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# The ECB's Unconventional Monetary Policy Effects on the Economies of Bulgaria and Ireland

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## Summary

This paper analyzes the impact of the ECB's euro short-term interest rate – the Euro overnight index average (EONIA) – on the long-term government bond yields in one economy in the non-euro area (Bulgaria) and one economy in the euro area (Ireland) through the interest rate transmission channel. The paper's main contention is that the ECB's non-standard monetary policy directly affects the euro area member states, such as Ireland. At the same time, its impact on the changes in the interest rates in Bulgaria is indirect.

The result from the econometric modeling demonstrates that if EONIA rises by 0.1 percentage point, the yields on the long-term government bonds in Ireland and Bulgaria will increase, respectively, by 0.175 and 0.123 percentage points. Given fixed levels of EONIA each month, the interest rates on the 10-year government bonds in Ireland and Bulgaria are expected to decline, respectively, by 0.006 and 0.036 percentage points. The large-scale bond-buying programmes and the negative deposit rates have driven significant increases in negative-yielding debt in the euro area, including in Ireland. In contrast, Bulgaria's long-term government bond yield is positive but dropped significantly during the reviewed period (January 2012 to December 2020).

**Keywords:** European Central Bank (ECB), Euro overnight index average (EONIA), Long-term government bond yields, Bulgaria, Ireland

**JEL:** E52, E58, G21, G28

## 1. Introduction

In June 2014, the ECB started a new phase of unconventional monetary policy in the euro area. It became the first major central bank to lower its deposit facility rate below zero – at -0.10%. It provided the additional accommodative monetary policy with close to zero or negative nominal interest rates.

Unlike the earlier phase of unconventional monetary policy which was aimed to relieve financial and sovereign stress triggered by crises, the new phase of this policy was initiated to address persistently weak growth prospects and the risk of a prolonged period

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of low inflation in the euro area (Varghese and Zhang, 2018, p. 4). The new monetary policy measures, including asset purchase programs, are aimed to increase credit supply to the private sector. At the same time, to stimulate economic activity, and support inflation expectations through various monetary policy transmission channels – signaling a channel, a credit or bank lending channel, and a portfolio rebalancing channel. Introducing unconventional monetary policy measures correlates with a decline in the interest rates (yields) on long-term government bonds and, in some cases, in credit spreads and exchange rates.

The main precondition for the choice of the two countries in the current analysis – Bulgaria and Ireland, is that they have a relatively similar economic development. The scope of the study is narrowed not only geographically, but also in relation to a single interest rate transmission channel of the unconventional monetary policy. This transmission monetary channel plays a major role in the EU member states and has been empirically confirmed by numerous studies.

The paper focuses on the interest rate transmission channel, particularly on the ECB's euro short-term interest rate – EONIA, and the 10-year government bond yields in Bulgaria and Ireland. These effects are somewhat new to the financial theory and practice and motivated the authors to contribute.

The structure of the paper is in section 2; the discussion centers on the critical developments in the ECB's interest rate policy. Section 3 presents a brief discussion of the relevant literature. Section 4 outlines the methodology and the data used for conducting the empirical analysis and econometric study. Section 5 is devoted to the discussion and results obtained from the empirical assessment of the impact of the euro short-term interest rate on the long-term government bond yields in Bulgaria and Ireland. This section also presents the results of all diagnostic tests of the constructed econometric models for Bulgaria and Ireland. Section 6 concludes the paper based on the summary of the results.

## 2. The ECB's interest rate and Unconventional Monetary policy

In the economic literature, there is no precise definition of the term "unconventional monetary policy". The term gathered momentum due to reference to monetary policy measures that are non-standard and unusual. There is no reference to the introduction of the exact date. However, it is permanency in the vocabulary of central bankers and economists, especially after the global financial crisis, which has led to unprecedented action by governments, central banks, and regulators.

González-Páramo (2009) points out that the central banks worldwide reacted to the global financial crisis by cutting interest rates and engaging in so-called "non-standard" monetary policy measures. So named because they go beyond changes in the interest rate, which is the traditional instrument used by central banks to manage monetary conditions in the economy. According to Trifonova S. et al. (2019, p. 20), purchases of assets, low nominal interest rates, i.e., a policy of zero, even negative nominal interest rates, and forward guidance are applied in the unconventional (non-traditional, non-standard) monetary policy. The problem dictates the introduction of such unconventional monetary measures given that, in a period of deep recession or economic crisis, the usefulness of conventional monetary instruments becomes limited. Bernanke (2017, p. 4) defines as non-standard monetary policy instruments – forward guidance, quantitative easing, negative rates, and yield curve control (i.e., targeting and managing longer-term bond yields). BIS (2019, p. 10) argues that unconventional measures target something other than short-term interest rates, unlike conventional monetary policy. Some unconventional monetary policy tools are designed to affect term spreads (or, equivalently, long-term risk-free rates).

In contrast, others influence liquidity and credit spreads (or, equivalently, interest rates on various non-risk-free instruments). Some tools aim to restore liquidity conditions and asset valuations in the financial system to support the monetary policy transmission mechanism. According to Schnabel (2020), the ECB tailored its non-standard measures to the structure of the euro area economy, where banks play a significant role in credit intermediation. In essence, this meant providing ample liquidity for a much more extended period than under the ECB's standard operations.

Following the deepening financial crisis in the autumn of 2008, the ECB pursued a lasting and consistent policy of lowering its key interest rates for the euro area, including targeting (a) the rate on the main refinancing operations, which provide the bulk of liquidity to the banking system; (b) the rate on the deposit facility, which banks may use to make overnight deposits with the Eurosystem; and (c) the rate on the marginal lending facility, which offers overnight credit to banks from the Eurosystem. In its interest-rate policy, the ECB followed the behavior of the U.S. Federal Reserve, which significantly reduced its key policy interest rates. Typically, lower favorable policy rates transmit to lower rates on both deposits and market-based short-term debt (Heider et al., 2019, p. 5).

The overall reduction in the ECB's key interest rates in 2008 alone was 175 basis points. In the first half of 2009, the ECB reduced the interest rate on its main refinancing operations by another 150 basis points (ECB, 2010, pp. 16-17). At the same time, the severe hampering of the functioning of the financial system led to the ECB adopting additional non-standard measures, thereby coping with dysfunctional money markets and facilitating the transmission of lower-key ECB interest rates to the money market and bank lending rates. All non-standard monetary policy measures adopted by the ECB have been temporary and designed to maintain price stability over the medium term both directly and indirectly by ensuring that inflation expectations remain firmly anchored in line with price stability.

Between October 2008 and May 2009, there was a reduction in the ECB's key interest rate on the main refinancing operations by a cumulative 325 basis points. The speed and extent of the ECB's monetary policy easing during this period was unprecedented. The ECB has been responsible for conducting monetary policy in the euro area since the beginning of 1999, a little over a decade. However, changes in interest rates of this magnitude remain remarkable, even if we look at other major central banks' much longer historical experience (González-Páramo, 2009). From the beginning of the global financial crisis until the first quarter of 2016, the ECB lowered the key interest rate 11 times by a cumulative 400 basis points up to 0%.

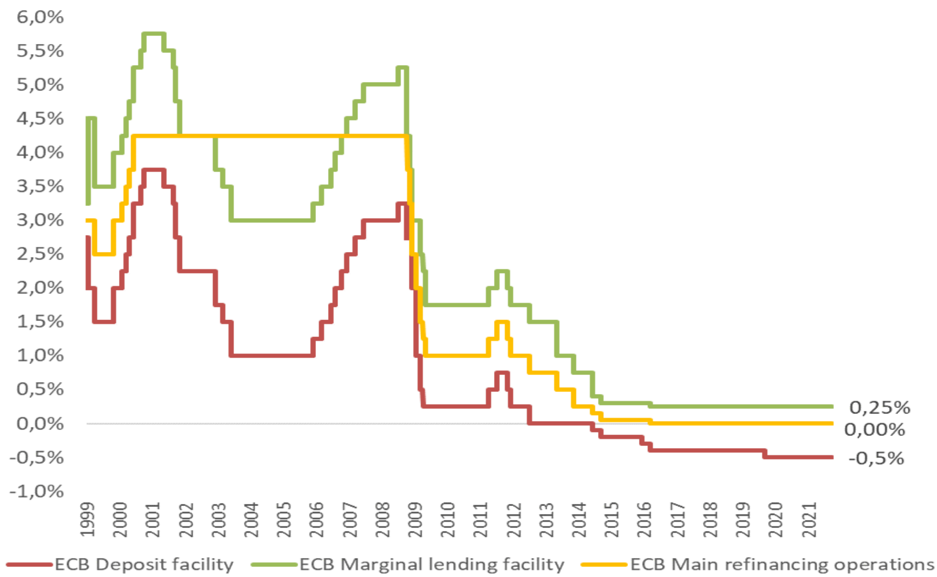
Before 2007, there was a widely held perception that policy rates must be positive, even those close to zero, and hence the reference to a zero lower bound (ZLB) for monetary policy (BIS, 2019, p. 11). When short-term interest rates reached the ZLB, the world's leading central banks introduced a negative nominal interest-rate policy (NIRP).

The NIRP is an unconventional monetary policy tool in which key nominal interest rates are set and maintained at a negative, below the theoretical lower limit of the interest rate, which is assumed to be zero. The negative nominal interest rates differ from the negative real interest rates obtained when considering the inflation rate. The Zero Interest Rate Policy (ZIRP) is an unconventional monetary policy tool in which the critical nominal interest rates of the central bank are lowered and maintained to or close to zero. The ZIRP considers that the central bank cannot lower interest rates further, limiting conventional monetary policy and making it ineffective. As a result, in exceptional circumstances, such as financial crises, the central bank may also directly influence the amount of money through asset purchase programs or quantitative easing (QE). BIS (2019, p. 11) explains that negative policy interest rates are unconventional as the owner of excess reserves incurs a cost for placing them with the central bank, overturning the usual pattern of interest payment flows in a monetary economy. They also imply a one-time broadening in perceptions of the range of possible rates, thus influencing the formation of agents' future rate expectations. Their implementation requires some adjustment of the operational details of the policy framework.

The ECB was the first central bank to set a negative rate on its deposit facility – "a step that no major central bank had taken in central banking history" (Rostagno et al., 2019, p. 18). The ECB's unprecedented move in June 2014 to lower the interest rate on overnight deposits from 0% to -0.10% was a direct attempt to stimulate bank lending in the euro area. Because the banks in the euro area held significant amounts of excess liquidity during this period, short-term market rates closely tracked the deposit facility rate, effectively making it the main policy rate. With this decision, the ECB ventured into negative territory for the first time in its history. At its meeting in September 2014, the Governing Council of the ECB lowered the negative interest rate on deposit facility to -0.20%. In March 2016, the deposit facility rate was reduced by ten basis points to -0.40%, and that of the marginal credit facility by five basis points to a level of 0.25%. With the introduction of a negative interest rate on the deposit facility, the ECB pursued two key objectives: first, to further lower money market interest rates, and second, to increase the circulation rate of excess reserves on the interbank market. Prerequisites for lower interest rates and the introduction of a negative interest rate are that the macroeconomic indicators continued to signal a slowdown in the euro area economic activity.

Along with falling inflation, there was a decline in inflation expectations in the medium term. The dynamics of economic indicators for the period was the main reason for adopting additional measures to lower interest rates and providing liquidity by the ECB in September 2014. The additional reduction in the interest rate on the main refinancing operations positively affected the conditions under which banks may borrow funds through the ECB's credit support programs (BNB, 2014).

The reduction in the ECB key interest rates led to a significant decline in the interbank interest rates in the euro area. As the ECB notes (ECB, 2021), market interest rates are directly influenced by the Governing Council's monetary policy measures. Constancio (2016) points out that the reduction in the ECB's overnight deposit facility rate to negative levels has led to a further decline in money market interest rates and has increased the circulation rate of excess reserves on the interbank market to banks experiencing liquidity shortages. While the interest rate on the main refinancing operations remained at 0%, the rate on the marginal lending facility was reduced to 0.25%. The negative rate on the deposit facility changed again from -0.40% to the record low -0.50% in September 2019. At the end of October 2021, the key ECB interest rates remain unchanged, intending to not rise until at least the end of 2022 (Figure 1). Ultimately, Schnabel (2020) observes that negative interest rates have become a standard tool in the ECB's toolkit over time, but they remain controversial in central banking circles and academia.




**Source:** ECB

**Figure 1.** Key ECB interest rates (%)

Implementing the new programmes and tools to provide additional liquidity while preparing the markets for the launch of QE was the primary response of ECB to the damaging global financial crisis of 2007-2008; the debt crisis in the euro area in 2012; the low inflation and the risk of deflation over a long period. The ECB introduced the following asset purchase programmes, which have been enriched over time and in practice from the QE that continue to be in place: Asset-Backed Securities Purchase Programme (ABSPP); Covered Bond Purchase Programme 1, 2, and 3 (the last of which is CBPP3); Corporate Sector Purchase Programme (CSPP); Public Sector Purchase Programme (PSPP).

These programmes form the ECB's Asset Purchase Programme (APP), which includes the Targeted Longer-Term Refinancing Operations (TLTRO I), launched in September 2014, and their second series, introduced in 2016 TLTRO II. In essence, designed TLTROs are credit support programmes that enhance the functioning of the monetary policy transmission mechanism by supporting bank lending to the real economy in the euro area by providing borrowing funds to banks on favorable terms (ECB, 2014). The borrowing conditions for TLTROs relate to the ECB's deposit facility rate (ECB, 2016). As Marinova (2016, p. 365) argues, the ECB's different programmes for buying private and public securities implemented since the beginning of the euro area debt crisis have been without any risk-related constraints. In an environment of low inflation, even deflation in some countries (like Greece, Portugal), investors have accumulated debt of EU periphery countries. They decreased nominal interest rates to levels prior to the introduction of the Euro. The decrease in prices augmented the real debt burden in many peripheral EU economies in terms of deflation. The real interest rate on government bonds has slowly declined, and interest rates in the EU periphery countries have become higher than those in the core euro area countries. Research carried out by Goldman and Zhang (2021, p. 202) finds that euro area GDP growth is still sluggish despite the monetary conventional and unconventional policies implemented since 2015.

## 3. Salient unconventional monetary policy discussion

Most research papers find that unconventional monetary policy lowers long-term government bond yields and mitigates market fragmentation in sovereign bond markets. For instance, ECB, 2000; Cúrdia and Woodford, 2011; Boeckx et al., 2014, Peersman, 2014; Fratzscher et al., 2014, 2016; Rogers et al., 2014; Altavilla et al., 2014; Janus, 2016; Varghese and Zhang, 2018; Strasser, 2018; Lane, 2019; BIS, 2019, to cite a few).

The ECB explains that the transmission mechanism primarily works in two broad stages (ECB, 2000, p. 43): In the first stage, changes in the policy interest rate or base money led to changes in financial market conditions, as reflected in market interest rates, asset prices, the exchange rate, and general liquidity and credit conditions in the economy. In the second stage, the changes in financial market conditions lead to households' and firms' nominal spending on goods and services. In the long run, such nominal changes may not affect the real sector of the economy but only the general price level. In the short run, however, changes in nominal spending may impact actual economic activity. Most economists point out that the transmission of monetary impulses runs primarily through interest rates and other financial prices and their effect on spending and inflation (ECB, 2000, p. 46). Also, the ECB states that the effects on financial markets and the aggregate economy change the ECB key interest rates depending on anticipatory moves and, more generally, on how it affects expectations of future interest rate decisions and future output and inflation. The ECB acknowledges that it is generally difficult to measure expectations or predict how they respond to the news. BIS (2019, pp. 8-9) also discusses the transmission chain of conventional monetary policy from the policy rate to financial conditions, including links related to short-term funding markets, to longer maturity bonds and bank funding and lending markets, exchange rates, and equity markets. The conditions are identified and met for the transmission chain to operate.

Strasser (2018, p. 5) also explains how the interest rate channel works. A change in official interest rates directly affects money market rates, followed by subsequent bank loans and deposits. There are more indirect effects on long-term market rates (expectations), affecting returns on savings and borrowing costs, thus spending and investment decisions of firms and households, and the price level. A change in discount factors may also affect asset prices and thus also spending and investment via wealth effects. Strasser (2018, p. 19) also points out the role of credit easing in the unconventional monetary policy interest rate transmission channel. The central bank aims to compress the spread between financing conditions in the capital market and borrowing conditions faced by individual borrowers in the market for individual loans. The mechanism is to target financial instruments with immediate influence on financial intermediaries' setting of credit conditions affecting portions of the banks' liability structures (central bank credit, wholesale funding), where the connection with the pricing of bank credit is closest.

Cúrdia and Woodford (2011) analyze the unconventional and traditional interest rate policies. They find that pure "quantitative easing" in the strict sense is likely to be ineffective, but that targeted asset purchases ("credit easing") by a central bank can instead be effective when financial markets are sufficiently disrupted. "Credit easing" is more likely to improve welfare at the interest rate zero lower bound. Unconventional policies are not perfect substitutes for interest rate policy.

According to BIS (2019, p. 17), the NIRP and other unconventional monetary policy tools have had a reasonably strong impact in lowering short- and long-term government bond yields, with yields becoming negative in several euro area countries. Unconventional monetary policies also have helped lower yields on corporate debt. In addition, BIS (2019, p. 2) finds that the NIRP effectively deals with lower bound events: long-term yields have adjusted downwards in line with expectations of future short-term rates, thus providing the desired expansionary stimulus. Although side effects, such as the compression of bank interest margins, have been detected, they have not posed a significant problem for banking stability to date. The offsets from other sources of income impacted the eventual recovery of bank portfolio values, including the declines in non-performing loans. That is why the BIS (2019) argues that the potential longer-term effects of a prolonged period of negative rates on financial intermediaries cannot be fully assessed based on recent experience.

Boeckx et al. (2014, p. 2) use the structural vector autoregressive (SVAR) model to examine the macroeconomic effects of ECB's interest rate policy changes. They argue that there is considerable agreement in the literature that a decline in the policy rate leads to a hump-shaped temporary rise in economic activity while prices increase persistently. However, in contrast, little is known about the effectiveness and pass-through of monetary policy measures that expand central bank balance sheets for a given policy rate. The authors estimate a benchmark monthly SVAR model for the euro area containing output, consumer prices, the policy rate, central bank total assets, the composed indicator of systemic stress. Moreover, the spread between the EONIA and the policy rate finds that an exogenous expansion in total assets leads to a significant but temporary rise in output and prices. The dynamic effects are very similar to those typically found in the literature on the conventional interest rate.

Cœuré (2017) focuses on two prime channels underlying the second stage of the ECB's transmission mechanism: the exchange rate channel and the real interest rate channel. He claims that these two transmission channels provide a good understanding of the effectiveness of recent policy measures. He finds that the ECB can stimulate aggregate demand by easing market-based financial conditions and putting downward pressure on the real interest rate that banks charge to borrowers, even when short-term interest rates approach the effective lower bound.

Peersman (2014, p. 7) points out that borrowing and lending in the euro area predominantly take place through the intermediation of the banking sector, in contrast to economies where securities markets play a crucial role in the funding of the private sector. The ECB's non-standard policy measures primarily aimed at fueling the banking system and even the limited outright purchases of covered bonds intend to improve bank funding conditions. The author finds that the unconventional monetary policy shocks are characterized by a significant shift in the monetary base or the balance of the Eurosystem's size of the significant impact on economic activity and inflation. He also finds that the transmission mechanism turns out to be different for both instruments.

Janus (2016) argues that the transmission channels of the standard interest rate policy are based on a set of theories that are relatively consistent and well documented. On the contrary, identifying such a framework for unconventional monetary measures proves to be a complex task. The author discusses three broad channels of the unconventional policies transmission mechanism: the signaling channel, the liquidity channel, and the portfolio-balance channel.

Lane (2019) studies the international transmission of the ECB's monetary policy. He indicates that global portfolio rebalancing is an important channel through which an asset purchase programme can stimulate the domestic economy and that its presence can influence the evolution of the trade balance. In particular, the impact of portfolio rebalancing on the EUR/USD exchange rate is quite powerful in reinforcing the monetary policy stimulus imparted by asset purchases. The author finds that the impact of the ECB's policy rate cuts on the euro exchange rate has intensified over time, especially since the deposit facility rate moved into negative territory in June 2014.

Fratzscher et al. (2014) study the impact of the central banks' unconventional monetary policies on financial markets and asset prices using daily data (high frequency). The authors highlight the importance of the sovereign credit risk channel due to ECB's programmes, the Securities Markets Programme (SMP), and Outright Monetary Transactions (OMT). These introduced ECB's programmes repair the transmission mechanism of monetary policy by containing sovereign risk premia that are considered excessive. In other words, ECB's policy indirectly target sovereign credit risk, following the ECB's assessment that the latter is not in line with fundamentals and reflected panic or unfounded fears of euro area break up, thereby impairing the transmission mechanism of the monetary policy. The author tests the impact of the ECB's monetary policy on sovereign credit risk by looking at sovereign credit default swaps (CDS) spreads.

Rogers et al. (2014) examine the effects of unconventional monetary policies by the U.S. Federal Reserve, the Bank of England, ECB, and the Bank of Japan on bond yields, stock prices, and exchange rates by using standard methodologies for the four leading central banks, with daily and intraday asset price data. They find that these unconventional monetary policies effectively ease financial conditions when policy rates are stuck at the ZLB, apparently primarily by reducing term premia. Altavilla et al. (2014) use high-frequency data and scenario analysis to suggest that the reduction in government bond yields, following the OMT announcements by the ECB, supports a significant increase in actual activity, credit, and prices in periphery economies in the euro area. At the same time, they observe a relatively muted impact on core euro area countries. Varghese and Zhang (2018, p. 5) aim to quantitatively analyze the transmission channels through which ECB's unconventional monetary policy affects financial markets. The authors extract monetary policy shocks from yield curves and decompose them into factors that capture signaling and portfolio rebalancing channels. They expect the signaling channel to stimulate aggregate demand by "signaling" ECB's commitment to maintaining an accommodative monetary policy stance over many years. The portfolio rebalancing channel works through market demand and supply of government securities; that is, through ECB's exchange of longer-term and relatively more minor liquid assets for very short-term and highly liquid central bank assets. The lowering long-term government bond yields raise riskier asset prices and pump excess liquidity into the market, which, in turn, strengthens balance sheet conditions, relax borrowing constraints, and ease credit availability for firms and households, and thereby stimulate spending (Varghese and Zhang, 2018, p. 5).

According to the ECB, government bond yields are leading indicators for financing conditions at the later stages of transmission (ECB, 2021). These are the critical benchmark rates used in pricing other capital market instruments – such as corporate and bank bonds – and the pricing of bank loans to households and firms. It follows that shocks originating in the government bond markets tend to trickle down the transmission chain and downstream influence indicators of financing conditions with a lag. Accordingly, developments in sovereign bond yields, measurable in real-time, could warn about potential developments in the later stages of the transmission chain with a lag (ECB, 2021). Moreover, longer-term sovereign yields are identified as prominent among the key variables used to evaluate financing conditions. They are also indicative of future changes in other components of the euro area financing conditions. The importance of government bond yields for the monetary policy transmission mechanism warrants an examination to assess the impact of the ECB's euro short-term interest rate on Bulgaria – a non-euro area member state, and Ireland – a euro area member state.

## 4. Methodology and Data

The methodology used warrants the construction of a linear econometric model aimed to evaluate the impact of the ECB's accommodative monetary policy at nominal interest rates, close to zero or even below zero on the long-term (10-year) Treasury bond yields in Bulgaria and Ireland.

The linear econometric model used monthly data from January 2012 to December 2020 (end of each month). The time series comprises 108 observations, which are sufficient for constructing econometric models and carrying out the necessary analysis. The observed period captures the unconventional monetary policy measures implemented by the ECB during their second phase. Furthermore, the econometric models are tested by various diagnostic tests for the presence of autocorrelation, autocorrelation in residuals, and the type of distribution of residuals.

A widespread benchmark used in financial markets is the 10-year maturity of central government bonds. The 10-year government securities are selected in the paper instead of other government bond maturities due to their role as widely accepted in the literature and practice benchmark of a country's yield and risk premium.

The data used was the Bulgarian 10-year government bond yield data from the Bulgarian National Bank (BNB)'s statistics and the Irish 10-year government bond yield data from the Central Bank of Ireland's statistics. The statistical software EViews, version 10, is applied.

## 5. Discussion and Results

The results are based on the impact of changes in the overnight money market index in the euro area – EONIA, on the yield on 10-year government securities in Bulgaria and Ireland in this section.

In this part, econometric models are constructed for estimating the impact of the ECB's unconventional monetary policy at nominal interest rates, close to zero or even below zero on the long-term (10-year) government bond yields in Bulgaria and Ireland during the period from January 2012 up to December 2020, by using monthly data (end of each month) with totally 108 months, included in the observations.

A two-step methodology is used to conduct the statistical analysis. First, it is checked whether EONIA is driven by a determinist (time) trend. The same exercise is then applied to 10-year government bond yields in Bulgaria and Ireland and econometric models are evaluated for both interest rates.

### 5.1. Impact of EONIA on the long-term government bond yields

EONIA's underlying interest is the rate at which banks of sound financial standing in the European Union (EU) and European Free Trade Area (EFTA) countries lend funds in the interbank money market in Euro. EONIA is the rate at which banks could lend or borrow in the money market the interbank exchange. Banks, together with other investors, engage in key intertemporal arbitrage activities to help bridge long-term government bond yields and the very short-term interest rates in fixed income markets – using lending and borrowing at various maturities. A key market in which this intertemporal arbitrage takes place is a particular segment of the interest rate swap market, the so-called overnight index swap (OIS) market, where the periodic floating payment in the swap contracts are indexed to the EONIA (Rostagno et al., 2019, p. 168).

Moreover, according to Rostagno et al. (2019, pp. 167-168), after the Lehman crisis, the euro area banking system was divided into two subgroups: "ostracized" and "non-ostracized" banks. The former group comprises credit institutions that either face systematic credit rationing in the interbank market or lack sufficiently liquid collateral to engage in market trading. These "ostracized" banks have become persistent bidders in the Eurosystem's lending operations because they have little or no access to alternative sources of funding. In fact, for them, the interest rate on the main refinancing operations is the marginal cost of funding and thus a good proxy for the prevailing monetary policy stance. However, for the "non-ostracized" banks, slow normalization of money market conditions has regained access to an interbank source of liquidity and has accumulated comfortably large amounts of reserves. The relevant metric for the prevailing stance is closer to the EONIA than to the main refinancing operations rate. These banks remain active participants in the money market.

The EONIA is a reference interest rate calculated daily as the weighted average of unsecured credit transactions concluded overnight in the EU and EFTA interbank money market. According to the methodology, EONIA is calculated by the ECB and published by the European Money Markets Institute (EMMI).

The EOINA index is the explanatory variable in the econometric model to examine its relationship with yields on 10-year government securities in Bulgaria and Ireland. The reasons for using EOINA are:

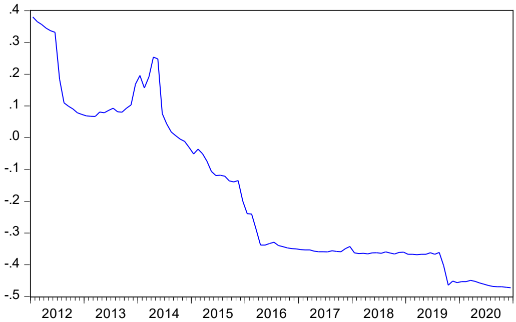
- EONIA is calculated based on concluded transactions, unlike other money market interest indices; for example, EURIBOR constitutes the basis of quotations.
- Tests made with other interest rates, for example, EURIBOR with different maturities (6 months, nine months) and the key interest rates of the ECB, do not give such good results compared to the results obtained when using EONIA for assessing the relationship with the long-term government bond yields in the selected countries.
- EONIA is published daily (overnight), making it possible to better capture the market's response to the impact of the ECB's monetary policy on the euro area and non-euro area Member States, but the EU and EFTA countries for which it is determined.
- EONIA is the basis for the interest rates on loans. The Euro short-term interest rate index change could quickly transfer to the loan price under the monetary policy's interest rate transmission channel.

Since 1 October 2019, EONIA has been calculated with a reformed methodology tracking the €STR, the new euro short-term rate of the ECB. The €STR reflects the wholesale Euro unsecured overnight borrowing costs of euro area banks. Prior to 1 October 2019, EONIA was computed as a weighted average of overnight unsecured lending transactions in the EU and EFTA interbank market. Under the reformed methodology, EONIA is calculated as the €STR plus a spread of 8.5 basis points. The spread calculated by the ECB on 31 May 2019 reflects the historical difference between the underlying interests of the two benchmarks: interbank lending rate for EONIA versus wholesale borrowing rate for the €STR.

### 5.2. Impact of EONIA on the long-term government bond yields in a NON-EURO Area State: Bulgaria

Figure 2 presents the dynamics of EONIA during the period January 2012 – December 2020. This figure demonstrates that the highest value of EONIA during the surveyed period in January 2012 is – 0.38%. There is a constant downward trend in EONIA, and even in October 2014, the value of the index became negative. The negative values remain until the end of the reviewed period, reaching in December 2020 to -0.472%.

As a result of the lowering of the ECB's key interest rates, the interest rates on deposits in Bulgaria have also shown a tendency to decrease gradually. Other factors for this trend have been the persistently high liquidity of the banking system, the high saving rate of households, the relatively weak demand for credit, and the indirect impact of the ECB's liquidity-providing policy through non-standard measures. Interest rates on bank loans in Bulgaria have also been declining due to the declining funding cost of banks (BNB, 2014, p. 8).




**Source:** ECB

**Figure 2.** Dynamics of EONIA during the period January 2012 – December 2020 (%)

In general, EONIA follows a straight-line development trend, gradually decreasing from January 2012 – December 2020.

The following linear econometric model established the relationship between EONIA (represented as the dependent variable) and the time:

$$EONIA_t = \beta_0 + \beta_1 . t + \varepsilon_t \qquad [1]$$

where:

$EONIA_t$ (Dependent variable) – Euro overnight index average.

$t$ (Independent variable) is for the time.

$\varepsilon_t$ is for the residual component.

Table 1 presents the results based on the econometric model assessed.

**Table 1.** Results from the econometric model for by EONIA by the Least squares method

Dependent Variable: EONIA
Method: Least Squares
Date: 11/05/21 Time: 10:57
Sample: 2012M01 2020M12
Included observations: 108

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.411678 | 0.023332 | 17.64459 | 0.0000 |
| T | -0.007485 | 0.000276 | -27.09785 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.873854 | Mean dependent var | -0.175919 |
| Adjusted R-squared | 0.872664 | S.D. dependent var | 0.250799 |
| S.E. of regression | 0.089496 | Akaike info criterion | -1.970911 |
| Sum squared resid | 0.849002 | Schwarz criterion | -1.921242 |
| Log likelihood | 108.4292 | Hannan-Quinn criter. | -1.950772 |
| F-statistic | 734.2937 | Durbin-Watson stat | 0.101374 |
| Prob(F-statistic) | 0.000000 | | |

**Source:** own estimations

The estimated model has the following analytical view:

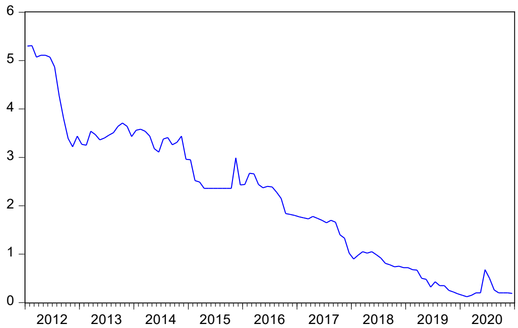
$$EONIA_t = 0.412 - 0.007 . t + \varepsilon_t \qquad [2]$$

The obtained results indicate that EONIA decreased each month on an average by 0.007 percentage points from January 2012 to

December 2020, making an average annual decrease by 0.09 percentage points.

Furthermore, the study investigated the relationship between EONIA and the long-term (10-year) government bond yield in Bulgaria, using monthly data (end of the month) from January 2012 to December 2020.

Figure 3 presents the dynamics of the 10-year Bulgarian government bond yield during the reviewed period.




**Source:** Eurostat

**Figure 3.** Dynamics of the 10-year Bulgarian government bond yield during the period January 2012 – December 2020 (%)

Figure 3 demonstrates that the yield on 10-year government securities in Bulgaria showed a declining trend from the beginning of 2012, when it had a value of the order of 5.3%, until February 2020, when it reached its lowest value of 0.12%.

A linear econometric model is used to describe the trend in the long-term government bond yield in Bulgaria. The relationship is as follows:

$$BG_t = \beta_0 + \beta_1 t + \varepsilon_t \qquad [3]$$

where:

$BG_t$ is the long-term government bond yield in Bulgaria.

$t$ is for the time.

$\varepsilon_t$ is for the residual component.

Table 2 presents the results obtained.

**Table 2.** Results of the evaluation of the trend model for the long-term government bond yield in Bulgaria by the Least squares method

Dependent Variable: BULGARIA
Method: Least Squares
Date: 11/05/21 Time: 11:06
Sample: 2012M01 2020M12
Included observations: 108

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 5.621605 | 0.086750 | 64.80257 | 0.0000 |
| T | -0.044352 | 0.001027 | -43.18305 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.946214 | Mean dependent var | 2.140000 |
| Adjusted R-squared | 0.945707 | S.D. dependent var | 1.428070 |
| S.E. of regression | 0.332754 | Akaike info criterion | 0.655516 |
| Sum squared resid | 11.73685 | Schwarz criterion | 0.705186 |
| Log likelihood | -33.39789 | Hannan-Quinn criter. | 0.675656 |
| F-statistic | 1864.776 | Durbin-Watson stat | 0.267201 |
| Prob(F-statistic) | 0.000000 | | |

**Source:** own estimations

The estimated model has the following analytical view:

$$BG_t = 6,622 - 0,044.t \quad [4]$$

The following conclusion from the obtained results is drawn: Bulgaria's long-term government bond yield decreased on average each month by 0.044 percentage points from January 2012 to December 2020, making an average annual decrease by 0.53 percentage points.

In order to avoid the false correlation, time is an additional factor in the constructed econometric model for the relationship between EONIA and the interest rate on Bulgaria's 10-year government bonds.

In this way, the following is the analytical form of the econometric model:

$$BG_t = \beta_0 + \beta_1 EONIA_t + \beta_2 t + \varepsilon_t \quad [5]$$

Table 3 presents the results obtained.

**Table 3.** Results from the econometric model of the relationship between the long-term government bond yield in Bulgaria and the time by the Least squares method

Dependent Variable: BULGARIA
Method: Least Squares
Date: 11/05/21 Time: 11:09
Sample: 2012M01 2020M12
Included observations: 108

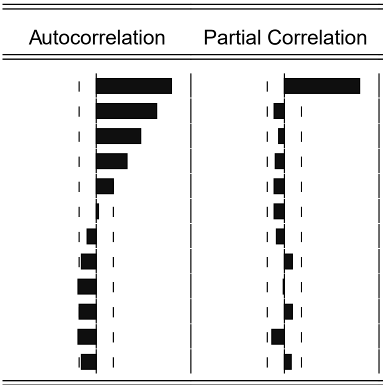
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 5.100794 | 0.162628 | 31.36472 | 0.0000 |
| EONIA | 1.265091 | 0.341200 | 3.707768 | 0.0003 |
| T | -0.034882 | 0.002732 | -12.76740 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.952441 | Mean dependent var | 2.140000 |
| Adjusted R-squared | 0.951535 | S.D. dependent var | 1.428070 |
| S.E. of regression | 0.314386 | Akaike info criterion | 0.550996 |
| Sum squared resid | 10.37806 | Schwarz criterion | 0.625499 |
| Log likelihood | -26.75376 | Hannan-Quinn criter. | 0.581204 |
| F-statistic | 1051.391 | Durbin-Watson stat | 0.293135 |
| Prob(F-statistic) | 0.000000 | | |

**Source:** own estimations

From the obtained results, the following are the main conclusions. First, the developed econometric model is adequate as by F-test $-\text{Prob}\left(\text{F} - \text{statistic}\right) < \alpha;$ where $\alpha = 0,05.$ The model has very high explicability $R^2 = 0.95.$95% of the changes in the interest rate on the long-term government securities in Bulgaria can be explained by changes in the two observed factors – EONIA and the time. In addition, each of these two factors has a statistically significant impact since the resulting significance level (probability.) is much lower than the error $\alpha$.

A serial autocorrelation test revealed the following results (Figure 4).



| Lag | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|
| 1 | 0.833 | 0.833 | 76.960 | 0.000 |
| 2 | 0.658 | -0.114 | 125.51 | 0.000 |
| 3 | 0.497 | -0.061 | 153.45 | 0.000 |
| 4 | 0.338 | -0.102 | 166.50 | 0.000 |
| 5 | 0.182 | -0.109 | 170.32 | 0.000 |
| 6 | 0.031 | -0.115 | 170.43 | 0.000 |
| 7 | -0.103 | -0.090 | 171.69 | 0.000 |
| 8 | -0.167 | 0.090 | 175.00 | 0.000 |
| 9 | -0.202 | -0.014 | 179.90 | 0.000 |
| 10 | -0.190 | 0.082 | 184.28 | 0.000 |
| 11 | -0.201 | -0.137 | 189.23 | 0.000 |
| 12 | -0.172 | 0.076 | 192.88 | 0.000 |

**Source:** own estimations

**Figure 4.** Autocorrelation plot of $\varepsilon_t$

In Figure 4, the first autocorrelation coefficient has a high value $r_1 = 0.833$ and is statistically significant (its probability. is lower than $\alpha = 0,05$). The second, third and fourth autocorrelation coefficients revealed a similar conclusion suggesting a need for employing a random component. Table 4 provides the results obtained after applying the procedure.

**Table 4.** Results and model evaluation after modeling the residual component between the long-term government bond yield in Bulgaria, EONIA, and time, in order to clear the serial autocorrelation

Dependent Variable: BULGARIA
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 11/05/21 Time: 11:14
Sample: 2012M01 2020M12
Included observations: 108
Convergence achieved after 11 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 5.227638 | 0.370440 | 14.11196 | 0.0000 |
| EONIA | 1.233516 | 0.548155 | 2.250307 | 0.0265 |
| T | -0.035946 | 0.005321 | -6.755765 | 0.0000 |
| AR(1) | 0.869627 | 0.051864 | 16.76730 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.986873 | Mean dependent var | 2.140000 |
| Adjusted R-squared | 0.986495 | S.D. dependent var | 1.428070 |
| S.E. of regression | 0.165960 | Akaike info criterion | -0.704740 |
| Sum squared resid | 2.864430 | Schwarz criterion | -0.605402 |
| Log likelihood | 42.05597 | Hannan-Quinn criter. | -0.664462 |
| F-statistic | 2606.263 | Durbin-Watson stat | 1.841904 |
| Prob(F-statistic) | 0.000000 | | |

| | |
|---|---|
| Inverted AR Roots | .87 |

**Source:** own estimations

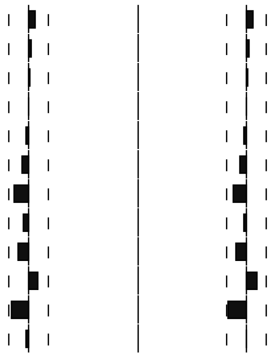
The results demonstrate that the constructed econometric model is adequate - $\text{Prob}(\text{F}-\text{statistic}) < \alpha$; where $\alpha = 0,05$. The model has very high explicability $R^2 = 0,99$. 99% of changes in the interest rate on 10-year government bonds in Bulgaria can be explained by changes in the two factors. In addition, these two factors have a statistically significant impact since the resulting significance level (probability.) is lower than the error $\alpha$.

The estimated econometric model has the following analytical view:

$$BG_t = 5.2276 + 1.2335.EONIA_t - 0.0359.t + 0.8696.\varepsilon_{t-1} \qquad [6]$$

The two main conclusions based on the results are: By increasing EONIA by 1 percentage point, the interest rate on the Bulgarian 10-year government bonds, ceteris paribus, will increase by 1.23 percentage points. Since the increase in EONIA by 1 percentage point in practice is considerable, for practical purposes, if EONIA rises by 0.1 percentage point, the interest rate on the long-term Bulgarian government bonds will increase by 0.123 percentage points.

Given fixed levels of EONIA each month, the interest rate on the Bulgarian 10-year government bonds is expected to decline by 0.036 percentage points. Figure 5 indicates the autocorrelation tests.




| | AC | PAC | Q-Stat | Prob* |
|---|---|---|---|---|
| 1 | 0.066 | 0.066 | 0.4765 | |
| 2 | 0.021 | 0.017 | 0.5267 | 0.468 |
| 3 | 0.015 | 0.013 | 0.5535 | 0.758 |
| 4 | 0.002 | 0.000 | 0.5541 | 0.907 |
| 5 | -0.025 | -0.026 | 0.6259 | 0.960 |
| 6 | -0.064 | -0.061 | 1.0987 | 0.954 |
| 7 | -0.136 | -0.128 | 3.2681 | 0.775 |
| 8 | -0.048 | -0.030 | 3.5372 | 0.831 |
| 9 | -0.106 | -0.098 | 4.8947 | 0.769 |
| 10 | 0.086 | 0.105 | 5.7970 | 0.760 |
| 11 | -0.159 | -0.176 | 8.8911 | 0.542 |
| 12 | -0.019 | -0.004 | 8.9357 | 0.628 |

**Source:** own estimations

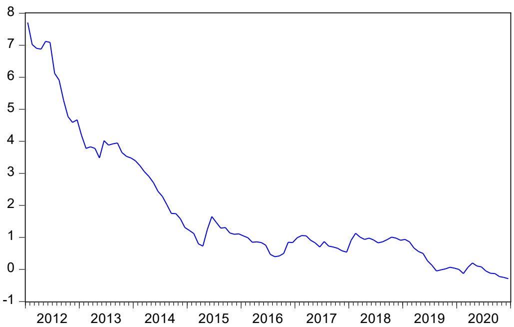
**Figure 5.** Autocorrelation plot of the random component in the final (transformed) econometric model for Bulgaria

The autocorrelation coefficients in the random component are low and are not statistically significant. In other words, the autocorrelation in the residual component is no longer an issue. The constructed econometric model for Bulgaria passes all basic diagnostic tests for serial autocorrelation.

## 5.3. Impact of EONIA on the long-term government bond yields in Euro area State: Ireland

This section provides an empirical analysis of the dynamics and relationship between EONIA and the interest rate on the Irish government's long-term (10-year) government securities. The period under study is again from January 2012 until December 2020, using monthly data with 108 months included in the observations. The impact of changes in the euro area overnight money market index (EONIA) on Ireland's 10-year government bond yield is studied.

Figure 6 presents the dynamics of the 10-year Irish government bond yield during the period January 2012 – December 2020.




**Source:** Eurostat

**Figure 6.** Dynamics of the 10-year government bond yield in Ireland during the period January 2012 – December 2020 (%)

The yield on long-term government securities in Ireland has been declining since the beginning of 2012, when it was about 7.7%, until December 2020, when it reached its lowest (negative) value of -0.29%.

A linear econometric model is used to describe the trend in the long-term government bond yield in Ireland. The relationship is as follows:

$$Y_t = \beta_0 + \beta_1 t + \varepsilon_t \qquad [7]$$

where:

$Y_t$ (Dependent variable) is the 10-year government bond yield in Ireland.

$t$ (Independent variable) is for the time.

$\varepsilon_t$ is for the residual component.

The same model was evaluated using the Least squares method, and the results obtained are presented (Table 5).

**Table 5.** Results of the evaluation of the trend model for the long-term government bond yield in Ireland by the Least squares method

Dependent Variable: IRELAND
Method: Least Squares
Date: 11/05/21 Time: 11:27
Sample: 2012M01 2020M12
Included observations: 108

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 6.031580 | 0.260287 | 23.17279 | 0.0000 |
| T | -0.053803 | 0.003082 | -17.45920 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.741982 | Mean dependent var | 1.808056 |
| Adjusted R-squared | 0.739548 | S.D. dependent var | 1.956335 |
| S.E. of regression | 0.998407 | Akaike info criterion | 2.853033 |
| Sum squared resid | 105.6625 | Schwarz criterion | 2.902702 |
| Log likelihood | -152.0638 | Hannan-Quinn criter. | 2.873172 |
| F-statistic | 304.8236 | Durbin-Watson stat | 0.043663 |
| Prob(F-statistic) | 0.000000 | | |

**Source:** own estimations

The estimated model has the following analytical view:

$$\widehat{Y}_t = 6.03 - 0.054.t \qquad [8]$$

Following the obtained results: Ireland's long-term government bond yield decreased on average each month by 0.054 percentage points from January 2012 to December 2020, making an average annual decrease by 0.65 percentage points.

Including time removed the problem of autocorrelation. The econometric model becomes:

$$Y_t = \beta_0 + \beta_1 EONIA_t + \beta_2 t + \varepsilon_t \qquad [9]$$

Table 6 presents the results of the model based on Ireland data.

**Table 6.** Results from the econometric model of the relationship between the long-term government bond yield in Ireland and the time by the Least squares method

Dependent Variable: IRELAND
Method: Least Squares
Date: 11/05/21 Time: 11:31
Sample: 2012M01 2020M12
Included observations: 108

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 3.584906 | 0.439151 | 8.163272 | 0.0000 |
| EONIA | 5.943167 | 0.921354 | 6.450473 | 0.0000 |
| T | -0.009316 | 0.007378 | -1.262791 | 0.2095 |

| | | | |
|---|---|---|---|
| R-squared | 0.815209 | Mean dependent var | 1.808056 |
| Adjusted R-squared | 0.811689 | S.D. dependent var | 1.956335 |
| S.E. of regression | 0.848947 | Akaike info criterion | 2.537745 |
| Sum squared resid | 75.67469 | Schwarz criterion | 2.612249 |
| Log likelihood | -134.0382 | Hannan-Quinn criter. | 2.567954 |
| F-statistic | 231.6051 | Durbin-Watson stat | 0.077464 |
| Prob(F-statistic) | 0.000000 | | |

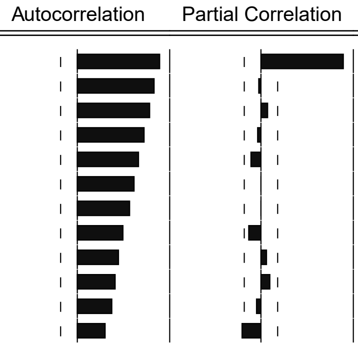
**Source:** own estimations

The conclusion is as follows. First, there is sufficient justification that the constructed econometric model is adequate with an F-test $\alpha = 0,05$. The model has very high explicability $R^2 = 0.815$. 81.5% of the changes in the interest rate on the long-term government securities in Ireland can be explained by changes in the two observed factors – EONIA and the time.

In addition, EONIA should have a statistically significant impact, as the resulting level of significance (prob.) is significantly lower than the accepted risk of error $\alpha$.

The autocorrelation coefficients in the random component are low and are not statistically significant. In other words, the autocorrelation in the residual component is no longer an issue.

The constructed econometric model for Ireland also passes all basic diagnostic tests for serial autocorrelation (Figure 7).




| | AC | PAC | Q-Stat | Prob |
|---|---|---|---|---|
| 1 | 0.932 | 0.932 | 96.436 | 0.000 |
| 2 | 0.865 | -0.024 | 180.38 | 0.000 |
| 3 | 0.813 | 0.071 | 255.14 | 0.000 |
| 4 | 0.759 | -0.037 | 320.96 | 0.000 |
| 5 | 0.694 | -0.107 | 376.51 | 0.000 |
| 6 | 0.635 | 0.005 | 423.44 | 0.000 |
| 7 | 0.583 | 0.007 | 463.45 | 0.000 |
| 8 | 0.516 | -0.141 | 495.14 | 0.000 |
| 9 | 0.461 | 0.061 | 520.66 | 0.000 |
| 10 | 0.426 | 0.095 | 542.68 | 0.000 |
| 11 | 0.387 | -0.053 | 560.99 | 0.000 |
| 12 | 0.319 | -0.212 | 573.56 | 0.000 |

**Source:** own estimations

**Figure 7.** Autocorrelation plot of $\varepsilon_t$

Figure 7 indicates that the first autocorrelation coefficient has a high value $r_1 = 0.932$ and is statistically significant (its probability. is lower than $\alpha = 0,05$). The second, third and fourth autocorrelation coefficients revealed a similar conclusion suggesting a need for employing a random component. Table 7 provides the results obtained after applying the procedure.

**Table 7.** Results and model evaluation after modeling the residual component between the long-term government bond yield in Ireland, EONIA, and time, in order to clear the serial autocorrelation

Dependent Variable: IRELAND
Method: ARMA Generalized Least Squares (Gauss-Newton)
Date: 11/05/21 Time: 11:35
Sample: 2012M01 2020M12
Included observations: 108
Convergence achieved after 20 iterations
Coefficient covariance computed using outer product of gradients
d.f. adjustment for standard errors & covariance

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 8.070924 | 2.044513 | 3.947602 | 0.0001 |
| EONIA | 1.750475 | 0.697446 | 2.509836 | 0.0136 |
| T | -0.060198 | 0.021682 | -2.776444 | 0.0065 |
| AR(1) | 0.993339 | 0.016460 | 60.34848 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.989516 | Mean dependent var | 1.808056 |
| Adjusted R-squared | 0.989214 | S.D. dependent var | 1.956335 |
| S.E. of regression | 0.203178 | Akaike info criterion | -0.273119 |
| Sum squared resid | 4.293256 | Schwarz criterion | -0.173781 |
| Log likelihood | 18.74842 | Hannan-Quinn criter. | -0.232841 |
| F-statistic | 3272.040 | Durbin-Watson stat | 1.594187 |
| Prob(F-statistic) | 0.000000 | | |

| | |
|---|---|
| Inverted AR Roots | .99 |

**Source:** own estimations

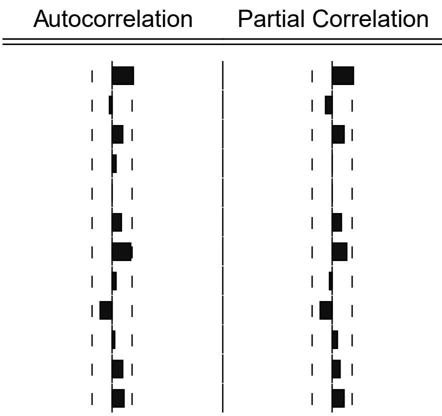
The results demonstrate that the constructed econometric model is adequate - $\text{Prob}\left(\text{F}-\text{statistic}\right)<\alpha$; where $\alpha=0,05$. The model has very high explicability $R^2=0,99$. 99% of changes in the interest rate on 10-year government bonds in Ireland can be explained by changes in both factors. In addition, these two factors have a statistically significant impact since the resulting significance level (prob.) is lower than the error $\alpha$.

The estimated econometric model has the following analytical view:

$$\widehat{Y}_t = 8.07+1.75.EONIA_t - 0.06.t + 0.99.\varepsilon_{t-1} \qquad [10]$$

Since the observed parameters can be considered statistically significant, the two main conclusions follow: By increasing EONIA by 1 percentage point, the interest rate on the Irish 10-year government bonds, ceteris paribus, will increase by 1.75 percentage points. Since the increase in EONIA by 1 percentage point in practice is substantial, for practical purposes, if EONIA rises by 0.1 percentage point, the interest rate on the long-term Irish government bonds will increase by 0.175 points. Given fixed levels of EONIA each month, the interest rate on the Irish 10-year government bonds is expected to decline by 0.006 percentage points.

In order to ensure the quality of the results obtained, the model will be checked for the presence of autocorrelation in the residuals and the type of distribution of residuals (Figure 8).




| | AC | PAC | Q-Stat | Prob* |
|---|---|---|---|---|
| 1 | 0.201 | 0.201 | 4.4820 | |
| 2 | -0.019 | -0.062 | 4.5226 | 0.033 |
| 3 | 0.091 | 0.113 | 5.4648 | 0.065 |
| 4 | 0.038 | -0.007 | 5.6281 | 0.131 |
| 5 | 0.003 | 0.007 | 5.6294 | 0.229 |
| 6 | 0.090 | 0.085 | 6.5660 | 0.255 |
| 7 | 0.178 | 0.147 | 10.294 | 0.113 |
| 8 | 0.035 | -0.025 | 10.437 | 0.165 |
| 9 | -0.113 | -0.122 | 11.983 | 0.152 |
| 10 | 0.031 | 0.053 | 12.101 | 0.208 |
| 11 | 0.099 | 0.073 | 13.307 | 0.207 |
| 12 | 0.112 | 0.110 | 14.871 | 0.188 |

**Source:** own estimations

**Figure 8.** Autocorrelation plot of the random component in the final (transformed) econometric model for Ireland

From Figure 8, the autocorrelation coefficients in the random component have low values and are generally not statistically significant. Once again, there is clearance of autocorrelation in the residual.

In conclusion, the constructed econometric model for Ireland has passed all diagnostic tests for serial autocorrelation.

## 6. Conclusion

The primary response from the ECB and other leading central banks to the global financial crisis is to lower key interest rates to unprecedented low levels, including negative nominal values, and to keep this trend for an extended period. Along with this measure, central banks have implemented a wide range of asset purchase programmes targeting the securities of various issuers, both public and private. Central banks provide credit support and future guidance on the monetary policy path. The combination of these non-standard instruments defines unconventional monetary policy as a contemporary variant of monetary policy.

The results of the econometric analysis confirm the central thesis of the study that the ECB's unconventional monetary policy affects the 10-year government bond yields in Bulgaria and Ireland through the interest rate transmission channel. The econometric modeling shows similar results for Bulgaria and Ireland. If EONIA increases by one percentage point, it is expected that in Ireland and Bulgaria, ceteris paribus, the yields on 10-year government bonds will increase, respectively, by 1.75 and 1.23 percentage points. The increase in EONIA by 1 percentage point is substantial. If EONIA rises by 0.1 percentage point, the yields on the long-term government bonds in Ireland and Bulgaria will increase, respectively, by 0.175 and 0.123 percentage points. Given fixed levels of EONIA each month, the interest rates on the 10-year government bonds in Ireland and Bulgaria are expected to decline, respectively, by 0.006 and 0.036 percentage points.

However, there are specific differences concerning the impacts of ECB's unconventional monetary policy on the euro area economy such as Ireland and non-euro area economy as Bulgaria.

While the ECB's monetary policy implications for the economy of Ireland are direct, for the Bulgarian economy, they are primarily indirect, passing through the interest rate transmission channel. In addition, the Bulgarian banking system dominated mainly by subsidiaries of European banks can directly benefit from the ECB's unconventional monetary policy measures by borrowing funds at low-interest record rates. The large-scale bond-buying programmes and the negative deposit rates have driven significant increases in negative-yielding debt in the euro area, including Ireland (to the lowest level of -0.29% in December 2020). In contrast, Bulgaria's long-term government bond yield is still positive but dropped significantly during the reviewed period (to the lowest level of 0.12% in February 2020). The favorable market conditions determine this, increased investors' interests in central government bonds, and the limited amount of Treasury bond issues in the primary auctions in Bulgaria.

The limitation of this study is that those general conclusions cannot be drawn based on the two-country data analysis.

## Acknowledgments

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## References

Altavilla, C., Carboni, G., and Motto, R., 2015. Asset purchase programs and financial markets: lessons from the euro area, ECB Working Paper Series No. 1864, Frankfurt am Main: European Central Bank, November, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1864.en.pdf [Accessed September 2021]

Altavilla, C., Giannone, D., and Lenza, M., 2014. The Financial and Macroeconomic Effects of the OMT Announcements, ECB Working Paper Series No. 1707, Frankfurt am Main: European Central Bank, August, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1707.pdf [Accessed September 2021]

Baumeister, C., and Benati, L., 2020. Unconventional monetary policy and the Great Recession. Estimating the impact of a compression in the yield spread at the zero lower bound, ECB Working Paper Series No. 1258, Frankfurt am Main: European Central Bank, October, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1258.pdf [Accessed September 2021]

BIS, 2019. Unconventional monetary policy tools: a cross-country analysis, Report prepared by a Working Group chaired by Simon M. Potter (Federal Reserve Bank of New York) and Frank Smets (European Central Bank), CGFS Papers No. 63, Committee on the Global Financial System, Basel: Bank for International Settlements, October, [online] Available at: https://www.bis.org/publ/cgfs63.pdf [Accessed September 2021]

Boeckx, J., Dossche, M., and Peersman, G., 2014. Effectiveness and transmission of the ECB's balance sheet policies, National Bank of Belgium Working Paper Series No. 275, December, [online] Available at: http://aei.pitt.edu/63428/1/WP275En.pdf [Accessed September 2021]

BNB, 2014. Impact of the ECB's monetary policy measures in 2014 on the financial market in the euro area and on the Bulgarian banking system, BNB Economic Review, Vol. 3/2014, Sofia: Bulgarian National Bank, pp. 23-29, [online] Available at: https://www.bnb.bg/bnbweb/groups/public/documents/bnb_publication/pub_ec_r_2014_03_bg.pdf [Accessed September 2021] (in Bulgarian)

Cœuré, B., 2017. The transmission of the ECB's monetary policy in standard and non-standard times, Speech by Benoît Cœuré, Member of the Executive Board of the ECB, at the workshop "Monetary policy in non-standard times", 11 September, Frankfurt am Main: European Central Bank, [online] Available at: https://www.ecb.europa.eu/press/key/date/2017/html/ecb.sp170911.en.html [Accessed September 2021]

Constancio, V., 2016. International headwinds and the effectiveness of monetary policy, Speech given at the 25th Annual Hyman P. Minsky Conference on the State of the U.S. and World Economies at the Levy Economics Institute of Bard College, New York: Blithewood, Annandale-on-Hudson, 13 April, [online] Available at: https://www.ecb.europa.eu/press/key/date/2016/html/sp160413.en.html [Accessed September 2021]

ECB, 2010. Annual Report 2009, European Central Bank, Frankfurt am Main, [online] Available at: https://www.ecb.europa.eu/pub/pdf/annrep/ar2009en.pdf [Accessed October 2021]

ECB, 2014. ECB announces further details of the Targeted Longer-Term Refinancing Operations, Frankfurt am Main: European Central Bank, 3 July, [online] Available at: https://www.ecb.europa.eu/press/pr/date/2014/html/pr140703_2.bg.html [Accessed September 2021]

ECB, 2016. ECB Press Release: Monetary policy decisions, Frankfurt am Main: European Central Bank, 10 March, [online] Available at:

https://www.ecb.europa.eu/press/pr/date/2016/html/pr160310.en.html [Accessed October 2021]

ECB, 2021. Meeting of 10-11 March 2021. Account of the monetary policy meeting of the Governing Council of the European Central Bank held in Frankfurt am Main on Wednesday and Thursday, 10-11 March 2021, Frankfurt am Main: European Central Bank, 10 March, [online] Available at: https://www.ecb.europa.eu/press/accounts/2021/html/ecb.mg210408~46b9deaa4a.en.html [Accessed October 2021]

EMMI, About EONIA, [online] Available at: https://www.emmi-benchmarks.eu/euribor-eonia-org/about-eonia.html [Accessed October 2021]

Fratzscher, M., Lo Duca, M., and Straub, R., 2016. ECB Unconventional Monetary Policy: Market Impact and International Spillovers, *IMF Economic Review*, 64 (1), Washington D.C.: International Monetary Fund, pp. 36-74.

Fratzscher, M., Lo Duca, M., and Straub, R., 2014. ECB unconventional monetary policy actions: market impact, international spillovers and transmission channels, paper presented at the 15th Jacques Polak Annual Research Conference, hosted by the International Monetary Fund, Washington D.C., 13-14 November, [online] Available at: www.imf.org/external/np/res/seminars/2014/arc/pdf/fratzscher_loluca_straub.pdf [Accessed October 2021]

Heider, F., Saidi, F. and Schepens, G., 2019. Life below zero: Bank lending under negative policy rates, The Review of Financial Studies, 32, pp. 3728-3761, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2173.en.pdf [Accessed October 2021]

Goldman, S., and Zhang, S., 2021. Monetary Policy within a COVID-19 Environment: The Role of Central Banks and the Main Challenges for the Euro-zone, *Economic Alternatives Journal*, Issue 2, pp. 197-212, [online] Available at: https://doi.org/10.37075/EA.2021.2.02 [Accessed October 2021]

González-Páramo, J. M., 2009. The response of the Eurosystem to the financial crisis, Speech by José Manuel González-Páramo, Member of the Executive Board of the ECB, Keynote Speech at the European Parliament's Special Committee on the Financial, Economic and Social Crisis (CRIS), Brussels, 10 November, [online] Available at: https://www.ecb.europa.eu/press/key/date/2009/html/sp091110.en.html [Accessed October 2021]

Cúrdia, V., and Woodford, M., 2011. The central-bank balance sheet as an instrument of monetary policy, *Journal of Monetary Economics*, Vol. 58(1), pp. 54-79, [online] Available at: https://doi.org/10.1016/j.jmoneco.2010.09.011 [Accessed February 2022]

Janus, J., 2016. The transmission mechanism of unconventional monetary policy, *Oeconomia Copernicana*, Vol. 7(1), pp. 7-21, [online] Available at: https://doi.org/10.12775/OeC.2016.001 [Accessed February 2022]

Lagard, C., and de Guindos, L., 2021. Monetary Policy Statement, Press Conference, Christine Lagarde, President of the ECB, Luis de Guindos, Vice-President of the ECB, Frankfurt am Main: European Central Bank, 28 October, [online] Available at: https://www.ecb.europa.eu/press/pressconf/2021/html/ecb.is211028~939f22970b.en.html [Accessed November 2021]

Lane, Ph. R., 2019. The international transmission of monetary policy, Keynote speech by Philip R. Lane, Member of the Executive Board of the ECB, CEPR International Macroeconomics and Finance Programme Meeting, [online] Available at: https://www.ecb.europa.eu/press/key/date/2019/html/ecb.sp191114~dbaf624e6a.en.html [Accessed September 2021]

Marinova, T., 2016. Comparative Study on Monetary and Fiscal Policy in the Eurozone and Bulgaria, *Economic Alternatives Journal*, Issue 3, pp. 367-378, [online] Available at: https://www.unwe.bg/uploads/Alternatives/9-Marinova_broi_3_2016-en.pdf [Accessed September 2021]

Peersman, G., 2011. Macroeconomic Effects of Unconventional Monetary Policy in the Euro area, ECB Working Paper Series No. 1397, Frankfurt am Main: European Central Bank, November, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1397.pdf [Accessed September 2021]

Rogers, J. H., Scotti, C., and Wright, J. H., 2014. Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Cross-Country Comparison, International Finance Discussion Papers No. 1101, Board of Governors of the Federal Reserve System (U.S.).

Rostagno, M., Altavilla, C., Carboni, G., Lemke, W., Motto, R., Guilhem, A. S. and Yiangou, J., 2019. A tale of two decades: the ECB's monetary policy at 20, ECB Working Paper Series No. 2346, Frankfurt am Main: European Central Bank, December, [online] Available at: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2346~dd78042370.en.pdf [Accessed October 2021]

Schnabel, I., 2020. Going negative: the ECB's experience, Speech by Isabel Schnabel, Member of the Executive Board of the ECB, at the Roundtable on Monetary Policy, Low Interest Rates and Risk Taking at the 35th Congress of the European Economic Association, 26 August, [online] Available at: https://www.ecb.europa.eu/press/key/date/2020/html/ecb.sp200826~77ce66626c.en.html [Accessed October 2021]

Strasser, G., 2018. The monetary policy transmission mechanism in the euro area, ECB Central Banking Seminar, 11 July, Frankfurt am Main: European Central Bank, [online] Available at: https://www.ecb.europa.eu/pub/conferences/shared/pdf/20180709_ecb_central_banking_seminar/2018-07-11_The_monetary_policy_transmission_mechanism_in_the_euro_area_-_Strasser.pdf [Accessed October 2021]

Trifonova, S., Trifonova, V., Atanassov, A., and Kolev, S., 2019. Status and impact of the unconventional monetary policy of the world's leading central banks for developed and developing countries, with emphasis on Bulgaria, Collective Monograph, Sofia: Publishing House – UNWE (in Bulgarian).

Varghese, R., and Zhang, Y.S., 2018. A New Wave of ECB's Unconventional Monetary Policies: Domestic Impact and Spillovers, IMF Working Paper, WP/18/11, January, Washington D.C.: International Monetary Fund.

Zahariev, A., Radulova, A., Aleksandrova, A., and Petrova, M. 2021. Fiscal sustainability and fiscal risk in the EU: forecasts and challenges in terms of COVID-19, Entrepreneurship and Sustainability Issues, Vol. 8, Issue 3, March, pp. 618-632, [online] Available at: https://doi.org/10.9770/jesi.2021.8.3(39) [Accessed September 2021]

Zahariev, A., Zveryakov, M., Prodanov, S., Zaharieva, G., Angelov, P., Zarkova, S., and Petrova, M. 2020. Debt management evaluation through support vector machines: on the example of Italy and Greece, *Entrepreneurship and Sustainability Issues,* Vol. 7, Issue 3, March, pp. 2382-2393, [online] Available at: https://doi.org/10.9770/jesi.2020.7.3(61) [Accessed September 2021]