72418) = 0.256125
Ljung-Box Q' = 1.20213 with p value = P(Chi-square (2) > 1.20213) = 0.548

Source: calculated by the authors using OECD data and the GRETL programme.

Table 2. OLS estimation; n=68 observations from 2000:1–2016:4, lag order 3; dependent variable: ld_GDP

Variable	Coefficient	Standard error	t-Student	p-value	
d_IR~_1	–0.00317	0.001343	–2.359	0.0217	**
d_IR~_2	–0.00633	0.001494	–4.235	8.10E-05	***
d_IR~_3	–0.00315	0.001356	–2.319	0.0239	**
ld_GDP~_1	0.617611	0.178503	3.46	0.001	***
ld_GDP~_2	0.23695	0.192234	1.233	0.2226	
ld_GDP~_3	–0.07232	0.192646	–0.3754	0.7087	
ld_IT~_1	–0.01349	0.078169	–0.1725	0.8636	
ld_IT~_2	0.013596	0.081408	0.167	0.8679	
ld_IT~_3	0.106673	0.084974	1.255	0.2143	

R-square: 0.708114
Adjusted R-square: 0.668536
F(9,59) 15.90375P-value for F test: 8.12e-13
Residuals autocorrelation – rho1: 0.033062
Durbin-Watson statistics: 1.931959
null hypothesis: the ARCH effect is not present
test statistics: LM = 5.55338
p-value = P(Chi-square (2) > 5.55338) = 0.0622442
Ljung-Box Q' = 0.440728 with p value = P(Chi-square (2) > 0.440728) = 0.802

Source: calculated by the authors using OECD data and the GRETL programme.

Table 3. OLS estimation; n=68 observations from 2000:1–2016:4; lag order 3, dependent variable: ld_IT

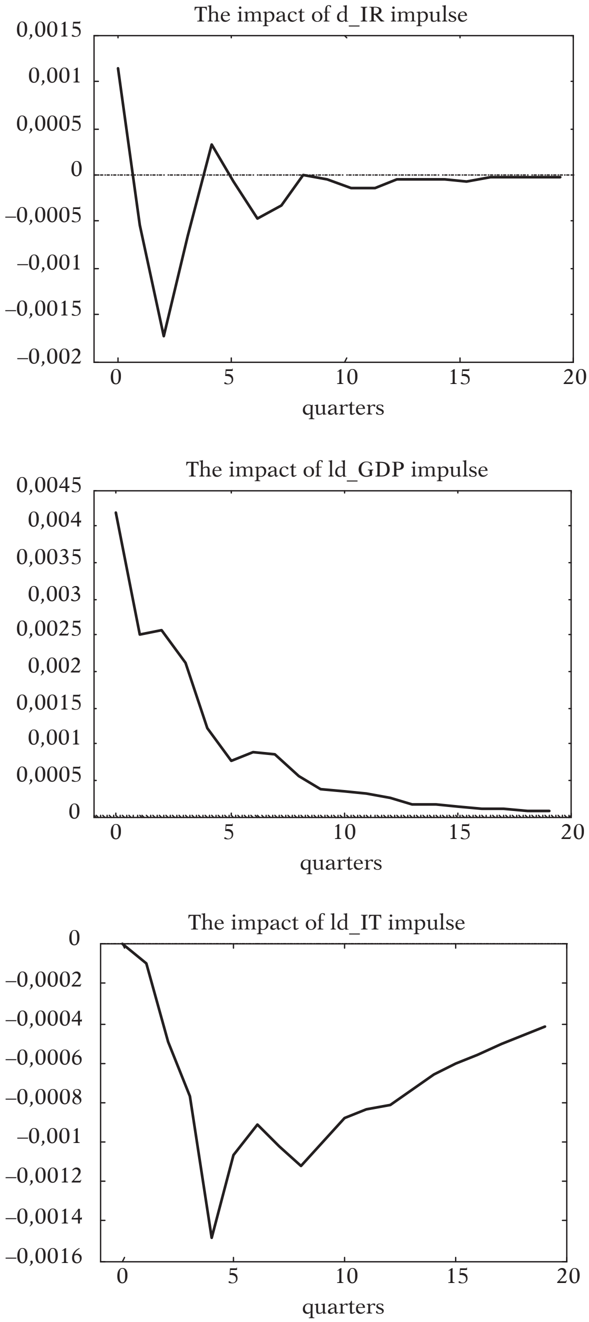
Variable	Coefficient	Standard error	t-Student	p-value	
d_IR~_1	–0.00513	0.003164	–1.62	0.1106	
d_IR~_2	–0.01149	0.00352	–3.264	0.0018	***
d_IR~_3	–0.00465	0.003195	–1.457	0.1505	
ld_GDP~_1	1.27496	0.420435	3.032	0.0036	***
ld_GDP~_2	–0.48476	0.452775	–1.071	0.2887	
ld_GDP~_3	–0.71525	0.453746	–1.576	0.1203	
ld_IT~_1	0.107274	0.184115	0.5826	0.5624	
ld_IT~_2	0.501946	0.191742	2.618	0.0112	**
ld_IT~_3	0.35285	0.200142	1.763	0.0831	*

R-square: 0.571747
Adjusted R-square: 0.513679
F(9,59) 8.752116 P-value for F test: 3.26e-08
Residuals Autocorrelation – rho1: 0.002674
Durbin-Watson statistics: 1.931959
null hypothesis: the ARCH effect is not present
test statistics: LM = 0.532071
p-value = P(Chi-square (2) > 0.532071) = 0.766412
Ljung-Box Q' = 0.290013 with p value = P(Chi-square (2) > 0.290013) = 0.865

Source: calculated by the authors using OECD data and the GRETL programme.

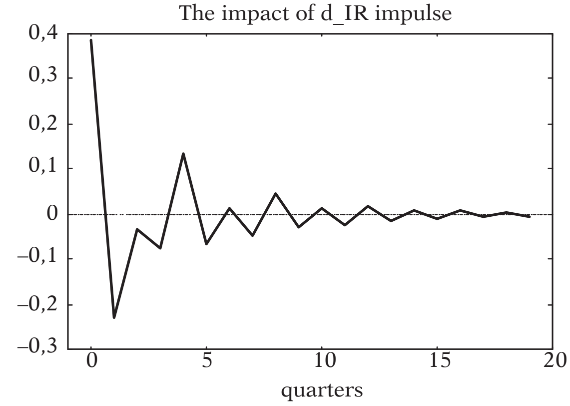
Annex 2

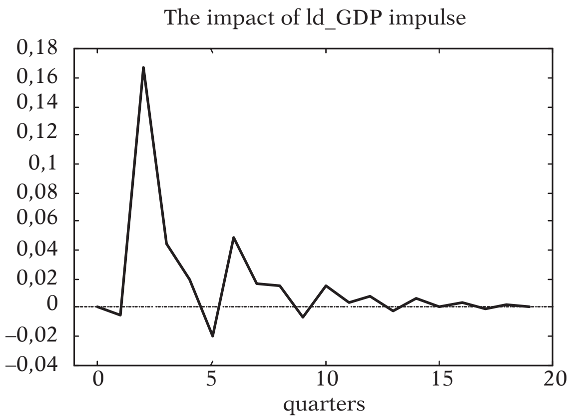
Graph A. The ld_GDP response to impulses from d_IR, ld_GDP and ld_IT

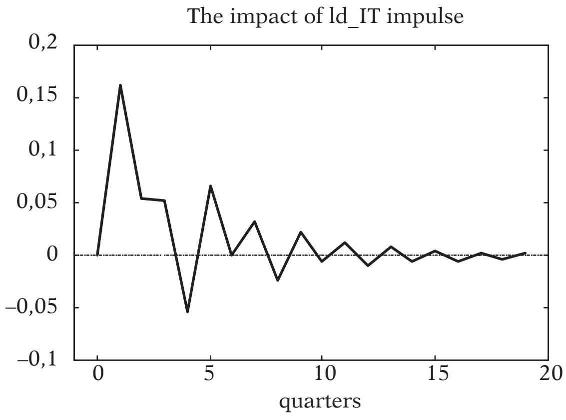


Source: developed by the authors using OECD data and the GRETL programme.

Graph B. The d_IR response to impulses from d_IR, ld_GDP and ld_IT







Source: developed by the authors using OECD data and the GRETL programme.

WPŁYW STÓP PROCENTOWYCH BANKU CENTRALNEGO NA INWESTYCJE W STREFIE EURO

Streszczenie

Głównym celem artykułu jest zbadanie wpływu stóp procentowych banku centralnego na inwestycje w strefie euro. Na podstawie przeprowadzonej analizy można wywnioskować, że stopa referencyjna ECB opóźniona o dwa kwartały miała odwrotnie proporcjonalny i statystycznie istotny wpływ na poziom inwestycji w strefie euro w latach 1999–2016. Powinniśmy pamiętać, że badany okres obejmuje silne zawirowania w gospodarkach strefy euro spowodowane przez ostatni kryzys finansowy, które w istotnym stopniu wpłynęły na osłabienie oddziaływania polityki monetarnej na sferę realną gospodarki. Pomimo tego w omawianym okresie zależność pomiędzy podstawową stopą EBC opóźnioną o dwa kwartały a inwestycjami była istotna statystycznie, co może wskazywać na to, że stopa procentowa w omawianym okresie miała znaczenie w procesie oddziaływania banku centralnego na inwestycje.

Słowa kluczowe: bank centralny, stopa procentowa, inwestycje, strefa euro, VAR

Kody klasyfikacji JEL: E22, E43, E52, E58, F33