

The role of implied volatility for explaining consumer sentiment: evidence for the U.S. and Germany^{*}

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Abstract

In this paper we examine the information content of interest rate volatility for explaining economic agents' expectations on the business cycle as measured by consumer confidence indicators. For that purpose we suggest using a forward-looking measure of volatility: one-year implied volatility quotes for caps and floors. We find that implied volatility adds significant explanatory power to the yield spread and the change in the short-term interest rate for explaining consumer sentiment before and during the current financial crisis in the U.S. and Germany. Moreover, implied volatility outperforms realized volatility in all the cases.

Keywords: consumer sentiment; expectations; term structure of interest rates; implied interest rate volatility

JEL classification: E32, E44, G02

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1. Introduction

There is an extensive literature devoted to the relationship between financial variables and the real economy (as measured by such variables as GDP or consumption growth). So far, we can find a great number of academic papers showing empirical evidence on the predictive power of financial variables with respect to the business cycle, but the theoretical explanation for this link is not quite satisfactory.

A recurrent argument used to explain the leading indicator properties of financial variables can be found in Dotsey (1998). According to the author, financial market participants are forward-looking, and hence the prices of various securities embody expectations of future economic activity. That is, the link between the real economy and financial variables rests on the latter containing information about economic agents' expectations concerning the future state of economy.

One of the financial variables that have been profusely used to predict future economic activity is the yield spread (i.e., the difference between interest rates on long- and short-term debt securities). A widespread explanation of the forecasting ability of the yield spread is based on the expectations theory of the term structure of interest rates. According to it, long-term interest rates are analyzed as geometric averages of current and expected future short-term interest rates. Thus, the yield curve inverts in advance of an economic slowdown and vice versa.¹ In addition, Harvey (1988) provides a theoretical model based on the CCAPM (consumption-based capital asset pricing model) that relates economic growth to the slope of the term structure. The underlying idea behind this model also has to do with expectations: interest rates reflect investors' expectations about the future economic situation when deciding their plans for consumption and investment.

In this study we focus on another variable: the interest rate volatility. Particularly, we aim to check whether interest rate volatility can add significant explanatory power to the yield spread in order to explain economic agents' expectations. According to Bittlingmayer (1998), volatility may reflect diffuse and

¹ This hypothesis has been usually tested in the literature by analyzing whether the yield spread continues to have explanatory power once a variable that reflects the stance of monetary policy is added to the regression equation. See, for instance, Estrella and Hardouvelis (1991), Plosser and Rouwenhorst (1994), Estrella and Mishkin (1997), Moersch (1996), Kozicki (1997), Dotsey (1998), and Hamilton and Kim (2002).

easily changed beliefs about the future, particularly the chance of “bad news”. Thus, the intuitive idea is that volatility may contain useful information about the level of uncertainty and risk perceived by economic agents regarding future economic growth, and so a significant negative relationship between economic agents’ expectations of economic growth and volatility should be expected.

In order to achieve the previous goal we first need to deal with the problem that both expectations and volatility are non-observable variables. The way we face this double problem is the main contribution of this paper.

Concerning expectations, let’s remember that most of modern literature on macroeconomics relies on the idea that agents’ expectations play a large role in driving economic activity, and so their decisions about consumption and investment. The rational expectations hypothesis, which rests on relatively solid theoretical foundations, is usually assumed in order to model expectations in empirical papers. However, it is not clear for econometricians how to measure them. In this paper we approach to this issue by using consumer confidence indicators as proxies of economic agents’ expectations. According to Curtin (2007), consumer sentiment data improves near-term forecasts of potential changes in economic activity not just because the data is available sooner than the underlying economic data, but because it provides independent information about the future state of the economy. This way, a fall in consumer confidence may be expected to depress or postpone consumption and investment, and hence have a negative impact on real activity.

The second point referred to before, deals with how to measure volatility. In finance, volatility is likely the most common risk measure; but risk has to do with uncertainty about the future, not the past. However, most of the volatility estimates are based on the past behavior of financial or economic variables, and this is somehow a contradiction. In fact, when doing that, you are inferring the level of uncertainty about the future from the past; that is, you are assuming that the past captures what economic agents think is going to happen in the near or even the far future. And this contradiction holds even when volatility is modeled using GARCH or MIDAS models. Thus, the second contribution of this paper is that we suggest using a forward-looking measure of volatility not based on past information.

In particular, we suggest using the volatility implied from the market prices of cap (floor) contracts, one of the simplest and most liquid over-the-counter (OTC) interest rate derivatives (Li and Zhao, 2009). Indeed, the market convention for caps and floors is to quote their prices in terms of the implied value of volatility which sets prices from the well-known Black pricing formula equal to the market prices. This implied volatility can be then understood as an estimation of the average future volatilities of a set of forward interest rates with consecutive terms to maturity up to the expiration date of the cap (floor). That is, it depicts the consensus of market participants on the expected future volatility of interest rates. Thus, implied volatility seems to be the most suitable candidate to implicitly test the hypothesis about the information content of financial variables regarding economic agents' expectations.

The remainder of the paper is organized as follows. Section Two offers a review of the literature on the forecasting ability for economic growth of the yield spread and interest rate volatility. Section Three provides a description of the data and some summary statistics. In Section Four we present the regression equations tested in this study and the results from the empirical analysis. Finally, Section Five provides a summary of the study.

2. Literature review

In this section we review part of the literature on the usefulness of the yield spread for predicting economic growth, paying special attention to the explanations provided in order to justify this link. In addition, we also consider recent empirical evidence on the forecasting ability of interest rate volatility.

Kessel (1965) showed evidence, for the first time, on the procyclical behavior of the yield spreads between nine-to twelve-month government securities and Treasury bills in the U.S. for the period from 1942 to 1953. Since the late eighties, consistent empirical evidence on the predictive power of the yield spread can be found for different countries and time periods.² See, for instance, Estrella and Hardouvelis (1991) for evidence in the U.S. over the period 1955-1988; Davis and Fagan (1997) for the E.U. countries from various 1970s up to 1992; Estrella and Mishkin (1997) for the U.S., the U.K., Germany, France, and Italy, covering the period from 1973 to 1995; Kozicki

² The most commonly used spread in the literature is the one computed as the difference between the yield on a ten-year government security and the yield on a three-month security.

(1997) for the G-7, Australia, Sweden, and Switzerland from 1970 up to 1996; or, more recently, Duarte *et al.* (2005) for the Euro area over the period 1970-2000.³

Harvey (1988) provides a theoretical model based on the CCAPM that establishes a positive linear relationship between expected real yield spreads and expected consumption growth. The underlying idea behind this model can be described as follows. If investors expect an economic downturn, they will tend to reduce current consumption in order to invest in long-term bonds that will provide an extra income in the bad times. This practice then will raise the price of long-term bonds and reduce the corresponding long rate, whereas the sale of short-term bonds will push short rates up. As a result, the yield curve will flatten.

That is, according to Harvey (1988), current consumption and investment decisions are driven by expectations about the future state of the economy and are reflected in the current shape of the real term structure of interest rates.⁴

In particular, the model derived by Harvey (1988) can be generally expressed as:

$$\Delta C_{t+m:t+N} = \beta_0 + \beta_1 E_t[RR_t^{(N)} - RR_t^{(m)}] + \beta_2 E_t[RR_t^{(m)}] + \varepsilon_{t+N}, \quad m < N, \quad [1]$$

where

$\Delta C_{t+m:t+N} = \ln \frac{C_{t+N}}{C_{t+m}}$ represents ex-post annualized growth in real consumption from time $t+m$ to $t+N$ as a proxy of expected growth in real consumption at time t , $E_t[\Delta C_{t+m:t+N}]$, by assuming rational expectations; $E_t[RR_t^{(N)} - RR_t^{(m)}]$ is the expected real yield spread at time t obtained as the difference between the N -period (long-term) expected real interest rate (annualized), $E_t[RR_t^{(N)}]$, and the m -period (short-term) expected real interest rate (annualized), $E_t[RR_t^{(m)}]$; and ε_{t+N} is the forecast error.

Harvey (1988) tests this model on U.S. data from 1953-1987 and finds that the short end of the real term structure of interest rates is significant for predicting

³ See also Wheelock and Wohar (2009) for a review of the most recent research on the usefulness of the term spread for predicting changes in economic activity. According to the authors, many studies find that the spread predicts output growth and recessions up to one year in advance, although several also find that its usefulness varies across countries and over time.

⁴ Harvey's framework on the usefulness of the yield spread for explaining future economic growth based on the CCAPM has been followed in papers such as Chapman (1997) and Roma and Torous (1997).

consumption growth from quarter $t+1$ to quarters $t+3$ and $t+4$, mainly since 1972. Furthermore, he finds that the model outperforms both in sample and out-of-sample alternative models based on lagged consumption growth or lagged real stock returns as explanatory variables.

Results in Harvey (1988) show that the short-term expected real rate does not contribute significantly to the explanatory power of the model, thus Harvey (1989) extends the analysis in Harvey (1988) by using a simplified version of his model in which the only explanatory variable is the spread, with the expected real short-term rate contained in the intercept. In addition, some other changes are introduced into the model. In particular, the U.S. real GNP annualized growth from quarter $t+1$ to quarter $t+5$ is used as a proxy of expected consumption, and the real yield spread is also replaced by the nominal spread, where the long-term rates are the five- and ten-year yields instead of the yield of a bond with five quarters to maturity. He finds that the spread alone is able to explain more than 30 per cent of the variation in economic growth. The simplified version of the model is also tested for the G-7 countries over the period 1970-1989 by Harvey (1991), where the most favorable empirical evidence on the predictive power of the yield spread is reported for Canada, Germany, and Italy, in addition to the U.S.

Another branch of the literature (see Davis and Henry, 1994; Davis and Fagan, 1997; Dueker, 1997; Dotsey, 1998; and Hamilton and Kim, 2002, among others) attributes the ability of the yield spread to forecast economic activity to monetary policy actions. The argument runs as follows. A contraction of monetary policy causes short-term interest rates to rise; however, market participants will probably expect future short-term rates to be lower than current short-term rates once economic growth slows or inflation decreases. As a result, according to the expectations theory of the term structure, long-term rates will rise less than short-term rates and, hence, the slope of the yield curve will drop. Monetary policy tightening will bring about a future decline in investment and, consequently, an economic deceleration. Thus, the yield spread falls in advance of an economic slowdown and vice versa.⁵

The monetary policy explanation has been repeatedly tested in the literature by regressing real economic growth from time t to time $t+N$, $\Delta y_{t:t+N}$, on both the yield

⁵ Nevertheless, according to Wheelock and Wohar (2009), this argument has been usually stated with little underlying theory.

spread observed at time t , $spread_t$, and a new variable, X_t , representing the current stance of monetary policy. That is,

$$\Delta y_{t:t+N} = \beta_0 + \beta_1 spread_t + \beta_2 X_t + \varepsilon_{t+N} . \quad [2]$$

Based on this regression equation, Estrella and Hardouvelis (1991) find that the yield spread (computed as the difference between yields on ten- and three-month Treasury securities) alone is able to explain more than 30 percent of the cumulative change in real GNP from three- to eight-quarter horizons, and that it continues to be statistically significant when the real (nominal) federal funds rate or the three-month Treasury bill rate are also significantly included into the equation as explanatory variables. That is, the spread appears to contain information for future economic growth over and above that provided by variables that reflect the stance of monetary policy.⁶ Plosser and Rouwenhorst (1994), Estrella and Mishkin (1997), Moersch (1996), Kozicki (1997), Dotsey (1998), and Hamilton and Kim (2002) confirm these results and extend the evidence to other countries.

Thus, the joint forecasting ability of the yield spread and short-term interest rates on economic growth has been consistently tested in the financial literature for different countries. Concerning interest rate volatility, we are aware of only a few studies that address the information content of interest rate volatility for predicting economic activity using realized volatility measures.

Andreou *et al.* (2000) analyze the behavior of certain financial variables and their volatilities over the business cycle in the U.S., the U.K., and Germany from 1970 up to 1998. Volatilities are calculated as the square of the first difference of the series. They find that the volatility in the term structure appears to be procyclical and to lead industrial production growth in the U.K., whereas the volatility of real short- and long-term rates appears to have countercyclical and leading indicator properties in Germany.⁷ However, interest rate volatility does not seem to lead economic activity in the U.S.

Annaert *et al.* (2001) analyze the extra information content of short-term interest rate and stock return volatility over two traditional leading indicators of the business

⁶ According to Beranke and Blinder (1992), short-term rates can be considered good indicators of monetary policy actions.

⁷ See also Sun (2005) and Gerlach *et al.* (2006) for further evidence on the countercyclical properties of the volatility of short-term interest rates (Treasury bill rates and interbank rates) and bond returns, respectively.

cycle: the yield spread and stock returns. Volatility estimates of short-term interest rates as constructed as mean absolute deviations, over a one-month interval, of daily changes in three-month interest rates. Results in this study show that interest rate volatility adds significantly to the yield spread and real stock returns to forecast the probability of future recessions up to twelve months in advance in the U.S., Germany, and Japan for a sample starting at different 1960s and ending at 2000. As expected, higher interest rate volatility increases the probability of entering a recession. However, the sign and the statistical significance of stock return volatility differ between countries.

More recently, Fornari and Mele (2009) analyze the single and in blocks forecasting power on industrial production growth of a wide set of macroeconomic and financial variables and their volatilities (including the yield spread) in the U.S. for the period 1957-2008. They obtain that in-sample forecasts of up to two-year growth in industrial production based on the volatility of the spread between the ten-year government bond yield and the three-month Treasury bill rate outperform forecasts based on stock market volatility. Volatility is defined as a moving average of past absolute returns.

3. Data

The study is performed on U.S. and Germany data from January 1995 to July 2011. Next we describe the four variables involved in our empirical model: the consumer confidence index (CCI), the yield spread, the change in the three-month interest rate, and the implied volatility of one-year caps and floors. Then we analyze the statistical properties of the series.

In order to measure expectations about future economic activity, we employ the Conference Board CCI for the U.S. and the Ikon CCI for Germany. Data have been obtained from Reuters.

The link between consumer confidence and spending can be found in the work by Katona (1968). The author states that consumer spending is a function both of ability to buy and willingness to buy. While the ability to buy is mainly a function of disposable income, the willingness to buy depends primarily on attitudes and expectations about personal finances and the economy as a whole. And this is specifically what questions included in these two indices cover.

In addition, according to Curtis (2007), consumer spending accounts for one-half to two-thirds of all spending in market-based economies, and hence even small changes in household spending can have a major impact on the economy. Empirical evidence in this study for an extensive group of countries shows that consumer confidence in Germany and the U.S. (based on the same questionnaires that we use in this paper) Granger causes changes in more than 50% of the economic variables included in the analysis.⁸

The Conference Board CCI is closely followed by financial markets and business community and so it is treated by financial press as an important piece of economic information. It is constructed on the basis of a monthly household survey of consumers' perceptions of current business and employment conditions, and their expectations over the next six months concerning business situation, employment, as well as their total family income. Component questions of the Conference Board CCI and the Icon CCI are provided in the Appendix. The index is benchmarked to 1985 = 100. Thus, values greater than 100 indicate above-average consumer confidence and vice-versa.

Questionnaires used to obtain the monthly value of the index are mailed to sample households at the end of the previous month, and responses flow in throughout the survey month. Responses received up to approximately the eighteenth of the month are used for the preliminary estimates of the index, which the Conference Board releases on the last Tuesday of the survey month. Final estimates for the month based on all the responses received are released with the next month's preliminary figures and are not subject to further revision. So we use final estimates of the index in our study, which are published with a one-month lag.

The Icon CCI is based on the German consumers' responses to the E.U. harmonized consumer survey elaborated by the European Commission.⁹ However, we prefer this index instead of the one published by the European Commission since the former is scaled to have a long-term mean of 100. In this way, values above 100

⁸ These variables are the unemployment rate, inflation rate, interest rates, personal income, GDP, total personal consumption, retail sales, expenditures for durables, and vehicle registrations.

⁹ See "Joint Harmonised E.U. Programme of Business and Consumer Surveys (12.10.2006)" and "The Joint Harmonised E.U. Programme of Business and Consumer Surveys. User Guide 2007" for a complete description of the survey (questionnaires, timetable, use of information...). Further information about the Icon CCI can be found at <http://icon-added-value-source.com/>.

indicate that optimistic consumer estimates outweigh the pessimistic ones, while values below 100 indicate the opposite.

Specifically, consumers are asked about their expectations of change in the financial position of their households, the general economic situation and employment, as well as their saving possibilities over the next 12 months.¹⁰

Survey responses are normally collected in the first half of the month and transmitted to the European Commission services around one week before the end of the month. Based on the results of the surveys, the Icon CCI is then released in the first calendar week after the end of the month that is reported about. Thus, the index is released with a lag of about three weeks.

A usual dilemma that academics have to face when working with indicators of consumer sentiment is whether to focus on index-level or monthly changes. The decision must depend basically on the time frame of the questions included into the consumer surveys. In this case, both consumer confidence indices ask about changes in the near-future, suggesting that the indices are measures of change in sentiment (see Matsusaka and Sbordone (1995)). Given this and the fact that both indices are scaled to have a long-term mean of 100, we use data in levels.

As for interest rates, we collect daily data on three- and 12-month yields on U.S. Treasury securities, and three- and 12-month interbank interest rates from the Bundesbank. Given that the Conference Board CCI and the Icon CCI cover expectations over the next six and 12 months, respectively, the 12-month interest rate is selected to represent the long-term rate.¹¹

In order to obtain the monthly data of interest rates, we proceed in two different ways depending on the collection period of the survey responses used to estimate the values of the consumer confidence indices. This way, since the final monthly data of the Conference Board CCI are based on responses received during the whole month, the monthly interest rate data for the U.S. are the average of the daily data corresponding to the month of reference. However, in regard to German interest rates, given that surveys

¹⁰ Thus, it must be highlighted that consumers are not surveyed on the future development of any financial market variable in any case.

¹¹ This is in accordance to Plosser and Rouwenhorst (1994), who match the maturity of long-term rates to the forecast horizon of growth rates of industrial production.

responses used to estimate the Icon CCI are collected in the first half of the month the index is reported about, the monthly data on interest rates are the average of daily data collected from the second fortnight of the prior month up to the first fortnight of the month of reference.

The yield spreads for both countries are then just obtained as the difference between the monthly continuously compounded annualized 12- and three-month interest rates. As usual in the literature on the predictive power of the yield spread, we also use a monetary policy variable: the monthly change in the three-month interest rate.¹²

With respect to interest rate volatility, most papers first need to deal with the problem of its estimation since it is a non-observable variable. However, in this study we use implied volatilities from the cap (floor) market with a twofold purpose. First, data can be directly obtained from the market, and second, this is a forward-looking measure of interest rate volatility.

In particular, we collect daily volatility quotes of at-the-money (ATM) one-year caps and floors for the U.S. and Germany provided by Datastream. It is important to point out that these implied volatilities are used to obtain the prices of caps and floors by applying the well-known Black pricing formula. According to the Libor Market Model (LMM), the use of this pricing formula can be justified under the assumption that forward interest rates follow a lognormal stochastic process. Implied volatility can be then understood as an estimation of the average future volatilities of a set of forward rates with consecutive terms to maturity up to the expiration date of the contract.¹³ Thus, the one-year implied volatility represents the market estimation of the volatility of three-month forward interest rates over the next year.¹⁴ Monthly observations are computed in a similar way as for interest rates for the U.S. and Germany.

Table 1 and 2 provide some summary statistics for the monthly data on the consumer confidence index, the yield spread, the change in the three-month interest rate, and the one-year implied volatility for the U.S. and Germany, respectively. Statistics are provided for the whole period (Panel A), as well as for the two subperiods

¹² Dotsey (1998) and Hamilton and Kim (2002), for instance, use the change in the Federal funds rate as a measure of changes in monetary policy.

¹³ See, for instance, Brigo and Mercurio (2001) for a comprehensive overview of caps (floors) valuation within the LMM framework.

¹⁴ Caps and floors with terms to maturity of one year from the U.S. and German markets have a three-month tenor.

we divide the sample into (Panels B and C). The first subperiod extends from March 1995 up to July 2007 (what we call the pre-crisis period), and the second one from August 2007 up to July 2011 (denoted as the crisis period in this study).¹⁵

In the U.S., the average level of consumer confidence remained just below the neutral 100 mark over the whole period. However, as suggested by the standard deviation, it was remarkably variable not only across the entire sample but also within the two subperiods. Thus, the differences in the index level before and during the crisis are noticeable: the mean of the index values dropped from 110.16 to 58.66. It is not the case for Germany, where consumer confidence stayed on average around 92 over the two subperiods. The yield spread between the 12- and the three-month interest rates was three times higher during the crisis period than before in Germany, and nearly 50 percent higher in the U.S. Statistics also show that the monthly difference in the three-month interest rate series was more stable in both countries before the crisis burst out. The average implied volatility level and its standard deviation were greater in the U.S. than in Germany throughout the sample period and in both subperiods. Moreover, as expected, interest rate volatility was noticeably higher during the crisis period than before in the U.S. and Germany: more than 3.5 and two times higher, respectively. The autocorrelations show that consumer confidence and implied volatility are the most persistent series in both countries.

In order to obtain an appropriate specification of our regression equations, that will be performed over the pre-crisis and the crisis periods, we further investigate the stationarity of the series over both subperiods by conducting the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) stationarity test (specified with and without a time trend).¹⁶ The null hypothesis of stationarity is accepted at the 1% level for both specifications of the test for the four series in both countries over the first period. From the KPSS test performed over the second period, the null hypothesis is also accepted in all the cases, with the possible exception of the implied volatility for the U.S. where the evidence is mixed. Nonetheless, results from the test should again be considered with caution due to the well-known limited power of stationarity and unit root tests when conducted on small size samples.

¹⁵ Statistics reported for the second period should be interpreted with caution given the small size of the sample (48 observations) in comparison to the first period (149 observations).

¹⁶ Results will be provided upon request.

4. The information content of implied interest rate volatility on consumer sentiment

In this section we analyze whether implied interest rate volatility alone provides significant information on consumer sentiment and whether it contains additional information not already embodied in the yield spread and a monetary policy variable. Thus, we first estimate two separate basic empirical models in which CCI is regressed on the yield spread and the change in the three-month interest rate, on the one hand; and, on the other hand, on the one-year implied volatility. Then, we check whether implied volatility contains significant additional information over the yield spread and the change in the short-term interest rate for explaining consumer sentiment, and whether it outperforms realized volatility. In order to improve the robustness of our analysis, separate regressions for the pre-crisis and the crisis periods are run for the U.S. and Germany.

A priori, we should expect consumer confidence to be positively related to the yield spread. Both the theoretical model provided by Harvey (1988) and the monetary policy explanation on the usefulness of the yield spread for predicting future economic activity are based on economic agents' expectations, and hence we should expect a positive relationship between the yield spread and consumer confidence.¹⁷ Concerning the sign of the relationship between the change in the short-term interest rate and consumer confidence, empirical evidence in the work by Hamilton and Kim (2002) shows that the change in the Federal funds rate is significant and positively related to one-quarter growth in real GDP, and negatively related to from eight to 16 quarters ahead. Thus, the evidence on the sign of the relationship in this study is mixed and seems to depend on the term output growth is referred to. In this sense, according to Hamilton and Kim (2002), the positive sign might reflect that monetary authorities try to raise interest rates to hold down the inflation pressure in an expansionary period. The negative sign might just be interpreted in a causal fashion: an increase in short-term interest rates implies low current investment opportunities and lower output in the (less near) future. Since consumer confidence indices measure economic agents' expectations up to the next twelve months, it seems reasonable to expect a positive relationship between consumer confidence and the change in the short-term interest rate. Finally, as

¹⁷ This is indeed the case in the study by Ferreira *et al.* (2008) based on the European Economic Sentiment Indicator.

for volatility, since it can be considered a proxy of risk, we should expect a negative relationship between consumer confidence and interest rate volatility.

Figures 1 through 6 show CCI against the yield spread (*spread*), the change in the three-month interest rate (ΔR), and the one-year implied volatility (*ivol*) for the U.S. and Germany, respectively, for the overall period. In addition, Table 3 shows the linear correlation coefficients between CCI and the explanatory variables the index will be regressed on, for both countries and for the two subperiods we divide the sample into. Results show that there exists a positive relationship between the German CCI and the yield spread, but this is weaker since the beginning of the crisis. Unexpectedly, we obtain the opposite sign for the U.S. before and during the crisis, where the linear fitting releases a correlation coefficient of -0.54. CCI and the change in the three-month interest rate are positively correlated in Germany. In addition, the relationship is particularly strong during the crisis period: the correlation coefficient is 0.61. In the case of the U.S., we observe that after the burst of the crisis, the relationship between these two variables has inverted. Unlike correlation coefficients between CCI and the previous two variables, linear fitting results obtained for the one-year implied volatility are robust between countries: there exists a strong negative correlation between consumer confidence and volatility during the pre-crisis and crisis periods.

In this study we analyze the run the following regression equations:

$$CCI_{t+k} / 100 = \beta_0 + \beta_1(R_t^{(12)} - R_t^{(3)}) + \beta_2\Delta R_t^{(3)} + \varepsilon_t, \quad [3]$$

$$CCI_{t+k} / 100 = \gamma_0 + \gamma_1ivol_t + \varepsilon_t, \quad [4]$$

$$CCI_{t+k} / 100 = \beta_0 + \beta_1(R_t^{(12)} - R_t^{(3)}) + \beta_2\Delta R_t^{(3)} + \beta_3ivol_t + \varepsilon_t, \quad [5]$$

$$CCI_{t+k} / 100 = \beta_0 + \beta_1(R_t^{(12)} - R_t^{(3)}) + \beta_2\Delta R_t^{(3)} + \beta_3hvol_t + \varepsilon_t, \quad [6]$$

where CCI_{t+k} is the Consumer Confidence Index for month t , which is released in $t+k$ (with $k = 4$ weeks for the U.S. and $k = 3$ weeks for Germany); $R_t^{(12)}$ and $R_t^{(3)}$ are the monthly 12- and three-month interest rates, respectively; $\Delta R_t^{(3)}$ represents the monthly change in the three-month interest rate; $ivol_t$ is the monthly one-year implied volatility;

and $hvol_t$, stands for the historical volatility constructed as mean absolute deviations, over a one month interval, of daily logarithmic changes in the one-year interest rate¹⁸.

OLS regressions results based on Equation [3] for the U.S. and Germany over the pre-crisis and crisis periods are depicted in Table 4. Given the possible correlation between the explanatory variables, the change in the short-term interest rate is orthogonalized. In addition, since the Conference Board CCI measures expectations over the next six months and the Icon CCI does over the next 12 months, we consider that there exists overlap in the dependent variables of five and 11 months, respectively. Overlapping does not affect the consistency of the OLS regressions coefficients but does affect the consistency of the OLS standard errors. Thus, standard errors are corrected by using the Newey and West (1987) method of adjustment, including five lags in regressions for the U.S. and 11 lags in the case of Germany.

We find that the coefficients on the yield spread and the monetary policy variable are not different from zero at usual levels of significance during the pre-crisis period in both countries. Thus, the explanatory power of these regressions is low. However, the yield spread and the change in the three-month interest rate significantly help explain CCI during the crisis period. Particularly, both variables jointly are able to explain a striking 45 percent of the variation in CCI in the U.S., and more than 30 percent in Germany. In addition, as expected from the linear correlation analysis, we obtain that the coefficients on the yield spread and the short-term interest rate have opposite signs in these two countries: negative in the U.S. and positive in Germany.

Regression results based on Equation [4] are provided in Table 5. In this case, we find that the coefficients on the implied interest rate volatility are negative and significant before and during the crisis in the two countries. That is, results suggest that volatility is a robust variable in explaining economic agents' expectations on the future state of the economy. In particular, implied volatility alone helps explain 35 percent of the variation in CCI before the crisis, and 22 percent during the crisis period in Germany. Results are more favorable for the U.S., especially before the crisis, where implied volatility alone is able to explain nearly an outstanding 50 percent of the variation in CCI.

¹⁸ This is also the volatility measure employed in the work by Annaert *et al.* (2001). Poon and Granger (2003) provide an extensive review on the forecasting performance of various volatility measures and find that after implied volatility, the historical volatility provides the second best forecasting.

Results for the augmented regression equation in [5] are depicted in Table 6. In this case, in addition to the three-month interest rate, the implied volatility variable is also orthogonalized. As expected, implied volatility noticeably increases the in-sample forecasting accuracy obtained from Equation [3] before the crisis in both countries, but the adjusted R^2 s are the same obtained when CCI is regressed only on implied volatility. The second part of the sample offers the most appealing results. They show that implied interest rate volatility lets enhance the explanatory power of the model including only the spread and the change in the short-term interest rate as explanatory variables in a 42 percent and a 58 percent for the U.S. and Germany, respectively. Particularly, the augmented model is able to explain a remarkable 64 percent of the variation in CCI for the U.S., and a 54 percent in the case of Germany.

Finally, Table 7 reports the results based on Equation [6]. We find that historical volatility is negative and significant at usual levels of significance, except for the crisis period in Germany. Favorable to our expectations, we obtain that the in-sample forecasting ability of the model including the implied volatility outperforms the model including the historical volatility measure in all the cases. The explanatory power of the model including the implied volatility within the pre-crisis period is 42 percent higher than that of the model including the historical volatility for the U.S., and 36 percent higher in the case of Germany. For the crisis period, adjusted R^2 s from regressions based on Equation [5] for Germany and the U.S. are 63 and 33 percent, respectively, greater than those based on Equation [6].

Thus, overall, results from this study suggest that implied volatility contains extra information for capturing consumer sentiment not already embodied in two traditional leading economic indicators of the business cycle: the yield spread and a variable that reflects the stance of monetary policy. In addition, these results are robust to the inclusion of the period associated to the current financial crisis. Given that we use interest rate and volatility data that are available at least three weeks before the consumer confidence indices are published, we are able to explain in advance an important percentage of the variability of the indices. Concerning the most suitable volatility measure for capturing uncertainty on interest rates, the results we obtain are quite concluding. As expected, a forward-looking measure of volatility is able to explain a greater percentage of the variation in CCI than a volatility measure based on historical data of interest rates.

5. Conclusions

Since the late eighties, many papers have shown consistent empirical evidence on the usefulness of the slope of the term structure of interest rates (the yield spread) for predicting economic growth. Moreover, expectations are the foundation of the most widespread explanations on this forecasting ability. In this paper we want to implicitly check the hypothesis on the information content of financial variables for explaining economic agents' expectations by using another variable in addition to the yield spread: the interest rate volatility. In particular, we analyze the ability of interest rate volatility to capture economic agents' expectations regarding future economic activity, and whether it provides extra information content over the yield spread.

For this purpose we must decide how to measure expectations and volatility. For the first issue we employ consumer confidence indicators which contain consumers' expectations over the near-future (six or twelve months) concerning micro- and macro-economic aspects over which they have no control. Concerning the second non-observable variable, we suggest using a forward-looking measure of volatility not based on historical data of interest rates. This is the volatility implied from the market prices of caps and floors, one of the most important and liquid fixed-income options in the market.

Outcomes from this study suggest that implied volatility is a robust variable for explaining consumer sentiment before and during the crisis both in Germany and the U.S. As expected, there exists a significant negative relationship between consumer sentiment and interest rate volatility. In addition, we find that implied volatility can add significant explanatory power to the yield spread in order to explain economic agents' expectations of future economic growth. Moreover, the in-sample forecasting accuracy of the model including the implied volatility as the volatility measure is always greater than that obtained when a realized volatility measure is used instead. Thus, it seems to support the extra information content of a forward-looking measure of volatility on economic agents' expectations.

Appendix

Component questions of the Conference Board CCI and the Icon CCI.

Conference Board Survey	European Commission Survey
<p>1) How would you rate present general business conditions in your area? [good/ normal/ bad]?</p> <p>2) What would you say about available jobs in your area right now? [plentiful/ not so many/ hard to get]</p> <p>3) Six months from now, do you think business conditions in your area will be [better/ the same/ worse]?</p> <p>4) Six months from now, do you think there will be [more/ the same/ fewer] jobs available in your area?</p> <p>5) How would you guess your total family income to be six months from now? [higher/ the same/ lower]</p>	<p>1) How do you expect the financial position of your household to change over the next 12 months? [a lot better/ a little better/ the same/ a little worse/ a lot worse/ don't know]</p> <p>2) How do you expect the general economic situation in this country to develop over the next 12 months? [a lot better/ a little better/ the same/ a little worse/ a lot worse/ don't know]</p> <p>3) How do you expect the number of people unemployed in this country to change over the next 12 months? [increase sharply/ increase slightly/ remain the same/ fall slightly/ fall sharply/ don't know]</p> <p>4) Over the next 12 months, how likely is that you save any money? [very likely/ fairly likely/ not likely/ not at all likely/ don't know]</p>

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Figure 1. The Conference Board CCI for the U.S. (line) and the yield spread between the 12- and three-month interest rates (dash).

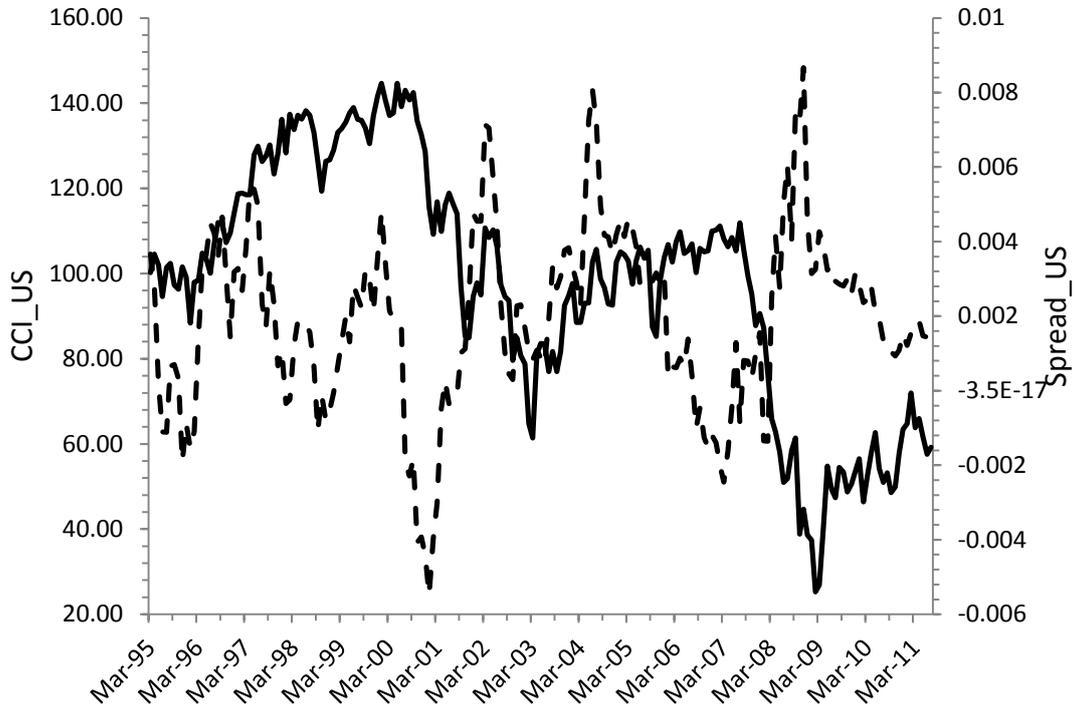


Figure 2. The Icon CCI for Germany (line) and the yield spread between the 12- and three-month interest rates (dash).

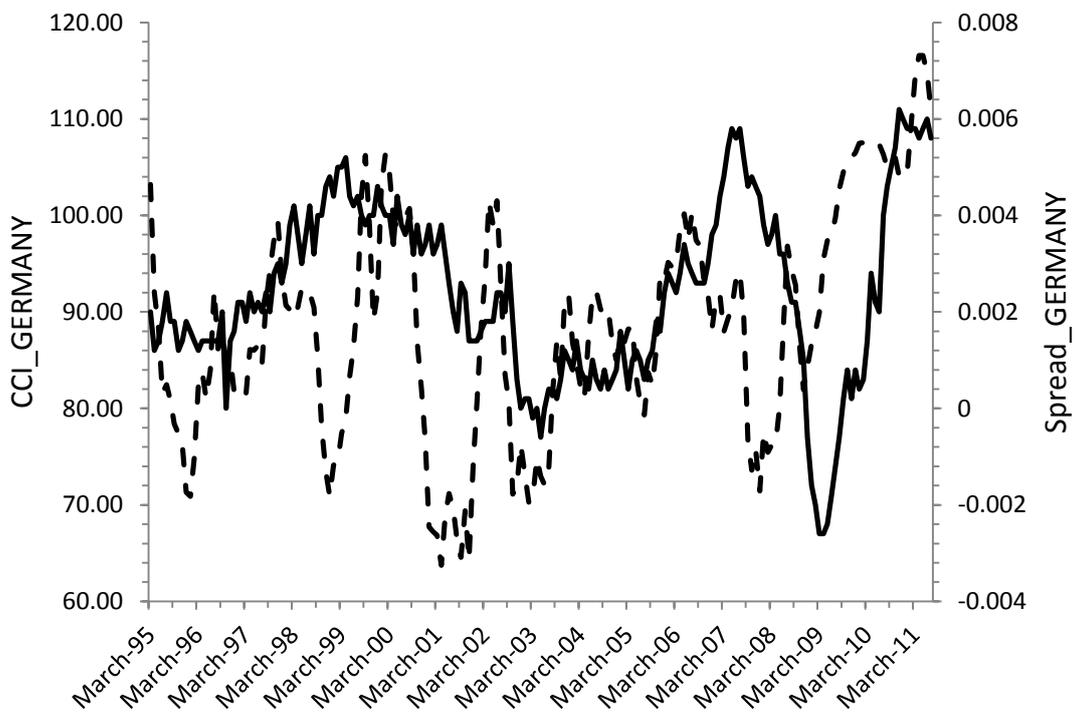


Figure 3. The Conference Board CCI for the U.S. (line) and the change in the three-month interest rate (dash).



Figure 4. The Icon CCI for Germany (line) and the change in the three-month interest rate (dash).

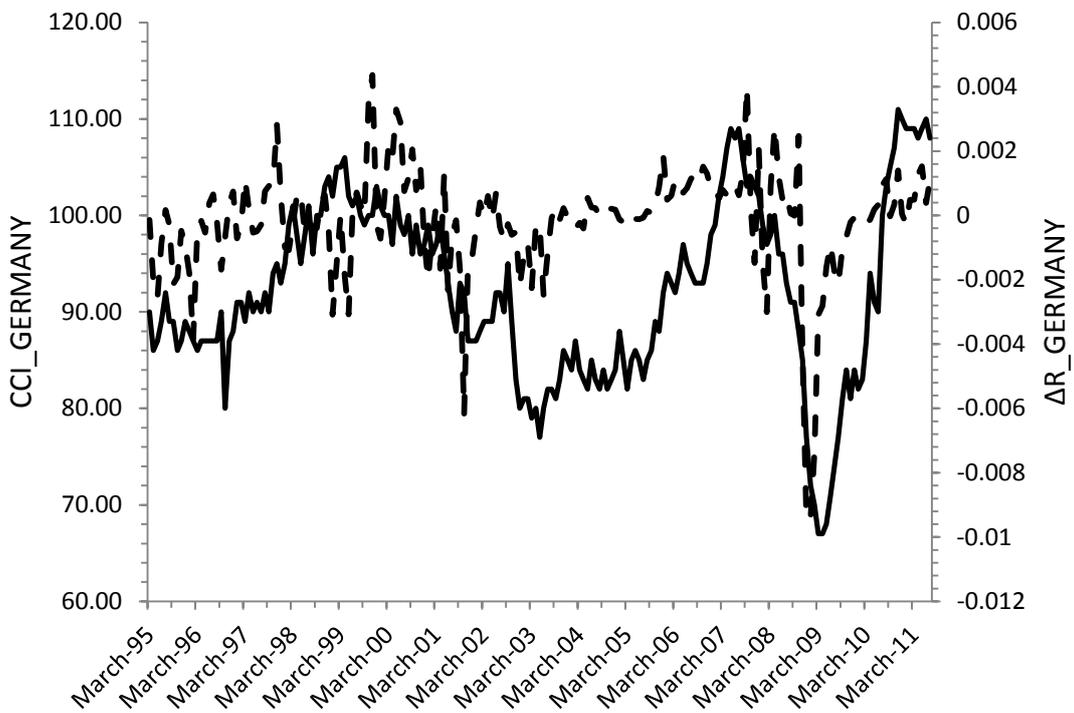


Figure 5. The Conference Board CCI for the U.S. (line) and the one-year implied volatility (dash).

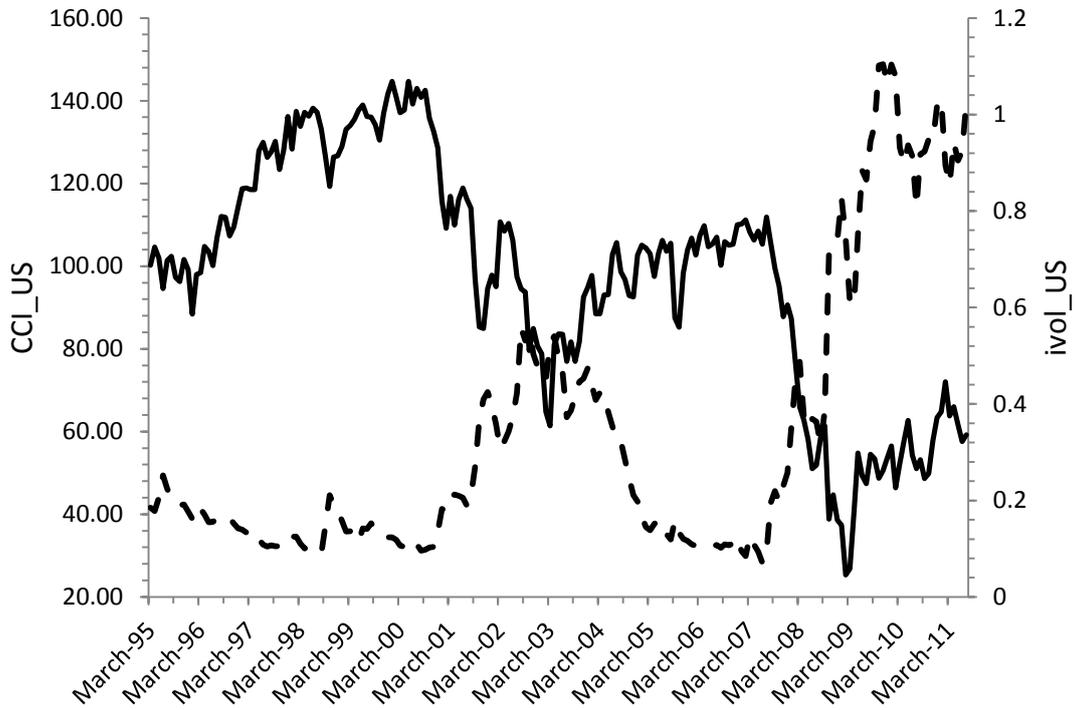


Figure 6. The Icon CCI for Germany (line) and the one-year implied volatility (dash).

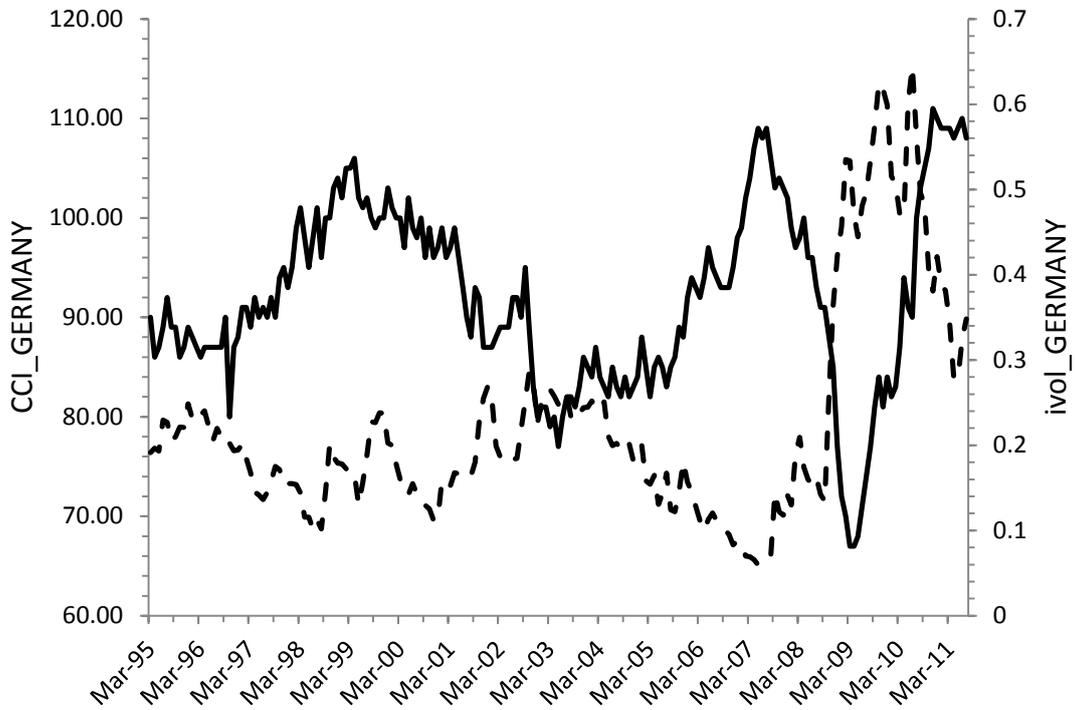


Table 1. Summary statistics for the consumer confidence index (*CCI*), the yield spread (*spread*), the change in the short-term interest rate (ΔR), and the one-year implied volatility (*ivol*) based on U.S. data.

Series	Mean	Std. dev.	Autocorrelations			
			ρ_1	ρ_2	ρ_3	ρ_{12}
Panel A: March 1995 to July 2011 (197 observations)						
CCI	97.61	28.68	0.97	0.94	0.92	0.71
spread ^a	0.0019	0.0024	0.88	0.74	0.63	-0.11
ΔR ^b	-0.0002	0.0020	0.36	0.30	0.27	0.08
ivol ^c	0.33	0.28	0.97	0.94	0.91	0.67
Panel B: March 1995 to July 2007 (149 observations)						
CCI	110.16	18.64	0.94	0.90	0.86	0.61
spread	0.0017	0.0024	0.89	0.76	0.62	-0.16
ΔR	0.0000	0.0017	0.52	0.33	0.39	0.09
ivol	0.20	0.13	0.97	0.93	0.89	0.59
Panel C: August 2007 to July 2011 (48 observations)						
CCI	58.66	16.99	0.83	0.68	0.55	-0.14
spread	0.0025	0.0020	0.76	0.60	0.51	-0.18
ΔR	-0.0010	0.0028	0.12	0.24	0.06	0.04
ivol	0.73	0.29	0.91	0.81	0.73	0.21

^aThe first data for *spread* is obtained as the difference between the monthly average data on the twelve- and the three-month interest rates corresponding to March 1995.

^bThe first data for ΔR is obtained as the difference between the monthly average three-month interest rate data corresponding to March 1995 and the monthly average data corresponding to February 1995.

^cThe first monthly average data for *ivol* is obtained from daily data on one-year implied volatilities corresponding to March 1995.

Table 2. Summary statistics for the consumer confidence index (*CCI*), the yield spread (*spread*), the change in the short-term interest rate (ΔR), and the one-year implied volatility (*ivol*) based on data for Germany.

Series	Mean	Std. dev.	Autocorrelations			
			ρ_1	ρ_2	ρ_3	ρ_{12}
Panel A: March 1995 to July 2011 (197 observations)						
CCI	92.06	9.21	0.94	0.89	0.84	0.19
spread ^a	0.0017	0.002	0.92	0.81	0.69	0.06
ΔR ^b	-0.0001	0.0017	0.63	0.34	0.29	0.04
ivol ^c	0.22	0.12	0.97	0.92	0.88	0.54
Panel B: March 1995 to July 2007 (149 observations)						
CCI	91.85	7.31	0.92	0.86	0.81	0.52
spread	0.0011	0.0019	0.89	0.74	0.59	-0.28
ΔR	0.0000	0.0013	0.52	0.24	0.28	0.04
ivol	0.17	0.05	0.92	0.82	0.74	0.32
Panel C: August 2007 to July 2011 (48 observations)						
CCI	92.70	13.60	0.94	0.88	0.80	-0.15
spread	0.0033	0.0026	0.94	0.85	0.74	0.29
ΔR	-0.0005	0.0026	0.68	0.37	0.26	-0.05
ivol	0.37	0.17	0.92	0.83	0.73	0.02

^aThe first data for *spread* is obtained as the difference between the monthly average data on the twelve- and the three-month interest rates corresponding to the period from the second fortnight of February 1995 up to the first fortnight of March 1995.

^bThe first data for ΔR is obtained as the difference between the monthly average three-month interest rate data corresponding to the period from the second fortnight of February 1995 up to the first fortnight of March 1995 and the one corresponding to the period from the second fortnight of January 1995 up to the first fortnight of February 1995.

^cThe first monthly average data for *ivol* is obtained from daily data on one-year implied volatilities corresponding to the period from the second fortnight of February 1995 up to the first fortnight of March 1995.

Table 3. Linear correlation coefficients between CCI and the explanatory variables.^a

	<i>spread</i>	ΔR	<i>ivol</i>
United States			
Pre-crisis period (1995:03-2007:07)	-0.15	0.14	-0.69
Crisis period (2007:08-2011:07)	-0.54	-0.26	-0.53
Germany			
Pre-crisis period (1995:03-2007:07)	0.26	0.25	-0.59
Crisis period (2007:08-2011:07)	0.11	0.61	-0.48

^a*Spread* is the difference between the 12-and three-month interest rates; ΔR represents the change in the three-month interest rate; and *ivol* stands for the one-year implied volatility.

Table 4. OLS regression results based on Equation [3].^a

	$CCI_{t+k} / 100 = \beta_0 + \beta_1(R_t^{(12)} - R_t^{(3)}) + \beta_2\Delta R_t^{(3)} + \varepsilon_t$			
	β_0	β_1	β_2	$\overline{R^2}$
United States				
Pre-crisis period (1995:03-2007:07)	1.11 ^{**} (0.12)	-9.93 (10.78)	22.64 (14.34)	0.04
Crisis period (2007:08-2011:07)	0.71 ^{**} (0.02)	-51.25 ^{**} (7.29)	-20.35 ^{**} (6.66)	0.45
Germany				
Pre-crisis period (1995:03-2007:07)	0.90 ^{**} (0.05)	9.77 (6.25)	8.32 (5.38)	0.07
Crisis period (2007:08-2011:07)	0.90 ^{**} (0.05)	6.04 ^{**} (0.48)	31.49 ^{**} (0.11)	0.34

^aInside the parentheses are standard errors computed using the Newey and West (1987) correction for autocorrelation and heteroskedasticity. One asterisk denotes statistical significance at the 5% significance level. Two asterisks denote statistical significance at the 1% significance level. $\overline{R^2}$ is the adjusted coefficient of determination.

Table 5. OLS regression results based on Equation [4].^a

$CCI_{t+k}/100 = \gamma_0 + \gamma_1 ivol_t + \varepsilon_t$			
	γ_0	γ_1	$\overline{R^2}$
United States			
Pre-crisis period (1995:03-2007:07)	1.31 ^{**} (0.20)	-0.99 [*] (0.49)	0.48
Crisis period (2007:08-2011:07)	0.81 ^{**} (0.06)	-0.31 ^{**} (0.06)	0.26
Germany			
Pre-crisis period (1995:03-2007:07)	1.06 ^{**} (0.03)	-0.83 ^{**} (0.15)	0.35
Crisis period (2007:08-2011:07)	1.07 ^{**} (0.01)	-0.39 ^{**} (0.05)	0.22

^aInside the parentheses are standard errors computed using the Newey and West (1987) correction for autocorrelation and heteroskedasticity. One asterisk denotes statistical significance at the 5% significance level. Two asterisks denote statistical significance at the 1% significance level. $\overline{R^2}$ is the adjusted coefficient of determination.

Table 6. OLS regression results based on Equation [5].^a

$CCI_{t+k}/100 = \beta_0 + \beta_1 (R_t^{(12)} - R_t^{(3)}) + \beta_2 \Delta R_t^{(3)} + \beta_3 ivol_t + \varepsilon_t$						
	β_0	β_1	β_2	β_3	$\overline{R^2}$	$\overline{R^2}^{[5]} / \overline{R^2}^{[3]}$
United States						
Pre-crisis period (1995:03-2007:07)	1.11 ^{**} (0.09)	-9.93 (9.83)	22.64 (24.45)	-1.01 ^{**} (0.34)	0.47	11.75
Crisis period (2007:08-2011:07)	0.71 ^{**} (0.02)	-51.25 ^{**} (3.67)	-20.35 ^{**} (4.55)	-0.26 ^{**} (0.03)	0.64	1.42
Germany						
Pre-crisis period (1995:03-2007:07)	0.90 ^{**} (0.02)	9.77 ^{**} (2.91)	8.32 ^{**} (2.67)	-0.80 ^{**} (0.18)	0.34	4.85
Crisis period (2007:08-2011:07)	0.90 ^{**} (0.02)	6.04 [*] (8.47)	31.49 ^{**} (7.90)	-0.52 [*] (0.20)	0.54	1.58

^aInside the parentheses are standard errors computed using the Newey and West (1987) correction for autocorrelation and heteroskedasticity. One asterisk denotes statistical significance at the 5% significance level. Two asterisks denote statistical significance at the 1% significance level. $\overline{R^2}$ is the adjusted coefficient of determination; and $\overline{R^2}^{[5]} / \overline{R^2}^{[3]}$ stands for the quotient between the adjusted coefficients of determination obtained from regressions based on Equation [5] and the adjusted coefficients of determination obtained from regressions based on Equation [3].

Table 7. OLS regression results based on Equation [6].^a

$CCI_{t+k} / 100 = \beta_0 + \beta_1(R_t^{(12)} - R_t^{(3)}) + \beta_2\Delta R_t^{(3)} + \beta_3hvol_t + \varepsilon_t$						
	β_0	β_1	β_2	β_3	$\overline{R^2}$	$\overline{R^2}^{[5]} / \overline{R^2}^{[6]}$
United States						
Pre-crisis period (1995:03-2007:07)	1.11** (0.10)	-9.93 (10.48)	22.64 (18.16)	-14.33** (4.93)	0.33	1.42
Crisis period (2007:08-2011:07)	0.71** (0.03)	-51.25** (6.81)	-20.35** (3.28)	-2.74* (1.09)	0.48	1.33
Germany						
Pre-crisis period (1995:03-2007:07)	0.90** (0.00)	9.77** (2.60)	8.32 (4.79)	-11.83** (1.92)	0.25	1.36
Crisis period (2007:08-2011:07)	0.90** (0.03)	6.04 (30.50)	31.49** (9.37)	2.06 (9.63)	0.33	1.63

^aInside the parentheses are standard errors computed using the Newey and West (1987) correction for autocorrelation and heteroskedasticity. One asterisk denotes statistical significance at the 5% significance level. Two asterisks denote statistical significance at the 1% significance level. $\overline{R^2}$ is the adjusted coefficient of determination; and $\overline{R^2}^{[5]} / \overline{R^2}^{[6]}$ stands for the quotient between the adjusted coefficients of determination obtained from regressions based on Equation [5] and the adjusted coefficients of determination obtained from regressions based on Equation [6].