New Trends and Issues Proceedings on Humanities and Social Sciences

Volume 4, Issue 10, (2017) 398-405

www.prosoc.eu
ISSN 2547-8818

Selected Paper of 6th World Conference on Business, Economics and Management (BEM-2017)
04-06 May 2017, Acapulco Hotel and Resort Convention Center, North Cyprus

The relationship of bond yield curves and gross domestic product growth in Scandinavia

Jana Hvozdenska [a]*, Department of Finance, Faculty of Economics and Administration, Lipova 41a, 60200 Brno, Czech Republic

Suggested Citation:
Hvozdenska, J. (2017). The relationship of bond yield curves and gross domestic product growth in Scandinavia. *New Trends and Issues Proceedings on Humanities and Social Sciences*. [Online]. *4*(10), 398–405. Available from: www.prosoc.eu

Selection and peer review under responsibility of Prof. Dr. Çetin Bektaş, Gaziosmanpasa University, Turkey

Abstract

The steepness of the bond yield curve is an excellent indicator of a possible future economic activity. A rise in the short rate tends to flatten the yield curve and slows down real growth in the near-term. This paper analyses the dependence between slope of the yield curve and an economic activity of selected countries between 2000 and 2016. The slope of the yield curve can be measured as the yield spread between sovereign 10-year and 3-month bonds. The results showed that the best predictive lags are the lag of four and five quarters. The results also confirm that 10-year and 3-month yield spread has a significant predictive power for real GDP growth after a financial crisis. These findings can benefit investors and provide evidence of the potential usefulness of the yield curve spreads as indicators of the future economic activity.

Keywords: GDP prediction, yield curve, slope, spread.

* ADDRESS FOR CORRESPONDENCE: **Jana Hovzdesnska,** Department of Finance, Faculty of Economics and Administration, Lipova 41a, 60200 Brno, Czech Republic.
E-mail address: 174974@mail.muni.cz / Tel.:+ 420-776-333-646

1. Introduction

The financial turmoil during 2007–2009 affected the euro area financial sector in ways that differ considerably across market segments and countries. A consequence was a temporary reduction of market activity within national borders. The impact was felt most strongly in the money markets and relatively less in bond activities. However, economic growth stopped and still many countries are not able to follow Maastricht Convergence Criteria.

On the one hand, the integrated financial markets and the common currency may help protect the countries from the negative impacts of a financial crisis, because the countries are part of a large, stable economic unit. On the other hand, financial instability may spread easily from country to country, since barriers to the capital movements have been reduced.

Many market observes carefully track the yield curve's shape, which is typically upward sloping and convex. However, when the yield curve becomes flat or slopes downward (the spread between sovereign 10-year and 3-month bond is negative) it may signal GDP decrease (recession). The spread of 10-year and 3-month government bond is widely used and it is the most common measurement of the yield spread.

The yield curve simply plots the yield of the bond against its time to maturity. Many markets observe carefully the yield curve which simply plots the yield of the bond against its time to maturity. Many market observes carefully track the yield curve's shape, which is typically upward sloping and convex. However, when the yield curve becomes flat or slopes downward (the spread between sovereign 10-year and 3-month bond is negative) it may signal GDP decrease (recession).

The yield curve – specifically the spread between long-term and short-term interest rates is a valuable forecasting tool. It is simple to use and significantly outperform other financial and macroeconomic indicators in predicting recessions two to six quarters ahead.

Widespread use of the yield curve makes assessing its accuracy a worthwhile exercise for economists. But policymakers too need an accurate and timely predictor of future economic growth.

With sophisticated macro-econometric models and highly paid professional forecasters, is there any place for a simple indicator like the yield curve? Aside from the knowledge gained about the curve itself, there are several reasons to answer that question in the affirmative. Simple predictions may serve as a check on more complex models, perhaps highlighting when assumptions or relationships need rethinking. Agreement between predictions increases confidence in the results, while disagreement signals the need for a second look. A simple, popular indicator also provides some insight into market sentiment. It is always a good idea to check whether the expensive and complicated forecasts actually do perform better. After first reviewing some basics about the yield curve and the reasons it might predict future growth, we look at the actual relationship (Haubrich & Dombrosky, 1996).

This paper builds on a wide range of previous researches, but differs in some ways. Bernard and Gerlach (1998) in their paper showed empirically on eight countries that the slope of the yield curve is a good predictor of the real economic activity. Berk and Van Bergeijk (2001) examined 12 euro-area countries over the period of 1970–1998 and found that the term spread contains only limited information about future output growth. Their work is based on the previous theoretical researches of Estrella and Hardouvelis (1991), Estrella and Mishkin (1996). There was proven the evidence that the slope of the yield curve and the future GDP activity are related together. However, it is necessary to say that this rule was true until the end of the 20th century and it mostly disappeared at the beginning of the 21st century and appeared again during the financial crisis (from 2008) and later on (Chinn & Kucko, 2010; De Pace, 2011; Giacomini & Rossi, 2006; Wright, 2006). Most of the studies are focused on the relationship of the yield curve and GDP activity of the United States of America.

The aim of this paper is to show if the yield spread possesses the predictive power of future economic activity in Nordic countries and to examine which time lag of the spread is the best for prediction of the future GDP.

Despite various researches, there is not any comprehensive theory that would prove the correlation between the yield spread and economic development of the country yet. We often come across the statements that have only theoretical basis without generally valid empirical evidence. Economic models are largely based on the argument that the yield curve tends to be flatter in the situation of the tight monetary policy and the economic slowdown typically occurs with a slight time lag (Szarowska, 2015).

Almost perfect tool containing the relevant future data provides the yield spread of government bonds. The simplest interpretation of the yield spread is through monetary policy of the country. Based on this criterion – relatively low spread reflects the restrictive and tight monetary policy and vice versa – high spread reflects loose monetary policy. We can find the theoretical justification for using of the spread in expectations hypothesis. It assumes that a long-term rate of return is the average of the current and expected future short-term yields. The investor's decision to invest in short-term or long-term asset is completely irrelevant (Mishkin, 1990).

Dependence of the yield spread and GDP can be derived from their connection to the monetary policy of the state. As bond yields react to monetary policy as well as monetary policy is able to respond to the output of the economy, the yield curve assumes overlapping of policy measures and responses. The yield curve has the ability to reflect future production either directly or indirectly. Indirectly it comes to predicting of the future interest rate and the future monetary policy. It may also reflect the future production directly because the 10-year yields may depend on estimates of the output of the economy in 10 years.

A question arises – how many months, quarters, years of future economic activity can be predicted by the yield spread? Based on the study of Bonser-Neal and Morley (1997) as well as Chinn and Kucko (2010) spread has the greatest ability in predicting one-year horizon (four quarters ahead). As it was mentioned above, to prove if the spread has the best predictive power in one-year horizon is one of the aims of this paper.

2. Methodology and Data

There are many ways of using the yield curve to predict the future real activity. One common method uses inversions (when short-term rates are higher than long-term rates) as recession indicators. Obtaining predictions from the yield curve requires a lot of preliminary work. There is the principle which needs to be held: keep the process as simple as possible.

A yield curve may be flat, up-sloping, down-sloping or humped. The standard solution uses a spread (difference between two rates). The problem is to choose the spread between the right terms. The most used spread is between 10-year and 3-month bonds. The problem is that there are rarely bonds which mature exactly in 10 years (or 3 months). In that case the best solution is to use the yield curve, which shows the yield of each maturity. Creating and calculating of the yield curve is a rather difficult task because there are many ways how to do it and every country uses a different model of construction.

The yield curves are constructed by Bloomberg, therefore the data for spreads were gained from Bloomberg. For the spreads 10-year government bond rates minus 3-month sovereign bond rates were chosen (Estrella & Hardouvelis, 1991; Estrella & Mishkin, 1996). Quarterly data were used for the spreads because the data of the economic activity are taken on quarterly basis as well. The data of real GDP can be found at Eurostat, OECD statistics or Bloomberg. The data of real GDP obtained and used in this paper are from OECD statistics.

The selected countries are countries of Scandinavia (Denmark, Finland, Iceland, Norway and Sweden).

There is no previous research which would prove or reject the hypothesis of real GDP and bond spread dependence in European countries.

As a measure of real growth four-quarter percent change in real GDP was used (thus the percent change of the quarter against the last year's same quarter was calculated, e.g., the change from 1Q2004 and 1Q2003 real GDP was used). GDP is standard measure of aggregate economic activity and the four-quarter horizon answers the frequently asked question – what happens the next year?

The sample period starts from 1Q2000 and ends on 4Q2016. This time range covers the period before financial crisis, period of financial crisis and period after financial crisis. The basic model is designed to predict real GDP growth/decrease two to six quarters into the future based on the current yield spread (Bonser-Neal & Morley, 1997).

This was accomplished by running of a series of regressions using real GDP activity and the spread between 10-year and 3-month bond yields lagged two to six quarters (e.g. if the spread was lagged by 4 quarters, the interest rate spread used for 3Q2001 is actually from 3Q2000).

The last step is to find out which spread lag is the best for which country and to prove the hypothesis that the lag of four quarters is the best one for prediction of future GDP growth.

To generate the GDP predictions the regression using the whole sample was run, and later on two divided samples of real GDP and spreads of each selected country (the sample is divided in 4Q2007/1Q2008, because this period preceded financial crisis and should show some changes in prediction of the yield curve spread) were run.

The following equation (1) was estimated for each country:

$$Real\,GDP_{t+n} = \propto + \beta * spread_t + \varepsilon_t \quad (1)$$

where

$Real\,GDPt+n$ is a prediction of the future real GDP in time $\mathrm{t+n}$

n is the lag of spread, value of the lag can be 2, 3, 4, 5 or 6

$spread_t$ is spread between 10-year and 3-month state bonds in time t

ε_t is a white noise

3. Results and Discussion

Does the yield curve accurately predict the future GDP?

First we can look at the data. Figure 1 shows the growth of real GDP and the lagged spread (4 quarters) between 10-year and 3-month bond yields in Sweden, Figure 2 shows the GDP activity and lagged spread (5 quarters) in Finland (similar figures can be constructed for the rest of the countries, these two are for example). A decline in the growth or real GDP is usually preceded by a decrease in the yield spread and narrowing yield spread often signals a decrease in real GDP growth. A negative spread usually precedes recessions, but not always. It is clearly visible that the dependency between real GDP and lagged spread is more visible from the year 2008 than before.

When we constructed a scatterplots with each point representing a particular combination of real GDP growth and the lagged yield spread of Sweden and Finland, it showed that the relationship between the two variables is mostly positive. It means that positive real GDP growth is associated with a positive lagged yield spread and vice versa. Plotting the data gives a strong impression that the yield spread predicts future real activity.

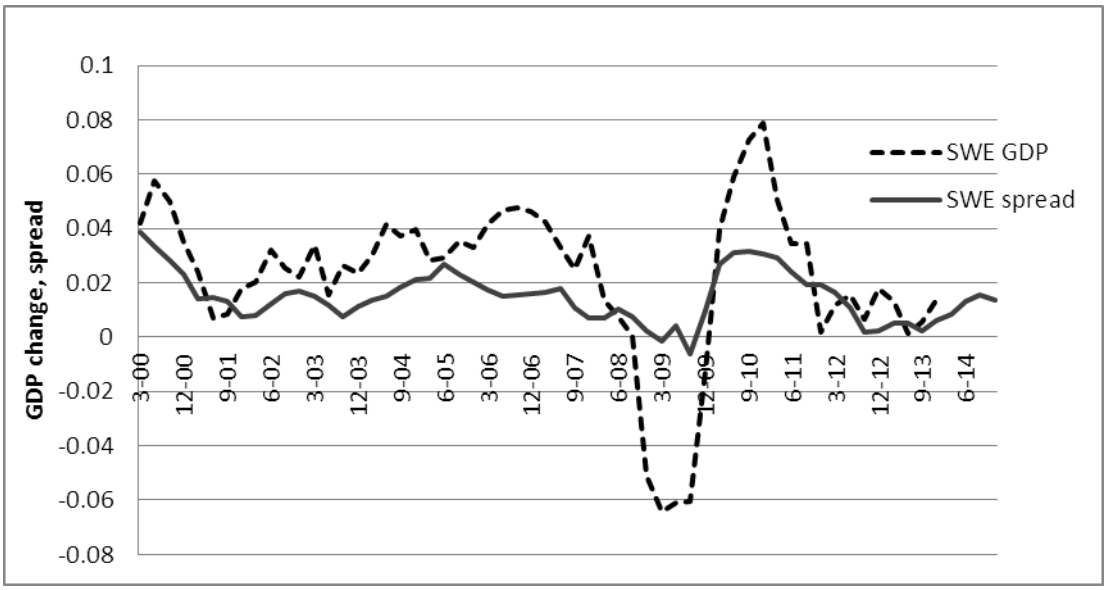

Figure 1. Real GDP and spread in Sweden (spread lagged four quarters)

The recession that began in 2009 was preceded by many quarters of decreasing spread and at the end the spread was very close to zero and negative. The same situation repeated in 2011 and 2012.

The prediction of the future GDP for 2014 is also quite clear - Sweden should remain in positive GDP growth situation because of upward sloping spread, GDP in Finland should decrease in the first two quarters of 2014 because of slight decline of spread and after that real GDP should increase.

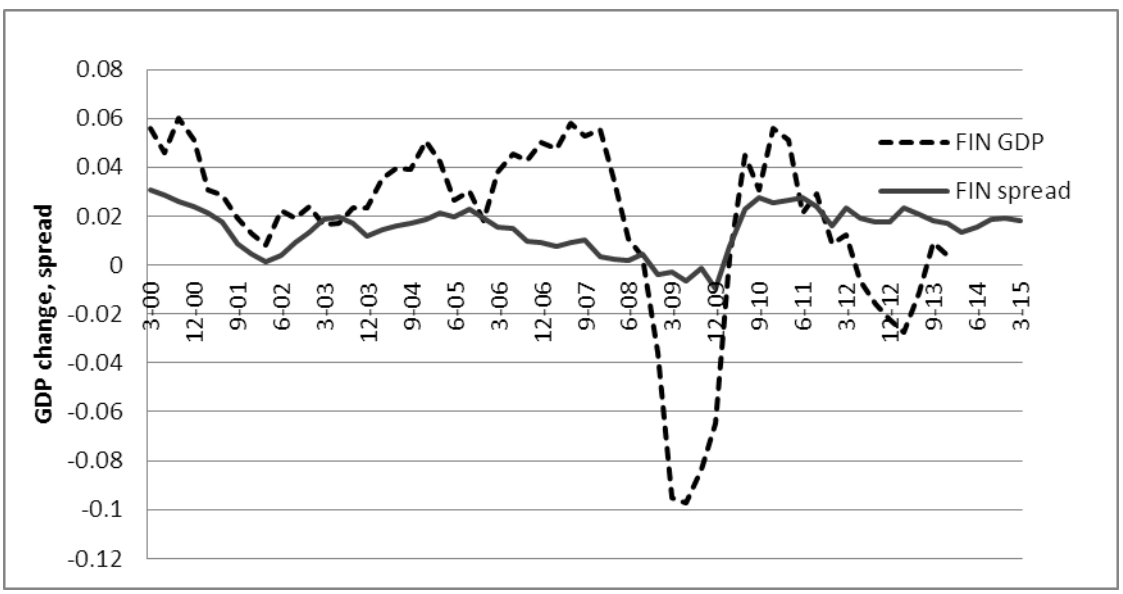

Figure 2. Real GDP and spread in Finland (spread lagged five quarters)

3.1. Results of regression for Denmark, Finland, Iceland, Norway and Sweden – whole sample

The whole sample of dataset contains the real GDP from 1Q2000 to 4Q2016. A regression of the whole sample was run and we got the results as seen in Table 1.

It is necessary to say that we can contribute this model statistically significant for all the countries because of *p*-value under 1% (***) respective under 5% (**). However R^2 are not very high in any models except of the model for Sweden (58%). R^2 coefficients show us how many percentage of the sample can be explained by these models. We got the best results of the models mostly for lag of spreads 4 (Denmark, Sweden). The lag of spreads 2, 5 and 6 is the second best choice (Iceland, Finland, Norway). Models for countries mentioned above may be used as predictive models.

Table 1. The results of all countries and whole sample from OLS regression

Whole sample	Constant	Spread	*P*-value (*F*-test)	R^2
Denmark *n* = 4	−0.0081970	1.185795	0.0018***	0.181458
Finland *n* = 5	−0.0085967	1.915698	0.00057***	0.245986
Iceland *n* = 2	0.1212486	−2.068759	0.000798***	0.185369
Norway *n* = 6	0.019671	−0.068259	0.01745**	0.114587
Sweden *n* = 4	−0.017359	2.657955	3.67e-011***	0.5856958

** *p*-value under 5%, *** *p*-value under 1%

For example we can say that future GDP growth of Sweden will be:

$$Real\,GDP\,Sweden_{t+4} = -0.017359 + 2.657955 * spread_{Sweden\,t}$$

3.2. Results of regression for Denmark, Finland, Iceland, Norway and Sweden – divided samples

The research continued as follows – the whole sample was divided into two samples. The first one is from 1Q2000 to 4Q2007, the second one is from 1Q2008 to 4Q2016 in order to show if there is any dependency between the variables before or after the financial crisis. Regressions of the first sample and the second sample were run. The results for the time span of 1Q2000–4Q2007 (first sample) are possible to see in Table 2, the results for the period of 1Q2008–4Q2016 (second sample) are in Table 3.

Table 2. The results of all countries and sample of period 1Q2000 – 4Q2007 from OLS regression

1Q2000–4Q20007	Constant	Spread	*P*-value (*F*-test)	R^2
Denmark *n* = 4	0.00896117	0.686048	0.054216**	0.118022
Finland *n* = 6	0.0402452	−0.361997	0.4042	0.023303
Iceland *n* = 3	0.00975569	1.04365	0.29564	0.036835
Norway *n* = 6	0.0228765	−0.058467	0.01286**	0.195463
Sweden *n* = 3	0.0127549	1.24421	0.0005***	0.339790

** *p*-value under 5%, *** *p*-value under 1%

Table 3. The results of all countries and sample of period 1Q2008 – 4Q2014 from OLS regression

1Q2008–4Q2016	Constant	Spread	*P*-value (*F*-test)	R^2
Denmark *n* = 5	−0.033548	2.099568	0.00023***	0.478592
Finland *n* = 5	−0.0408759	2.554756	2.89e-05***	0.545695
Iceland *n* = 2	0.08569855	−2.08968	0.0025***	0.357815
Norway *n* = 5	0.00045485	0.695369	0.076595**	0.143659
Sweden *n* = 4	−0.0224698	2.7678525	3.65e-08***	0.682596

** *p*-value under 5%, *** *p*-value under 1%

It is clearly visible, that the dividing of sample made a great difference in results. In the first period (2000–2007) only model of Denmark, Norway and Sweden were statistically significant and their *p*-values were below 5%. The models of Finland and Iceland could not be used as predictive models because of their statistical insignificance (high *p*-values ad low R^2).

The second period (2008–2016) showed a difference. Models for all the selected countries may be used as predictive models because they are statistically significant.

The models for Denmark, Finland, Iceland and Sweden have very low *p*-values (under 1%) and high R^2 (more than 35%). The model for Norway is predictable as well but the *p*-value is under 10% and R^2 may explain only 14%. These models are therefore usable for future prediction of GDP. In the second period the best results were gained by lag of spreads by 5 quarters, the second best results we got with the lag of 2 and 4 quarters.

We can say that:

$$Real\,GDP_{Denmark\ t+5} = -0.033548 + 2.099568 * spread_{Denmark\ t}$$

$$Real\,GDP_{Finland\ t+5} = -0.0408759 + 2.554756 * spread_{Finland\ t}$$

$$Real\,GDP_{Iceland\ t+2} = 0.08569855 - 2.08968 * spread_{Iceland\ t}$$

$$Real\,GDP_{Norway\ t+5} = 0.00045485 + 0.695369 * spread_{Norway\ t}$$

$$Real\,GDP_{Sweden\ t+4} = -0.0224698 + 2.7678525 * spread_{Sweden\ t}$$

For example if there would be a change of 1% up in the spread of Iceland then the GDP would decrease about 2.00% (0.08569855–2.08968*1%).

The findings of De Pace (2011) were confirmed in all selected countries. The models should predict the future GDP well after 2008. The best model for Finland, Iceland, Norway and Sweden are taken from the whole sample (1Q2000–4Q2016).

4. Conclusion

Does the yield curve accurately predict the real economic growth? Answering this seemingly simple question requires a surprising amount of preliminary work. The 10-year - 3-month spread has substantial predictive power and should provide good forecast of real growth two to six quarters into the future. We showed that the best predictive lags of spreads are lags of four and five quarters in order to get the best results for predictive models. The results presented above confirm that 10-year and 3-month yield spread has a significant predictive power for real GDP growth and the behavior of the models changed during and after the financial crisis. The results show that the dividing of the sample made a difference between pre-crisis and after-crisis period and it showed bigger influence of spreads on predicting of the future GDP.

This paper confirms the previous work of De Pace, who says there was a break in the time of financial crisis and the hypothesis that future growth of GDP can be explained by spread of bonds did not work properly at the beginning of 21st century, however it started to work after 2008 again.

The simple yield curve growth forecast should not serve as a replacement for the predictions of companies, which deal with predicting of many economic indicators, it however does provide enough information to serve as a useful check on the more sophisticated forecasts.

Future research could be extended to a wider examination of the best lags of spreads in more countries around the world. It would be interesting to see if there is any rule which would prove the hypothesis that lag of four and five quarters is the best for predicting future GDP growth in the countries of the whole world (it was empirically proved that in the USA during 1970 and 2000 the best lag of spread was a lag of 4 quarters).

Acknowledgements

Support of Masaryk University within the Project MUNI/A/1039/2016 'Modelling of volatility in financial markets and its application in risk management and asset pricing' is gratefully acknowledged.

References

Berk, J. & Van Bergeijk, P. (2001). On the information content of the yield curve: lessons for the eurosystem? *Kredit und Kapital, 34*(1), 28–47.

Bernard, H. J. & Gerlach, S. (1998). *Does the term structure predict recessions? The International Evidence* (BIS Working Paper 1998-37). Basle, Switzerland: Bank for International Settlements.

Bonser-Neal, C. & Morley, T. R. (1997). Does the yield spread predict real economic activity? a multicountry analysis. *Economic Review - Federal Reserve Bank of Kansas City, 82*(3), 37–53.

Chinn, M. & Kucko, K. (2010). *The predictive power of the yield curve across countries and time* (NBER Working Paper Series 2010-16398). Cambridge, UK: National Bureau of Economic Research.

De Pace, P. (2011). GDP growth predictions through the yield spread: time – variation and structural breaks (EABCN Working Paper 2011-38). Florence, Italy: European University Institute, Euro Area Business Cycle Network Training School.

Estrella, A. & Hardouvelis, G. A. (1991). The term structure as a predictor of real economic activity. *Journal of Finance, 46*(2), 555–576.

Estrella, A. & Mishkin, F. S. (1996). The yield curve as a predictor of U. S. recessions. *Current Issues in Economics and Finance, 2*(7), 1–6.

Giacomini, R. & Rossi, B. (2006). How stable is the forecasting performance of the yield curve for output growth. *Oxford Bulletin of Economics and Statistics, 68*(1), 783–795.

Haubrich, J. & Dombrosky, A. (1996). Predicting real growth using the yield curve. *Economic Review: Federal Reserve Bank of Cleveland, 32*(1), 26–35.

Mishkin, F. (1990). *Yield curve* (NBER Working Papers Series, no. 1990-3550). Cambridge, UK: National Bureau of Economic Research.

OECD Statistics. (2017). Quarterly national accounts: quarterly growth rates of real GDP, growth rate compared to the same quarter of previous year. Retrieved May 01, 2017 from: http://stats.oecd.org/index.aspx?queryid=350

Szarowska, I. (2015). Tax shift by economic functions and its effect on economic growth in the European Union. *Acta Universitatis Agriculturae at Silviculturae Mendelianae Brunensis, 63*(6), 2127–2135. ISSN 1211-8516.

Wright, J. H. (2006). *The yield curve and predicting recessions* (FEDs Working Paper No. 2006-7). Retrieved May 01, 2017 from: http://ssrn.com/abstract=899538