Are lower interest rates really associated with higher growth? New empirical evidence on the interest rate thesis from 19 countries

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Abstract

There is a substantial literature on the link between finance and growth. Empirical evidence remains inconclusive and the debate continues. In this paper we adopt the research strategy of focusing on a narrower underlying issue that remains at the core of most macroeconomic theories, namely the interest rate thesis (that lower rates result in higher growth and vice versa). If there are issues with this relationship, this could explain the lack of consensus on the finance-growth nexus. The question is also of practical relevance: Central banks have been focusing on interest rate policy on the assumption that the interest rate thesis holds. There are theoretical reasons why this may not be the case. We conduct an analysis of time-varying dynamic conditional correlation in a GARCH model and of the direction of statistical causation between nominal interest rates and real economic activity in 19 industrialised and emerging economies. We find evidence that interest rates are not negatively correlated with economic growth and do not cause growth. Instead, we find evidence that the relationship may be the opposite in both dimensions. This adds to recent doubts about the prevailing conduct of monetary policy and common theoretical models. Specifically, lowering interest rates may be counter-productive.

Keywords: forecasting; GARCH models; interest rates and economic activity; monetary policy; time-varying dynamic conditional correlation; disequilibrium; rationing; credit;

JEL Classification: E43; E50; G20

Running head: Verdict on the interest rate thesis from DCC GARCH & Granger causality

1. Introduction

Since 2008, central banks have repeatedly reduced nominal policy interest rates, even to zero or negative territory, in an attempt to stimulate real economic activity. Meanwhile, bond yields have also fallen towards zero or beyond, at least partly influenced by central bank action. In May 2020, the UK government joined many European governments and Japan as it sold its first government bond with a negative yield. More recently, there are worries that rate rises may dampen economic growth. While such low or negative interest rates appear to have contributed to asset price bubbles, the impact on economic growth remains unclear.

The role of interest rates in the economy has long been considered self-evident (Woodford, 2003). Bernanke and Blinder (1992) argued that the short-term nominal interest rate is the best indicator of monetary policy. This was supported by Taylor (1993) for the US. As Cecchetti (2000) summed it up: "a central banker moves interest rates" (p. 43), whereby lower rates are thought to boost economic activity and/or inflation, while the reverse is thought to hold for raising rates. This interest rate thesis has been well established since the early 1980s, as illustrated by Chimerine (1985) who, among similar voices, warned that US growth would slow due to rising interest rates, while a continuation of economic growth required lower interest rates. The interest rate thesis is also deployed in dynamic stochastic equilibrium models, such as Keen's (2009) or dynamic panel studies on the link between financial development and growth, which propose an inverse correlation between interest rates and growth and causation from rates to growth (e.g. Swamy, 2018).

Even quantitative monetary policy since September 2008 has mainly been evaluated by researchers as to its effectiveness in lowering interest rates, while taking for granted that such interest rate reductions would be positive for the economy (see, for instance, Eggertsson and Woodford, 2003; Okina and Shiratsuka, 2004; Gagnon et al., 2011; Glick and Leduc, 2012; Joyce et al., 2012; Christensen and Krogstrup, 2019; Guo et al., 2020).

However, the success of the longstanding policy of lowering rates in stimulating the economy is in dispute: Federal Reserve economists raised doubts about the wisdom of extremely low interest rates (Kliesen, 2011). Nucera et al. (2017) found that negative rates may affect banks negatively, which in turn could harm the economy. Summers warned in 2019 that

> “reducing interest rates may not be merely insufficient, but actually counterproductive” (Summers and Stansbury, 2019).[1]

Senior monetary policy-makers, such as Dame Kate Barker, have also expressed their doubts. Having been a member of the Bank of England Monetary Policy Committee for a number of years, in 2019 Dame Kate reflected on her work as central bank interest rate setter and concluded:

> “I have come to wonder about my time at the Monetary Policy Committee setting interest rates. It’s been a bit of a waste of time, really” (Barker, 2019).

Already earlier, King and Watson (1996) reported with some puzzlement that nominal rates and economic activity were in fact positively correlated in the US, noting that the relationship of interest rates to the business cycle is a disputed topic in macroeconomics (p. 35). Their work however assumed constant correlation and did not deploy a dynamic conditional correlation analysis. Furthermore, their findings did not spawn suitable careful multi-country empirical studies. However, other puzzles in the literature on economic growth remind us that even basic relationships should be empirically tested.[2]

Already Taylor (1999) called for new research, noting that

> “Given the importance in the transmission mechanism, it is not surprising that the presence of a fairly strong link between real interest rates and real macroeconomic activity appears to be strongly imbued in the underlying beliefs of many economists and policy makers. …the weak empirical evidence for this link underscores the need for research…(p. 110),

suggesting that “the key to further progress may lie in increasing theoretical and econometric sophistication in the analysis of this link” (p.111).

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[1] This is a step beyond his earlier doubts about the efficacy of monetary policy in an environment of ‘secular stagnation‘ (Summers, 2015).

[2] As illustrated by the careful empirical work on the term structure of interest rates by Lustig et al. (2013). There are many studies examining the link between financial sector and development (e.g. Demetriades and Law, 2006; Caporale et al., 2009; Yildirim et al., 2013; Alexiou et al., 2018) and “it would appear that the economics profession has not reached a consensus regarding the direction of causality between finance and growth” as the “empirical results vary considerably” (Alexiou et al., 2018, p. 157).

In this paper we thus focus on the link between nominal interest rates – a key target of central bank action – and real economic growth. Economic theory postulates a negative correlation, and at least some causal effect running from interest rates to economic growth. Surprisingly, there are almost no open-ended studies focusing on this question without presuming their findings.[3] We believe this is the first such empirical multi-country examination of the question of what the data tells us about this link, except for Lee and Werner (2018), who took a first step with data from the G-4 economies over half a century using quarterly data and Werner (2005), whereby both contributions focused on nominal growth. Their findings indicated a rejection of interest rate thesis and they called for further work, given the lack of support they found concerning the interest rate thesis, raising the question what the findings might be in a much larger sample of countries and using higher frequency data. This is what we present, using dynamic conditional correlation GARCH and statistical causality analysis.

2. The theoretical argument for the 'interest rate thesis', and the doubts

The most common explanation for the expected negative correlation between interest rates and growth, and presence of some kind of causation from interest rates to growth (the 'interest rate thesis'), is a variation of the capital budgeting process: Calculating the net present value of expected future income streams of a proposed project by the discount factor means that the lower interest rates, the more projects become viable, and vice versa.

For such capital budgeting to yield macroeconomic insights about the relationship between interest rates and economic activity, a number of conditions must be met. Firstly, all planned investment must become actual investment, which requires a world without 'frictions', without credit rationing, illiquidity, imperfect and/or asymmetric information concerning borrowers, etc. Secondly, there must not be any obstacles to the aggregation of individual investment demand schedules into one aggregate planned investment schedule. Thirdly, any effects of the opposite kind, such as lower savings incomes and thus potentially weaker consumption, must not dominate or must be outweighed by a positive wealth effect from higher net present value calculations and/or higher asset prices. Fourthly, the aggregation of individual investor behaviour requires individual demands to be homogeneous. Gabaix (2011) has demonstrated

[3] This may be due to the tendency for "inconvenient realities" being played down (Baily and Elliott, 2013, p. 5).

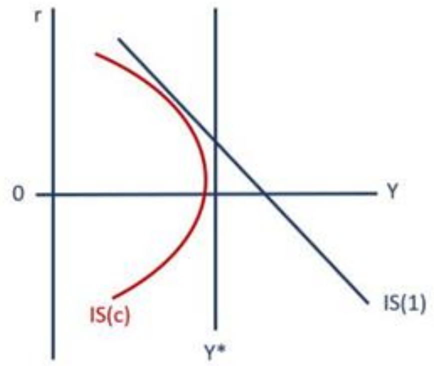
mathematically that the actions of individuals shape the aggregate outcome when the individuals are not identical and their size distribution is not normal. Nirei (2015) showed that even if the number of agents tends to infinity and agents are symmetric, the actions of a small number of players, by affecting the behaviour of the others, will have a significant impact on the aggregation outcome. Fifthly, interest rates must be at least weakly exogenous. However, Floyd (1969), Willett and Forte (1969) and Niehans (1984) pointed out the danger of the fallacy of composition concerning interest rates: An individual will take interest rates as an exogenous variable that cannot be influenced, but it doesn't follow that in aggregate interest rates can be taken as given, since the collective action of market participants determines them. Consequently, building the macroeconomic model based on the multiplication of one representative agent leaves out the likely interaction between them. In systems theory this is described as *emergence*, when the whole has properties not found in each individual part that emerge when the parts interact within the whole. This is a fundamental flaw in the first principles approach involving a representative agent.

Sixth, the interest rate thesis requires general equilibrium, which causes the dominance of prices (including the price of money) over quantities. In macroeconomics, including central bank policy-making, DSGE models are deployed, indeed assuming general equilibrium. These models have major weaknesses, including the absence of a banking sector and, more fundamentally, their assumption of equilibrium in all markets. Some economists do not assume equilibrium, however, but instead expect disequilibrium: Barro and Grossman (1976), Maulinvaud (1977), Muellbauer and Portes (1978), Benassy (1986) and Quandt and Rosen (1986) and Werner (2005). This disequilibrium research agenda fell by the wayside as the micro-foundation approach to macroeconomics and its assumed general equilibrium became dominant. However, recently interest has picked up in disequilibrium economics (e.g. Amior and Manning, 2018, on the US labour market). In finance, there is a substantial literature that establishes less than general equilibrium in important markets.[4] If equilibrium is not assumed, then it becomes less likely that the postulated negative and also causal relationship between interest rates and economic growth should hold. Hendry and Muellbauer (2018) criticise the failure of traditional DSGE models used at central banks and the subsequent attempts to

[4] A few examples are Smith and Brainard (1982) on disequilibrium in the mortgage market; among the large literature on disequilibrium and arbitrage opportunities in the FX and money markets see Rhee and Chang (1992); Zhu (2012) on opaque OTC markets; on the bias in CDS auctions, see Du and Zhu (2017). Finally, on the quantity effect dominating prices – a distinguishing feature of disequilibrium and lack of market-clearing – see Duffie and Zhu (2017).

improve them, which however often continue to "seek to impose simplistic and unrealistic theory" in preference to empirically-based models (for an overview from an econometric perspective, see also Hendry, 2020).

Summers (2019) has recently proposed disequilibrium due to an IS-curve that bends backwards, preventing full employment, irrespective of monetary policy (Figure 1).



Source: Summers (2019)

Figure 1: Backward-bending IS curve: No equilibrium

Based on Stiglitz and Weiss (1981) and Bernanke and Blinder (1988), one could similarly postulate a backward bending credit curve (the latter authors' CC-curve, replacing the LM curve in the IS-LM framework) due to credit market disequilibrum (see Werner, 2005).

Given the theoretical indeterminacy, it remains an empirical question whether the negative correlation between interest rates and individual investment propositions, which exist for each firm or project, also holds in aggregate, as many central bank policy-makers presently assume.

Examples of earlier work along these lines are Schumpeter (1912) and Haberler (1951). The former emphasised the role of the quantity of bank credit in economic growth and the business cycle, in a disequilibrium framework. The latter elaborated on the implications for the role of interest rates, which are seen as diverging from the traditional Keynesian postulates. He could rely on an earlier recognition given by Keynes (1930: 198) that the role of interest rates was possibly being misunderstood, reflected in his reference to the 'Gibson's paradox'. More recently, researchers supporting the 'credit view' have emphasised the role of bank credit, which could be seen as an alternative transmission mechanism of monetary policy (King and Levine, 1993; Bernanke and Gertler, 1995, Werner, 2005, Stiglitz, 2016a).[5]

As Werner (2005) and Lee and Werner (2018) noted, the assumption of disequilibrium seems to be empirically better supported than the common assumption of equilibrium. In a disequilibrium framework one would expect quantities being of greater importance than prices (i.e. interest rates), hence delivering a different relationship between interest rates and economic growth.

3. The Empirical Evidence

The relationship implied by conventional equilibrium analysis is (1) a negative correlation between nominal interest rates and economic activity; (2) causation from nominal interest rates to economic growth.

We examine these two dimensions of this relationship empirically in 19 industrialised and emerging market economies, using industrial production as a monthly indicator of real economic activity and three types of nominal interest rates (the overnight call rate, the 3-month interbank rate and the 10-year government bond yield). We estimate and evaluate time-varying conditional correlations using bivariate DCC-GARCH models and Granger causality, using a 30-year sample period on average. 19 countries are covered by the sample (see Section 3.2 for the list of countries examined).

[5] Note, however, that the credit view, neither in its lending nor in its balance sheet version, delivers any new insights concerning the relationship between interest rates and economic growth, since the credit view argues that the bank credit channel and/or balance sheet channel enhances the postulated and unquestioned negative correlation between interest rates and economic growth and the direction of causation running from interest rates to growth (see Werner, 2005). Similarly, the credit rationing argument of Stiglitz and Weiss (1981) does not deliver a macroeconomic mechanism why credit rationing should have any macroeconomic effect, as banks are considered mere financial intermediaries (when in actual fact they are not, as Werner, 2014 and 2016, has shown).

3.1. Methodology

First, the question whether the correlation between interest and growth is static or dynamic needs to be examined. We do this, using the Tse test (Tse, 2002). If constant correlation is rejected, a bivariate dynamic conditional correlation (DCC) GARCH model should be used to estimate the time-varying correlation. Since Engle (2002), DCC models have been increasingly used in the finance literature, mainly to estimate the ARCH/GARCH-type behaviour of each individual variable in a multivariate approach (see Galeano and Ausin, 2010; Audrino and Trojani, 2011; Engle, 2012; Aielli, 2013; Amado and Teräsvirta, 2014). Usually employed to estimate individual parameters, here we instead use DCC GARCH to extract the time-varying correlation that describe best both the individual and joint behaviours of the two variables. To obtain the best DCC series for each pair of economic growth and interest rate, we first estimate a number of DCC-GARCH(p,q) model specifications by combining p (=1,2,3) and q (=1,2,3) with different options for the mean/variance equations in the model.[6] We then select several competing model specifications, based on model convergence and performance measured in terms of general significance level of parameter estimates. The principle of parsimony is applied, so that the selected model best fits the data with least number of parameters. In parallel, the Granger causality test is implemented to examine the existence and direction of statistical causation between interest rate and growth.

3.2. Data

We use monthly data on industrial production and the overnight call, the 3-month interbank and the 10-year government bond yield rate of 19 countries, which include both industrialised countries and emerging markets: Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, the Netherlands, Slovenia, Spain, Sweden, Switzerland, the UK and the US. The sample period varies, depending on data availability from the central bank or the IMF. For example, the data on industrial production in the US covers

[6] Option 1 = no constant term or asymmetric effect in the mean/variance equations; Option 2 = with a constant term (μ) in the mean equation; Option 3 = with asymmetric effects (δ) in the variance equation; Option 4 = with a constant term (μ) in the mean equation and asymmetric effects (δ) in the variance equation.

the longest sample, ranging from 1955:01 to 2015:03 with 723 observations, while the overnight call rate in Slovenia is confined to the shortest sample period, from 2004:01 to 2015:03 with 135 observations.

3.3. Empirical results

3.3.1 Dynamic conditional correlation

The Tse test rejects the assumption of a constant correlation between variation of industrial production and each of the three types of interest rates for all countries examined without exception (available upon request). Consequently, we estimated the DCC series for each of the 19 countries.

Correlation between economic growth and the overnight call rate

Figure 2 depicts the estimated DCC series, which show a common feature in virtually all countries: the correlation is positive in most time periods, while turning negative in some time periods that seem to correspond to crisis episodes.[7] For instance, the US shows a close-to-minus-one correlation when a serious crisis occurs (e.g., the oil price shocks of 1973-1974 and 1979-1980; the US banking crisis of 1982-1983; the recession of 1991 due to the Fed's monetary restriction; the 'dot-com' bubble bursting of 2001-2002, and the subprime and global crisis of 2008-2009). But most of the time, the correlation is very highly positive (close to one) and remains relatively stable.

Three groups of countries can be distinguished, depending on the DCC series' mean (or strength), variability (measured by relative standard deviation - RSD), and the overall amount of time the correlation is positive or negative. Table 1 reports descriptive statistics of the estimated DCC series.

The first group includes Austria, Belgium, Ireland, Israel, the Netherlands, Korea, Slovenia and the US. They show a high positive mean of DCC, low variability and a positive 0.25-fractile.

[7] Due to the space limit, the model parameters estimates cannot be reported here. They are available upon request.

This indicates that the time-varying correlation remains relatively stable, and it is highly positive more than 75% of time. For instance, Korea shows a DCC series corresponding to the highest mean (0.5878), lowest variability (0.8239), highest 0.25-fractile and one of the highest medians (0.8194), meaning that the DCC of Korea is one of the most stable and strongest positive correlations in most time periods (see also Figure 3). Lowering interest rates cannot be effective in stimulating the economy in the countries in this group.

The second group includes Canada, France, Germany, Japan, Spain, Sweden, Switzerland and the UK, characterised by a relatively strong positive mean of DCC, a high variability, a positive median, but a negative 0.25-fractile. The correlation in these countries is strongly time-varying and turns negative more than 25% of time, even though the correlation is relatively strongly positive in most time periods. Within this group, Canada and Sweden show the most strongly negative 0.25-fractile, suggesting that the correlation is particularly strongly negative in times of bad economic performance. On the other hand, Japan shows an average 0.25-fractile (-0.0995) of this group but the lowest median (0.0736) in this group, so the positive DCC in Japan is generally weaker than that in other countries. This can be observed visually in Figure 3: the DCC in Japan is close to zero between 2001 and 2007, and oscillates between -0.2 and +0.2 during the recent period from 2010 to 2015. By contrast, Germany shows a DCC with a higher median of 0.4341 and a lower 0.25-fractile of -0.0685 than Japan, meaning that the correlation is relatively strong (either positively or negatively) and thus almost never close to zero during the sample period. The UK is between Japan and Germany in this aspect: its DCC is fairly positive in most time periods with a peak in 1994-1995 and 2000, and fairly negative in times of crisis with a negative peak in 1991 and 2002. Overall, the strong negative correlation in times of crisis in these countries may be why central banks in Japan, Sweden and Switzerland implemented negative interest rates to stimulate the economy. But even in these countries the correlation is strongly positive in most time periods, indicating that such policies would be of limited effect. Further, even if one grants that crisis reactions of lowering rates were correct, the corresponding raising of rates upon economic recovery has recently been absent, leaving policy-makers near the zero bound, limiting interest rate policy options.

The third group includes Denmark, Greece and Italy and is characterised by a close-to-zero mean and a negative 0.25-fractile, meaning that the correlation is not significant in general, but it is negative more than 25% of time. In emerging market economy Greece, it is negative even more than 50% of time. This negative median can be partly explained by the fact that the strong negative correlation covers a relatively long period of crisis in the country (2008-2012), triggered by the global crisis of 2008 and extended by its own sovereign debt problems, whereas the total sample period is relatively short (1999-2015) due to the limited availability of the Greek data. On the other hand, Denmark shows an exceptional feature: according to the Jarque-Bera statistic, its DCC series can be considered normally distributed with a positive mean of 0.0775 and a variance of 0.0390. This implies that the Danish central bank's negative-rate-based policies are likely to be ineffective in stimulating the economy. The negative 0.25-fractile or median in these three countries indicates that lowering short-term interest rates can be effective in stimulating the economy in times of crisis.

Correlation between economic growth and the 3-month interbank rate

Figure 4 depicts the estimated DCC series between IP growth and 3-month interbank rate, and Table 2 reports their descriptive statistics.

When comparing Figure 4 with Figure 2, for any given country, the 3-month-rate-based DCC series is very similar, if not identical, to that based on the overnight call rate. In parallel, one can also observe that the correlation is positive in most time periods, but negative in times of crisis, virtually in all countries examined. Keeping in mind this general feature, we attempt to identify countries that can show some different DCC behaviour, possibly depending on the type of interest rate. In parallel, we also attempt to detect the sensitivity of the DCC relationship vis-à-vis the type of interest rate. To this end, we again classify the countries into three groups based on Figure 4 and Table 4.

The first group includes Austria, Ireland, Israel, the Netherlands, Korea, Slovenia and the US. They all show a high positive mean of DCC, a low variability and a positive 0.25-fractile. This group corresponds to the first group based on the overnight call rate, excluding Belgium.

The second group includes Belgium, Canada, France, Germany, Spain, Sweden, Switzerland and the UK. This group shows a relatively strong positive mean of DCC, a high variability, a positive median but a negative 0.25-fractile. This group corresponds to the second group based on the overnight call rate, excluding Japan but including additionally Belgium.

Finally, the third group includes Denmark, Greece, Italy and Japan. They are characterised by a close-to-zero mean of DCC and a negative 0.25-fractile. Greece even shows a negative median (-0.1168). This group corresponds to the third group based on the overnight call rate, including additionally Japan.

These three groups are the same as those based on the overnight call rate, except for Belgium and Japan. This means that if the DCC behaviour is sensitive to the type of interest rate, it is not a country-specific feature but a common feature to all countries. A synthesis of all statistics reported in Tables 3 and 4 allows us to formally confirm that the DCC based on the 3-month interbank rate are stronger, either positively or negatively, than the DCC based on the overnight call rate in all countries examined, including Belgium and Japan.

Correlation between economic growth and the 10-year government bond yield

Figure 2 depicts the estimated DCC series between economic growth and 10-year government bond yield rate, and Table 3 reports their descriptive statistics. Comparing Figure 2 with Figures 3 and 4, we notice that the DCC series based on the long-term rate are very similar. This confirms the general finding that the correlation is positive in most time periods and negative in times of crisis. We however notice that the long-term-rate-based DCC are stronger (either positively or negatively). This difference seems to confirm the idea that the correlation between economic growth and interest rate is stronger (positively or negatively) when based on a longer-term interest rate.

Again, we classify the countries into three groups. The first includes Austria, Ireland, Korea, Slovenia and the US. This group shows a high positive mean, a low variability and a positive 0.25-fractile, meaning that the DCC is relatively stable, and strongly positive more than 75% of time in these countries.

The second group includes Belgium, Canada, France, Germany, Israel, Japan, the Netherlands, Spain, Sweden, Switzerland and the UK. The DCC series of these countries commonly show a relatively strong positive mean, a high variability, a positive median, but a negative 0.25-fractile. The correlation is relatively strong positive in most time periods, but it turns negative more than 25% of time.

The third group includes Denmark, Greece and Italy. They all show a close-to-zero mean and a negative 0.25-fractile. Furthermore, Greece and Italy show a negative median, meaning that the correlation is negative more than 50% of time.

A comparative analysis on Figures 2 to 4 and Tables 1 to 3 leads us to conclude that the long-term-rate-based DCC are stronger (positively in most time periods and negatively in times of crisis) than the short- and medium-term-rate-based DCC, in all countries examined. Shorter-term interest rates are less relevant to economic growth than longer-term interest rates.

We note that the classification into groups of countries, based on our empirical findings, does not confirm to the usual centre vs. periphery literature on Europe. However, we do believe an explanation are likely to be institutional details of the financial sector, as for instance identified by Dore (2000) and Hall and Soskice (2001). Furthermore, the careful examination of interest rates and growth showed that traditional interest rate policy should not have been effective in the US, while it could have been somewhat effective in Japan. The reality that the US economy recovered quickly after the 2008 crisis, while the Japanese economy failed to recover for two decades after the 1990 slump must be explained by other variables than interest rates – as Werner (2005) has argued.

3.3.2. Causation

Table 4 reports results of Granger causality tests. First, the overnight call rate Granger-causes economic growth in 9 countries (Column 1), but the opposite also holds in 10 countries (Column 2). Second, a significant causality from 3-month interbank rate to growth is confirmed in 10 countries (Column 3), while the opposite holds in 12 countries (Column 4). Third, a significant causality from 10-year government bond yields to growth is confirmed in 7 countries (Column 5), while the opposite holds in 8 countries (Column 6).

While the numbers of countries where a significant, opposite causality is confirmed are similar to each other (i.e, 9 vs. 10 for the short-term rate; 10 vs. 12 for the medium-term rate; 7 vs. 8 for the long-term rate), the causality from growth to interest rate is confirmed in more countries than the opposite causality. Similar results apply when using the bootstrapping technique (available on request).

When combining these causation results with the estimated DCC series, we notice that the "standard and theoretical" expectation that interest rates and growth are in a negative correlation *and* causation runs from rates to growth is not generally supported by the data, because the correlation is *positive* in most countries, and/or the causality is more likely to run from economic growth to interest rates when the correlation is negative.

4. Conclusion

Much of modern macroeconomics presupposes that lowering interest rates has a positive effect on economic growth (Rogoff, 2017; Lilley and Rogoff, 2019). Despite the pervasiveness of the idea that interest rates and growth are inversely related and there is some causality from rates to growth, economic theory has never delivered a convincing argument why the microeconomic negative relationship between rates and investment must survive the problem of aggregation. Our empirical findings reject the theoretical argument that interest rates affect economic growth causally, and in an inverse manner.

On balance, our empirical results show that (1) the correlation between economic growth and interest rates is not negative but positive in virtually all countries examined over most time periods, and; (2) when significant, the majority of evidence suggests that the causal link does not run from interest rates to economic growth, but more likely from economic growth to interest rates; (3) the findings apply also to the period before the 2008 crisis. We believe these results hold for both industrialised and emerging market economies. This means that monetary policy confined to lowering or raising interest rates cannot be effective in moving the economy in the claimed direction, and that this could be a general result applying not just to a post-crisis situation. This finding is in line with the empirical evidence produced by Lee and Werner (2018) and by a number of empirical researchers that investigated other phenomena, but reported, some as a side result, that interest rates did not appear to show explanatory power of economic growth (e.g. Sims, 1992, King and Levine, 1993; Author, 1997; Hanson, 2004; Chu et al., 2020). Meanwhile, Lee and Werner (2018) remind us that the Department of Commerce does not consider interest rates a 'Leading Indicator' nor a 'Coincident Indicator'. Its researchers have long considered interest rates a lagging indicator of economic growth. This fact has remained little known and is rarely cited by the economic literature.[8]

There are implications for further research and for policy. Firstly, the vast literature on the finance-growth nexus, which has been empirically inconclusive, often assumes the interest thesis to hold. That this is not the case may explain the diverging empirical results reported over the years. Secondly, recent models attempting to forecast interest rates (e.g. Dua, 1988; Ang and Bekaert, 2002; Bali et al., 2009) would do well to utilise the explanatory power of a measure of economic activity, such as industrial production. Thirdly, the finding that interest rates are not a good lead indicator of economic activity points towards the prevalence of disequilibrium, in which case not prices but quantities determine outcomes (Lee and Werner, 2018). Further research in disequilibrium economics is thus likely to be fruitful. Fourthly, Floyd (1969) and Willetts and Forte (1969), as quoted in Werner (1997), pointed out that once all market participants are aggregated, interest rates are likely to be the result of the collective actions so that interest rates become endogenous. Thus the search should be on for the truly exogenous factors influencing economic growth. Fifthly, as in Taylor (1999), our finding again "underscores the need for research into alternative routes for the monetary transmission mechanism such as the 'credit channel' of monetary policy" (Taylor, p. 111) (see, for example, Bernanke and Gertler, 1995; Werner, 1997). We suggest that 'bank credit for the real economy', as identified by Werner (1997, 2005, 2012) who defines credit for GDP transactions (i.e. credit for the real economy) vs. credit for non-GDP (i.e. asset) transactions, is a reasonable candidate, as also effectively argued by Goodhart and Kabiri (2019): "Banks, and the bank lending channel, are left out of too many models. In such cases the benefits of lowering interest rates to, and beyond, the zero lower bound are much exaggerated, and the net effect of such measures could even have been net contractionary (24)… Once rates fall to exceptionally low levels, banks are forced to take countervailing measures to protect their profitability. These measures, raising spreads and fees, will raise the cost of intermediation, and via ever-greening and other steps to lower write-offs, will lower the allocative quality of the loan book. The efforts of the banks in such conditions to maintain profitability will have corresponding costs in holding down both the quantity and quality of bank domestic credit" (22).

[8] Exceptions are Stock and Watson (1989) and King and Watson (1996).

Finally, and of immediate importance, our findings cast doubt on the wisdom of the longstanding conventional monetary policy *modus operandi* of attempting to stimulate economic growth by lowering nominal rates, and attempting to dampen growth and inflationary pressures by raising rates. This is in line with Belongia and Ireland (2015) whose findings also cast doubt on the sole focus of interest rates and suggested policies to expand the money supply, echoing Werner (1995). Interest rate reductions towards or beyond zero may even hurt economic growth. Our evidence shows that policy-makers aiming at higher economic growth should instead be looking to arrange for interest rates to be *moved higher*. Our simplest intuition for these findings is via the effect of a steepening yield curve, which would render supplying credit for business investment more attractive for banks – undoubtedly a positive factor for output and growth, as well as financial stability. On the other hand, lowering short rates and pushing long rates down flattens the yield curve and drives banks to lend for asset purchases (or drives them out of business), hurting economic growth. The role of the yield curve in monetary policy is thus an important area for further research (in line with Lucas et al., 2019; Drakos, 2001). Since there is no empirical evidence to support general equilibrium, in the more likely disequilibrium scenario bank credit would be rationed (Stiglitz and Weiss, 1981), and hence high rates and/or a steeper yield curve may trigger a larger quantity of bank credit being released by banks, outweighing any potential negative effect of higher rates (such as fewer projects being able to demonstrate positive NPV). This is supported by Goodhart and Kabiri (2019) among others. What this means concerning the recent policy by central banks of engaging in 'forward guidance' remains subject to further research. Here, it could be suggested that verbal guidance towards higher interest rates (a la Mark Carney for instance) could accelerate attempts by borrowers to lock in lower rates, helping to expand bank credit creation in quantity terms, again contributing towards an acceleration of growth and helping to outweigh any potential negative pricing effect.

What are the implications of our findings for Gesellian-type negative interest rates (Gesell, 1916; Rogoff, 2017)? Our findings serve as a reminder that Gesell had a different rationale for favouring negative interest rates, namely his aversion to interest rates per se and the desire to punish hoarders of money and incentivise them to spend. Modern central banks, on the other hand, have been favouring ever lower rates, including lowering them into negative territory, mainly on the basis of the theory that lowering interest rates should stimulate economic growth. It is the latter theory that was being subjected to empirical testing in our paper and found wanting.

Data

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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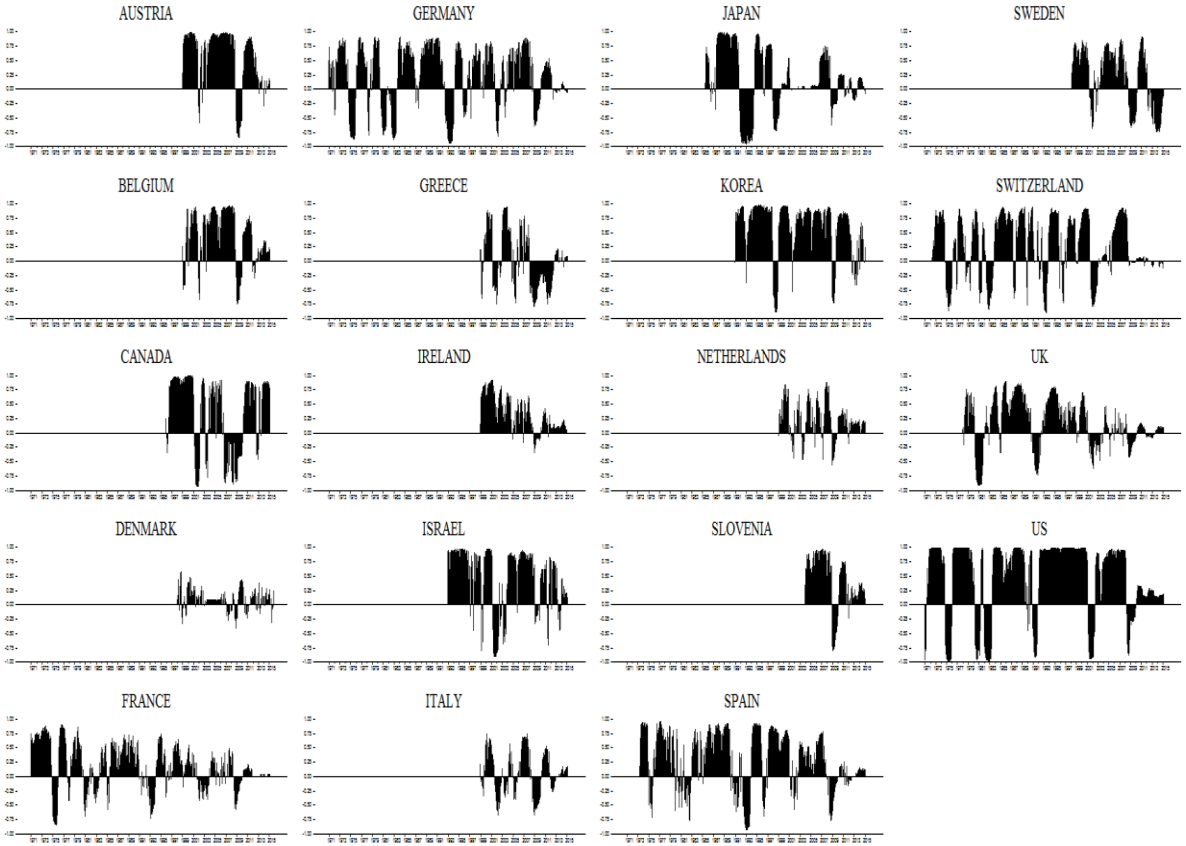
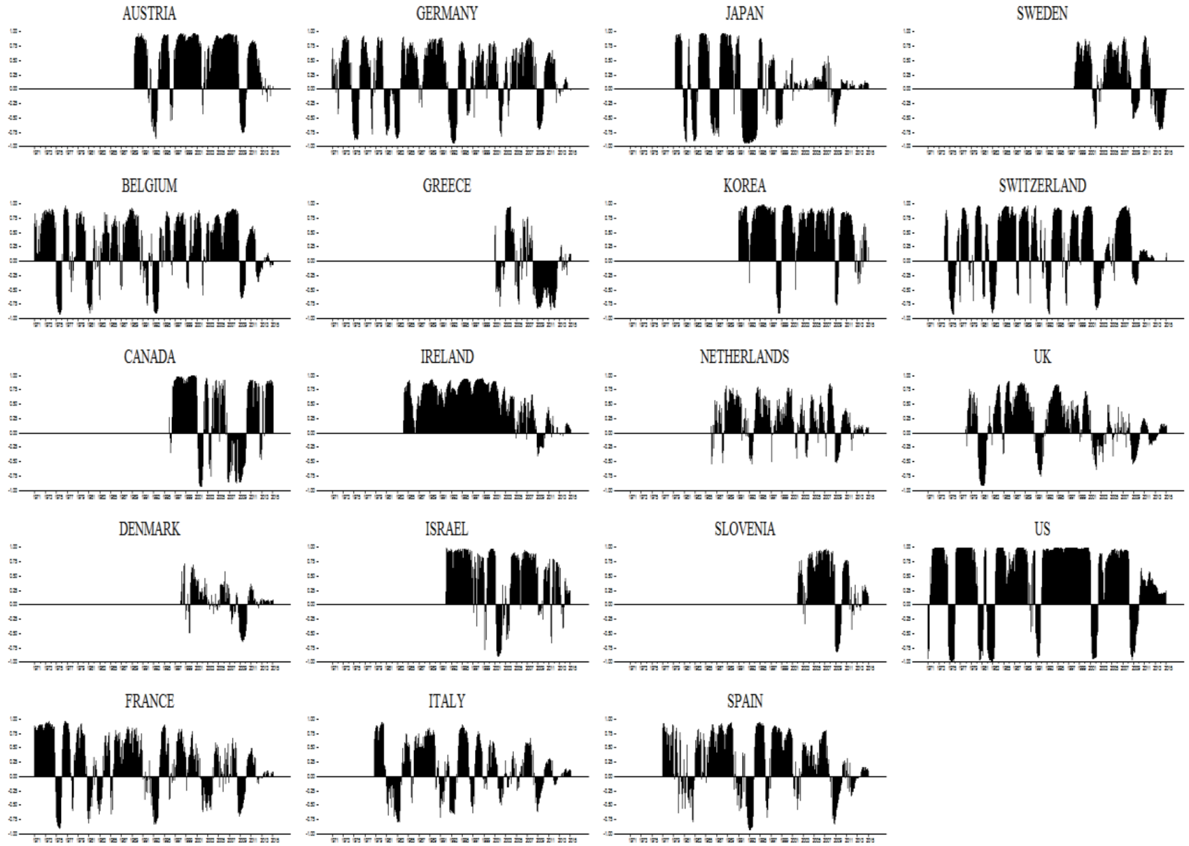
Figure 2. Dynamic conditional correlation between economic growth and overnight call rate



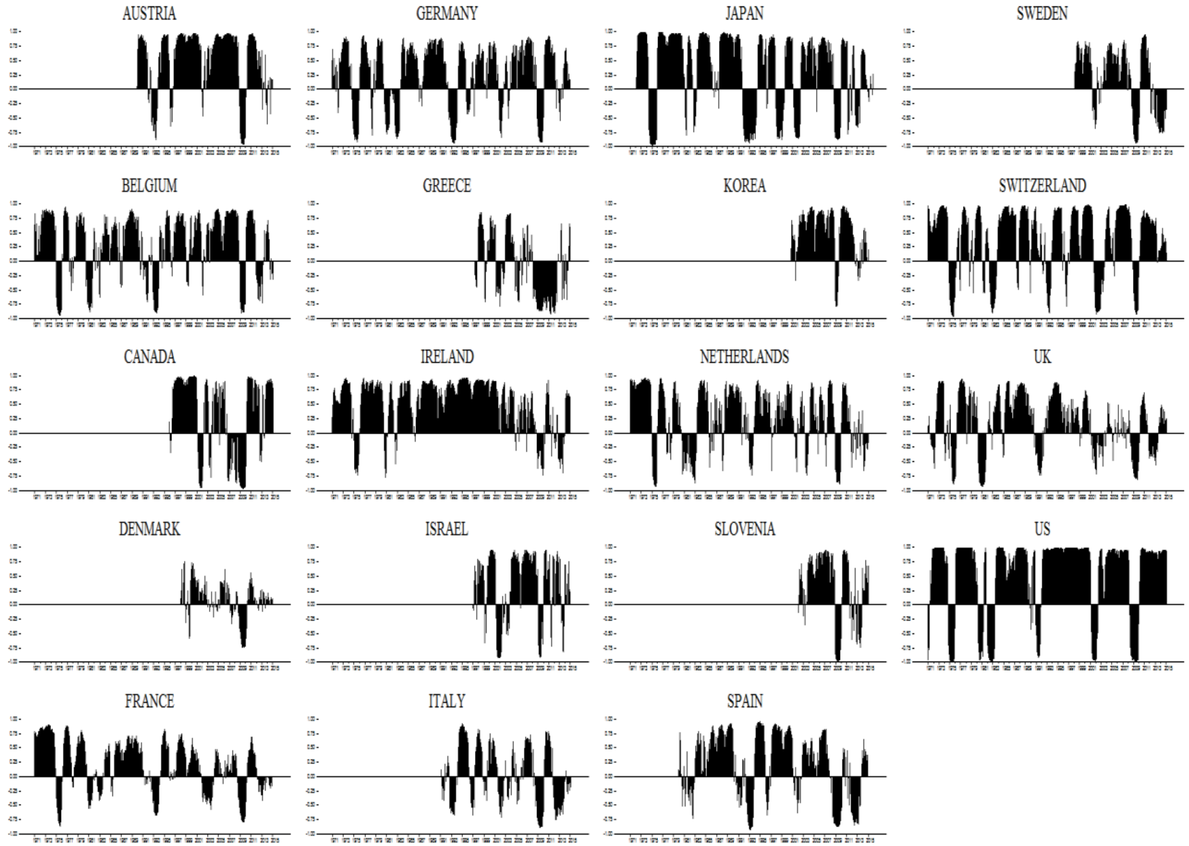
Notes: Each of the depicted series refers to the dynamic conditional correlation between economic growth and overnight call rate, estimated for each of the 19 countries using a bivariate DCC-GARCH(1,1) model. The maximum time period presented in the figures ranges from 1970:01 to 2015:03.

Figure 3. Dynamic conditional correlation between economic growth and 3-month interbank rate



Notes: Each of the depicted series refers to the dynamic conditional correlation between economic growth and 3-month interbank rate, estimated for each of the 19 countries using a bivariate DCC-GARCH(1,1) model. The maximum time period presented in the figures ranges from 1970:01 to 2015:03.

Figure 4. Dynamic conditional correlation between economic growth and 10-year government bond yield rate



Notes: Each of the depicted series refers to the dynamic conditional correlation between economic growth and 10-year government bond yield rate, estimated for each of the 19 countries using a bivariate DCC-GARCH(1,1) model. The maximum time period presented in the figures ranges from 1970:01 to 2015:03.

Table 1. Descriptive statistics of the estimated DCC series between economic growth and overnight call rate

Country	Obs.	Mean	RSD	JB Stat.	JB signif.	Min.	Fractiles										Max.
							0.01	0.05	0.10	0.25	0.50	0.75	0.90	0.95	0.99		
AUSTRIA	195	0.551	0.96	54.17	0.000	-0.853	-0.839	-0.668	-0.305	0.195	0.827	0.948	0.974	0.978	0.985		0.988
BELGIUM	195	0.424	1.15	21.46	0.000	-0.773	-0.749	-0.518	-0.394	0.142	0.574	0.870	0.938	0.944	0.955		0.961
CANADA	231	0.352	1.93	32.71	0.000	-0.954	-0.947	-0.871	-0.804	-0.338	0.764	0.894	0.966	0.982	0.990		0.990
DENMARK	216	0.077	2.55	0.52	0.770	-0.424	-0.328	-0.249	-0.188	-0.058	0.083	0.184	0.329	0.425	0.562		0.584
FRANCE	531	0.165	2.47	13.68	0.001	-0.872	-0.826	-0.561	-0.383	-0.081	0.154	0.515	0.700	0.779	0.860		0.908
GERMANY	531	0.250	2.19	55.80	0.000	-0.957	-0.931	-0.846	-0.674	-0.068	0.434	0.720	0.837	0.871	0.899		0.916
GREECE	195	0.007	75.20	10.74	0.005	-0.811	-0.775	-0.723	-0.649	-0.429	-0.015	0.388	0.771	0.881	0.932		0.940
IRELAND	195	0.328	0.96	7.66	0.022	-0.360	-0.276	-0.145	-0.081	0.097	0.278	0.599	0.804	0.861	0.914		0.927
ISRAEL	268	0.476	1.17	57.02	0.000	-0.921	-0.914	-0.703	-0.451	0.174	0.760	0.899	0.953	0.963	0.972		0.973
ITALY	195	0.060	6.34	7.71	0.021	-0.682	-0.635	-0.561	-0.461	-0.236	0.061	0.385	0.581	0.651	0.738		0.753
JAPAN	357	0.166	3.27	9.34	0.009	-0.977	-0.951	-0.906	-0.693	-0.100	0.074	0.635	0.942	0.967	0.985		0.989
KOREA	291	0.588	0.82	167.20	0.000	-0.910	-0.888	-0.585	-0.254	0.466	0.819	0.908	0.946	0.956	0.969		0.972
NETHERLANDS	195	0.233	1.46	3.06	0.217	-0.582	-0.514	-0.446	-0.240	0.061	0.205	0.443	0.705	0.774	0.857		0.879
SLOVENIA	135	0.443	1.07	25.90	0.000	-0.809	-0.786	-0.651	-0.228	0.165	0.564	0.867	0.931	0.945	0.965		0.969
SPAIN	502	0.293	1.74	37.63	0.000	-0.951	-0.905	-0.661	-0.475	-0.069	0.382	0.757	0.880	0.911	0.939		0.969
SWEDEN	207	0.213	2.52	21.89	0.000	-0.764	-0.757	-0.696	-0.619	-0.294	0.419	0.680	0.803	0.836	0.888		0.912
SWITZERLAND	519	0.260	2.06	36.89	0.000	-0.914	-0.867	-0.740	-0.561	-0.057	0.289	0.771	0.879	0.902	0.931		0.948
UK	447	0.158	2.70	12.03	0.002	-0.930	-0.917	-0.640	-0.389	-0.099	0.124	0.480	0.719	0.798	0.867		0.891
US	531	0.482	1.40	118.91	0.000	-0.991	-0.988	-0.957	-0.878	0.156	0.897	0.979	0.987	0.990	0.994		0.996

Notes: This table describes the distribution of the estimated dynamic conditional correlation (DCC) series for each country examined. Each of these DCC series is depicted in Figure 2.

Table 2. Descriptive statistics of the estimated DCC series between economic growth and 3-month interbank rate

Country	Obs.	Mean	RSD	J-B Stat.	J-B signif.	Min.	Fractiles										Max.
							0.01	0.05	0.10	0.25	0.50	0.75	0.90	0.95	0.99		
AUSTRIA	310	0.515	1.05	69.46	0.000	-0.884	-0.784	-0.690	-0.399	0.140	0.799	0.920	0.952	0.959	0.969		0.976
BELGIUM	531	0.314	1.72	65.21	0.000	-0.950	-0.921	-0.812	-0.578	-0.049	0.514	0.775	0.856	0.889	0.917		0.968
CANADA	231	0.346	2.01	33.48	0.000	-0.951	-0.946	-0.873	-0.819	-0.342	0.775	0.905	0.966	0.981	0.989		0.990
DENMARK	207	0.075	3.98	6.48	0.039	-0.655	-0.639	-0.548	-0.352	-0.033	0.078	0.263	0.426	0.566	0.701		0.770
FRANCE	531	0.218	2.39	34.86	0.000	-0.923	-0.880	-0.721	-0.561	-0.141	0.302	0.698	0.857	0.896	0.940		0.961
GERMANY	531	0.260	2.13	59.65	0.000	-0.952	-0.924	-0.838	-0.687	-0.094	0.457	0.717	0.841	0.872	0.902		0.922
GREECE	171	-0.117	-4.57	11.09	0.004	-0.859	-0.843	-0.808	-0.780	-0.593	-0.117	0.262	0.678	0.898	0.936		0.941
IRELAND	375	0.529	0.68	38.36	0.000	-0.408	-0.305	-0.116	-0.019	0.218	0.635	0.852	0.908	0.930	0.942		0.945
ISRAEL	278	0.505	1.06	69.87	0.000	-0.911	-0.899	-0.647	-0.372	0.240	0.769	0.908	0.953	0.961	0.971		0.981
ITALY	438	0.161	2.86	19.41	0.000	-0.809	-0.776	-0.622	-0.496	-0.176	0.150	0.561	0.773	0.842	0.922		0.945
JAPAN	430	0.068	8.44	15.13	0.001	-0.962	-0.956	-0.910	-0.821	-0.376	0.089	0.477	0.923	0.957	0.975		0.978
KOREA	291	0.587	0.82	174.52	0.000	-0.929	-0.886	-0.580	-0.217	0.462	0.817	0.904	0.946	0.963	0.971		0.973
NETHERLANDS	351	0.243	1.48	15.19	0.001	-0.644	-0.532	-0.450	-0.318	0.034	0.272	0.534	0.702	0.765	0.825		0.859
SLOVENIA	159	0.405	1.23	22.65	0.000	-0.837	-0.832	-0.744	-0.228	0.097	0.576	0.823	0.924	0.939	0.958		0.962
SPAIN	459	0.269	1.93	34.42	0.000	-0.949	-0.921	-0.714	-0.495	-0.118	0.362	0.755	0.861	0.901	0.933		0.951
SWEDEN	207	0.255	2.03	20.93	0.000	-0.723	-0.703	-0.669	-0.527	-0.231	0.462	0.711	0.819	0.860	0.901		0.921
SWITZERLAND	495	0.277	2.11	41.05	0.000	-0.936	-0.924	-0.791	-0.651	-0.121	0.309	0.840	0.927	0.943	0.957		0.970
UK	447	0.157	2.83	13.90	0.001	-0.939	-0.921	-0.653	-0.466	-0.137	0.150	0.502	0.736	0.822	0.879		0.899
US	530	0.489	1.40	132.59	0.000	-0.991	-0.989	-0.961	-0.897	0.233	0.901	0.980	0.987	0.990	0.994		0.996

Notes: This table describes the distribution of the estimated dynamic conditional correlation (DCC) series for each country examined. Each of these DCC series is depicted in Figure 2.

Table 3. Descriptive statistics of the estimated DCC series between economic growth and 10-year government bond yield rate

Country	Obs.	Mean	RSD	JB Stat.	JB signif.	Min.	Fractiles 0.01	0.05	0.10	0.25	0.50	0.75	0.90	0.95	0.99	Max.
AUSTRIA	302	0.513	1.12	82.84	0.000	-0.973	-0.970	-0.770	-0.502	0.205	0.818	0.928	0.956	0.962	0.974	0.978
BELGIUM	531	0.314	1.80	72.64	0.000	-0.963	-0.918	-0.863	-0.684	-0.067	0.533	0.782	0.869	0.886	0.905	0.946
CANADA	231	0.324	2.22	33.04	0.000	-0.979	-0.977	-0.959	-0.875	-0.383	0.753	0.915	0.965	0.976	0.985	0.986
DENMARK	206	0.085	3.92	14.29	0.001	-0.775	-0.756	-0.604	-0.352	-0.066	0.092	0.307	0.448	0.619	0.733	0.790
FRANCE	531	0.185	2.47	27.68	0.000	-0.874	-0.813	-0.647	-0.446	-0.147	0.230	0.577	0.754	0.826	0.882	0.910
GERMANY	531	0.274	2.08	66.76	0.000	-0.944	-0.932	-0.857	-0.730	-0.106	0.483	0.760	0.850	0.874	0.911	0.935
GREECE	213	-0.103	-5.58	17.82	0.000	-0.949	-0.927	-0.880	-0.833	-0.637	-0.167	0.417	0.704	0.799	0.836	0.862
IRELAND	530	0.518	0.90	148.86	0.000	-0.791	-0.735	-0.536	-0.316	0.313	0.706	0.866	0.911	0.924	0.947	0.957
ISRAEL	218	0.344	1.79	30.76	0.000	-0.938	-0.935	-0.912	-0.701	-0.136	0.665	0.847	0.924	0.943	0.953	0.955
ITALY	289	0.022	24.08	19.73	0.000	-0.898	-0.890	-0.764	-0.673	-0.435	-0.039	0.512	0.754	0.795	0.885	0.922
JAPAN	526	0.335	2.10	75.92	0.000	-0.989	-0.979	-0.890	-0.859	-0.344	0.703	0.911	0.968	0.979	0.990	0.991
KOREA	174	0.511	0.86	53.79	0.000	-0.812	-0.807	-0.352	-0.158	0.286	0.694	0.849	0.904	0.931	0.948	0.957
NETHERLANDS	531	0.275	2.02	49.15	0.000	-0.956	-0.905	-0.748	-0.604	-0.148	0.423	0.783	0.887	0.914	0.943	0.956
SLOVENIA	156	0.339	1.79	23.68	0.000	-0.986	-0.985	-0.970	-0.670	0.005	0.563	0.857	0.915	0.935	0.944	0.948
SPAIN	423	0.212	2.71	37.53	0.000	-0.944	-0.906	-0.842	-0.715	-0.250	0.368	0.734	0.870	0.898	0.932	0.962
SWEDEN	207	0.190	3.04	21.13	0.000	-0.945	-0.942	-0.790	-0.728	-0.349	0.371	0.690	0.804	0.862	0.948	0.958
SWITZERLAND	531	0.390	1.56	84.12	0.000	-0.978	-0.942	-0.864	-0.699	0.041	0.648	0.892	0.948	0.961	0.972	0.980
UK	531	0.154	3.32	28.56	0.000	-0.952	-0.919	-0.792	-0.611	-0.238	0.210	0.583	0.825	0.872	0.906	0.927
US	531	0.548	1.30	181.03	0.000	-0.996	-0.991	-0.977	-0.936	0.523	0.936	0.981	0.990	0.992	0.994	0.997

Notes: This table describes the distribution of the estimated dynamic conditional correlation (DCC) series for each country examined. Each of these DCC series is depicted in Figure 4.

Table 4. Granger causality between interest rates and economic growth

Granger causality						
From	overnight call rate	growth	3-m interbank rate	growth	10-y gov. bond rate	growth
To	growth	overnight call rate	growth	3-m interbank rate	growth	10-y gov. bond rate
AUSTRIA	YES	NO	YES	YES	NO	NO
BELGIUM	YES	YES	YES	NO	YES	YES
CANADA	NO	YES	YES	YES	YES	NO
DENMARK	NO	YES	YES	YES	NO	YES
FRANCE	NO	YES	NO	YES	NO	NO
GERMANY	YES	YES	YES	YES	YES	YES
GREECE	NO	NO	NO	NO	NO	YES
IRELAND	NO	NO	NO	NO	NO	YES
ISRAEL	NO	NO	NO	NO	NO	NO
ITALY	YES	YES	NO	YES	NO	YES
JAPAN	NO	NO	NO	NO	NO	NO
KOREA	NO	NO	NO	YES	NO	YES
NETHERLANDS	YES	YES	YES	YES	YES	NO
SLOVENIA	YES	YES	NO	YES	NO	NO
SPAIN	NO	NO	NO	NO	NO	NO
SWEDEN	YES	NO	YES	NO	NO	NO
SWITZERLAND	NO	NO	YES	YES	YES	YES
UK	YES	YES	YES	YES	YES	NO
US	YES	YES	YES	YES	YES	NO

Notes: The tests for Granger causality were implemented with three lags. "YES" confirms the Granger causality at 10% significance level, while "NO" indicates that the Granger causality is rejected at 10% significance level.