The Predictive Power
of Interest Rates Spread
for Economic Activity

Raffaele Passaro*

University of Siena

Since the 1980s, economists argued that the spread between the long-and short-term interest rates is a good predictor of future economic activity. Developing Estrella (2006) study, I investigate the ability of the interest rate spread to predict USA and Germany recessions using a probit model. The results show that the slope of the yield curve well predicts recession periods. I also compare the performance of the spread to the performance of the Chicago Federal Nation Index (CFNAI) — a credited leading indicator for the economic activity of the US — finding out that the yield-spread based forecast anticipates by several months the CFNAI forecast [JEL Classification: E37, E43, C53].

1. - Introduction

The study of variables able to grasp information about the determint of the business cycle has always been treated in several studies. In the past years the attention focused on the of interest-rate term structure, which seems to be a good predictor of the economic activity. In fact interest rates spread is able to anticipate real GDP growth (Stock e Watson, 1989; Harvey, 1989; Estrella e Hardouvelis, 1991; Plosser e Rouwenhorst, 1994) and to predict periods of recession (Estrella e Mishkin, 1997; Dotsey,

1998; Estrella, 2006). This last phenomenon, that is the inversion of the yield curve followed by a period of recession, has occurred with a certain frequency in the course of the last forty years especially in the United States. As experiment in the past, an inversion of the yield curve strikes a certain fear for market operators who are always in need of accurate predictions in order to make the best possible choices for the investments. The ability to forecast a recession can also work towards helping the Central Bank decide when to stimulate the economy through lowering interest rates in an attempt to elude a recession or at least reduce its impact on the country.

If a recession is forecast, equity analysis may reduce firms' earning growth rates according to capital market expectations.

2. - Review of Literature

A study by Stock and Watson[1] examines combinations of fifty-five various macroeconomic variables and selects the combination that best predicts future economic activity. Out of the massive sample of variables they limit their selection to seven variables in order to create an index used to predict future economic activity. Of the seven variables they find that the yield spread measured by the difference between the 10-year and 1-year Treasury bond is a valuable component of their index.

An article that tests the yield spread in isolation is that of Harvey[2] who examines the 1953 to 1989 period. His results overwhelmingly indicate that the bond market contains information to more accurately predict economic growth. The bond market variable tested is the yield spread. A simple linear regression model is used with real GNP as the dependent variable and the yield spread as the independent variable. The yield spread is tested in two forms. One, as the spread between the 5-year and 3-month Treasury yields. Two, as the spread between the 10-year and 3-month Treasury yields (same form as the one tested

---

[1] STOCK J.H. - WATSON M.W. (1989, pages 352-394).
[2] HARVEY C.R. (1989, pages 38-45).

in this paper). The results indicate that the spread variable is significant in terms of its ability to explain the variability of economic. During the entire sample period its R-squared measure is greater than 30 percent, indicating that the yield curve explains more than 40 percent of the variation in economic growth. The results are even more compelling in the sub-periods tested. In contrast, the stock market is tested using the return on the S&P 500 as the independent variable, and the results during the entire sample period are bleak, as the stock market variable indicated less than 5 percent explanatory power on economic growth. An interesting observation is that the yield spread based forecasts for the third quarter of 1989 through the third quarter of 1990 suggested slowing of economic growth. Needless to say, the start of the third quarter in 1990 was designated as the start of the 1990 recession.

The interest rate spread as a predictor of economic activity is once again tested in an article by Estrella and Hardouvelis[3]. Examining data from 1955 to 1988 they find that the slope of the yield curve has extra predictive power over and above the predictive power of lagged output growth, lagged inflation, the index of leading indicators and the level of real short-term interest rates. Furthermore, they find that the interest rate spread is a useful predictor of real GNP, composed by consumption, consumer durables and investment. The usefulness of the slope of the yield curve is tested in and out-of-sample. The results of this article strongly support the slope of the yield curve as a valuable indicator of future economic activity and also of inflation. Furthermore, they also find the spread useful in forecasting the probability of a recession. An important implication of this article is its rule of thumb applicability.

The next flood of articles emerged when the 1990 recession provided another opportunity for researchers to test the usefulness of financial indicators in predicting recessions. The predictive power of the yield curve is tested out-of-sample by Hu[4] through

---

[3] ESTRELLA A. - HARDOUVELIS G. (1991, pages 339-362).
[4] HU Z. (1993, pages 781-806).

examining real GDP growth rates in the G7 industrialized countries. He finds that the yield spread is a good predictor of future economic growth. The empirical results suggest that the slope of the yield curve has more forecasting power than variables such as lagged GDP growth, stock price changes and inflation. He advocates that policy makers and private investors obtain useful information about the business cycle by simply observing the yield curve.

Plosser and Rouwenhorst[5] examine whether the ability of term structure to predict economic activity stems from information in the short-end or long-end of the yield curve. This is important because monetary policy primarily controls over rates on the short-end. Therefore, if the predictability is coming from the short-end then a connection may exist between monetary policy and future economic growth. They use data from 1973:08 to 1988:12. The most significant finding in this paper is that the slope of the yield curve has information about economic growth beyond movements in short-term interest rates.

Haubrich and Dombrosky[6] use out-sample testing to examine the yield curve's capacity to predict future economic activity using data from 1961 to 1995. They compare the performance of the spread and those of other financial indicators such as lagged GDP growth, index of leading indicators, Blue Chip Economic Indicators forecast. They consider term spread measured by the difference between the 10-year and 3-month Treasury bond. The empirical tests indicate that the yield spread provides the best forecast in the last 30 years of real growth four quarters ahead. However, the *caveat* arises in examining the sub-period of 1985-95, which completely reverses the results. During this sub-period, the yield curve actually produces the worst results and the leading indicators index the best results. One of the explanations given for this phenomenon is the changing relationship between the yield curve and the economy over the last 30 years. Advances in technology, new production processes

---

[5] PLOSSER C.I. - ROUWENHORST K.G. (1994, pages 133-156).
[6] HAUBRICH J.- DOMBROSKY A. (1996, pages 26-35).

and the market reaction to new information may be responsible for altering the relationship between the yield curve and economic activity.

Estrella and Mishkin[7] examine the usefulness of various financial variables in predicting recessions one to eight quarters ahead. They focus on recession predictability and use out-of-sample data in their analysis that uses quarterly data from 1973 to 1994 of different countries (Germany, US, France, Italy and UK). They find that the basic results of Estrella and Hardouvelis (1991) continue to hold in the United States as well as in the other countries analized.

Finally, in recent work, Estrella[8] shows that the spread is a good predictor of recession for the US during the period 1968-2005. The combination adopted is ten year (for long term) and three month (for short term). He finds that the performance of the yield curve as an indicator does not depend on the movements of the long-term rate but the results indicate that a rise in the three-month rate preceded each recession during this period. In that sense, we could think of every yield curve inversion as resulting at least partly from a rise at the short end.

This study provides a detailed analysis of research first published by Estrella in (1991) and improved by the author in later works (1997, 2006). First I test the relationship between spread and real GDP growth for the US and Germany, finding this relation significant and robust. Next I analyze the ability of term spread to predict recessions using a probit model. I use ten year-three month spread for each country using data from 1968-2006 (for the US) and 1972-2006 (for Germany). Probit regressions are run with the use of dummy variables, distinguishing between recessionary periods and non-recessionary periods as designated by the National Bureau of Economic Research. The model generates recession probabilities based on forecast horizons of two, four, six, twelve and eighteen months. I test the yield spread in isolation as the sole explanatory variable in the probit model for these

---

[7] ESTRELLA A. - MISHKIN F. (1997, pages 1375-1401).
[8] ESTRELLA A. - TRUBIN M. (2006).

two countries. My results strongly support the predictive power of the yield curve particularly at forecast horizons beyond four month. The best performance is obtained using lag of yield spread of six and twelve months. Next I investigate whether an inversion is determined by the short or long end of yield curve. I find that a rise in the three-month rate preceded each recession so the three month rate most directly influences a yield curve inversion. Finally I provide comparative analysis between spread and Chicago Federal Nation Index (a good leading indicator of US economic activity building by Stock and Watson). The results show that the forecast of CFNAI is significant only when using forecast horizons of one and two months and that the forecast obtained using the spread, anticipates by several months, the forecast based on the Chicago Federal Nation Index (CFNAI).

3. - Theoretical Background

As seen in the previous section, the are a lot of works that have analized the relationship beetween spread and economic activity. At this point, it's useful to explain why this relationship exists.

The first reason stems from the expectations hypothesis of the term structure of interest rates. It claims that, the long-term rates can be considered a weighted average of expected future short-term rates:

(1)
$$R_t^{(N)} = \frac{1}{k} \sum_{i=0}^{k-1} E_t R_{t+mi}^{(m)} + \theta_t$$

In particular, for any choice of holding period, investors do not expect to realise different returns from holding bonds of different maturity dates. Obviously, if people had perfect foresight about future short-term interest rates, holding-period returns would necessarily be equalized through arbitrage. However, uncertainty regarding future short-term interest rates causes the interest-rate term structure to deviate from the shape implied by

the risk-neutral expectations hypothesis. In particular, the yield curve normally is upward-sloping, even when investors expect relatively constant short-term rates, because holders of long-term securities bear the risk that future interest rates will be higher than expected, so they require a positive risk premium (*theta* of equation *(1)*) in long-term bond yields. Fluctuations in interest-rate risk premiums are thought to be relatively small, at least in the short run, so changes in market expectations of future short-term rates are still considered the primary determinant of changes in the slope of the yield curve. If investors begin to suspect that a recession is near, it implies an expectation of decline of future short interest rates that is translated in a decrease of long-term interest rates. These reductions in short-term interest rates may stem from countercyclical monetary policy designed to stimulate the economy, or they may simply reflect low real rates of return during the recession[9]. In either case, the anticipated severity and duration of the recession will strongly influence the expected path of short-term interest rates, which will show up in the shape of the yield curve.

Another reason which explains the above relationship is related to the effects of monetary policy[10]. For example, when monetary policy is tightened, short-term interest rates rise; long-term rates also typically rise but usually by less than the current short rate, leading to a downward-sloping term structure. The monetary contraction can eventually reduce spending in sensitive sectors of the economy, causing economic growth to slow and thus, the probability of a recession to increase.

The third reason is given by Harvey[11] and Hu[12] and it is based on the maximisation of the intertemporal consumer choices. The central assumption is that consumers prefer a stable level of income rather than very high income during expansion and very low income during slowdowns. In a simple model where the

---

[9] HAUBRICH J.- DOMBROSKY A. (1996, pages 26-35).
[10] ESTRELLA A. - MISHKIN F. (1997) show that the monetary policy is an important determinant of term structure spread.
[11] See HARVEY C.R. (1988, pages 305-333).
[12] See HU Z. (1993, pages 781-806).

default-free bond is the only financial security available, if the consumers expect a recession, they prefer to save and buy long-term bonds in order to get payoffs in the slowdown. By doing that they increase the demand for long-term bond and that leads to a decrease of the corresponding yield. Further, to finance the purchase of the long-term bonds, a consumer may sell short-term bonds whose yields will increase. As a result, when a recession is expected, the yield curve flattens or inverts.

4. - Data

The interest rates used to calculate the spread between long term and short-term rates vary in the literature on the yield curve's predictive power. For example, market analysts often choose to focus on the difference between the ten-year and two year Treasury rates, while some academic researchers have favored the spread between the ten-year Treasury rate and the federal funds rate. In choosing the most appropriate rates, one should consider a number of criteria, including the ready availability of historical data. For the US, Treasury rates readily meet our criteria for the short-end side of the curve since the from 1950 up to now are available. Treasury securities are also useful because they are not subject to significant credit risk premiums that, at least in principle, may change with maturity and over time. For the US at the long end of the curve, the clear choice seems to be a ten-year rate, the longest maturity available in the United States while with regard to the short-term rate, earlier research suggests that the three-month Treasury rate, when used in conjunction with the ten-year Treasury rate, provides a reasonable combination of accuracy and robustness in predicting US recessions over long periods (Estrella, 2006). So, regarding the US spread we use *Ten Year Constant Maturity rate* and *Three month Treasury rate*[13], from 1968 to 2006.

---

[13] *Source*: Federal Reserve.

The spread used for Germany is the difference between *Federal public bonds with a remaining maturity of ten years* and the *Three month Money Market rate*,[14] the only combination available from 1972 to 2006 that allows us to perform a stable and robust analysis.

5. - Spread and Real GDP Growth

One of the most popular approaches used by most researchers to measure the predictive ability of the yield spread for future output is the simple OLS regression. In fact we can use the spread to predict real GDP growth over the next k quarters estimating this equation:

(2) $$\frac{400}{k} \log\left(\frac{RGDP_{t+k}}{RGDP_t}\right) = \alpha_s + \beta_s\left(Spread_t\right) + \varepsilon_{t+k}$$

The errors in *(2)* can be heteroskedastic (that is, the variance of μ_{t+1} can depend on X_{t+k} and autocorrelated (μ_{t+1} can be correlated with its previous values), so, standard errors are calculated with the Newey-West[15] correction. In left side, the factor of 400/k standardizes the logarithm to annual percentage growth rates[16]. The results of equation *(2)* are show in table 1. With regard to the US, as we can see, the relationship between the yield curve and real economic activity is very strong, as previous work for the US had shown, with estimated coefficients varying between 0,8 and 1. The results tend to be very significant for a horizon of four and five quarters ahead where the R^2 values are 38% and 35%. So the relationship between spread and real economic activity is positive and significant: one-percentage-point increase in the yield spread, is associated with a one-percentage-point increase in real GDP growth. For Germany this relationship is less strong than for the US. Nevertheless, estimated coefficients are significant and the

---

[14] *Source*: Bundesbank.
[15] Newey W.K. - West K.D. (1987, pages 703-708).
[16] This metodology is used by a lot of researchers to test the predictive power of yield curve. See Stock J.H. - Watson M.W. (2000, revised 2003).

TABLE 1

$$\frac{400}{k} \log\left(\frac{RGDP_{t+k}}{RGDP_t}\right) = \alpha + \beta\left(Spread_t\right) + \varepsilon_{t+k}$$

US

k	β*	R^2	n. obs.
1	0.839 (0.196)	0.1343	153
2	1.004 (0.208)	0.2110	152
3	0.952 (0.180)	0.2678	151
4	0.942 (0.173)	0.3864	150
5	0.915 (0.171)	0.3506	149
6	0.848 (0.156)	0.3582	148

Germany

k	β*	R^2	n. obs.
1	0.202 (0.0693)	0.0427	131
2	0.227 (0.0556)	0.1059	130
3	0.237 (0.0495)	0.1607	129
4	0.307 (0.0443)	0.213	128
5	0.272 (0.0404)	0.288	127
6	0.218 (0.0324)	0.3383	126

In parenthesis are heteroskedasticity and autocorrelation corrected standard errors (Newey-West).
(*): Coefficient significant at 10%.

best predictions are obtained with horizons of 3 and 4 quarters head. In this case, a one-percentage point increase in the yield spread is associated with a quarter percentage-point increase in real GDP growth.

6. - Spread and Recession: A Probit Model

As shown in the Graph 1 (the shaded bars represent recession periods defined as classical cycles), there is no doubt that the yield curve has inverted prior to every recession[17] in the United States and in Germany.

The only exception is the recession of 1989-90 in the US and the recession of 2001 with regards to Germany, where the yield curve compressed to a mere few basis points. In this section, I look at the ability of the spread to predict recession using the probit model described in Estrella (1991, 1997, 2006), where the
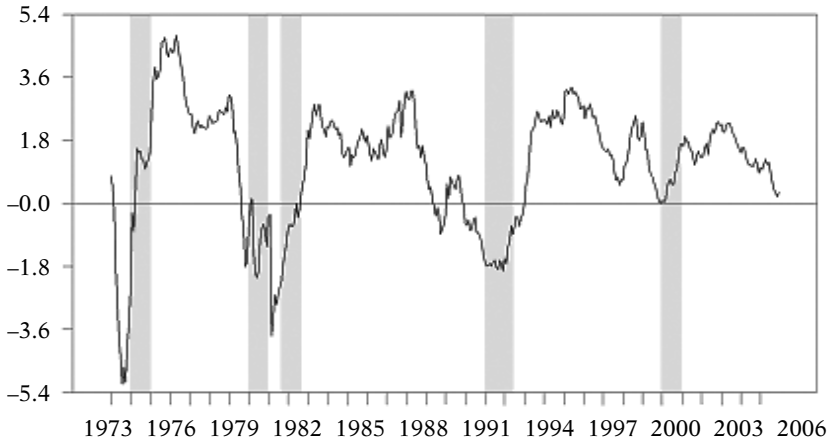
Graph 1

US
SPREAD VS CLASSICAL RECESSION DATE: 1968-2006

_____
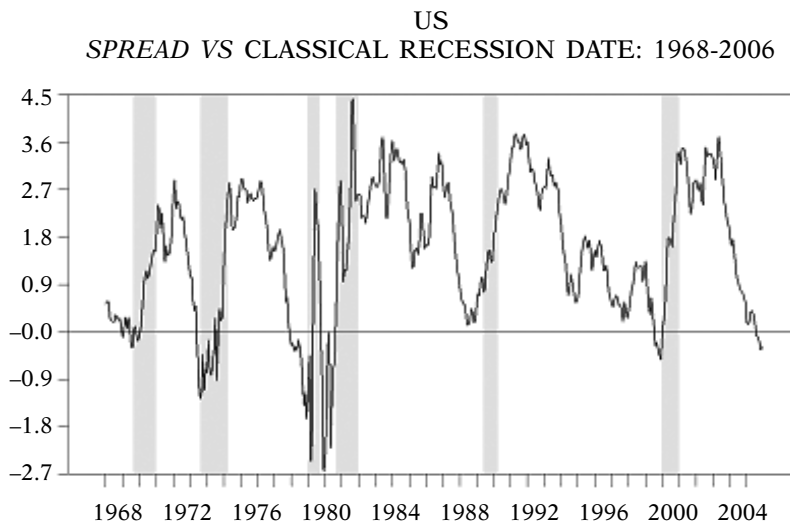
[17] Recession data: Source NBER for US and OECD for Germany.

GRAPH 2

GERMANY
SPREAD VS CLASSICAL RECESSION DATE: 1968-2006

sole explanatory variable is the yield spread. The probit regressions we estimate take the form

$$(3) \qquad P_t\left(Y = 1 \middle| X_{t-k}\right) = \Phi\left(\beta_0 + \beta_1 X_{t-k}\right)$$

$Y = 1$ if the economy is in a recession at period t

$$X_1 = spread_{t-k} = R_{10y} - R_{3m}$$

The goodnees of fit is based on *pseudo-R^2* developed by Estrella in the working paper version of Estrella and Mishkin (1997)[18]. We consider a forecast horizon of k periods, where k is 2, 4, 6, 12 and 18 months. The coefficients in equation 3 are estimated using the maximum likelihood method and are reported in the appendix in table 3 and 4. Once we have obtained coefficient values, we can

---

[18]

$$pseudo\ R^2 = 1 - \left(\frac{\ln\left(f_{max}^u\right)}{\ln\left(f_{max}^c\right)}\right)^{-\left(\frac{2}{n}\right)L_c}$$

are reported in Tables 3 and 4 of *APPENDIX*.

forecast the probability that a recession will occur in the future, k periods head. So fitted values, P_t, can be interpreted as the probability that a recession will occur, subject to the observed value of the spread (the estimeted probabilities are reported in Graphs 13 and 14 of *Appendix*). The best forecast is obtained using six and twelve months lags of spread, with values of pseudo R^2 of 0.4787 e 0.3941 for US and 0.4374 e 0.3255 for Germany.

In graphs 3 and 4 one can see the estimates obtained using six months lag of the spread for the two countries examined.

In the case of the US for the recession of 1980 and 1981 the probabilities are almost equal to one, while in that of 1975 the values estimated are around 80 and 90 percent. The recessions of the 90s, that of 1969-70 and the most recent of 2001, are forecast with a probability of around 50 percent. It must also be said that certain false signals produced by the forecast exist, all relative to the last ten years, that is in 1996, 1998 and lastly in 2005. This

GRAPH 3

US
PROBABILITY OF US RECESSION SIX MONTHS AHEAD ($K= 6$)
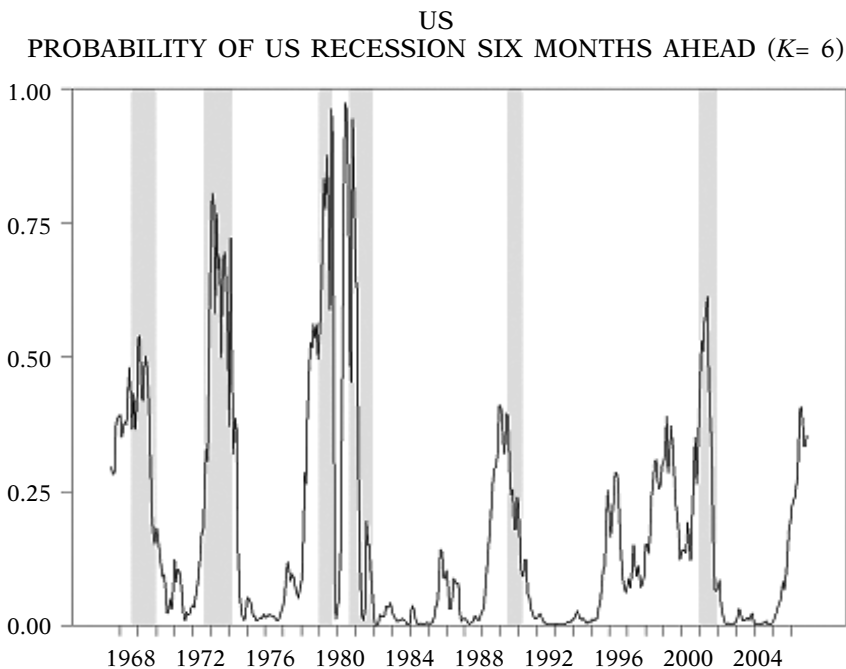
GRAPH 4

GERMANY
PROBABILITY OF GERMAN RECESSION SIX MONTHS AHEAD (K= 6)
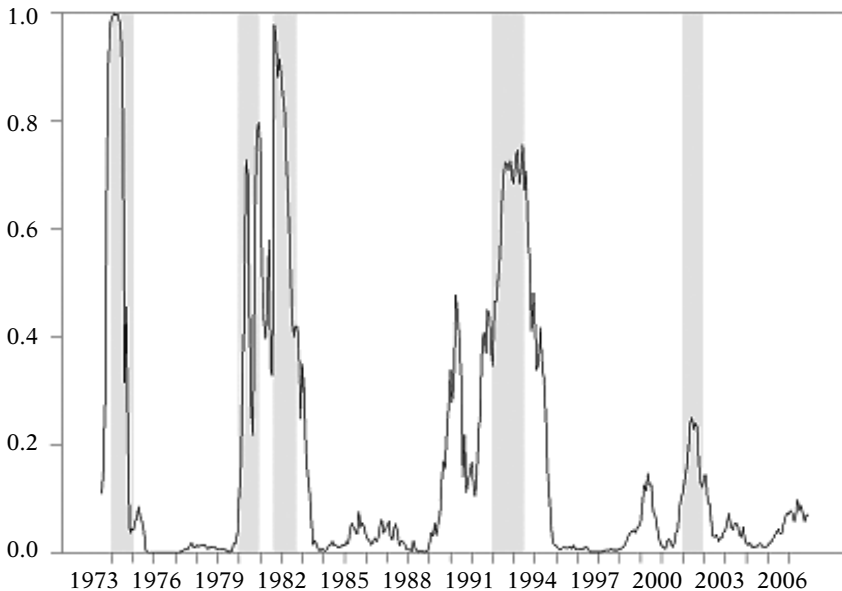

last false alarm was the one that, around November 2005, shook the United States' markets creating noticeable tension. As far as Germany is concerned, we observe in the Graph 4 that the model predicts well the first three recessions, those that took place in 1974-75,1980 and 1981 attributing to them probabilities that go from 80 percent to 98 percent. Furthermore the one concerning the 90s also assumes significant values and it is preceded by a false signal that does not seem to be very misleading since it anticipates by a year the recessive period that took place in the 90s. The recession of 2001 seemed to be one of the weak points of the model. In fact the probability of such an event is only 30 percent, considering that for the United States the model predicts a probability of 55 percent.

To provide further the statistical distribution of spread both a year prior to a recession period and a year prior to a non-recession period is verified. The results are in the following graph.
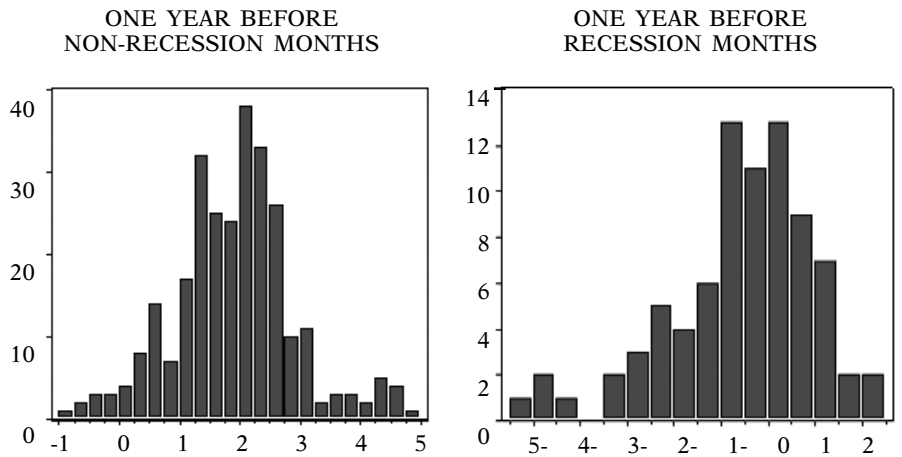
Graph 5

US
SPREAD DISTRIBUTION

ONE YEAR BEFORE
NON-RECESSION MONTHS

ONE YEAR BEFORE
RECESSION MONTHS
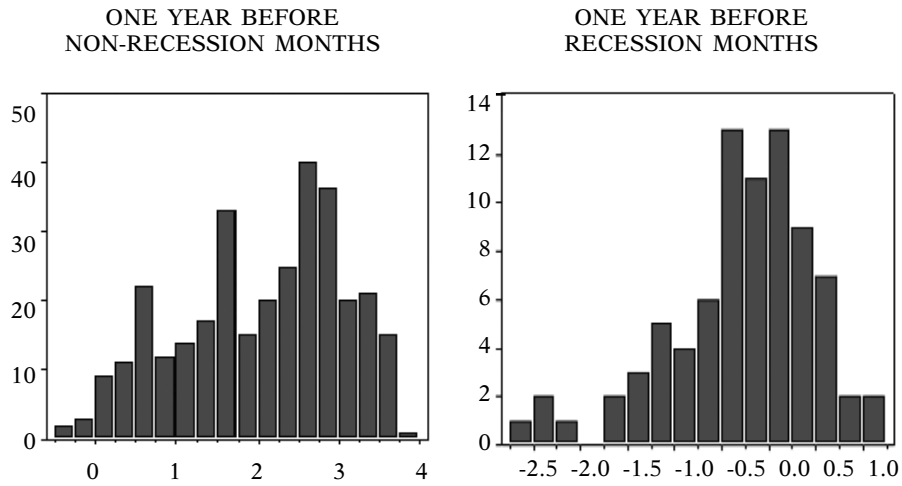
Graph 6

GERMANY
SPREAD DISTRIBUTION

ONE YEAR BEFORE
NON-RECESSION MONTHS

ONE YEAR BEFORE
RECESSION MONTHS

As you can note the distribution of the spreads shifted toward the right in the first case (spread mostly positive). This means that the difference between the long and short rate during the periods which don't precede a recession are positive. In those preceding a phase of decline in the economy, it is obvious that the distribution of the spreads shifted toward the left with regards to the zero, highlighting how the yield curve begins to invert prior to a recession. For the United States such a phenomenon is more prominent, while for Germany the distribution of the spread shift toward the left (negative differentials) but in a less accentuated way.

7. - Intensity and Nature of the Signal before a Recession

As we have just seen the inversion of the yield curve can be considered a good anticipator of a recession, even though there is not a strong connection from a theoretical point of view that could explain such a phenomenon thoroughly.

Since we are dealing with empirical evidence, we can now see the sort of information that it is possible to deduce from the data, in order to quantify and interpret better the signal given by a spread.

Intensity and Persistence of Signal

The first step to be taken[19] is to see first of all if the entity of the recession is related to the wide of spread, *i.e.* a very negative spread predicts a strong recession.

Furthermore it is possible to verify if a negative spread for many months, (that is a greater persistence of signal) means a heavy phase of decline for the economy. Lastly another very interesting aspect is that linked to the role of the two curves segments of the performance, short-end and long-end. An inversion of the curve in fact can either be lead by a strong reduction of the long-rate or by a great increase of short-rate.

---

[19] See ESTRELLA A. - TRUBIN M. (2006).

Table 2

US

Recession date		No. of months with the negative spread	Min. level of spread
1969 (9)	1970 (12)	3	-0.28
1973 (9)	1975 (3)	6	-1.27
1980 (1)	1980 (9)	12	-2.45
1981 (9)	1982 (12)	10	-2.65
1990 (6)	1991 (3)	1	-0.01
2001 (1)	2001 (12)	6	-0.53

Source: NBER.

GERMANY

Recession date		No. of months with the negative spread	Min. level of spread
1974 (1)	1975 (12)	10	-4.9
1980 (1)	1980 (12)	6	-1.82
1981 (9)	1982 (9)	12	-3.79
1992 (1)	1993 (6)	12	-2.3
2001 (1)	2001 (12)	3	-0.21

Source: OECD.
In parenthesis are months of recession.

In the latter case, the inversion is mainly due to the actions of the Central Bank which influences in a stronger way the short-end of yield curve. Table 2 makes a connection between the persistence of the signal with the minimum level reached by the spread. The data regarding the United States show that in the years preceding the two most deep recessions — those dated 1980 and 1991 — the spread is negative for almost every month preceding these two recessions. Also the lower levels of the spread are recorded right before these two periods. The recession of 1991 and that of the 1970s are those that show the lowest levels of the spread. As far as the first is concerned, there is a flattening of the curve yet not quite an inversion while before the second the differential between the short-rate and the long-rate assume

negative values close to zero. These are periods of recessions that didn't shake the economy in as a strong way as that of the 90s. The last one in 2001 is preceded by six months of negative spread with a minimum equal to 0.53 percent points. Then, it is possible to say that for the United States, long periods of negative spreads (such as greater persistence) and fairly pronounced values of it, are related to strong recessive periods and that the signal of the term structure offers, has a strong significance. For Germany, as seen for US, the minimum levels of spread are recorded prior to extremely severe recessive phases, those of 1974-75, 1981-82, 1992-93 where the differential of the ten-year rates and those of three months reach values equal to –4.9, –3.79, and –2.3 respectively. Further more prior to these periods the spread are negative during almost all months that precede the above mentioned recessions. In the most recent case of 2001, the signal does not seem particularly strong, making it obvious that there is no persistence (the months where the spreads are negative are few) and also the spread does not reach negative levels (–0.21). In conclusion we can say that the higher the persistence the wict(her of the spread are, the deeper the recession will be.

Nature of Signal

Regarding the nature of the signal it is useful to understand which segment of the curve prevalently influences the inversion of the yield curve. In Graphs 7 and 8 are reported the changes (represented by vertical bars) in the ten-year rate and the three-month rate calculated between the interval T_0 (recession period) and T_1 (18 months before a recession period). For the United States it is possible to see that prior to all the recessions there was a noticeable increase of the short-term rate which reached very defined value increases. In fact, prior to the recessions of 1973-75, 1980 and 1981 the changes in the short term rate almost pass 5 percent (see Graph 7). As far as the ten-year rates, there is a less constant path. This last one doesn't contribute to the inversion of the curve for the first four recessions as we can note a positive variation before the periods considered. Instead the last two
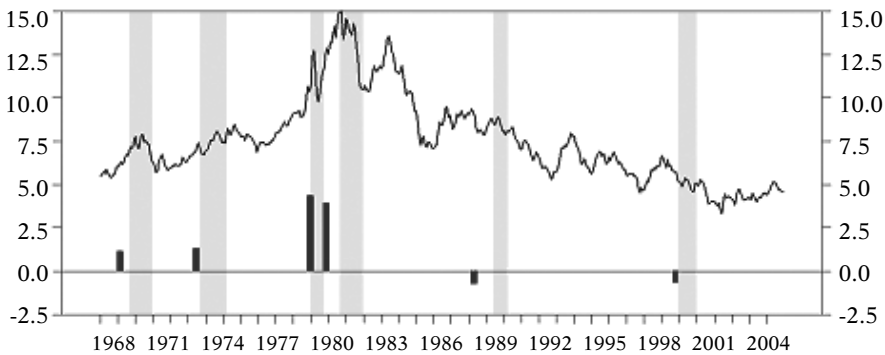
GRAPH 7

US: SHORT RATE CHANGES
SHORT RATE CHANGE 18 MONTHS BEFORE
A RECESSION PERIOD
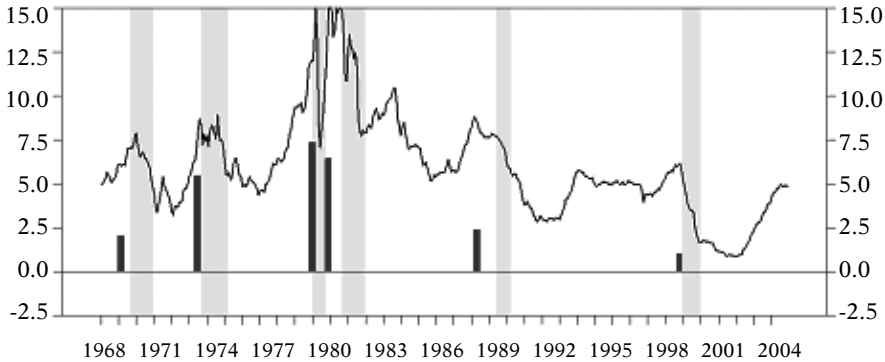
GRAPH 8

US: LONG RATE CHANGES
LONG RATE CHANGE 18 MONTHS BEFORE A RECESSION PERIOD


recessions are followed by negative changes in long-term rate and in this case even if slightly, the ten-year rate contributes to the inversion of the yield curve. The same results are obtained for Germany in which the first three recessions are followed by strong increase of the short-term rate which contribute to the inversion

of the curve while the long-term rate, similarly to the United States recorded positive changes. As it is possible to note, the behaviour of the long rate contribute to a reduction of the yield curve slope only in the last years like in 1991 and in 2001, even if in a less decisive way while, in previous years its behaviour could have been guided by the role of the expectations[20]. It is not possible then to make affirmations on the role that such a variable has in this approach given its unpredictable nature, which surely does not depend on the monetary policy but on other market variables.
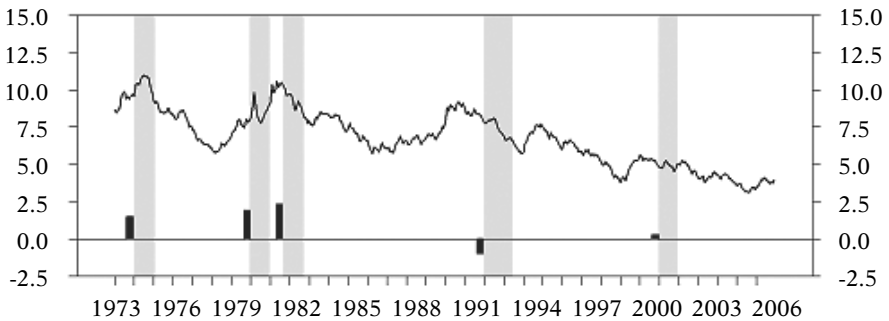
GRAPH 9

GERMANY: SHORT RATE CHANGES
SHORT RATE CHANGE 18 MONTHS BEFORE A RECESSION PERIOD
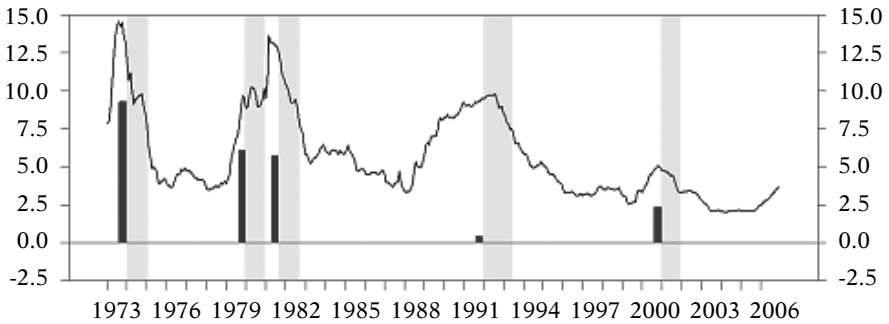
GRAPH 10

GERMANY: LONG RATE CHANGES
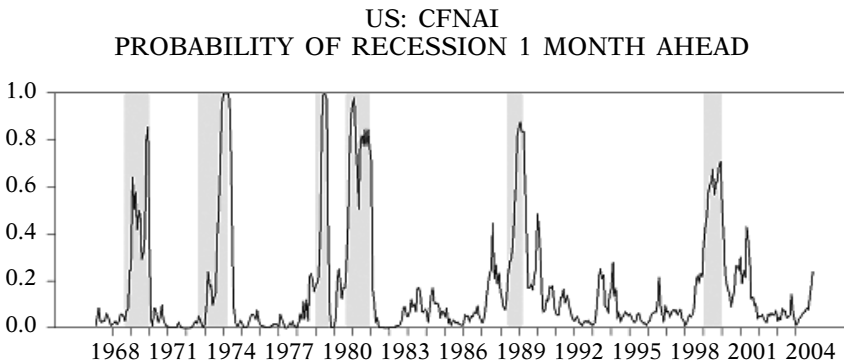LONG RATE CHANGE 18 MONTHS BEFORE A RECESSION PERIOD
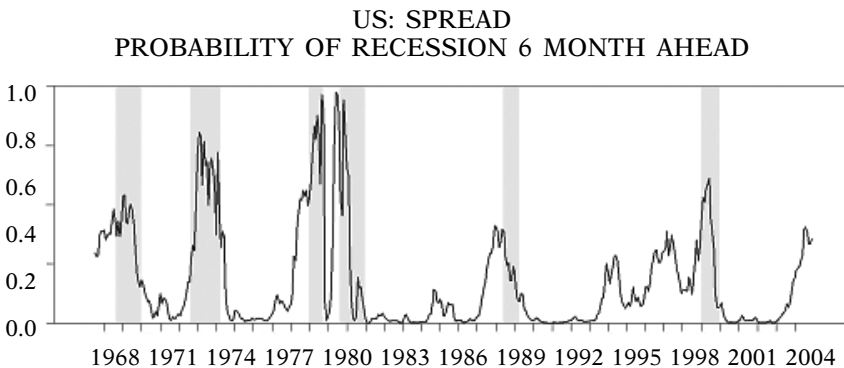

[20] See section 3.

100

8. - A Comparison between Spread and CFNAI: Evidence for the US

In this section a comparison between the performance of the spread in predicting recession and that of the Chicago Fed National Activity Index (CFNAI)[21] is made. The latter is an index that contains 85 monthly leading indicators built using the same methodology adopted by Stock and Watson in the construction of their XCI index. The two authors sustain that this last generation instrument is a great predictor of the economic activity and so also for the recessive phase of the economy.

GRAPH 11

US: CFNAI
PROBABILITY OF RECESSION 1 MONTH AHEAD

GRAPH 12

US: SPREAD
PROBABILITY OF RECESSION 6 MONTH AHEAD

---

[21] For further information or for the downloadable index see: *http://ksghome.harvard.edu/~JStock/xri/*

101

In this section we have estimated the probit model seen previously, using as independent variable the 1, 2, 3, 4, 6, and 12 month lags of the CFNAI.

The reason for which such a comparison was effected only for the United States is due to the fact that for Germany an index very similar to the CFNAI, EUROCOIN, is only available since 1990, and so the analysis would have been weak. The estimated coefficients are reported in Table 5 of the appendix. From the latter, it emerges that the spread is able to predict sooner a recession in compare to the CFNAI, which has a good forecasting capacity only regarding delays of one and two months.

In the Graph 15 of the appendix are reported charts of the probability that a recession could occur, using as leading indicators the 1, 2, 4, and 6 month lags of CFNAI respectively.

It is possible to note the good predicted power of the index considered, which signals all six recessions that took place in the United States, which a probability greater to 65%. In Graphs 11 and 12 we show the performances of CFNAI (using one month lag) and spread (using six months lag). The first, it's able to predict all recessions with very high probabilities, while the second predicts with lower probabilities such phenomenon, signaling only with probability of 50% the 1990s and 2001s recessions. One of the possible reason for such a gap is due to the fact that prior to the recessive phase of the 90s an actual inversion of the curve had not been witnessed, since the spread reached values near zero without becoming negative. In spite of this, it has to be said that even if less strong, the signal launched by the spread arrives first and so it has a greater utility, contrary to that offered by CFNAI, which has the capacity to signal recession only a month before it occurs.

9. - Conclusions

The analysis conducted in this work has emphasised the capacity of the spread between 3-months and ten-year rate to forecast the recession phase of the economy. The results obtained

for the United States seem to come to the same conclusions made by Estrella (2006) in a recent paper. The inversion of the yield curve shows to be a good indicator for Germany as well, by forecasting all the recessions with relevant probabilities. The only false signal is constituted by the 2001 recession, which is forecast with a probability equal only to 20%. In the end the comparison made with the CFNAI seems to be favourable to the spread, since it is able to predict periods of recession much earlier than what happens for the CFNAI. The phenomenon of inversion of the yield curve as leading indicator of a future recessive period continues to find comfort in the data and seems to be taken into consideration by financial analysts and economists.

As seen in the section 3, the cause of this phenomenon could be attribute to the conduct monetary policy. In fact, as in 70s and 80s, when monetary policy is tightened for a long time, these influences the short rate behaviour. The latter (as seen in section 3) strongly contributes way to the inversion of the curve, so the action of monetary policy authority plays a fundamental role in this phenomenon[22].

As far as 2007 is concerned it, can be said that the model constructed here attributes a probability only equivalent to 30% that in the United States there could be a recession, even though there was an inversion of the curve at the end of 2005. It has to be said that the slowing down of the economy of the States in 2006 leads to believe to an imminent recession in 2007. To this purpose the ex-governor of the FED, Alan Greespan, and his new predecessor Bernanke, have two contrasting opinions. The first affirmed that "The economic growth in United States for the next 2 years will be much weaker than the last years" and that "There is one-third chance of recession in 2007". The thesis of the ex-governor of the FED contrasts the forecast made by Ben Bernanke, who sustains that the economy could gain strength this year, seeing a resumption in the second part of the year. Our model is

---

[22] For a pleasant reading, see Bernanke B., «Money, Gold, and the Great Depression», *H. Parker Willis Lecture in Economic Policy*, Washington and Lee University, Lexington, Virginia March, no. 2, 2004, about the wrong use of monetary policy before 1929 crisis.

then in agreement with Alan Greenspan's statement, forecasting a 30% probability of recession in 2007.

To explain this phenomenon and better investigate about the inversion of yield curve, further analysis could be made about the role of short-term segment and then about the conduct of monetary policy.

PROBIT COEFFICIENTS TABLES

TABLE 3

US
Estimed Probit coefficients

$$\Pr\left(Y = 1 \middle| X_{t-k}\right) = \Phi\left(\alpha + \beta X_{t-k}\right)$$

$K^{(1)}$	α	β	*Pseudo R²*	N. obs.
2	-0.462 (0.096)	-0.375 (0.056)	0.1192	464
4	-0.284 (0.097)	-0.568 (0.064)	0.3244	462
6	-0.126 (0.102)	-0.776 (0.079)	0.4787	460
12	-0.111 (0.10)	-0.788 (0.079)	0.3941	454
18	-0.844 (0.084)	-0.549 (0.0657)	0.164	448

In parenthesis are standard errors of coefficients.
(1) *K* are expressed in month.

TABLE 4

GERMANY
Estimed Probit coefficients

$$\Pr\left(Y=1\middle|X_{t-k}\right)=\Phi\left(\alpha+\beta X_{t-k}\right)$$

$K^{(1)}$	α	β	*Pseudo* R^2	N. obs.
2	-0.734 (0.087)	-0.469 (0.050)	0.2898	404
4	-0.715 (0.092)	-0.574 (0.057)	0.3285	402
6	-0.679 (0.099)	-0.710 (0.073)	0.4374	400
12	-0.656 (0.089)	-0.488 (0.055)	0.3255	394
18	-0.844 (0.084)	-0.176 (0.042)	0.0299	388

In parenthesis are standard errors of coefficients.
[1] *K* are expressed in month.

TABLE 5

CFNAI
Estimed Probit coefficients

$$\Pr\left(Y=1\middle|X_{t-k}\right)=\Phi\left(\alpha+\beta X_{t-k}\right)$$

| $K^{(1)}$	α	β	*Pseudo* R^2	N. obs.
1	-1.312 (0.098)	-1.301 (0.1217)	0.3823	465
2	-1.196 (0.087)	-0.982 (0.097)	0.2744	464
3	-1.115 (0.081)	-0.755 (0.085)	0.1839	463
4	-1.063 (0.077)	-0.609 (0.079)	0.1206	462
6	-0.991 (0.072)	-0.403 (0.076)	0.0383	460
12	-0.927 (0.068)	0.090* (0.082)	0.00324	454

In parenthesis are standard errors of coefficients.
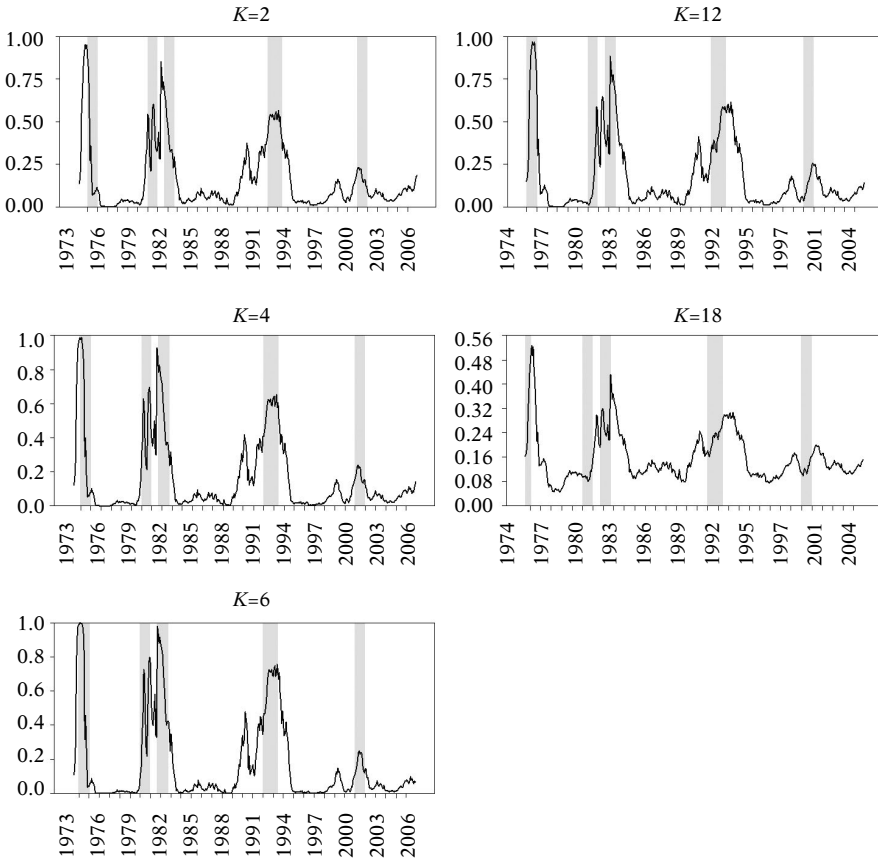[1] *K* are expressed in month.
[2] Coefficients are not meaningful at 10%.

Graph 13

US
RECESSION PROBABILITIES WITH LAG *K*
(in months)

K=2
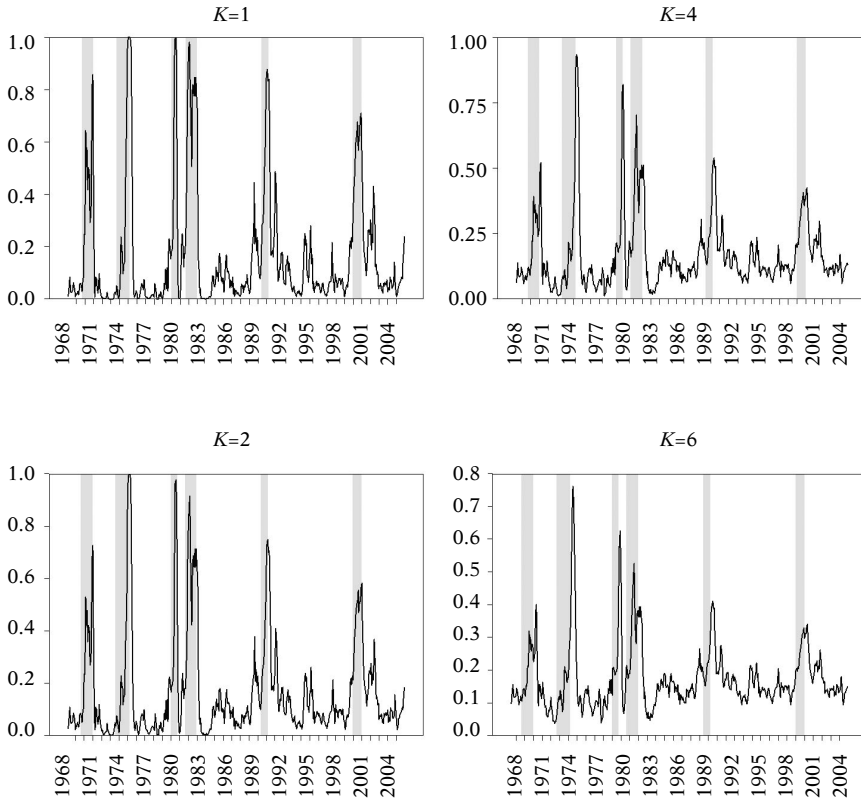
K=12

K=4

K=18

K=6
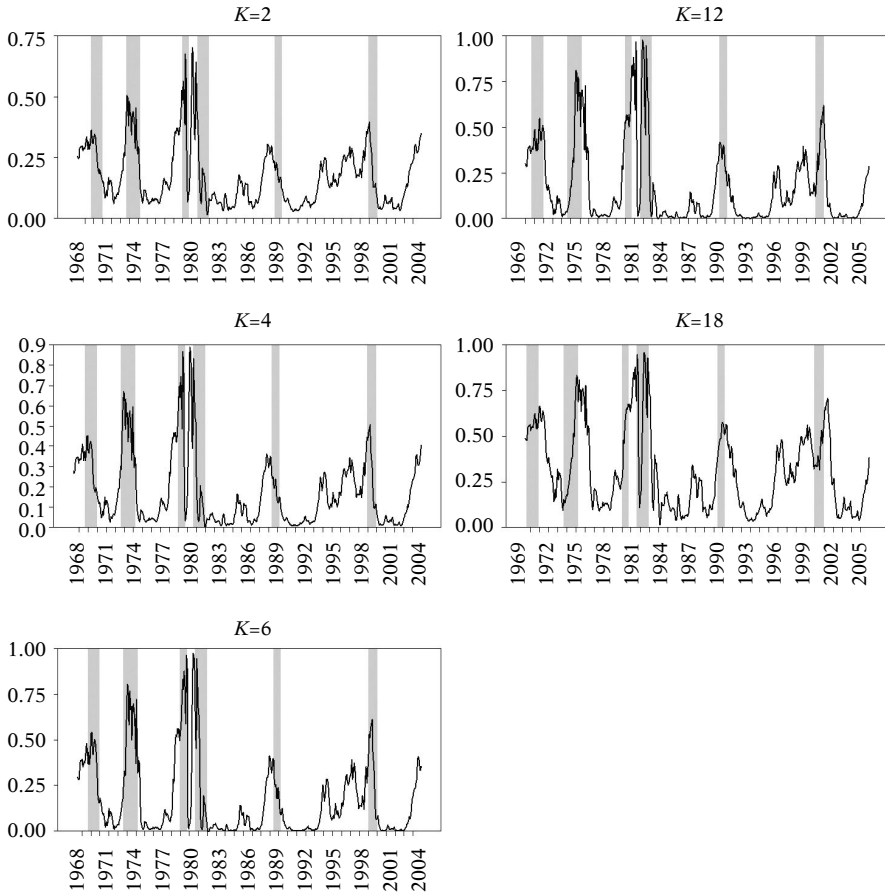
Graph 14

GERMANY
RECESSION PROBABILITIES WITH LAG *K*
(in months)

Graph 15

CFNAI
RECESSION PROBABILITIES WITH LAG *K*
(in months)

BIBLIOGRAPHY

BERNARD H. - GERLACH S., «Does the Term Structure Predict Recessions? An International Evidence», *International Journal of Finance and Economics*, vol. 3, 1998, pages 195-215.

DOTSEY M., «The Predictive Content of the Interest Rate Term Spread for Future Economic Growth», Federal Reserve Bank of Richmond, *Economic Quarterly*, no. 84:3, 1998, pages 31-51.

DOTSEY M. - OTROK C., «The Rational Expectations Hypothesis of the Term Structure, Monetary Policy, and Time-Varying Term Premia», Federal Reserve Bank of Richmond, *Economic Quarterly*, vol. 81, 1995, pages 65-81.

ESTRELLA A., «Why Does the Yield Curve Predict Output and Inflation?», *Economic Journal*, n. 505, July, 2005, pages 722-744.

ESTRELLA A. - HARDOUVELIS G., «Possible Roles of the Yield Curve in Monetary Policy», Federal Reserve Bank of New York, *Intermediate Targets and Indicators for Monetary Policy - A Critical Survey*, July, 1991, pages 339-362.

ESTRELLA A. - MISHKIN F., «The Predictive Power of the Term Structure of Interest Rates in Europe and the United States: Implications for the European Central Bank», *European Economic Review*, vol. 41, 1997, pages 1375-1401.

— — - — —, «The Yield Curve as a Predictor of US Recessions», Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, June, no. 7, 1996.

ESTRELLA A. - TRUBIN M., «The Yield Curve as a Leading Indicator: Some Practical Issues», Federal Reserve Bank of New York, *Current Issues in Economics and Finance*, July/August, 2006.

HARVEY C.R., «The Real Term Structure and Consumption Growth», *Journal of Financial Economics*, vol. 22, 1988, pages 305-333.

— —, «Forecasts of Economic Growth from the Bond and Stock Markets», *Financial Analysts Journal*, September/October, 1989, pages 38-45.

HARDOUVELIS G., «The Term Structure Spread and Future Changes in Long and Short Rates in the G7 Countries: Is There a Puzzle?», *Journal of Monetary Economics*, vol. 33, 1994, pages 255-283.

HAUBRICH J. - DOMBROSKY A., «Predicting Real Growth Using the Yield Curve», Federal Reserve Bank of Cleveland, *Economic Review*, 1996, pages 26-35.

HU Z., «The Yield Curve and Real Activity», *International Monetary Fund Staff Papers*, vol. 40(4), 1993, pages 781-806.

KOZICKI S., «Predicting Real Growth and Inflation with the Yield Spread», Federal Reserve Bank Kansas City, *Economic Review*, vol. 82, 1997, pages 39-57.

NEWEY W.K. - WEST K.D., «A Simple Positive, Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix», *Econometrica*, vol. 55, 1987, pages 703-708.

PLOSSER C.I. - ROUWENHORST K.G., «International Term Structures and Real Economic Growth», *Journal of Monetary Economics*, vol. 33, 1994, pages 133-56.

STOCK J.H. - WATSON M.W., «New Indexes of Coincident and Leading Economic Indicators», *NBER, Macroeconomics Annual*, BLANCHARD O.J. - FISCHER S. (eds.), 1989, pages 352-94.

— — - — —, «A Procedure for Predicting Recessions with Leading Indicators: Eco-

nometric Issues and Recent Experience», in STOCK J.H. - WATSON M.W. (eds.), *New Research on Business Cycles, Indicators and Forecasting*, University of Chicago Press, Chicago, 1993.

STOCK J.H. - WATSON M.W., «Forecasting Output and Inflation: The Role of Asset Prices», Mimeo, *Kennedy School of Government*, Harvard University, 2000 (revised 2003).