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German Government Bond Yields During the COVID-19 Pandemic: Some Thoughts About Monetary Policy and the Term Premium

Christoph Schwarzbach, Anna Klippstein, Johannes Tholl and *Tobias Basse*

Abstract

During the COVID-19 pandemic, German short-term government bond yields seem to Granger cause long-term government bond yields. Moreover, by examining 2- and

Christoph Schwarzbach (corresponding author)
Europäische Fernhochschule Hamburg
Doberaner Weg 20
22143 Hamburg
Germany
and
Leibniz University Hannover
Königsworther Platz 1
30167 Hannover
Germany
Email: schwarzbach@iwi.uni-hannover.de

Anna Klippstein
Touro University Berlin
Am Rupenhorn 5
14055 Berlin
Germany

Johannes Tholl
Universität Bayreuth
Universitätsstraße 30
95447 Bayreuth
Germany

Tobias Basse
Norddeutsche Landesbank Girozentrale
Friedrichswall 10
30159 Hannover
Germany
and
Touro University Berlin
Am Rupenhorn 5
14055 Berlin
Germany

Duncker & Humblot · Berlin

30-year interest rates, feedback effects between the two time series can be detected. This is not the case when analyzing 2- and 10-year bond yields. As is widely known, long-term interest rates are particularly important for the European life insurance industry. Given the period examined here, possible explanations of these empirical findings should certainly not focus on changes to the key interest rates because these remained unchanged during the years 2020 and 2021. The unconventional monetary policy measures implemented by the ECB and the existence of risk premia seem to be more promising starting points when trying to understand the results reported here.

Zusammenfassung

In der Zeit der durch COVID-19 ausgelösten Pandemie lässt sich eine Granger-Kausalität von kurzfristigen Renditen deutscher Staatsanleihen für langfristige Renditen nachweisen. Es existiert zudem eine bidirektionale Granger-Kausalität zwischen den Zinsen der Laufzeitbereiche 2 und 30 Jahre. Dies gilt nicht für die Renditen von Anleihen mit einer Restlaufzeit von 2 und 10 Jahren. Die langfristigen Renditen sind bekanntlich von besonderer Bedeutung für europäische Lebensversicherer. Zur Erklärung dieser Beobachtungen sollte nicht auf Veränderungen des Leitzinsniveaus zurückgegriffen werden, da dieses im Betrachtungszeitraum konstant war. Die unkonventionellen geldpolitischen Maßnahmen der EZB und die Existenz von Risikoprämien könnten bessere Erklärungsansätze liefern.

1. Introduction

In contrast to the European Central Bank (ECB), the U.S. Federal Reserve (FED) had already successively increased its key interest rate level starting in 2015 and, therefore, prior to the COVID-19 crisis. The FED was reacting to the improved economic conditions in North America (see, for example, Kurov and Stan 2018; Cukierman 2019) and was forced to row back in response to the new crisis. In fact, the U.S. monetary policy stance again became highly accommodative in this situation (see, for instance, Levy and Plosser 2022; Yilmazkuday, 2022). In this context, it should not be surprising that U.S. monetary policy played an essential role for the economic conditions outside the U.S. borders (see, for example, Yilmazkuday 2022). As discussed in more detail later, the ECB also responded to the pandemic. However, due to the already extremely low interest rate levels in the European Monetary Union (EMU), the central bankers in Frankfurt had to resort to unconventional monetary policy measures. At the time, the interest rate environment in this currency area still seemed to be a result of the European sovereign debt crisis and, additionally, of concerns about redenomination risk (see, for example, Basse 2014; Sibbertsen, Wegener and Basse 2014). Without a doubt, this crisis was an important event for the EMU (see, amongst others, Gruppe and Lange 2014; Basse, Wegener and Kunze 2018).

Subsequently, we take a more detailed look at the interrelationships among interest rates with different maturities of German government bonds. More specifically, we focus on the yields of 2-year as well as 10- and 30-year German bonds. The latter two financial market time series are important for the European life insurance industry (see, among others, Rodriguez Gonzalez, Basse and Tholl 2019; Tholl et al. 2021). This is mainly due to the liability structure originating from the traditional life insurance business (see, for example, Basse et al. 2014; Berdin and Gründl 2015). Thus, this empirical study examines the term premium (see, amongst others, Gil-Alana and Moreno 2012; James, Leister and Rieger 2017) in some detail. The concept of the term premium is based on the idea that investors who purchase long-term fixed-income securities and do not plan to hold these bonds until maturity often are assumed to require a compensation for the interest rate risk. For instance, Walsh and Tan (2006) argued that the term premium would compensate buyers of long-term bonds for the added price uncertainty that arises from the possibility that these fixed-income securities must be sold on the secondary market before maturity. At this point, the preferred-habitat theory might be of relevance. According to this concept, bonds of different maturities are not perfect substitutes because some investors seem to prefer fixed-income securities with certain maturities (see, for example, Doh 2010; Strohsal 2017). This could clearly affect the respective bond yields. Blinder (2010) argued convincingly that the demand driven by asset managers with preferences for high-duration fixed-income securities might reduce long-term bond yields by shrinking the term premium. The existence of a positive term premium might offer attractive investment opportunities for life insurance companies. Given the structure of their liabilities, these firms should tend to buy long-term bonds and then plan to hold these securities until maturity. Phrased somewhat differently, buy-and-hold investors of this type usually do not sell long-term bonds before maturity and, therefore, could harvest the risk premium, called term premium, without having to take a corresponding risk. Given that Lempérière et al. (2017) stressed the need for additional research analyzing the determinants of risk premia in financial markets, our findings should be of interest in this regard. Generally speaking, the empirical research strategy applied here is based on Gunay (2020), who analyzed how credit and liquidity risk in the U.S. are related to each other using the concept of Granger causality (respectively, Granger non-causality). More specifically, we employ a specific variant of the traditional Granger causality test (see, for instance, Granger 1969; Granger 1980) to improve our understanding of the relationships between long-term and short-term interest rates. As will be discussed later in more detail, the approach used here to test for Granger causality is particularly suitable given the properties of the time series under investigation (see, most importantly, Toda and Yamamoto 1995). It has to be emphasized that our empirical research puts the pandemic at the center of interest.

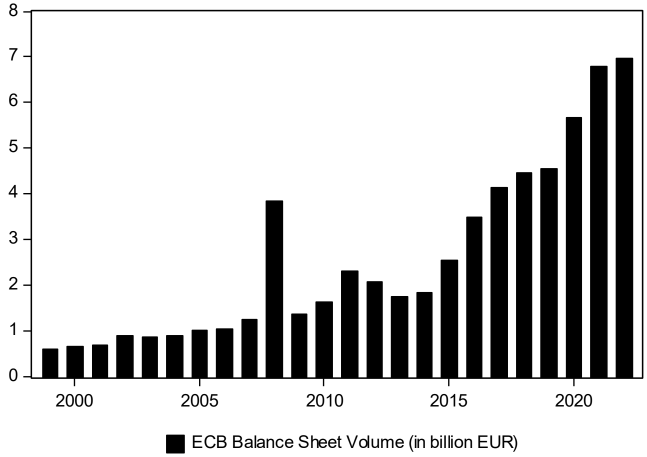
The paper is structured as follows: Section 2 analyzes some general issues focusing on the ECB's monetary policy and then examines the bank's response to the pandemic in some detail. This crisis burdened the European economy and presented a significant challenge for the ECB and other central banks. Given the focus of this empirical study, we are mainly interested in monetary policy issues that were relevant to the European fixed-income market. The 3rd section looks at the expectations theory of the term structure of interest rates, which serves as theoretical background for the subsequent empirical analysis. Section 4 then discusses the relevant methodological issues. Moreover, the data examined in this empirical study is presented here. Additionally, the results of unit root tests are reported in this section. Our findings are presented, discussed, and evaluated in the 5th section. The following section briefly examines questions linked to the issue of the stability of the results. Section 7 concludes.

2. The ECB and the COVID-19 Crisis

To limit the adverse economic consequences of the COVID-19 pandemic, European governments decided to use a wide range of fiscal policy measures and, as a consequence, implemented unprecedented rescue programs in order to shield the private sector from problems that otherwise could have had a lasting impact on global business activity (see, for example, Bergsen 2020; Zervoyianni, Dimelis and Livada 2023). In Europe and elsewhere, the need to respond to this crisis that affected both the supply and the demand side was seen. As a lesson learned from previous crisis events, policymakers reacted in a timely manner to the economic impact of the pandemic (see, most importantly, Haas et al. 2020). As mentioned above, the U.S. central bank – after already having raised the Fed Funds Target Rate after the end of the subprime mortgage crisis – was able to cut interest rates aiming to stimulate economic growth in North America. Moreover, the FED also decided to use quantitative easing instruments to try to stabilize the economy. The ECB at that time still needed to cope with the European sovereign debt crisis and, therefore, did not have much leeway to cut key interest rates. For this reason, the ECB also resorted to measures of quantitative easing (see, for example, Moessner and de Haan 2022; Quaglia and Verdun 2022) by announcing the so-called Pandemic Emergency Purchase Programme (PEPP). The goal of this non-standard monetary policy effort was to reduce borrowing costs of debtors and to increase the availability of credit in the common currency area in order to help stabilize economic activity and to avoid possible deflationary tendencies in the Euro Zone (see, amongst others, Quaglia and Verdun 2023; Tesche 2023). More specifically, it aimed to provide sufficient liquidity to foster lending among banks (see Aguilar et al. 2020). According to the point of view of Ortmans and Tripier (2021), these changes to the ECB's monetary policy at least helped to suppress a widening of interest rate spreads due to higher risk premia.

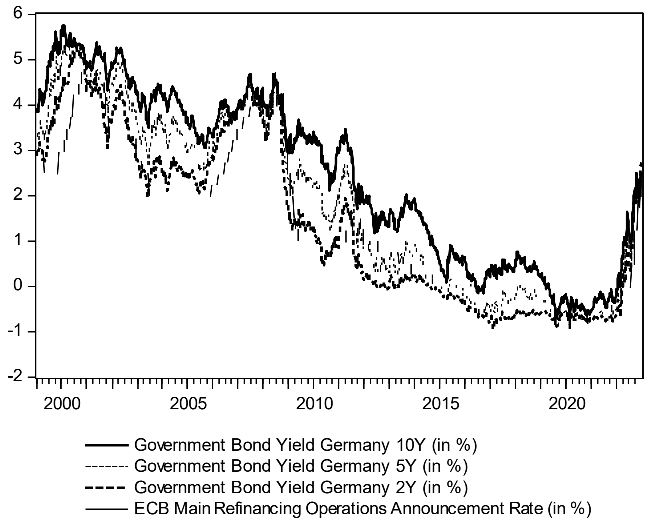
The program allowed the central bank to purchase different types of fixed-income securities issued by the private and public sectors. Accordingly, the adoption of this non-standard monetary policy measure by the ECB had implications for its balance sheet (see Chart 1), which expanded as a result of the security purchases (see, amongst others, Lyonnet and Werner 2012, Breedon 2014). Traditionally, monetary policymakers exert control over short-term interest rates, leaving the determination of the interest rate levels in the medium and longer maturity segments to the market. Meanwhile, central banks also seem to try to influence medium- and long-term interest rates directly by implementing quantitative easing measures (see, for instance, Martin and Milas 2012; Williamson 2016). In this context, the impact of a central bank's communication strategy on the effectiveness of its monetary policy is of particular importance. According to Phelps (1967), inflation expectations strongly affect inflation. Hence, central banks are keen on anchoring the long-term inflation expectations to their inflation targets and their mandates, respectively, which requires credibility (see, amongst others, Issing 2005). While recognizing the public demand for transparency regarding the communication policy of central banks, Issing (2005) points out that unlimited transparency is impossible to provide. It could even thwart the objective of making monetary policy understandable. As a general principle for a desirable degree of transparency, he argues that a central bank should be more transparent in its communication the more it takes discretionary decisions, which is to say, adhere to rules less. Moschella et al. (2020) claim that the ECB responded to public headwinds by widening its communication beyond its core mandate. Whether an increase in the complexity of the adopted monetary instruments also requires more transparency still needs to be analyzed.

As a result of the monetary policy measures that were used to contain the adverse economic effects of the pandemic, interest rates in the Euro Zone dropped to extremely low levels (see Chart 2). Due to the current developments regarding inflationary pressures in Europe, the central bank in Frankfurt was recently forced to raise key interest rates gradually and had to start the implementation of measures that will help to reduce its balance sheet volume.



Data: European Central Bank

Chart 1: Balance sheet volume of the European Central Bank



Data: Deutsche Bundesbank and European Central Bank

Chart 2: German government bond yields

3. The Expectations Theory of the Term Structure of Interest Rates

The expectations theory of the term structure of interest rates is important in the field of financial economics (see, for instance, Favero and Mosca 2001; Bulkley, Harris and Nawosah 2011). According to this theory, long-term and medium-term interest rates ought to be a function of the short-term interest rates expected to prevail in the period under investigation (see, most importantly, Russel 1992; Poole 2005). The simplest version of the expectations theory – which, for example, does not consider the existence of risk premia – implies that the 2-year bond yield should reflect what is happening in the market for 1-year bonds today and in the following year. In other words, the yearly 2-year bond yield *R2* ought to be closely related to the 1-year bond yields *R1* of different years (where E(·) is the expectations operator and t represents time in years):

$$(1) \qquad (1 + R2_t)^2 = (1 + R1_t) \times (1 + E(R1_{t+1})),$$

$$(2) \qquad 1 + 2 \times R2_t + R2_t^2 = (1 + R1_t) \times (1 + E(R1_{t+1})),$$

$$(3) \qquad 1 + 2 \times R2_t + R2_t^2 = 1 + E(R1_{t+1}) + E(R1_{t+1}) \times R1_t + R1_t \text{ and}$$

$$(4) \qquad 2 \times R2_t + R2_t^2 = E(R1_{t+1}) + E(R1_{t+1}) \times R1_t + R1_t.$$

This equation approximates to (see Choi and Wohar 1995):

$$(5) \qquad R2_t \approx (R1_t + E(R1_{t+1})) \;/\; 2\,.$$

More specifically, according to this version of the pure expectations theory of interest rates, the 2-year bond yield should equal the average of the present 1-year bond yield *R1* and the expected 1-year interest rate in the next year. Similarly, the current 10-year bond yield *R10* should reflect the expected path of the 1-year bond yields over the next 10 years (see, most importantly, Poole 2005). In fact, *R10* today should approximately equal:

$$(6) \qquad R10_t \approx (R1_t + E(R1_{t+1}) + E(R1_{t+2}) + E(R1_{t+3}) + \ldots + E(R1_{t+9})) \;/\; 10.$$

Focusing on 2-year bond yields, again rearranging Equation (5) yields:

$$(7) \qquad 2 \times R2_t \approx R1_t + E(R1_{t+1}),$$

$$(8) \qquad R2_t - R1_t \approx E(R1_{t+1}) - R2_t, \text{ and}$$

$$(9) \qquad R2_t - R1_t \approx (E(R1_{t+1}) - R1_t) \;/\; 2.$$

Assuming that interest rates are nonstationary variables that are integrated of order 1 (see, for example, Hall, Anderson and Granger 1992; King and Kurmann 2002), it can be argued that $E(R1t_{+1}) - R1_t = \Delta\ E(R1)$ therefore has to be a stationary time series. Thus, the right-hand side of Equation (9) is a stationary process, and – as a consequence – the two nonstationary time series R2 and R1 necessarily have to be cointegrated (see, for example, Hall, Anderson and Granger 1992; King and Kurmann 2002). At this point, it is relevant to note that the term cointegration describes a situation where a linear combination of two nonstationary variables integrated of order 1 exists that is stationary (see Engel and Granger 1987; Johansen 1988). In fact, Hall, Anderson and Granger (1992) stressed that the expectations theory of the term structure predicts cointegration among short-term (e.g., 2-year) and long-term bond yields (e.g., 10-year or 30-year bond yields). Additionally, the existence of a cointegration relationship between two variables also requires either bidirectional Granger causality or unidirectional Granger causality running from one time series to the other to exist (see, for example, Oxley 1993; Hendry and Mizon 1999). Thus, the theoretical ideas discussed in this chapter also show that employing the empirical research strategy suggested by Gunay (2020) makes sense given the presented research question.

Risk-averse investors who do not necessarily plan to hold long-term fixed-income securities until maturity should require an additional premium in order to be compensated for the risk that interest rates could rise in the future (see, amongst others, Cook and Hahn 1990; Walsh and Tan 2008). Adding a so-called term *TP* and again considering bonds with a maturity of 2 periods leads to (see Engle, Lilien and Robins 1987; Cook and Hahn 1990):

$$2 \times R2_t - R1_t - E(R1_{t+1}) \approx TP. \tag{10}$$

It can be seen that Equation (7) is just a special case of Equation (10), assuming that $TP = 0$.

4. Data and Methodological Issues

This empirical study examines government bond yields in Germany. More specifically, we analyze the relationship between short- and long-term interest rates in the biggest European economy. The main goal of this paper is to improve our understanding of the concept of the term premium. We examine 2-, 10-, and 30-year German government bond yields to achieve this. As mentioned, the last two variables are particularly important for European life insurers. The time series are taken from Deutsche Bundesbank. We examine weekly data and focus on the events around the global economic crisis that resulted from the COVID-19 pandemic. Consequently, our sample covers the time from 01/01/2020 to 12/22/2021. As will be discussed later in more detail, the chosen time period should help to avoid possible problems with structural change.

The procedure suggested by Phillips and Perron (1988) is used to test the null hypothesis that a unit root is present in the time series examined here. The respective results are reported in Table 1. While, according to the test, the two long-term interest rates are nonstationary and integrated of order 1, the 2-year German government bond yield appears to be a stationary time series. Given that only the 10- and 30-year interest rate time series seem to be nonstationary, the procedure developed by Johansen (1988) cannot be employed here to test for Granger causality.

Table 1

Results of the Phillips-Perron unit root tests

	Levels: Test Statistic	1% Level Critical Value	5% Level Critical Value	First Diff.: Test Statistic	1% Level Critical Value	5% Level Critical Value
2 Year	-4.628	-3.495	-2.890	-20.323	-3.495	-2.890
10 Year	-2.714	-3.495	-2.890	-11.583	-3.495	-2.890
30 Year	-2.601	-3.495	-2.890	-10.984	-3.495	-2.890

As already noted, our empirical research strategy follows Gunay (2020) and is based on the concept of Granger causality. One variable X is said to be Granger causing a second time series Y when past values of X can help to forecast future values of the variable Y (see, most importantly, Granger 1969; Granger, 1980). Phrased somewhat differently, X_t is not Granger causing Y_t if for all $n > 0$,

$$F(Y_{t+n} \mid \Omega_t) = F(Y_{t+n} \mid \Omega_t - X_t) \tag{11}$$

where F denotes the conditional distribution. In Equation (11), $\Omega_t - X_t$ is all potentially relevant information except X_t. Feedback effects among the two variables X_t and Y_t might exist. In this case, bidirectional Granger causality should be observable (see, for example, Tsen 2006; Amiri and Ventelou 2012). When one variable Granger causes the other variable but not vice versa, unidirectional Granger causality is said to exist. As noted before, the expectations theory of the term structure of interest rates predicts that short-term and long-term interest rates ought to be cointegrated when the bond yields examined are integrated of order 1. By now, it is known that cointegration among two variables requires the existence of either bidirectional or unidirectional Granger causality between these time series (see, most importantly, Granger 1988). Given that one of the variables (namely the 2-year bond yield) under investigation here appears to be stationary, while the other two seem to be nonstationary variables integrated of order 1, we employ the test for Granger causality (respectively Granger non-causality) suggested by Toda and Yamamoto (1995). This procedure seems to be well suited in this case. The approach is based on the concept of vector autoregressive models, which was introduced by Sims (1980).

Models of this type try to explain the *n* endogenous variables under investigation by past values of itself and of the remaining other variables examined. More formally, in Equation (12) Y_t is a vector of ($n1$) endogenous variables, A_i are ($n \times n$) coefficient matrices, C is a ($n \times 1$) vector of constants, and ε_t is an ($n \times 1$) vector of random disturbances:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t \,. \tag{12}$$

This approach is able to cope with possibly existing feedback effects among the examined variables. To test for Granger causality, Toda and Yamamoto (1995) suggested estimating a vector autoregressive model in levels considering p time lags and extending this model by m time lags to subsequently perform modified Wald tests to search for Granger causality, where m is the highest order of integration of any variable included in the model, and p is the optimal number of time lags to be considered when estimating the vector autoregression:

$$Y_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \cdots + A_{p+m} Y_{t-(p+m)} + \varepsilon_t \,. \tag{13}$$

Using this modified Wald test ensures that the test statistic is asymptotically chi-square distributed. At this point, it is vital to note that the Monte Carlo evidence presented by Zapata and Rambaldi (1997) seems to suggest that Granger causality tests based on the technique developed by Toda and Yamamoto (1995) show a good performance even for cointegrated systems examining samples with 50 or more data points. However, this procedure is known to be problematic when there is structural change (see, most importantly, Gormus, Nazlioglu and Soytas 2018). At this point, it is quite helpful that we examine data from the COVID-19 crisis period. As a matter of fact, shortening the sample under investigation can be a good empirical research strategy in order to cope with the problems that might result from structural change (see, amongst others, Beckmann, Menkhoff and Sawischlewski; 2006; as well as Tallman and Zaman 2020). Moreover, given that this crisis event seems to be a very unusual episode in financial history (not only from the viewpoint of monetary economics), examining data from a briefer observation period does not necessarily have to be disadvantageous and can even provide interesting insights.

5. Empirical Analysis

Given that our empirical study focuses on the term premium, we examine the relationship between 2-year and 10-year German government bond yields and 2-year and 30-year German government bond yields using the concept of Granger causality. The results of the Granger causality tests employing the technique suggested by Toda and Yamamoto (1995) are presented in Tables 2 and 3. More specifically, the likelihood ratio (LR) test is used to select the optimal lag order for the vector autoregressive models. In the case of 10-year bond yields, the number of time lags to be considered in the model is 4. The optimal number of time lags for the second model is 3. Then, the augmented vector autoregressions are estimated with 1 surplus time lag because the two long-term interest rate time series both seem to be nonstationary and integrated of order 1. As noted before, the reported probabilities are calculated using the asymptotic Chi-square distribution. The empirical findings are presented in Tables 2 and 3.

Table 2

Testing for Granger causality among 2- and 10-year German government yields

TY Granger Causality Tests Included observations: 99		
Dependent variable: 2 Year		
Excluded	Chi-sq	Prob.
10 Year	6.154518	0.1879
Dependent variable: 10 Year		
Excluded	Chi-sq	Prob.
2 Year	27.95452	0.0000

Table 3

Testing for Granger causality among 2- and 30-year German government yields

TY Granger Causality Tests Included observations: 100		
Dependent variable: 30 Year		
Excluded	Chi-sq	Prob.
2 Year	17.70371	0.0005
Dependent variable: 2 Year		
Excluded	Chi-sq	Prob.
30 Year	8.849693	0.0314

First, examining 2- and 10-year German government bond yields, the null-hypothesis of no Granger causality running from long-term to short-term interest rates cannot be rejected. However, 2-year German government bond yields seem to Granger cause 10-year German government bond yields (1 % significance level). Thus, there is empirical evidence for unidirectional Granger causality running from short-term to long-term interest rates. Phrased somewhat differently, the findings reported in Table 2 seem to imply that there is unidirectional Granger causality and that 2-year German government bond yields can help to forecast 10-year German government bond yields – but not vice versa. Using techniques of cointegration analysis, Lütkepohl and Reimers (1992) reported somewhat conflicting results examining U.S. interest rate data. Additionally, Basse et al. (2017) more recently showed that German long-term interest rates Granger cause U.S. short-term interest rates and that U.S. short-term interest rates do not Granger cause German long-term interest rates. To explain these interesting empirical findings, they argued that, assuming the existence of at least somewhat efficient markets, long-term interest rates should help to predict future short-term interest rates. Lütkepohl and Reimers (1992) stressed that the expectations theory predicts a relationship among bond yields that is compatible with the finding that long-term interest rates may contain useful information to forecast short-term interest rates and vice versa. This depends on further assumptions, and both cases can be plausible.

Examining 2- and 30-year German government bond yields, empirical evidence exists for Granger causality running from long-term to short-term interest rates and vice versa (see Table 3). Consequently, there seems to be bidirectional Granger causality between these two time series. Thus, 30-year German government bond yields seem to be helpful in forecasting 2-year German government bond yields, and 2-year German government bond yields also help to predict 30-year German government bond yields. In any case, our empirical findings still seem to be somewhat puzzling because, in the time period examined here (which is chosen according to economic theory in order to avoid possible problems with structural change), 30-year German government bond yields seem to be helpful forecasting 2-year bonds yields while 10-year bond yields are not. Additional empirical research is clearly needed. Generally speaking, the findings reported in Tables 2 and 3 seem to imply that for Germany, short-term interest rates can help to forecast long-term interest rates – at least during the time period under investigation here. This result, examining long-term interest rates, is very relevant for life insurance companies. Without a doubt, our empirical findings show that asset managers working in the European life insurance industry should still carefully analyze what is happening in the EMU money market. In fact, our results could be a consequence of monetary policy decisions. Kuttner (2001) argued convincingly that bond yields determined by forward-looking markets should respond very differently to anticipated and unanticipated elements of monetary policy actions. He noted that long-term interest rates, for example, only ought to react marginally – if at all – to anticipated key rate modifications. Given the period examined here, possible explanations of the results should not focus on such interest rate changes since they remained unchanged in 2020 and 2021 but rather on unconventional monetary policy measures implemented by the ECB. Monetary policymakers, for instance, could have tried not to let long-term interest rates diverge too much from short-term interest rates. Such a behavior of the ECB could help to explain why short-term bond yields seem to Granger cause long-term bond yields. Additionally, the ECB at the time made market participants believe that the key interest rates would remain near to or even below 0 % for many years. This fact might help to explain why 10-year German government bond yields did not Granger cause 2-year bond yields during the pandemic. While the existence of at least somewhat efficient markets supports the assumption that long-term interest rates are supposed to be helpful in predicting future short-term interest rates (see, most importantly, Basse et al. 2017), this effect, of course, only comes into play when investors have to expect future movements in short-term interest rates. But this is, of course, only one plausible explanation for our empirical findings, and there may also be other reasons. Particularly, the existence of risk premia might help explain the results reported above (see, most importantly, Hall, Anderson and Granger 1992). More specifically, the unconventional monetary policy measures implemented by the ECB and other central banks are supposed to affect risk premia and the investors' attitude towards risk (see, amongst others, Ireland 2015; Fassas, Papadamou, and Philippas 2019). Moreover, interest rate uncertainty among market participants might be reduced using these tools. In this context, the concept of quantitative easing is of crucial importance. As already noted, this approach is based on purchases of securities by a central bank and therefore affects the size of its balance sheet (see, for example, Lyonnet and Werner 2012; Breedon 2014). Quantitative easing measures mainly seem to have an impact on medium- and long-term interest rates and are supposed to influence the slope of the yield curve (see, for instance, Martin and Milas 2012; Williamson 2016). In other words, one intention is to change the term premium. As a result, the yield curve ought to become flatter. It could be argued that quantitative easing thus anchors long-term interest rates more strongly to the level of short-term interest rates. This might indeed help to explain the empirical findings reported above.

6. Some Thoughts About Stability

As already noted, shortening the examined sample should have helped to avoid major problems regarding structural change. This is important when using the technique developed by Toda and Yamamoto (1995) to test for Granger causality. However, from the perspective of an applied econometrician, there could be another relevant problem. Bierens (1997), for example, argued convincingly that it can be difficult to differentiate between stationary and nonstationary time series. Gil-Alana and Moreno (2012) also addressed this question.

Regarding the case under investigation here, it could, for instance, be possible that 2-year German government bond yields also are integrated of order 1. However, the results reported in Tables 2 and 3 would not be affected by this possible problem because m would still equal 1. In this case, it could be possible that 2-year and 10- or 30-year German government bond yields might be cointegrated. This would not be a serious difficulty either because it was already stressed that Zapata and Rambaldi (1997) reported that Granger causality tests based on the technique developed by Toda and Yamamoto (1995) seem to show a good performance even for cointegrated systems examining samples with 50 or more data points.

The importance of the precise period of time considered when analyzing the relationship between different interest rates was, for example, recently emphasized by Meier and Rodriguez Gonzalez (2023). It has already been suggested that structural breaks may have a significant impact on the stability of the linkages among the variables examined here. In fact, with other time periods under observation, the results also differ. Most importantly, when looking at data from early May 2004 to early September 2008 – and thereby focusing on a period in which the ECB continuously raised key interest rates – no Granger causality can be found between 2- and 10-year as well as 2- and 30-year German government bond yields when considering the typical significance levels commonly used in applied econometric work.[1] As already discussed earlier, these results obtained by analyzing more data seem to suggest that the phase of monetary policy in the EMU examined here in some detail (namely, the reaction of the ECB to the COVID-19 pandemic) is exceptional. Thus, our empirical findings may at least be taken as further evidence that the recent unconventional monetary policy measures implemented by the ECB had a noteworthy impact on the linkages between the money and the bond market of the EMU. In any case, further research seems to be recommendable at this point.

7. Conclusion

The empirical evidence reported above seems to imply that during the COVID-19 pandemic, German short-term government bond yields clearly seem

[1] In order to conserve space, no further details are discussed here. However, the results of the additional empirical investigations are available upon request. Moreover, we have to express our gratitude to a reviewer for suggesting to place more emphasis on this important issue.

to Granger cause long-term government bond yields. Moreover, examining 2- and 30-year interest rates, feedback effects between the two time series are detected. This is not the case for the analysis of 2- and 10-year bond yields. Given the period examined here, possible explanations of our empirical findings should not focus on changes to the key interest rates because these remained unchanged during the years 2020 and 2021. The unconventional monetary policy measures implemented by the ECB seem to be a more promising starting point when searching for possible ways to understand the results reported above. The central bank, for example, could have tried not to allow long-term bond yields to diverge too much from short-term interest rates. Such behavior of the monetary policymakers in Frankfurt might help explain why short-term interest rates seem to Granger cause long-term interest rates. In addition, at that time, the ECB sent out signals that made market participants expect very low key interest rates for a long time. This could explain the empirical finding that 10-year German government bond yields did not Granger cause 2-year bond yields during the pandemic. In principle, it can be argued that under the assumption of at least somewhat efficient markets, long-term interest rates should be helpful in forecasting future short-term interest rates (see, most importantly, Basse et al. 2017). Consequently, long-term bond yields ought to Granger cause short-term interest rates. However, this effect, of course, only comes into play when investors must expect future movements in short-term interest rates. Lütkepohl and Reimers (1992) stressed that the expectations theory predicts a relationship among bond yields that is compatible with the finding that long-term interest rates may contain useful information to forecast short-term interest rates and vice versa. This depends on further assumptions. Both cases might be plausible. Details can matter at this point, and the way monetary policy was conducted during the period under review here clearly can be regarded as exceptional. There may also be other possible explanations. The existence of risk premia, for example, could also matter (see, most importantly, Hall, Anderson and Granger 1992). The term premium is likely to be of particular relevance in this context. In any case, during the period under investigation here, it made sense for investors with a particularly strong exposure to Euro-denominated long-term bonds (e.g., European life insurance companies and pension funds) to keep an eye on short-term interest rates as well.

References

Aguilar, P./*Arce*, Ó./*Hurtado*, S./*Martinez-Martin*, J./*Nuño*, G./*Thomas*, C. (2020): The ECB monetary policy response to the Covid-19 crisis. Banco de Espana Documentos Ocasionales, No. 2026.

Amiri, A./*Ventelou*, B. (2012): Granger causality between total expenditure on health and GDP in OECD: Evidence from the Toda-Yamamoto approach. Economics Letters, 116, 541–544.

Basse, T. (2014): Searching for the EMU core member countries. European Journal of Political Economy, 34, 32–39.

Basse, T./*Friedrich*, M./*Kleffner*, A./*Schulenburg*, J. M. v. d. (2014): Are interest rates too low? Empirical evidence and implications for German life insurers. Zeitschrift für die gesamte Versicherungswissenschaft, 103, 31–43.

Basse, T./*Kunze*, F./*Krampen*, B./*Schwarzbach*, C. (2017): German bond markets and US monetary policy. Zeitschrift für die gesamte Versicherungswissenschaft, 106, 265–276.

Basse, T./*Wegener*, C./*Kunze*, F. (2018): Government bond yields in Germany and Spain – empirical evidence from better days. Quantitative Finance, 18, 827–835.

Beckmann, D./*Menkhoff*, L./*Sawischlewski*, K. (2006): Robust lessons about practical early warning systems. Journal of Policy Modeling, 28, 163–193.

Berdin, E./*Gründl*, H. (2015): The effects of a low interest rate environment on life insurers. Geneva Papers on Risk and Insurance, 40, 385–415.

Bergsen, P. (2020): A new political economy for Europe post-COVID-19. European View, 19, 131–137.

Bierens, H. J. (1997): Testing the unit root with drift hypothesis against nonlinear trend stationarity, with an application to the US price level and interest rate. Journal of Econometrics, 81, 29–64.

Blinder, A. S. (2010): Quantitative easing: entrance and exit strategies. Federal Reserve Bank of St. Louis Review, 92, 465–479.

Breedon, F. (2018): On the transactions costs of UK quantitative easing. Journal of Banking and Finance, 88, 347–356.

Bulkley, G./*Harris*, R. D./*Nawosah*, V. (2011): Revisiting the expectations hypothesis of the term structure of interest rates. Journal of Banking and Finance, 35, 1202–1212.

Choi, S./*Wohar*, M. E. (1995): The expectations theory of interest rates: Cointegration and factor decomposition. International Journal of Forecasting, 11, 253–262.

Cook, T./*Hahn*, T. K. (1990): Interest rate expectations and the slope of the money market yield curve. Federal Reserve Bank of Richmond Economic Review, 76, 3–26.

Cukierman, A. (2019): A retrospective on the subprime crisis and its aftermath ten years after Lehman's collapse. Economic Systems, 43, 100713.

Doh, T. (2010): The efficacy of large-scale asset purchases at the zero lower bound. Federal Reserve Bank of Kansas City Economic Review, 95, 5–34.

Engle, R. F./*Granger*, C. W. (1987): Co-integration and error correction: representation, estimation, and testing. Econometrica, 55, 251–276.

Engle, R. F./*Lilien*, D. M./*Robins*, R. P. (1987): Estimating time varying risk premia in the term structure: The ARCH-M model. Econometrica, 391–407.

Fassas, A./*Papadamou*, S./*Philippas*, D. (2019): Investors' risk aversion integration and quantitative easing. Review of Behavioral Finance, 12, 170–183.

Favero, C. A./*Mosca*, F. (2001): Uncertainty on monetary policy and the expectations model of the term structure of interest rates. Economics Letters, 71(3), 369–375.

Gil-Alana, L. A./*Moreno*, A. (2012): Uncovering the US term premium: an alternative route. Journal of Banking and Finance, 36, 1181–1193.

Gormus, A./*Nazlioglu*, S./*Soytas*, U. (2018): High-yield Bond and Energy Markets. Energy Economics, 69, 101–110.

Granger, C. W. (1969): Investigating causal relations by econometric models and cross-spectral methods. Econometrica, 424–438.

Granger, C. W. (1980): Testing for causality: a personal viewpoint. Journal of Economic Dynamics and Control, 2, 329–352.

Granger, C. W. (1988): Causality, cointegration, and control. Journal of Economic Dynamics and Control, 12, 551–559.

Gruppe, M./*Lange*, C. (2014): Spain and the European sovereign debt crisis. European Journal of Political Economy, 34, 3–8.

Gunay, S. (2020): Seeking causality between liquidity risk and credit risk: TED-OIS spreads and CDS indexes. Research in International Business and Finance, 52, 101189.

Haas, J./*Neely*, C. J./*Emmons*, W. R. (2020): Responses of international central banks to the COVID-19 crisis. Federal Reserve Bank of St. Louis Review, 102, 339–384.

Hall, A. D./*Anderson*, H. M./*Granger*, C. W. (1992): A cointegration analysis of treasury bill yields. Review of Economics and Statistics, 74, 116–126.

Hendry, D. F./*Mizon*, G. E. (1999): The pervasiveness of Granger causality in econometrics, in: Engle, R. F./White, H. (eds.), Cointegration, causality, and forecasting. Oxford University Press, Oxford, 102–34.

Ireland, P. N. (2015): Monetary policy, bond risk premia, and the economy. Journal of Monetary Economics, 76, 124–140.

Issing, O. (2005): Communication, transparency, accountability: monetary policy in the twenty-first century. Federal Reserve Bank of St. Louis Review, 87, 329–335.

James, J./*Leister*, M./*Rieger*, C. (2017): An empirical method of calculating the term premium. Quantitative Finance, 17, 1783–1793.

Johansen, S. (1988): Statistical analysis of cointegration vectors. Journal of Economic Dynamics and Control, 12, 231–254.

King, R. G./*Kurmann*, A. (2002): Expectations and the term structure of interest rates: Evidence and implications. Federal Reserve Bank of Richmond Economic Quarterly, 88, 49–95.

Kurov, A./*Stan*, R. (2018): Monetary policy uncertainty and the market reaction to macroeconomic news. Journal of Banking and Finance, 86, 127–142.

Kuttner, K. N. (2001): Monetary policy surprises and interest rates: Evidence from the Fed funds futures market. Journal of Monetary Economics, 47, 523–544.

Lemperiere, Y./*Deremble*, C./*Nguyen*, T. T./*Seager*, P./*Potters*, M./*Bouchaud*, J. P. (2017): Risk premia: Asymmetric tail risks and excess returns. Quantitative Finance, 17, 1–14.

Levy, M. D./*Plosser*, C. I. (2022): The Murky Future of Monetary Policy. Federal Reserve Bank of St. Louis Review, 104, 178–188.

Lütkepohl, H./*Reimers*, H. E. (1992): Granger-causality in cointegrated VAR processes The case of the term structure. Economics Letters, 40, 263–268.

Lyonnet, V./*Werner*, R. (2012): Lessons from the Bank of England on 'quantitative easing' and other 'unconventional' monetary policies. International Review of Financial Analysis, 25, 94–105.

Martin, C./*Milas*, C. (2012): Quantitative easing: a sceptical survey. Oxford Review of Economic Policy, 28, 750–764.

Meier, S./*Rodriguez Gonzalez*, M. (2023): Cointegration of EMU Government Bonds in Times of Financial Crises, COVID-19, and High Inflation – The Importance of Sovereign Debt for the European Insurance Industry. Zeitschrift für die gesamte Versicherungswissenschaft, 112, 181–212.

Moessner, R./*de Haan*, J. (2022): Effects of monetary policy announcements on term premia in the euro area during the COVID-19 pandemic. Finance Research Letters, 44, 102055.

Moschella, M./*Pinto*, L./*Martocchia Diodati*, N. (2020): Let's speak more? How the ECB responds to public contestation. Journal of European Public Policy, 27, 400–418.

Ortmans, A./*Tripier*, F. (2021): COVID-induced sovereign risk in the euro area: When did the ECB stop the spread?. European Economic Review, 137, 103809.

Oxley, L. (1993): Cointegration, causality and export-led growth in Portugal, 1865–1985. Economics Letters, 43, 163–166.

Phelps, E. S. (1967): Phillips curves, expectations of inflation and optimal unemployment over time. Economica, 34, 254–281.

Phillips, P. C./*Perron*, P. (1988): Testing for a unit root in time series regression. Biometrika, 75, 335–346.

Poole, W. (2005): Understanding the term structure of interest rates. Federal Reserve Bank of St. Louis Review, 87, 589–595.

Quaglia, L./*Verdun*, A. (2022): Explaining the response of the ECB to the COVID-19 related economic crisis: Inter-crisis and intra-crisis learning. Journal of European Public Policy, 30, 635–654.

Rodriguez Gonzalez, M./*Basse*, T./*Tholl*, J. (2019): Interest rate differentials and monetary policy in the European monetary union: the case of 10 and 30 year bonds. Zeitschrift für die gesamte Versicherungswissenschaft, 108, 19–42.

Russell, S. (1992): Understanding the term structure of interest rates: The expectations theory. Federal Reserve Bank of St. Louis Review, 74, 36–50.

Sibbertsen, P./*Wegener*, C./*Basse*, T. (2014): Testing for a break in the persistence in yield spreads of EMU government bonds. Journal of Banking and Finance, 41, 109–118.

Strohsal, T. (2017): Bond yields and debt supply: new evidence through the lens of a preferred-habitat model. Quantitative Finance, 17, 1509–1522.

Tallman, E. W./*Zaman*, S. (2020): Combining survey long-run forecasts and nowcasts with BVAR forecasts using relative entropy. International Journal of Forecasting, 36, 373–398.

Tesche, T. (2023): Trustee strategies, politicization and de-delegation: The case of the European Central Bank. Governance, 36, 125–140.

Tholl, J./*Basse*, T./*Meier*, S./*Rodriguez Gonzalez*, M. (2021): Risk premia and the European government bond market: new empirical evidence and some thoughts from the perspective of the life insurance industry. Zeitschrift für die gesamte Versicherungswissenschaft, 110, 49–78.

Tsen, W. H. (2006): Granger causality tests among openness to international trade, human capital accumulation and economic growth in China: 1952–1999. International Economic Journal, 20, 285–302.

Walsh, K./*Tan*, D. (2008): Monetary policy surprises and the bank bill term premium. Australian Journal of Management, 33, 231–260.

Williamson, S. D. (2016): Scarce collateral, the term premium, and quantitative easing. Journal of Economic Theory, 164, 136–165.

Yilmazkuday, H. (2022): COVID-19 and exchange rates: Spillover effects of U.S. monetary policy. Atlantic Economic Journal, 50, 67–84.

Zapata, H. O./*Rambaldi*, A. N. (1997): Monte Carlo evidence on cointegration and causation. Oxford Bulletin of Economics and Statistics, 59, 285–298.

Zervoyianni, A./*Dimelis*, S./*Livada*, A. (2023): Economic Sentiment and the Covid-19 Crisis: Evidence from European Countries. Applied Economics, 55, 113–130.