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Master Thesis

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The yield curve as a leading indicator for recessions - evidence from multiple countries

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Content

1.0 Introduction

1.1 Motivation

Predicting different macroeconomic measures, such as movements in stock indices and GDP growth can be a challenging task. One concept however, has served as a reliable indicator of US recessions up until recent time. This concept is referred to as an inverted yield curve, and US recessions has for a period of time all been preceded with such a yield curve. It would be fruitful to have a functional indicator for when the next recession is about to occur. The goal of this thesis will therefore be to identify whether an inversion of the US yield curve still serve as a leading indicator for US recessions, and whether the same can be said for large European countries, such as Germany, France, and Great Britain.

We want to develop a model with the intention of predicting GDP movements in the US economy, GDP contractions that is, with the yield curve as our starting point, in order to test whether this relation still holds. Our intention is then to address whether the same can be said for Germany, France and Great Britain. We would also like to address potential reasons why any relationships we discover might cease to exist, or why they already have done so. This is one of our main concerns when estimating a forecasting model. As we know, many established relationships have ceased to exist in the past, due to certain shocks or regulatory events, such as unpegging of the Swiss Franc and the oil price plunge.

Our preliminary thesis has been developed with a short introduction to the historical relationship between inverted yield curves and recessions, with the intention to provide a straightforward view of the key aspects. Next in line are a review of relevant research and literature on the topic, and an assessment of areas that may call for further investigation. Together, this should provide us with enough material to develop a suiting research question and possible hypotheses. In order to perform our analysis, we will try to address the most reasonable research methodology and identify the most sensible sources of data for the topic.

1.2 Background

The yield curve is an illustration of interest rates for different maturities with assets bearing the same risk. It's slope can be interpreted to represent expectations for future economic growth and is one of the most cited leading economic indicators. Traditionally, when talking about the yield curve, one is referring to the curve compromised of the 3-month, 2-year, 5-year, 10-year and 30-year US Treasuries. This curve is most often expected to have a concave, upwards sloping look. But it can take on an infinite number of shapes. We want to look further into the inversion of the yield curve, which is a phenomenon that occurs when the short-term rates have a higher yield than the long-term. This deviates from what one usually observes as the long-term rates inherits more risk and thus should yield a higher rate.

Since the mid 70s, the US has experienced several recessions, which is defined as two consecutive periods of negative GDP growth (NBER recession). These have been preceded with certain short-term rates crossing the long-term rates. This difference between short and long maturities is referred to as the term spread, and the term spread is also a measure of the slope of the yield curve, which has several interpretations in terms of monetary stance.

"*The simplest theoretical rationale for why term spreads might be a useful leading indicator is that under the expectations hypothesis (neglecting term premiums), the term spread (short-term rates less long-term yields) measures the difference between current short-term interest rates and the average of expected future short-term interest rates over a relatively long horizon. The term spread is thus a measure of the stance of monetary policy (relative to long-run expectations). The higher is the term spread, the more restrictive is current monetary policy, and the more likely is a recession over the subsequent quarter."* (Wright H. J. 2006-07)

However, this rationale alone does not serve as a fundamental explanation of why short-term rates over long-term yields may potentially serve as a predictor of GDP and capture the probabilities of an upcoming recession. Nonetheless, we have chosen to limit this paper to assessing whether the relationship still holds in the US and if it also serves the same function in the UK, France and Germany.

1.3 Today's situation

Currently, the US term spread between 3-months treasury bills and 10-years treasury bonds is at 1.29 percentage points, which means that the yield curve is currently "normal", that is not inverted. However, through the course of 2017 we saw that the yield curve was flattening. In the beginning of 2017, the term spread was 1.92 percentage points, and while the 10-year treasury bonds remained more or less constant throughout the year, the short-term 3-month treasury bills rose with 0.86 percentage points. If one uses a model developed by Estrella and Hardouvelis in 1991 one would get that this flattening of the yield curve would increase the probability of recession.

Shifting focus over to the large European countries we want to analyse in our study, we mainly observe the same pattern as in the US except for in Germany where the spread has widened somewhat over the last year. The term spread in France is 1.563 percentage points (p.p), in the UK it is 1.144 p.p. and in Germany it is 1.348 p.p. As such, we see that not only do the term spread in the two of the three European countries show the same trend as the US term spread, but they are also all at close to the same level.

After the financial crisis of 2008, the world economy needed stimuli, and this was the start of a low interest rate environment where negative rates have been observed in several countries. Most economists agree that this expansive monetary policy cannot continue forever. As it is the short-term rates that the central banks control, we expect that short-term rates will rise going forward. If the central banks are too aggressive in the interest rate increases, as was the case in the US in the years leading up to the crisis in 2008, we might see an inversion of the yield curve. This will happen if market players believe that the rate increases are too drastic and believe that a period of lower GDP growth will follow.

2.0 Literature review

2.1 The cyclical behavior of the term structure of interest rates

Kessel, in this paper first published in 1965, was one of the first to link the yields on different government debt instruments to economic cycles. His thesis was that one could better explain the term structure of interest rates by a combination of the expectations and liquidity preferences hypotheses than by either hypothesis alone.

Although not the primary focus of his paper, Kessel found evidence that yield curves tended to be most upward sloping in the beginning of economic growth periods and most downward sloping pre-recession. His argument is that, when liquidity effects and incorrect expectations are disregarded, long-term rates should be higher than short-term rates when short-term rates are low and that the reverse should hold when short-term rates are high. This follows from the expectations hypothesis. As short-term rates are often counter-cyclical, i.e. they are low near the troughs of the economic cycle and high near the peaks, one would expect a negative sloping yield curve at the peaks of economic cycles.

Kessel also discusses the effect the liquidity premium has. The liquidity premium refers to the fact that long-term assets are less liquid than short-term assets, and thus their yield should be higher. He argues that near the troughs of the cycle, both expectational and liquidity forces push in the same direction and results in a positively sloping yield curve. However, at times near peaks, they have opposite effects. As always, the liquidity effect pushes the short-term rates below long-term rates. At the same time, as the market expects future short-term rates to be lower, the expectation effect pushes the long-term rate below the short-term. The slope of the yield curve near peaks will depend on the relative force between the liquidity and the expectational effect. Lastly, Kessel argues that as the two effects push in the same direction near troughs but work in opposite directions near peaks, short-term yields do not exceed long-term yields at peaks as much as they fall beneath long-term yields at troughs.

Being one of the first papers linking the yield curve to economic cycles, the paper founds the basis of many of the papers and the research we will base our thesis on. It provides some interesting results such as that the yield curve can be inverted near peaks of an economic cycle. The article thus provides some evidence that the yield curve might be a leading indicator of recessions.

2.2 The Term Structure as a Predictor of Real Economic Activity

This article studies the relationship between the yield curve and real economic activity and finds that there is a positive relationship between the slope of the yield curve and increases in future real economic activity. The author also finds that, as a leading indicator, the yield curve outperforms survey forecasts. Interestingly, the study indicates that the yield curve does not only reflect the monetary policy of the economy, but also factors independent of the monetary policy. He concludes that the slope of the yield curve could provide useful information both to policy makers and private investors (Estrella and Hardouvelis 1991).

Although the study does not concern the inversion of the yield curve, it is useful to our thesis as it concerns the relationship between the yield curve and economic output. Especially the finding that the yield curve reflects factors other than monetary policy alone is interesting for our study as if it were only reflecting the monetary it would not provide any additional information. The author highlights that his findings may not hold in the future if the Federal Reserve were to adopt the slope of the yield curve as an information variable into its decision system. As this and several other similar studies has gotten a lot of attention over the last decades, our study is relevant as it analyses if the relationship still holds or not, and it tests if the same relationship holds in other economies.

2.3 A procedure for predicting recessions with leading indicators

James Stock and Mark Watson examined various leading indicators and composite indexes in their 1992 paper. They further addressed the 1990 recession and developed an experimental composite index with the purpose of forecasting how likely a US recession will be within six months. Despite exploring several

explanations, they were not able to provide clear signals before each recession. The key take-away from this paper was the findings regarding forecast error. Namely that the use of financial variables not associated with a tight monetary policy led to such errors. (Stock J. & Watson M., 1992)

When attempting to predict changes in US GDP growth we will therefore try to steer away from many such variables, which may cause errors, and rather focus directly on the slope of the yield curve. On the left side of the yield curve we have the shorter rates, which changes are associated with the current monetary policy.

2.4 A re-examination of the predictability of economic activity using the yield spread

The authors first test the hypothesis of a correlation between the yield spread of the 3-month Treasury bill rates and the 10-year Treasury bond rates. Although they confirm this relationship, it is not the primary objective of the article. Its focus is on why the yield curve can predict future economic output. Kim and Hamilton find that the spreads predictive power can be decomposed into two different effects: the expectation effect and the term premium effect. The expectations effect refers to the expectations hypothesis that states that long-term rates are a projection of expected future short-term rates. The term premium is the premium one usually obtains by being willing to hold the additional risk that is associated with owning longer-term bonds.

The article is useful for our studies as it goes deeper into the reasons why the yield curve might be a good leading indicator. Several studies, including this one has shown that the curve might be a good indicator, but it is necessary to also understand why this might be the case. This article builds on our understanding of the subject and also includes evidence that interest rate spread volatility is an important determinant of the spread.

2.5 What does the yield curve tell us about GDP growth?

As Ang, Piazzesi and Wei puts it in their 2006 paper, the yield curve's behaviour changes across the business cycle. The countercyclical premiums on long bonds

and procyclical yield on short bonds is a key element, and the latter can be explained by the Federal Reserve lowering short yields during recessions in hope of stimulating economic activity. A prime example of this is Taylors (1993) rule, which states "For every 2 percentage point decline in GDP growth, the Fed should lower the nominal yield by 1 percentage point". This is a prime example of the effects one seeks to achieve from monetary policy, and the role of the yield curve.

The article uses a slightly different approach than the other articles in this literary review as it is a dynamic model which rules out arbitrage possibilities. The authors use the whole yield curve instead of two maturities to construct the spread. They argue that this may give more precise forecasts of GDP. However, our goal is not to forecast future GDP-growth as precisely as possible. We want to test whether a yield curve inversion still is a leading indicator of recessions, as such we choose to not use a model similar to the one used in this paper.

2.6 The Yield Curve and Predicting Recessions

The paper by Jonathan H. Wright provides a method for testing the probability of a recession by using a probit model and, among others, the term spread between 3-months treasury bills and 10-year treasury bonds as the independent variable in the model. The article is useful in that it is the first among the articles in this literature review that only test what the inversion of the yield curve gives in probability of a recession. It is highly relevant for our thesis as it is the first that only focuses on the inversion of the yield curve, and not what the yield curve tells about future GDP growth.

Interestingly, the article was written in 2006-2007, just before "The Great Recession" which the financial crisis of 2008 often is referred to. At the time, the yield curve was flat to inverted, and time would prove that this was indeed a predictor of the recession to come. Today, as we discuss in 1.3, we also observe a flat yield curve. The world economy has experienced one of the longer periods of continuous growth after the world war, hence a period with lower or negative growth would not be peculiar.

Another important finding in Wright's paper is that models using an independent factor reflecting the level of the fund's rate performs better both in- and out-of-sample. More specifically, he shows that a model with only the term spread as an independent factor more often gives a high probability of a recession than models using both the term spread and the level of the fund's rate. The best indicator of a recession, according to this paper, is an inverted yield curve with a high level of the fund's rate. However, this method also has some limitations. It is only the model using only the term spread which at the time of the analysis, February 2006, predicted a probability of over 50% for a recession occurring within the next 6 quarters. The models using, among others, the level of the fund's rate, assigned a probability of around 20% of an imminent recession. Looking back, it is clearly model A which was the best in predicting a recession at that time. However, because using the level of the fund's rate gave better results for the other recessions, we will test if this is the case in our thesis as well.

3.0 Research question and objective

3.1 Research question

The research question will decide the limitations of the thesis, and narrow it within our field of study. The main objective of this thesis is to test if an inversion of the US yield curve still is a leading indicator of recession and to test if this relationship holds in other economies as well, namely the French, German and in Great Britain.

Is an inversion of the yield curve still a leading indicator of an imminent US recession, and can the same be said for other economies?

3. 2 Research question limitations

First of all, there are a limited number of recessions to be studied. The US for example, has not had many during the last forty years. The same can be said for Germany, France and UK.

Endogeneity issues will also have to be considered, as the yield curve in itself is not the direct cause of recessions, but rather underlying factors, which will have to be considered. However, as we are just addressing predictive powers and not concerned with actual causality, this is considered important.

Last but not least we are concerned that the historical relationships between the slope of the yield curve and economic development will seize to exist or change as we move into new times. We will do our best to address this.

3.3 Possible hypotheses

From the papers discussed in the literature review, our main hypothesis is that an inversion of the US yield curve will be a reliable predictor of GDP contraction, and that the same can be said for Germany, France and UK, with their respective yield curves. The rationale is that an inversion of the US yield curve has been shown several times to be a leading indicator of a recession.

Our second hypothesis is that this relationship no longer holds in the US, but that it does in one or more large economies. Which have several important interpretations.

Our last hypothesis is that this relationship does not hold in any economy. And if so is the case, we will seek to address why it does not.

4.0 Methodology, data collection and progression

4.1 Methodology

The objective of our thesis implies that the research should mainly rely on quantitative data and quantitative techniques. We will look into sets of data on interest rates, and identify whether an inversion of the US yield curve still serve as a leading indicator of recessions. A potential benefit from applying a quantitative approach will be that the external validity can be high. That is, effects we discover on certain markets have explanatory power on similar markets. However, due to

endogenous factors, the internal validity may suffer, and any association is just a reduced form correlation. However, due to the field of study, we identify the advantages of quantitative approach as far more important than the disadvantages of such an approach.

We will try to apply different econometric methods to estimate suitable models for our thesis. Regression techniques will be our preferred quantitative technique. It may however turn out that other methods are more suitable, as we analyse our dataset, which we will have to take a stance on as we investigate further. The software we plan to apply when conducting our statistical and econometric analysis is MatLab. However, as with our analysis method, we are not yet excluding the use of any other software, which may present itself as more favourable. At the current time however, this is our desired strategy.

We will investigate several data sets and movements in the relevant variables over different time spans. Due to the field of study, and the nature of this thesis, we plan to make use of secondary data. With secondary data we are referring to data already collected by an external part, such as governments, banks, statistics agencies etc. Since we are using secondary data, we will strive to ensure that the external validity is sufficient and that the desired research technique and methodology is suiting.

We have considered three probit models that estimate the likelihood of an upcoming recession, given a yield curve inversion; Jonathan H. Wright first used these in his 2006 paper.

Model A is the first and most simple model:

$$P(NBER_{t,t+h} = 1) = \Phi(\tilde{\alpha}_0 + \tilde{\alpha}_1 SPREAD_t^{3M-10Y})$$

where NBER is a dummy variable, that takes on the value 1 if there is an NBER-defined recession during quarters t+1 until and within t+h. SPREAD denotes the difference between the average 3-month and 10-year maturity Treasury, in quarters t. Φ the standard normal cumulative distribution function.

Model B takes into account the level of the nominal federal funds rate:

$$P(NBER_{t,t+h} = 1) = \Phi(\beta_0 + \beta_1 SPREAD_t^{3M-10Y} + \beta_2 FF_t)$$

where FF denotes the effective average Federal Funds rate in quarter t.

Model C takes into account both the nominal and real federal funds rates:

$$P(NBER_{t,t+h} = 1) = \Phi(\delta_0 + \delta_1 SPREAD_t^{3M-10Y} + \delta_2 FF_t + \delta_3 RF_t)$$

where RF denotes the real Federal Funds rate in quarter t, with log-difference in the PCE price index over the latest four quarters as a proxy for expected inflation. This will test which measure of monetary stance gives more predictive power in terms of forecasting.

4.2 Data collection

In our thesis we will use market data on different US interest rates and yields, US GDP development, as well as the corresponding measures for France, Germany and the UK. With interest rates we are referring to the rates on government bonds, which we, for the US, will obtain directly from the Federal Reserve's Monetary Division web pages or from Bloomberg. Initially, we plan to use the 3-month Treasury bill and 10-year Treasury bond as our short-term and long-term rates respectively, we will however also address other combinations. Data on GDP development can be collected from a variety of sources.

4.3 Thesis progression plan

The deadline for submitting the master thesis is on the 1st September 2018. Despite the scope of 9 months to develop our thesis, we wish to set up an effective schedule of around 5-7 months in order to provide ourselves with sufficient headroom for any unforeseen events or challenges that may arise. Deviations from the plan provided may occur.

January	Gain a deeper understanding of our chosen topic and develop our strategy going forward. Complete the Preliminary report. Ensure access to the required databases.
February	Review further literature, dig deeper into the aforementioned literature, and gather data from the aforementioned sources. Begin structuring and testing the data with models.
March	Look further into possible events that may destroy the predictability of our models. Continue our quantitative analysis, test different models.
April	Write up our first thesis draft. (Will be done continuously as we progress).
May - August	Review feedback on the first draft, make the necessary adjustments and finalize the thesis.

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