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The Role of the Financial Market Variables in Forecasting Macrovariables in Finland: Does the Financial Crisis Make a Difference?

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ABSTRACT

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A substantial body of stylized facts and empirical evidence exists regarding the relationships between financial variables and the macroeconomy in the United States. However, the question of whether this evidence is consistent with the cases of small open economies is less known. This paper focuses on the forecasting content of stock returns and volatility versus the term spread for GDP, private consumption, industrial production and the inflation rate in Finland.

Our results suggest that during normal times, the term spread is a much better tool than stock market variables for predicting real activity. However, during exceptional times, such as the recent financial crisis, the forecast performance is improved by combining the term spread and the stock market information.

JEL classification: E37, E44, E47

KEY WORDS: Term spread, Stock market, Forecasting, Macroeconomy.

1. INTRODUCTION

Because stock returns are forward looking and are related to the future state of the economy, they also constitute potential predictors of real economic activity and inflation. The stock market is easy to observe, it is an excellent aggregator of information, and it reacts to news vigorously and with short delay. Indeed, if investors strongly enough believe that a recession is imminent, the stock market will not hesitate to send such a signal. Consequently, the recession will likely not wait very long either. However, "[t]he stock market has predicted nine out of the last five recessions," as Samuelson (1966) famously stated, and stock prices are much too volatile to be justified only by subsequent changes in dividends, as Shiller declared (1981). In any event, stock market volatility may have important effects on the economy and predictive power concerning economic activity and inflation. Still, the following question remains: do stock market components, returns and volatility, include systematic and relevant information about the real economy and inflation?

There is a large body of evidence that the yield curve is a fast, simple and reliable predictor of real future activity and monetary policy. It has become a standard procedure to use the spread between 10-year Treasury notes and 3-month Treasury bills to predict U.S. recessions and future economic activity (e.g., Estrella & Mishkin, 1996; Haubrich & Dombrosky, 1996). Indeed, the yield curve has been able to predict the GDP, private consumption and industrial production growth and inflation, though some caution should be exercised in using the term structure as a guide for assessing inflationary pressures in the economy (Mishkin, 1988; Estrella, 2004). Models that predict real activity are often found to be more stable than those predicting inflation (Estrella, Rodrigues & Schich, 2003).

On the whole, there is a substantial amount of stylized facts and empirical evidence concerning the relationships between the yield curve, the stock market, the real economy and inflation in the United States. However, it is less clear whether these relationships apply to small open economies.

The purpose of this study is to analyze the ability of stock market variables vs. the yield curve to predict macroeconomic activity in Finland, a small open industrial economy that has experienced a remarkable transition from highly regulated financial markets to a liberalized market economy during the past 25 years. A special feature of the Finnish economy since the 1990s has been the Nokia Corporation’s significant contribution both to economic growth and to the value and volatility of the stock market. We scrutinize the predictive potential of stock returns and their volatility and compare the predictive potential with the predictive ability of the slope of the yield curve. Our analysis is focused on the four central macroeconomic variables, i.e., GDP, private consumption, industrial production and inflation, during the 1987–2010 timeframe. During this period, the Finnish economy experienced a number of structural and institutional changes, including the removal of restrictions on the foreign ownership of listed companies in the Finnish stock markets (1993), the commencement of memberships in the EU (1995) and EMU (1999), and the monetary transition to the euro (2002). Also during the research period, the Finnish economy has been subject to a number of economic shocks, including three stock market bubbles (1989, 2000 and 2007) and three subsequent crashes of 60–70%, one of the absolute worst recessions (1990–1993) to occur in the Western hemisphere since the 1930s, a strong recovery and subsequent rapid economic growth, and a remarkable slowdown of inflation. Finally, the recent global financial crisis caused a record 8% drop in GDP over 1 year (2009). Thus, it can be concluded that the example of Finland as a small European open economy does highlight the importance of the early indicators of recessions, and this case truly tests the old empirical regularities and stylized facts about stock markets and yield curves as the leading indicators of the economy.

Aside from focusing on the forecasting ability of stock markets and the yield curve, this study contributes to the existing literature by explicitly addressing stock market volatility as a potential predictor for macroeconomic variables. This issue has been overlooked in previous studies, and therefore, both the return and risk aspects of the stock markets are covered in this study.

The remainder of the paper is organized as follows. In Section 2, we review the previous evidence regarding empirical regularities and stylized facts between the yield curve, stock markets and macro variables. Section 3 presents the data, and Section 4 contains our empirical analysis. Finally, we present our conclusion in Section 5.

2. STYLIZED FACTS AND EMPIRICAL REGULARITIES

2.1. Yield curve, real economy and inflation

The slope of the yield curve was fully noticed as one of the best leading indicators of the economy in the United States in the late 1980s, and this result was confirmed in many studies throughout the 1990s (e.g., Estrella & Mishkin, 1995, 1996; Estrella, 2005). Monetary policy has a significant influence on the steepness of the yield curve; an increase in the short-term rate tends to flatten the yield curve and vice versa. The yield curve can also flatten if investors begin buying long-term bonds, which drives long-term rates down. In many cases, instant graphical evidence demonstrates that the yield curve tends to be flat or even negative at cyclical peaks. The inversion of the yield curve has been found to be a precise predictor of recession in the United States. Conversely, a nearly flat yield curve (i.e., the very low positive level of the 10-year minus 3-month term spread) has been observed without a subsequent recession (Estrella, 2005). However, this has been found to be a sign of a slowdown in economic activity or, in the worst case, of an impending recession. Alternatively, the steep yield curve is usually followed by recovery and a growing economy.

Over the past 20 years, research on forecasting economic activity and inflation has increased significantly. Because the simple measure of the yield curve inversion, as defined by the term spread between 10-year and 3-month rates, has preceded every recession in the

United States since 1960, many authors have begun using the term structure to predict real output, real consumption growth and future recessions (e.g., Harvey, 1988; Laurent, 1988, 1989; Estrella & Hardouvelis, 1991; Dueker, 1997). Indeed, because the yield curve is very simple to use and provides a reasonable combination of accuracy and robustness, Estrella & Mishkin (1996) concluded that it significantly outperforms other financial and macroeconomic indicators in predicting recessions in the United States. Thus, the yield curve has been celebrated as the single best indicator of economic performance or, as it was expressed in an article in *Fortune*, "[a] near-perfect tool for economic forecasting" and "an economist-obviation device" (Clark, 1996).

The best forecast of real future activity is provided by the level of the term spread, not by the change in the spread or by the source of the change in the spread. If a low or negative value of the spread is reached via an increase in the short-term rate or a decrease in the long-term rate, it is only the level that matters (Estrella, 2005). This stylized fact makes the yield curve a quick check to determine the state of the economy, providing an instant indication of future changes in real activity.

Although we have a very good rule of thumb in the idea that recession is preceded by the inversion of the yield curve, there are also some problems with this rule. First, inversions and recessions are not firmly connected by economic theory. Though there are predictive relationships between the term spread and the future real output, the precise parameters may change over time (Haubrich & Dombrosky, 1996; Dotsey, 1998; Estrella, 2005). Because instability cannot be ruled out by theoretical arguments, the issue becomes an empirical one (e.g., Estrella et al., 2003). For instance, Stock & Watson (2003) found the term spread to be the most reliable single asset price for predicting output across countries, though good predictive performance in some periods and countries was offset by poor performance in other periods and/or countries. Evidence from Germany and the United States shows that models predicting real activity are more stable than those predicting inflation (Estrella et al., 2003). Overall, it seems obvious that one should not expect a stable relationship between the term spread and the macroeconomy if the economy is subject to both monetary and real shocks.

2.2. Stock market, real economy and inflation

Stock prices almost always fall prior to a recession and rally vigorously at signs of an impending recovery. Thus, if you can predict the business cycle, you can easily beat the buy-and-hold strategy (Siegel, 2002). A commonly used rule of thumb is that the stock market helps to predict the future economy approximately half a year in advance. The results of Estrella & Mishkin (1995) show that stock prices are useful in macroeconomic predictions with one-quarter to two-quarter horizons, and beyond that timeframe, the slope of the yield curve emerges as the clear choice and performs better by itself out of sample than in conjunction with other variables. There is also evidence that stock returns contain information that is useful for predicting growth when the economy is contracting, but in nonrecession periods, the evidence is less clear (Henry, Olekalns & Thong, 2004). The evident problem is that the macroeconomy and the stock market are so often out of sync, causing the stock market to give misleading signals, as Samuelson (1966) famously noted.

If stock prices are too volatile to be justified only by subsequent changes in dividends, then we can expect that volatility may also include information on the path of the economy's future growth. It is common knowledge that stock market volatility is related to the uncertainty of economic activity and that volatility moves countercyclically, exhibiting high volatility during recessions and when stock prices are falling. In spite of the fact that there are large spikes in stock market volatility, it is striking that there is no long-term trend in volatility (Siegel, 2002). Thus, we can conclude that stock market volatility seems to be related to the general health and future state of the real economy.

Schwert (1989) found evidence that stock market volatility helps to predict future macroeconomic volatility in the United States. The volatility measures were also found to forecast GDP growth, diminishing the significance of stock index returns in forecasting GDP (Campbell, Lettau, Malkiel & Xu, 2000). Results for the United States and Germany have also demonstrated that stock market volatility significantly contributes to forecasting future recessions (Annaert, De Ceuster & Valckx, 2001). Guo (2002) concluded that even though both stock market volatility and returns forecast output in the United States, the information from stock returns is more important. There is also evidence that episodes of excess volatility may not have substantial real economic effects (Kupiec, 1991). Stock and Watson (2003) demonstrate that asset prices are more useful in predicting output growth than in predicting inflation. In contrast, other information beyond the yield curve spread can be useful in forecasting inflation (Estrella, 2004). Junttila and Kinnunen (2004) reported that industry-based stock portfolios have clear forecasting power for future inflation and changes in industrial production in the Finnish economy at short horizons.

3. DATA

3.1. Variables

The Finnish dataset consists of the following financial market variables: stock returns (R), the term spread (TS), stock market volatility (VOLA), and the change in stock market volatility (ΔVOLA). It also contains the following macroeconomic variables: GDP growth (ΔY), private consumption growth (ΔC), industrial production growth (ΔIP), and consumer price inflation (ΔP).

Nominal stock market returns were constructed from daily logarithmic changes in the Finnish general stock market index (HEX, renamed OMX in 2005) received from the ETLA database[1] and from the OMX. The stock market returns were defined as the quarterly average

[1] ETLA refers to the Research Institute of the Finnish Economy.

of logarithmic daily returns. To measure risk in stock markets and, thus, in the economy, the stock market volatility variable was constructed as a standard deviation of daily logarithmic stock returns over a quarterly interval. The term spread was constructed by calculating the difference between 10-year government bonds and 3-month interest rates. The quarterly interest rates were calculated from average daily observations. The daily interest rates were obtained from the ETLA database and from the Bank of Finland. The consumer price index and the time series for the real GDP and private consumption were retrieved from the OECD Economic Outlook and the total manufacturing output[2], from the OECD Main Economic Indicators databases. The levels of the four macrovariables were transformed into quarterly growth rates by taking logs and differencing.[3] The quarterly data cover the period 1987:2–2010:1 after the data transformations (92 observations).

Table 1. Descriptive statistics of the data.

	ΔC	ΔP	ΔIP	ΔY	TS	R	VOLA	ΔVOLA
Mean	0.53	0.56	0.61	0.53	1.16	0.03	1.54	0.01
Maximum	1.99	2.20	5.50	2.28	4.68	1.01	4.24	1.77
Minimum	-1.70	-0.57	-20.77	-5.33	-2.85	-0.70	0.39	-1.95
Std. dev.	0.87	0.53	3.13	1.20	1.54	0.27	0.87	0.59
Skewness	-0.76	0.56	-3.71	-2.16	-0.32	0.20	1.05	-0.08
Kurtosis	-0.18	0.16	23.54	6.92	0.54	1.33	0.45	1.99
Jarque-Bera (P-value)	8.87 (0.01)	4.88 (0.09)	2335.62 (0.00)	255.55 (0.00)	2.63 (0.69)	7.39 (0.02)	17.54 (0.00)	15.22 (0.00)

Notes: ΔC = quarterly private consumption growth, ΔP = quarterly inflation rate, ΔIP = quarterly industrial production, ΔY = quarterly GDP growth, TS = term spread, R = stock returns, VOLA = standard deviation of stock returns, and ΔVOLA = change of standard deviation of stock returns. Jarque–Bera refers to the normality test, H_0: variable is distributed normally. The sample period is 1987:2–2010:1.

The descriptive statistics in Table 1 demonstrate that during the 23-year sample period, the average quarterly growth of the Finnish macrovariables has been slightly over 0.50%, implying more than 2% annual growth. The quarterly growth of industrial production has

[2] The time series for total manufacturing production is seasonally adjusted by the OECD.
[3] More specifically, the vector of the macrovariables, X_t, consisting of GDP growth (ΔY_t), private consumption growth (ΔC_t), industrial production growth (ΔIP_t) and consumer price inflation (ΔP_t) is constructed as follows: $X_t = (lnX_t - lnX_{t-1})\times 100$.

been the highest, about 0.6% on average, and also the most volatile by a clear margin. The average term spread has been slightly over 1%, and the average stock returns have been around 7.4% annually[4]. The recent global financial crisis shows up in large quarterly drops in GDP growth (-5%) and in industrial production growth (-20%), both during the first quarter of 2009.

3.2. Research period

Figure 1 illustrates the time series of this study. The 1987:2–2010:1 research period covers many changes and transformations in the Finnish economy. The slope of the yield curve measured by the term spread inverted twice during that period (i.e., 1989:3–1992:3 and 2007:3–2008:4), sending serious warnings of impending recessions. In the beginning of the 1990s, the Finnish economy was hit by one of the worst recessions to occur in the Western world after the 1930s: the real GDP dropped by an amazing 13.5%, and private consumption declined by 12.4% during the 3-year period from 1990:2 to 1993:2. However, since that depression, the Finnish economy has experienced a long and lasting recovery. The recovery was accompanied by a positive and steep yield curve that reached its peak at the end of 1994, after which the difference between the long and short rates has been decreasing steadily but has nonetheless remained positive through mid-2007. The real GDP grew from 1993 to 2000 at an average annual rate of 4.7%. During the 2000s, economic growth slightly slowed, with the average growth nonetheless being a respectable 3.2% annually between 2000 and 2007. Then, the global financial crisis hit the Finnish economy in 2008, resulting in a 9% drop in the real GDP from 2008:3 to 2009:2. The collapse of industrial production was even worse (about 26% from 2008:1 to 2009:2), reflecting plunging world demand for Finnish exports. It

[4] Note that the stock returns have been defined as the quarterly average of daily returns. Thus, the annual average log-returns are 62×4×0.03% =7.4%, assuming 62 market days during the quarter, on average.

is also worth noting that in the case of the global financial crisis, the recession was anticipated by the inversion of the term spread (2007:3–2008:4).

The Finnish stock markets fluctuated tremendously during the research period. We observed a 68% crash from 1989:2 to 1992:3, a 71% crash from 2000:1 to 2003:1 and a 63% crash from 2007:3 to 2009:1, but also a 2,600% boom from 1992:3 to 2000:1 and a 150% boom from 2003:1 to 2007:3 in the general stock index. The stock market volatility seems to have had an upward trend during the sample period, up to the beginning of the year 2000, after which the volatility decreased substantially. However, the financial crisis broke that downward trend, and volatility again increased.

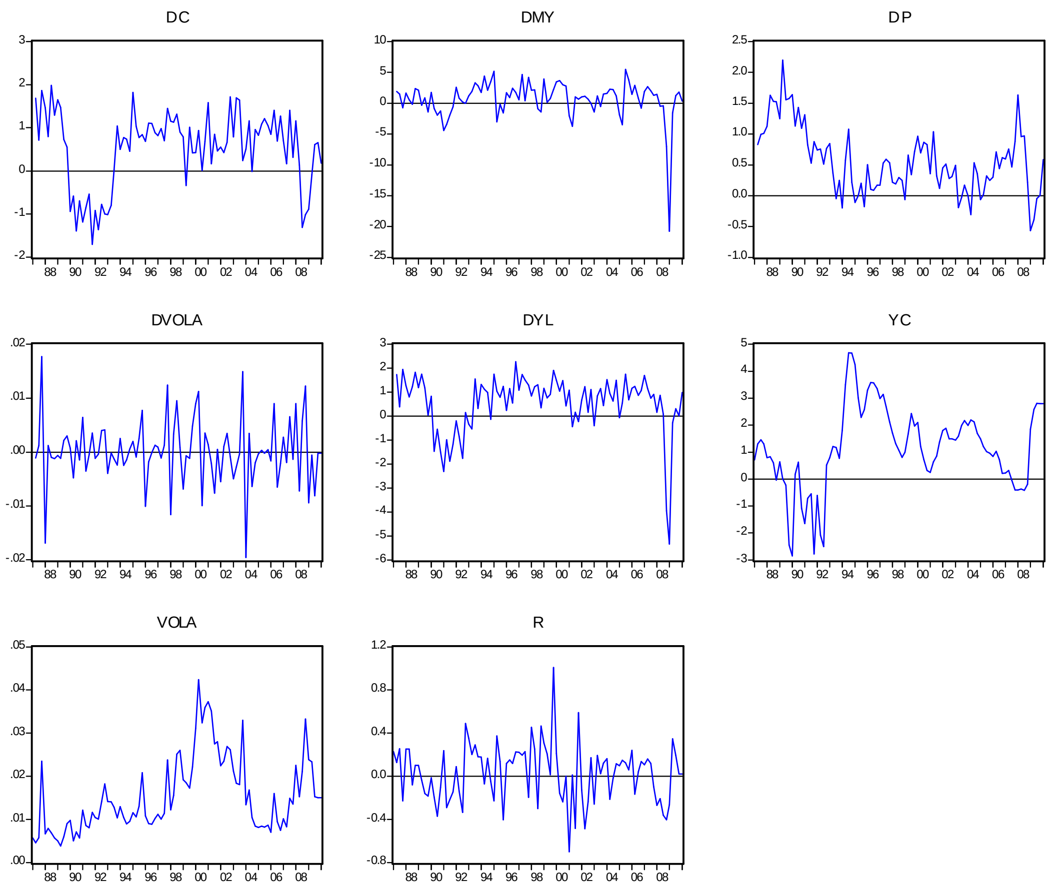

Figure 1. Time series of the data.

The distinctive feature of the Finnish stock market and its national economy is the vital importance of the Nokia Corporation; the stock markets and economic growth are connected by a single company in Finland. From the middle of the 1990s, Nokia emerged as the world leader in mobile communication. At best, Nokia has accounted for approximately one-quarter of Finland’s exports (Ali-Yrkkö, 2001), and Nokia’s effect on GDP growth was nearly half of the total 5% GDP growth in 2000 (Ali-Yrkkö, 2010). Nokia has also become a giant in the Finnish stock markets: the company’s share of the Helsinki Stock Exchange, in terms of market capitalization, has varied from 25–70% since the late 1990s. Therefore, when dealing with general Finnish stock market returns and economic growth, one inevitably deals with Nokia, at least from the middle of the 1990s to present.

4. EMPIRICAL RESULTS

4.1. Estimation models

While there is a large body of empirical evidence concerning the relationship between the yield curve and the macroeconomy, Estrella (2004) points out that a standard theory of that relationship is lacking. The relationship between the yield curve and economic activity has usually been justified by the expectations theory of the term structure and the Fisher equation. Estrella (2004) theoretically demonstrates that the forecasting ability of the yield curve is related to a monetary policy reaction function and that, in most cases, the yield curve should have predictive ability for output and inflation. Furthermore, Estrella’s (2004) theoretical results suggest that other information beyond the yield curve can be useful in forecasting output and inflation.

Theoretically, the connection between the stock market and the macroeconomic future arises from the fact that revisions of equity valuation are related to expected changes in macroeconomic variables (e.g., Junttila, 2007).

In this study, we analyze the forecasting ability of the term spread and stock market variables with the following models:

$$X_{t+k} = \alpha + \beta_1 TS_t + u_{t+k} \tag{1}$$

$$X_{t+k} = \alpha + \beta_2 R_t + \beta_3 VOLA_t + \beta_4 \Delta VOLA_t + u_{t+k} \tag{2}$$

$$X_{t+k} = \alpha + \beta_1 TS_t + \beta_2 R_t + \beta_3 VOLA_t + \beta_4 \Delta VOLA_t + u_{t+k} \tag{3}$$

The vector *X* contains the Finnish GDP growth (ΔY), private consumption growth (ΔC), industrial production growth (ΔIP) and the inflation rate (ΔP), i.e., X = (ΔY, ΔC, ΔIP, ΔP), and *u* is an error term of the regression. We consider one-quarter, one-half and 1-year forecasting horizons (*k* = 1, 2, 4). Further, we use 1987:2–2001:4 for the initial (in-sample) estimation period, and the out-of-sample forecasts are conducted for the 8-year period 2002:1–2010:1. Note that the monetary transition to Euro took place in 2002:1, making the out-of-sample forecast analysis even more challenging.

The models' setup can be characterized as follows: model (1) takes into account only the information from the term spread, whereas model (2) contains only the stock market variables. We assume that stock market volatility measures the degree of uncertainty of the macroeconomic future, and the changes in stock market volatility capture the changes in uncertainty. Therefore, our stock market variable setup captures both the growth (returns) and the risk (volatility) information regarding the macroeconomic future. Finally, model (3) combines information from both the term spread and the stock market variables.

The specification of equations (1–3) is based on the conventional assumption that the last observations of financial market data contain all of the relevant information regarding the macroeconomic future. Therefore, no additional lags of the explanatory variables are specified in the models.

4.2. Preliminary analysis of the data

As a preliminary assessment of the degree of association between the financial market and macroeconomic activity, Table 2 presents pairwise cross-correlations between the financial market and macroeconomic variables for the entire sample period.

A priori the macroeconomic variables excluding the inflation rate are assumed to positively correlate with the term spread and the stock returns and negatively with the stock market volatility and its' change. The inflation rate, in turn, is presumed to negatively correlate with the financial market variables in this study.

It can be seen that the term spread generally had the highest and in most cases (14/16) statistically significant correlations with the macroeconomic variables. The second highest correlations (11/16 significant) were found with the stock returns, while the stock market volatility and especially its change had very low and in the majority of cases (28/32) statistically insignificant correlations with the macroeconomic variables. However, note that all of the correlations between stock market volatility and inflation rate are correctly signed and consistently statistically significant.

Overall, the preliminary correlation analysis provided tentative support for the potential predictive capacity of the financial market variables (especially the term spread and the stock return) in forecasting macroeconomic developments in Finland.

Table 2. Cross correlations of the financial market and the macroeconomic variables.

	TS_{t-k}					R_{t-k}			
	k = 0	k = 1	k = 2	k = 4		k = 0	k = 1	k = 2	k = 4
ΔY_t	**0.35**	**0.45**	**0.50**	**0.47**		**0.27**	**0.39**	**0.35**	**0.28**
ΔC_t	**0.45**	**0.54**	**0.61**	**0.59**		0.10	**0.25**	**0.23**	**0.24**
ΔIP_t	0.20	**0.27**	**0.28**	0.19		**0.23**	**0.37**	**0.31**	**0.28**
ΔP_t	**-0.53**	**-0.45**	**-0.40**	**-0.30**		-0.14	-0.07	0.02	0.10
	$VOLA_{t-k}$					$\Delta VOLA_{t-k}$			
	k = 0	k = 1	k = 2	k = 4		k = 0	k = 1	k = 2	k = 4
ΔY_t	-0.11	-0.11	-0.05	0.06		0.02	0.09	-0.02	0.12
ΔC_t	0.00	0.00	0.06	0.18		0.02	-0.08	-0.06	-0.04
ΔIP_t	-0.14	-0.17	-0.06	-0.08		0.04	-0.17	-0.01	-0.16
ΔP_t	**-0.23**	**-0.30**	**-0.32**	**-0.29**		0.11	0.05	0.04	0.08

Notes: Bolded figures indicate statistically significant correlation coefficients at the 5% significance level. The sample period is 1987:2–2010:1.

4.3. Estimation and out-of-sample forecasting results

4.3.1. In-sample estimation results

Our empirical analysis consisted of estimating the models (1–3) and conducting out-of-sample forecasts with the estimated models. The out-of-sample forecasting analyses were performed recursively. In other words, we first used 1987:2–2001:4 to estimate and compute forecasts for 2002:1, 2002:2 and 2002:4. Then, we estimated the models through 2002:1 and computed forecasts for 2002:2, 2002:3 and 2003:1 and so on. The Newey–West estimator was applied throughout to correct for the influence of serial correlation and heteroscedasticity on standard errors of the estimates.

The initial in-sample estimation results from 1987:2–2001:4 are presented in Appendix. The following general remarks are noteworthy:

- The explanatory power of the GDP and the private consumption equations was generally better than that of the industrial production and inflation equations.

- Of the four explanatory variables, the term spread was statistically significant in 22 of 24 cases, thus being the single most important variable in terms of statistical significance. It was consistently significant in all of the GDP, private consumption and inflation equations.
- Statistically, the stock returns were a more significant explanatory variable than the stock market volatility or the changes in volatility and were consistently significant in the GDP and the industrial production equations.
- The stock market volatility or its change had little and nonsystematic explanatory ability.

The weak performance of the stock market variables in explaining private consumption appears rather puzzling; the stock returns and volatility were significant in only two of six cases. This may be explained by the strongly institutionalized ownership of the listed companies in Finland. Stocks of the listed companies are mainly owned by the state and local and foreign institutions rather than private citizens, who accounted for less than 15% of the capitalization of the Helsinki Stock Exchange in 2000. Because households have become a minor player in stock markets, it is not a surprise that private consumption appears nearly independent of the ups and downs in share prices in Finland.

4.3.2. Stability analysis

It is important to remember that forecasts based on an empirical regression model are subject to the fundamental assumption that the estimated parameters of the model remain constant during the entire sample period. For example, the predictive power of the term spread may depend on the relative importance of real and nominal shocks and changes in a monetary policy reaction function (Estrella et al., 2003; Estrella, 2005). If the assumption of parameter constancy does not hold, this is likely to cause severe consequences for forecasting performance. Applied forecasting models rarely are very structural and not derived from deep structural parameters. Consequently, instability essentially becomes an empirical issue that should be tested in practice, as stressed by Estrella et al. (2003). Considering the turbulent sample period in the present study, it is necessary to verify stability before performing the forecasting analysis.

We tested stability by means of the Chow predictive failure test (see e.g., Brooks, 2008). The basic idea of the test is to divide the data into subperiods, estimate the models for each of the subperiods and for the entire sample, and then compare the respective residual sums of the squares. If the residual sum of the square does not significantly differ between the restricted and the full samples, the model is stable. The test statistic is calculated as follows:

$$\frac{RSS - RSS_1}{RSS_1} \times \frac{T_1 - k}{T_2} \sim F(T_2, T_1 - k) \quad (4)$$

where T_2 = the number of observations in the forecasting period, T_1 = the number of observations in the estimation period, $k = n + 1$ (n = the number of parameters estimated), RSS = the residual sum of squares for the entire sample, and RSS_1 = the residual sum of squares for the estimation period. The null hypothesis is that the parameter estimates of the independent variables are identical both outside and within the sample period, i.e., the model is stable.

A priori, there are at least two obvious candidates for causing instability during the forecasting period: i) the monetary transition to Euro in the very beginning of the forecasting period (2002:1), and ii) the economic turbulence due to the global financial crisis, which is reflected in the Finnish economy in 2008 (c.f. Figure 1).[5] Therefore, we divided the stability tests in two parts: i) for the entire forecasting period 2002:1–2010:1, and ii) for the pre–financial crisis period (2002:1–2007:4).

[5] More specifically, Finnish industrial production growth turned negative in the second quarter, the private consumption growth in the third quarter and the GPD growth in the fourth quarter of 2008, and all of the growth rates remained negative until the third quarter of 2009. Similarly, the inflation rate turned negative in the first quarter of 2009 and remained negative until the fourth quarter of 2009.

The test results are presented in Table 3 and unambiguously demonstrate that the private consumption and the inflation models are stable, but the GDP and the industrial production models suffer from instability. The results also verify that the reason for the instability is not the monetary transition to common currency but the global financial crisis.

Table 3. Chow predictive failure test results.

MODEL SPECIFICATION	(1) TERM SPREAD MODEL		(2) STOCK MARKET MODEL		(3) MIXED MODEL	
Forecast horizon	2002:1-2008:2	2002:1-2010:1	2002:1-2008:2	2002:1-2010:1	2002:1-2008:2	2002:1-2010:1
ΔY						
t+1	0.368 (0.999)	**2.268** **(0.003)**	0.312 (0.999)	**1.717** **(0.038)**	0.418 (0.996)	**2.203** **(0.005)**
t+2	0.388 (0.998)	**2.310** **(0.003)**	0.291 (0.999)	**1.671** **(0.047)**	0.391 (0.997)	**2.137** **(0.007)**
t+4	0.350 (0.999)	**2.080** **(0.008)**	0.302 (0.999)	**1.811** **(0.028)**	0.379 (0.998)	**2.129** **(0.008)**
ΔC						
t+1	0.523 (0976)	0.847 (0.693)	0.349 (0.999)	0.584 (0.950)	0.565 (0.959)	0.851 (0.685)
t+2	0.561 (0.962)	0.854 (0.683)	0.443 (0.993)	0.698 (0.864)	0.670 (0.889)	0.963 (0.538)
t+4	0.538 (0.970)	0.843 (0.696)	0.472 (0.988)	0.781 (0.772)	0.683 (0.876)	1.030 (0.454)
ΔIP						
t+1	0.656 (0.903)	**4.338** **(0.000)**	0.649 (0.907)	**3.799** **(0.000)**	0.713 (0.849)	**3.989** **(0.000)**
t+2	0.634 (0.919)	**4.134** **(0.000)**	0.524 (0.975)	**3.664** **(0.000)**	0.598 (0.941)	**3.819** **(0.000)**
t+4	0.522 (0.976)	**3.729** **(0.000)**	0.638 (0.913)	**4.042** **(0.000)**	0.624 (0.923)	**3.894** **(0.000)**
ΔP						
t+1	0.513 (0.979)	0.941 (0.566)	0.534 (0.972)	0.795 (0.758)	0.508 (0.980)	0.822 (0.723)
t+2	0.502 (0.982)	1.034 (0.447)	0.483 (0.986)	0.755 (0.804)	0.457 (0.991)	0.865 (0.668)
t+4	0.476 (0.988)	0.971 (0.527)	0.356 (0.999)	0.624 (0.924)	0.311 (0.999)	0.705 (0.855)

Notes: *P*-values are in parentheses, and the bolded figures represent statistically significant test results.

4.4. Recursive out-of-sample forecasting results

The out-of-sample forecasting performance was evaluated by means of the root mean squared error (RMSE) of the forecasts. Outperforming the random walk can be regarded as the minimum requirement for successful forecasts. Hence, we used the random walk model as the benchmark against which the forecasting performance was compared:

$$X_{t+i} = X_t + u_{t+i}, \qquad i=1,2,4 \tag{5}$$

Pre–financial crisis forecasting period (2002:1–2008:1)

The out-of-sample forecasting results for the pre–financial crisis period are presented in Table 4. The best forecast (i.e., the lowest RMSE) of each forecast horizon can be read across the rows, and the total forecasting ability of the model is evaluated by summing the RMSEs of the different forecast horizons across the columns of the table. When evaluating the forecast performance, we denote the models as follows: (1) “the term spread model,” (2) “the stock variable model,” and (3) “the mixed model.”

Table 4. Out-of-sample recursive forecasting results. Forecast horizon: 2002:1–2008:1.

Forecast horizon	(1) TERM SPREAD MODEL	(2) STOCK MARKET MODEL	(3) MIXED MODEL	(4) RANDOM WALK
∆Y				
t+1	**2,570**	2,660	2,624	3,322
t+2	**2,507**	2,668	2,584	3,053
t+4	**2,447**	2,654	2,541	3,818
ΣRMSE	**7,524**	7,982	7,749	10,193
∆C				
t+1	2,666	**2,595**	2,698	2,882
t+2	**2,525**	2,941	2,813	2,532
t+4	**2,427**	2,770	2,554	3,818
ΣRMSE	**7,618**	8,306	8,065	9,232
∆IP				
t+1	**7,602**	7,729	7,780	9,384
t+2	7,583	**7,265**	7,447	11,548
t+4	**7,352**	7,985	7,977	11,978
ΣRMSE	**22,537**	22,979	23,204	32,91
∆P				
t+1	1,546	1,813	1,593	**1,381**
t+2	1,548	1,727	**1,497**	1,644
t+4	1,655	1,528	**1,354**	1,539
ΣRMSE	4,749	5,068	**4,348**	4,564

Notes: The bolded figures refer to the lowest RMSE of the out-of-sample forecasts of the four model specifications. The model specifications were as follows:

(1) $X_{t+k} = \alpha + \beta_1 TS_t + u_{t+k}$ ("*Term spread model*");

(2) $X_{t+k} = \alpha + \beta_2 R_t + \beta_3 VOLA_t + \beta_4 \Delta VOLA_t + u_{t+k}$ ("*Stock market model*");

(3) $X_{t+k} = \alpha + \beta_1 TS_t + \beta_2 R_t + \beta_3 VOLA_t + \beta_4 \Delta VOLA_t + u_{t+k}$ ("*Mixed model*"); and

(4) $X_{t+k} = X_t + u_{t+k}$ ("*Random walk*").

Forecast horizon: *k* = 1, 2, 4.

The results indicated that for GDP growth, the simple term spread model (1) yields the lowest RMSEs, outperforming the other models over all forecasting horizons. It is also important to note that the mixed model specification (3), with both the stock market variables and the yield curve, provides better forecasts than the pure stock market model (2). However, all three model specifications were capable of outperforming the random walk.

The strong performance of the term spread model (1) was also apparent in forecasting private consumption, yielding the lowest forecast errors on the two- and four-quarter forecast horizons, but on the one-quarter horizon, the best forecast was captured by the stock market model (2).When considering the total forecasting performance of private consumption (i.e., the sum of RMSEs over all forecast horizons), the term spread model (1) was again the best, followed by the mixed model specification (3), with the forecasting ability of the random walk model again being the worst. However, note that on the two-quarter forecast horizon, the simple random walk model was capable of yielding a better forecast than the stock market (2) and mixed (3) model specifications, which is rather surprising. Overall, the total forecasting ability of the stock market model (2) was weaker than that of the term spread (1) and the mixed (3) models, the obvious reason being the peculiarity of strong institutional ownership of stocks in Finland.

In the case of industrial production, the forecasting performance of the simple term spread model (1) was positive, again yielding the lowest RMSE over the one- and four-quarter forecast horizons. However, over the two-quarter forecast horizon, the mere stock variable model (2) performed best. It is remarkable that the RMSEs of the industrial production forecasts were much larger than is the case for the other macrovariables in this study.

While the forecasting results concerning the real activity (i.e., the GDP, private consumption and industrial production) provided rather strong support for the simple term spread model (1), this was not the case with inflation. On all forecasting horizons, the mixed model specification (3), which contains both term spread and the stock market variables, forecasted inflation better than the term spread model (1). Thus, stock market variables appear to contain additional relevant information beyond the term spread in forecasting inflation. It is noteworthy that the simple random walk outperformed all financial market models in the one-quarter forecast horizon. This suggests that the ability of financial market variables to forecast short-term inflation is rather weak.

The entire forecasting period (2002:1–2010:1)

The stability test results demonstrated that the GDP and industrial production forecasting equations were unstable due to the macroeconomic turbulence of the recent financial crisis. The consequences of instability are clearly visible in the Table 5.

Table 5. Out-of-sample recursive forecasting results. Forecast horizon: 2002:1–2010:1.

Forecast horizon	(1) TERM SPREAD MODEL	(2) STOCK MARKET MODEL	(3) MIXED MODEL	(4) RANDOM WALK
ΔY				
t+1	5.414	5.401	**5.251**	5.540
t+2	5.256	5.466	**5.167**	7.392
t+4	**5.160**	5.591	5.190	8.064
ΣRMSE	15.830	16.458	**15.608**	20.996
ΔC				
t+1	**2.864**	2.900	2.880	2.918
t+2	**2.660**	3.172	2.901	3.226
t+4	**2.623**	3.086	2.727	4.251
ΣRMSE	**8.147**	9.158	8.508	10.395
ΔIP				
t+1	17.013	16.542	**16.356**	19.102
t+2	16.898	16.784	**16.493**	24.102
t+4	**17.128**	17.258	17.133	25.381
ΣRMSE	51.039	50.584	**49.982**	68.585
ΔP				
t+1	1.837	1.933	1.770	**1.571**
t+2	1.948	1.891	**1.814**	2.061
t+4	2.062	**1.760**	1.774	2.556
ΣRMSE	5.847	5.584	**5.358**	6.188

Notes: see Table 4.

Here, the forecasting power of the GDP and industrial production equations collapsed dramatically, with the RMSEs greater than two times larger compared to the pre–financial crisis forecasting results (c.f. Table 4). Also, the RMSEs of the private consumption and inflation forecasts also slightly increased, though modestly compared to the GDP and the industrial production models.

In addition to a remarkable worsening of the forecasting ability of the GDP and industrial production equations, the emergence of the financial crisis somewhat altered the relative forecasting performance compared to that for the pre–financial crisis forecasting period. Before the financial crisis, the simple term spread model (1) was generally the best choice for forecasting macroeconomic activity, but this rule did not hold true during the financial crisis. The best forecasts for the GDP and industrial production were instead obtained using the mixed model specification (3), which combines both the term spread and the stock market information. Thus, during exceptional times, stock market information appears to become more important in forecasting the GDP and industrial production. However, when forecasting private consumption growth and inflation, the relative performance of the models largely remains the same as it was in the pre–financial crisis period. The mere term spread model (1) was the best at forecasting private consumption, while the combination of the term spread and stock market information was essential in forecasting inflation.

4.5. Analysis of the forecasting results

Our empirical evidence demonstrated that there is a wealth of wisdom in the stylized facts and rules of thumb as far as the slope of the yield curve is concerned, and a small open economy like Finland is no exception in that respect. The simple measure of the slope of the yield curve, i.e., the spread between 10-year and 3-month interest rates, proved to be a useful predictor and a leading indicator of the real economy across the range of forecasting horizons examined. Conversely, the importance of the stock market variables in predicting the real economy was much smaller. This especially held true in normal economic circumstances. However, in turbulent times (e.g., during the recent global financial crisis), both the term spread and the stock market information were necessary to predict real activity.

If recession is defined as a decline in GDP for two or more consecutive quarters, then the Finnish economy was in recession only twice during the sample period. First, there was the depression of the Finnish economy in the early 1990s, which lasted from 1990:2 to 1993:2 and was preceded by the steep inversion of the yield curve. Second, the Finnish GDP growth turned negative in 2008:4, and this continued until 2009:3 due to the global financial crisis. In this case too, the slump was preceded by the inversion of the term spread after 2007:3. This suggests that the inversion of the yield curve does anticipate recessions in small open economies.

In this study, we were able to verify many previous results from other studies. The slope of the yield curve or, more specifically, the term spread was found to be a very important tool in forecasting real activity, especially in normal times. We were able to verify that models based on the term structure tend to explain more than 30% of the in-sample variation in the real GDP growth (Estrella, 2005). We also determined that due to relatively low in-sample explanatory power, it is more difficult to model inflation than it is to model the real variables. Finally, like Henry et al. (2003), we found evidence that stock returns were more useful for predicting growth when the economy was contracting, and consistent with Kupiec (1991), we did not find any strong support that an increase in stock market volatility had serious negative effects on economic activity.

5. CONCLUSIONS

This paper deals with the usefulness of financial market variables in forecasting macroeconomic activity in a small open economy. More specifically, we compared the forecasting content of stock market variables with the term spread, which has previously been found to be a useful and robust predictor of macroeconomic activity in the United States and other leading industrial countries. As a novel feature, we explicitly addressed the role of stock market volatility (i.e., the elements related to risk) as a potential predictor for macroeconomic activity.

Our results from the Finnish economy suggest that during normal times, the forecasting content of the term spread is preferred over the stock market variables in forecasting macroeconomic activity. We also verified this stylized fact for very different economic environments and institutional circumstances than those in previous studies. As for the stock market variables, the main predictive capacity was found to be in the stock returns. However, extending the predictive variables set to include stock market volatility did not improve forecasting performance.

The results also stress the vital importance of economic circumstances for forecasting. The simple term spread was the best predictor of real activity during normal times. However, during exceptional times (e.g., the recent financial crisis), augmenting the term spread with the stock market information was advantageous. In contrast, when forecasting the inflation rate, both the term spread and the stock returns were found to be important irrespective of normal or exceptional economic conditions.

Our results also highlight the difficulties that exceptional times pose for forecasting. The results suggest that one should be extremely cautious with macroeconomic forecasts in turbulent times. Although the term spread did provide a reliable warning of coming recessions, the severe collapse of forecasting performance suggests that predicting precise point estimates is largely impossible during macroeconomic turbulence.

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Appendix. In-sample estimation results.

	ΔY(t+1)	**ΔY(t+1)**	**ΔY(t+1)**	**ΔY(t+2)**	**ΔY(t+2)**	**ΔY(t+2)**	**ΔY(t+4)**	**ΔY(t+4)**	**ΔY(t+4)**
Const.	0.816	0.84	0.139	0.627	1.271	0.30	0.615	0.503	-0.394
TS	**1.359**		**1.202**	**1.452**		**1.28**	**1.355**		**1.212**
R		**1.547**	**1.019**		**1.409**	**1.44**		**1.491**	**0.945**
Vola		0.570	0.368		0.468	0.23		0.851	0.617
ΔVola		**0.791**	**0.879**		-0.311	0.47		0.179	0.272
Adj.R^2	0.305	0.125	0.360	0.358	0.088	0.45	0.318	0.109	0.352
	ΔC(t+1)	**ΔC(t+1)**	**ΔC(t+1)**	**ΔC(t+2)**	**ΔC(t+2)**	**ΔC(t+2)**	**ΔC(t+4)**	**ΔC(t+4)**	**ΔC(t+4)**
Const.	0.486	0.871	-0.088	0.268	0.569	-0.55	0.147	-0.241	-1.153
TS	**1.430**		**1.228**	**1.386**		**1.25**	**1.357**		**1.221**
R		**0.809**	0.269		0.889	0.35		**1.346**	0.792
Vola		0.523	0.316		0.747	0.62		**1.073**	**0.835**
ΔVola		0.300	0.390		-1.274	-0.95		0.074	0.169
Adj.R^2	0.197	0.017	0.342	0.432	0.070	0.43	0.430	0.156	0.502
	ΔIP(t+1)	**ΔIP(t+1)**	**ΔIP(t+1)**	**ΔIP(t+2)**	**ΔIP(t+2)**	**ΔIP(t+2)**	**ΔIP(t+4)**	**ΔIP(t+4)**	**ΔIP(t+4)**
Const.	1.725	0.977	-0.112	1.758	2.069	1.84	2.837	1.901	1.685
TS	**1.807**		**1.393**	**1.709**		**1.55**	1.785		0.290
R		**3.045**	**2.433**		**2.76**	**1.92**		**3.135**	**3.004**
Vola		1.424	1.190		0.618	-0.10		0.717	0.661
ΔVola		0.495	0.598		2.662	**3.08**		-1.628	-1.605
Adj.R^2	0.122	0.113	0.178	0.108	0.046	0.14	0.008	0.115	0.101
	ΔP(t+1)	**ΔP(t+1)**	**ΔP(t+1)**	**ΔP(t+2)**	**ΔP(t+2)**	**ΔP(t+2)**	**ΔP(t+4)**	**ΔP(t+4)**	**ΔP(t+4)**
Const.	**3.356**	**3.894**	**4.309**	**3.355**	**3.874**	**4.39**	**3.146**	**3.787**	**4.099**
TS	**-0.629**		**-0.531**	**-0.578**		**-0.51**	**-0.421**		**-0.418**
R		-0.390	-0.157		-0.280	-0.09		0.075	0.266
Vola		-0.761	-0.672		**-0.796**	**-0.82**		-0.890	-0.809
ΔVola		0.252	0.213		0.582	**1.29**		0.763	**0.731**
Adj.R^2	0.196	0.069	0.239	0.211	0.063	0.20	0.104	0.038	0.139

Notes: Estimation period 1987:1–2001:4. ΔY = GDP growth, ΔC = private consumption growth, ΔIP = industrial production growth, TS = term spread (interest rate spread), R = Stock returns, Vola = volatility of the stock returns, and ΔVola = change in volatility of the stock returns. Bolded figures are significant at the 0.10 level or better (Newey–West corrected standard errors). ΔY, ΔC, ΔIP, and ΔP are given as annualized percentage values.

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