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Forecasting the Economic State with Financial Market Information and Term Structure of Interest Rates

ABSTRACT

This study examines whether financial markets, especially excess stock returns, contain information about changes in future values of certain macroeconomic variables. Earlier literature documents that term spreads of interest rates can predict both nominal activity, i.e. inflation, and real activity, i.e. output, consumption and industrial production, in economy. We combine stock returns and term spreads in an economic tracking portfolio framework and show that economic tracking portfolios can forecast changes in future macroeconomic variables, most accurately with 12 month forecasting horizon. The information content of industry stock portfolios depends on the target macroeconomic variable. The importance of term spreads is supported in two ways: first, they improve the performance of the ETP model even though the omission of them from the analysis seems to have only marginal effect; second, the only benchmark model that outperforms the ETP model in some cases uses solely term spreads as explanatory variables.

Key words: *economic tracking portfolios, forecasting, term structure of interest rates*
JEL Codes: C53, E44

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1. INTRODUCTION

Modern financial and economic research, both theoretical and empirical, faces a continuous battle in finding a forecasting tool that is able to predict future economic state with considerable accuracy. A useful forecasting model would imply opportunities to governments, politicians and practitioners to obtain information about future in order to make right decisions about current actions. There is little doubt about the growing importance of the stock market from the point of view of the aggregate economy, and since especially the stock market data are among the most sensitive in securities markets, it provides an attractive ground for models of aggregate economy.

Traditionally, the direction of the influence in relationship between stock market and economic activity has been from the economy to the stock market. Among the theoretical foundations for the analysis have been the Arbitrage Pricing Theory (see originally Chen, Roll and Ross, 1986) and the consumption Capital Asset Prising Model (e.g. Breeden, 1979; and Breeden, Gibbons and Litzenberger, 1989). Recently the interest in this area has shifted towards the information content of asset returns concerning the future values of macroeconomic variables. For example, Schwert (1989) has noted that there is weak evidence that macroeconomic volatility can help predict stock and bond return volatility, but somewhat stronger evidence that financial asset volatility helps to predict future macroeconomic volatility. Cochrane (1991) documents that a simple implementation of a production-based asset prising model gives an explanation to the fact that stock returns forecast real variables like investment and output. Lee (1992) finds that stock returns appear Granger-causally prior and help explain a substantial fraction of the variance in real activity. Vassalou (2002) and Liew and Vassalou (2000) use size and book-to-market portfolios and conclude that their returns contain information about the future state of macroeconomy. Lamont (2001), Hayes (2001), Junttila (2003) and Junttila and Kinnunen (2002) use economic tracking portfolio (ETP) approach in order to establish the forecasting ability of the stock market with respect to macroeconomy.

This study continues the work of Junttila and Kinnunen (2002) in searching for a forecasting framework by combining financial markets and macro economy, and examining whether financial markets contain information useful for predicting future macroeconomic variables like changes in inflation or output growth. We use the empirical methodology of economic tracking portfolios, a simple forecasting framework which states that it is possible to construct portfolios of assets whose unexpected returns track innovations in a particular macroeconomic variables. In this study we concentrate on stock prices, especially industry portfolios, as base assets in order to find out if they contain useful information about future.

Financial theory says that the current stock price reflects the sum of future expected dividends. One can show through Campbell's (1991) variance decomposition that investors will enjoy a positive unexpected excess return if expected dividend growth is revised upwards, or if expected risk-free real interest rate and/or expected future excess equity returns are revised downwards. Since revisions to these components of equity valuation are likely to be related to changes in expectations of macroeconomic variables of interest, current stock returns should reflect future, not current, economic variables.

In order to be able to statistically test the relationship between unexpected stock returns and innovations in future macroeconomic variables, we follow Lamont's (2001) research and add the control variables to the tracking portfolio framework. By choosing variables that explain both expected stock returns and changes in target macroeconomic variables, the chosen control variables are likely to improve the accuracy of the parameter estimates of ETP weights. Previous research has considered control variables based on earlier empirical work and these variables have mainly been presented in levels and sometimes in differences. Our contribution is to extent the set of possible control variables to be based on fundamental long-run relationships.

Historically, one of the most interesting areas of macroeconomic theory is the connection between prices and interest rates, in other words the long-term fundamental Fisher (1930) hypothesis. A standard Fisher hypothesis states that movements in short-term nominal interest rates primarily reflect fluctuations in expected inflation, so that a forecasting equation can tell whether the short-term interest rates help to predict future path of inflation. Mishkin (1990a and b) modifies the basic starting point in his inflation-change equation that uses term spreads between different interest rates instead of interest rates themselves. Furthermore, economic theory in several more or less formal ways states that term structure of interest rates can be related to real activity in economy: if future output is expected to be high, individuals wish to smooth consumption by attempting to borrow against the expected future production, thereby raising interest rates. Based on these relationships this study utilises the term spreads of interest rates from different maturities as the control variables.

Our results support the ETP framework in forecasting future economic state and it seems that the term spreads as control variables add to the accuracy of out-of-sample forecasts. The ETP model outperforms the benchmark models when measured with forecast errors. The information in stock portfolio returns is dependent on the industry classification of stock portfolios and on the target macroeconomic variables. There seems to be a positive relationship between the real macroeconomic variables and term spreads and a negative connection between future values of inflation and term spread variables. The term spreads are important in forecasting future values of macroeconomic variables and this is apparent in two ways. First, the ETP models seem to work slightly better when the control variables are included in the analysis, thus they add to the parameter accuracy. Second, the only benchmark model that can outperform the ETP models in few cases is a term spread model for macroeconomic variables.

Section 2 describes the methodology of economic tracking portfolios both from theoretical and empirical grounds. The choice of control variables from the basis of Mishkin's (1989, 1990a and b, 1991) inflation-change equation, and from the basis of several theoretical reasons linking term spreads to real economic activity is discussed in section 3. Section 4 contains description of the data, section 5 reports in-sample and out-of-sample results from the ETP regressions and section 6 concludes.

2. THEORETICAL BACKGROUND OF ECONOMIC TRACKING PORTFOLIOS

2.1. Rational valuation formula and variance decomposition in ETP analysis

The theoretical background of economic tracking portfolios goes back to the rational valuation formula of stock prices, which simply states that the current stock price reflects the sum of future expected dividends. To be more precise, consider the famous static Gordon's (1962) growth model that gives the fundamental price of an equity, p_t^f, as

$$p_t^f = \sum_{i=1}^{\infty}[1/(1 + r)]^i \, E_t\,(d_{t+1}), \tag{1}$$

where the key elements are expectations on future dividends, $E_t\, d_{t+1}$, and the discount factor r which may be time varying and as such dependent on macroeconomic conditions. One can show the connection between future values of macroeconomic variables and current stock returns through the growth model that is restated in dynamic form using the Campbell's (1991) variance decomposition. According to Campbell (1991), the unexpected excess return on equity is

$$e_{t+1} - E_t\, e_{t+1} = (E_{t+1} - E_t)\,(\sum_{j=0}^{\infty}\rho^j\, \Delta d_{t+1+j} - \sum_{j=1}^{\infty}\rho^j r^f_{t+1+j} - \sum_{i=0}^{\infty}\rho^j e_{t+1+j}) \tag{2}$$

where e_t is the log excess return on equity, Δd_t is the change in log real dividends, r_t^f is the log real risk-free interest rate and ρ is a linearisation parameter, which is a little less than unity. Investors will enjoy a positive unexpected excess return if expected dividend growth is revised upwards, or if expected risk-free real interest rate and/or expected future excess equity returns are revised downwards. Revisions to these components of equity valuation are likely to be related to changes in expectations of macroeconomic variables of interest. Hence, the innovations of future values of macroeconomic factors are reflected in unexpected changes in equity returns.

When we decompose the target variable into expectations and expectation errors, we will see the above implications more clearly (see also Lamont, 2001; Hayes, 2001; and Junttila, 2003). For any target variable y_t, its realised value at time $t + k$ can be expressed as a sum of the previous period's conditional expectation plus a one-period forecast error, ε_{t+k}, hence

$$y_{t+k} = E_{t+k-1}\, y_{t+k} + \varepsilon_{t+k}. \tag{3}$$

Correspondingly, the conditional expectation at $t + k - 1$ can be rewritten as a sum of the conditional expectation at $t + k - 2$ plus the change in the expectation between the two periods, yielding

$$y_{t+k} = E_{t+k-2}\, y_{t+k} + (E_{t+k-1} - E_{t+k-2})\, y_{t+k} + \varepsilon_{t+k}. \tag{4}$$

Backward reduction to time $t - 1$ results in an expression

$$y_{t+k} = E_{t-1}\, y_{t+k} + \sum_{j=0}^{k}(E_{t+k-j} - E_{t+k-j-1})\, y_{t+k}, \tag{5}$$

where $E_{t+k}\, y_{t+k} = y_{t+k}$. The second term on the right hand side of (5) is the sum of $k + 1$ one-period expectations revisions, and since expectations are revised only when news appear in the market, we assume that these are (iid) shocks. A tracking portfolio observes the first of these expectations revisions, $(E_t - E_{t-1})\, y_{t+k}$, which is distinct when we rewrite equation (5) as

$$y_{t+k} = E_{t-1}\, y_{t+k} + (E_t - E_{t-1})\, y_{t+k} + \xi_{t,\, t+k} \tag{6}$$

where $\xi_{t,\, t+k} \equiv \sum_{j=0}^{k} \varepsilon_{t+j}$ and $\varepsilon_{t+j} \equiv (E_{t+j} - E_{t+j-1})\, y_{t+k}$. Thus, the target variable is now the sum of the conditional expectation at time $t - 1$, the revision to this expectation between $t - 1$ and t, and the sum of k one-period future expectations revisions.

An economic tracking portfolio connects the change in expectations of y_{t+k} between time $t - 1$ and t to the unexpected returns on a portfolio of assets, that is

$$(E_t - E_{t-1})\, y_{t+k} = a\tilde{R}_t + \eta_t \tag{7}$$

where $\tilde{R}_t$ is a vector of unexpected (log) returns on N base assets, a is a $N \times 1$ vector of portfolio weights and η_t is a tracking error. As can be seen, the left-hand side of (7) is in general unobservable but as we next demonstrate in the spirit of Lamont (2001), the estimation and testing of the ETP weights can be conducted in terms of the observable actual future value y_{t+k}.

2.2. Estimation of the portfolio weights

Empirically, an economic tracking portfolio for any variable y can be obtained as the fitted value of a regression of y on a set of base asset returns. The portfolio weights for the economic tracking portfolio for y are the normalised coefficients of an OLS regression. According to Breeden (1979) and Breeden, Gibbons and Litzenberger (1989), the following statements that come directly from the definition of OLS regression are also an equivalent description of a maximum correlation portfolio (MCP). Out of all possible linear combinations of the base asset returns, the estimated OLS coefficient, and hence, the MCP

(1) has the minimum variance out of all portfolios with a given beta (univariate regression coefficient) on y;
(2) has returns with the maximum possible correlation with the target variable;
(3) has the highest R-squared in a regression of the target variable on returns.

Since an ETP can be obtained through OLS regression these three descriptions are also descriptions of an ETP (see also Lamont, 2001).

In the spirit of Lamont (2001) the ETP analysis starts with the construction of tracking portfolios so that the unexpected portfolio returns have the maximum correlation with revisions to expectations of the target macroeconomic variable. Thus, ETPs are designed to track a shock. Specifically, the target variable is "news" about y_{t+k}, where y_{t+k} is a macroeconomic variable such as the inflation rate in period $t+k$, and k denotes the forecast horizon. News is defined as innovations in expectations about y_{t+k} with notation $\Delta E_t\,(y_{t+k}) \equiv E_t\,(y_{t+k}) - E_{t-1}\,(y_{t+k})$, where ΔE describes changes in expectations. The tracking portfolio returns are obtained from equation $r_t = bR_t$, where R_t is a column vector of chosen asset returns from the end of period t–1 to the end of period t and b is a row vector of portfolio weights. Unexpected returns are actual returns minus expected returns, ie. $\tilde{R}_t \equiv R_t - E_{t-1}(R_t)$. The portfolio weights are chosen so that $\tilde{R}_t$ is maximally correlated with $\Delta E_t\,(y_{t+k})$. As is stated in equation (7), an economic tracking portfolio for news in macroeconomic variables can be expressed in terms of an equation that relates the change in expectations of y_{t+k} between time t–1 and t to the unexpected returns on a portfolio of assets.

In order to perform an OLS regression to equation (7) it seems that one needs to obtain $(E_t - E_{t-1})\;y_{t+k} = \Delta E_t\,(y_{t+k})$, i.e., the unobservable left hand side of equation (7). Lamont (2001) derives an alternative regression that can be used to estimate the ETP weights. The realisation of y_{t+k} can be written as the sum of the expectation in period t–1, the innovation in expectations occurring in period t, and the innovation in expectations from period t to period $t+k$, i.e.,

$$y_{t+k} = E_t\,(y_{t+k}) + e_{t+k} = E_{t-1}(y_{t+k}) + \Delta E_t\,(y_{t+k}) + e_{t+k}\,. \tag{8}$$

Assuming that the expected returns on the base assets in period t are linear functions of Z_{t-1}, a vector of control variables known at period t–1[1], we obtain

$$E_{t-1}(R_t) = dZ_{t-1}. \tag{9}$$

Finally, we define the projection equation of lagged expectations of y on the lagged control variables as

$$E_{t-1}(y_{t+k}) = fZ_{t-1} + \mu_{t-1}. \tag{10}$$

Combining equations (7)–(10) results in the representation

$$y_{t+k} = bR_t + cZ_{t-1} + \varepsilon_{t+k}, \tag{12}$$

where $\varepsilon_{t+k} \equiv \eta_t + \mu_{t-1} + e_{t+k}$, $b = a$ and $c = f–ad$. This is a consistent regression equation because all the components of ε_{t+k} are by definition orthogonal to both R_t and Z_{t-1}. OLS applied to equation (11) produces the tracking portfolio returns having unexpected components maximally correlated with $\Delta E_t\,(y_{t+k})$. The necessary assumptions are that

(1) innovations in returns reflect innovations in expectations about future variables (so that the vector a has non-zero elements in equation (7)); and

(2) expected asset returns and expected target macroeconomic variables are a linear function of the lagged control variables.

It might not be immediately clear that in estimating the parameter vector a only the correlation (i.e. the linear relationship) between $\tilde{R}_t$ and $(E_t - E_{t-1})\, y_{t+k}$ is being picked up as equation (7) requires, even though the regression equation (11) is equivalent to regressing y_{t+k} on $\tilde{R}_t$. However, if investors' expectations are efficient so that the expectation formed at time $t–1$ uses all the known relevant information, $\tilde{R}_t$ must be independent of all other components of y_{t+k}. Hence, since the unexpected return between $t–1$ and t cannot be correlated with $E_{t-1}\, y_{t+k}$ nor with shocks to investors' expectations from $t + 1$ onward, any correlation between y_{t+k} and $\tilde{R}_t$ can only arise because $\tilde{R}_t$ is tracking $(E_t - E_{t-1})\, y_{t+k}$.

1 The control variables are added to the regression equation because they are likely to affect the parameters, making them more precise and accurate. However, adding the possibly insignificant variables to the model may cause some deterioration in the out-of-sample performance. It is important to consider carefully the choice of control variables since according to e.g. Hayes (2001) they may be the key factors in improving the performance of the model, especially the out-of-sample performance, when the control variables have significant explanatory power for the state variables, too.

3. TERM STRUCTURE OF INTEREST RATES AND ETP

3.1. Term structure of interest rates as the background for control variables

Previous studies have pointed out the importance of control variables in ETP analysis. Lamont (2001) uses the standard variables known to forecast returns on stock and bonds[2] as control variables. He finds that when excluding the lagged control variables the tracking ability of the asset portfolios dramatically declines. Hayes (2001) concludes using only four prespecified variables that the control variables potentially have significant effects on the estimated portfolios and the intensity of the effects is dependent on the target variable. In his study using an international data set, Junttila (2003) utilises only two control variables, namely the dividend yield and term spread, which are more clearly connected only to the financial market than the control variables in the previous studies. His results indicate that the role of controls is highly relevant to the ETP analysis, although the choice of controls should be considered depending on the target variable and the country. Contrary to the other studies, using dividend yield and term spread as control variables Junttila and Kinnunen (2002) find that the role of controls is not so relevant when using industry level stock return data. The variables used as controls in all the previously mentioned studies are chosen on the basis of empirical evidence, not on profound and precise theory.

This paper aims to use a more theoretical approach when choosing the control variables. We extent the analysis by considering possible control variables based on the fundamental long-run relationships in macroeconomic theory. One of the most analysed areas of macroeconomic theory is the connection between prices and interest rates which is mainly based on the famous Fisher hypothesis that originates in the work of Irving Fisher (1930). He postulated that nominal interest rates should explain changes in expected inflation. Fama's (1976) classic study also confirms that movements in nominal interest rates for most part reflect fluctuations in expected inflation rather than changes in real interest rates. Mishkin (1989, 1990a and b, 1991) has extensively tested the Fisher hypothesis using the so-called inflation-change model and finds that the yield curve can predict inflation.

Under rather general assumptions, the term structure of interest rates can be related to economic growth, measured by variables like the growth rate of output and consumption. The intuition is straightforward: if future output (and hence income) is expected to be high, indi-

2 More precisely, the lagged control variables in Lamont (2001) are the Treasury bill return, a term premium for one-year government bonds, a term premium for one-year government notes, a default premium for corporate bonds, a default premium for commercial paper, the dividend yield on the value weighted aggregate portfolio and 12-month production growth, CPI inflation and excess stock returns. Thus, his variables are numerous and include factors from both real economy and financial markets.

viduals tend to smooth consumption by attempting to borrow against the expected future production growth, thereby bidding up interest rates. There are several theoretical points that can help explain what seems to cause a positive relationship between the term structure and future real activity. Empirically, the usefulness of the yield spread between long- and short-term interest rates for forecasting future macroeconomic variables has been well established (see for example Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1997; Davis and Fagan, 1997; Hamilton and Kim, 2000; and Estrella, Rodrigues and Schich, 2000). Thus, the choice of term structure of interest rates as the control variable in ETP analysis is a rather natural step.

One of the main assumptions in ETP analysis is that the control variables, i.e. the term spreads of interest rates in this case, form a linear combination with excess stock returns. Theoretically, this structure can be based on the assumption that stock markets do not permit the presence of arbitrage opportunities[3]. In the absence of this possibility, there exists a ″stochastic discount factor″ that relates payoffs to market prices for all assets in the economy. The expected stochastic discount factor is just the real price of the short-term riskless real asset, or equivalently, the reciprocal of its gross yield. One can also define a ″nominal stochastic discount factor″ and the expectation of that is simply the price of a short-term riskfree nominal asset[4]. Thus, the interest rates at least at the shorter end of the yield curve should be able to predict stock returns. The relationship between the stock market and term structure of interest rates is also widely documented in empirical literature. For example, Chen (1991) concludes that the term spread can explain stock returns.

3.2. Term spread and inflation

The standard Fisher hypothesis states that movements in short-term nominal interest rates primarily reflect fluctuations in expected inflation, so that a forecasting equation can tell whether the short-term interest rates help to predict future path of inflation. More specifically, the hypothesis can be expressed as

$$E_t \pi_t^m = i_t^m - rr_t^m, \tag{12}$$

where $E_t \pi_t^m$ is expected inflation over m periods, i_t^m is m-period nominal interest rate at time t and rr_t^m is m-period (ex ante) real interest rate at time t, ie. the ex ante real return on an m-period bond from t to $t+m$. The realised inflation rate over the next m periods can be written as the expected inflation rate plus the forecast error of inflation

3 The principle of no arbitrage simply states that all the alternative ways of constructing the same payoff must have the same cost or price. Thus, the opportunities to make riskless profits on an arbitrarily large scale do not exist.
4 See a more detailed discussion in Cochrane and Hansen (1992) and Campbell (2000).

$$\pi_t^m = E_t \pi_t^m + v_t^m. \tag{13}$$

In order to examine the information in the term structure about future changes in the inflation rate (see Mishkin, 1989) we subtract the *n*-period inflation rate from *m*-period inflation rate using equation (14), that is

$$\pi_t^m - \pi_t^n = i_t^m - i_t^n - rr_t^m + rr_t^n + v_t^m - v_t^n. \tag{14}$$

This equation can be rewritten in the form of Mishkin's (1989, 1990a and b, 1991) so called inflation-change equation. This equation is a regression of the change in the future *m*-period inflation rate from the *n*-period inflation rate ($\pi_t^m - \pi_t^n$) on the slope of the term structure, ($i_t^m - i_t^n$), that is

$$\pi_t^m - \pi_t^n = \alpha_{m,n} + \beta_{m,n} (i_t^m - i_t^n) + \eta_t^{m,n}, \tag{15}$$

where $\alpha_{m,n} = \bar{r}\bar{r}^m - \bar{r}\bar{r}^n$, $\eta_t^{m,n} = v_t^m - v_t^n - [(rr_t^m - \bar{r}\bar{r}^m) - (rr_t^n - \bar{r}\bar{r}^n)]$

and $\bar{r}\bar{r}^m - \bar{r}\bar{r}^n$ is the consistent estimate of the slope of the real term structure. If we assume that expectations are rational and the slope of the real term structure, $rr_t^m - rr_t^n$, remains constant over time, OLS estimates of the forecasting equation (15) produce a consistent estimator of $\beta_{m,n}$[5].

Tests of the statistical significance of the $\beta_{m,n}$ coefficient and whether it differs from one reveal how much information there is in the slope of the term structure about future changes in inflation. More specifically, as described in Mishkin (1990a), a statistical rejection of $\beta_{m,n} = 0$ provides evidence that (i) the term structure contains significant information about future path of inflation, and (ii) the slopes of the term structure of real and nominal interest rates do not move one-to-one with each other. On the other hand, a statistical rejection of provides evidence that (i) the slope of the term structure is not constant over time, and (ii) the term structure of nominal interest rates provides information about the term structure of real interest rates.

Previous research results (e.g. Mishkin, 1989, 1990a and b, 1991; Estrella and Hardouvelis, 1991; Valkanov, 1999) seem to indicate that the short-term nominal interest rates contain information about the real interest rates as opposite to long-term nominal interest rates which

5 This can be seen by recognising that rational expectations implies that the forecast errors of inflation, v_t^m and v_t^n, are orthogonal to the right-hand regressors because under rational expectations $E_t v_t^m = E_t v_t^n = 0$, i.e. the forecast errors of inflation must be unforecastable conditional on all available information at time t. Constancy of the slope of the real term structure then makes OLS estimates consistent because the real interest rate part in error term $\eta_t^{m,n}$ disappears, leaving only $v_t^m - v_t^n$ in the error term of the forecasting equation which is orthogonal to the right-hand-side regressors under rational expectations (see also Mishkin, 1989).

clearly explain changes in expected inflation[6]. These empirical findings support the use of the entire yield curve in analysing the information content of the term structure of interest rates. Moreover, one can draw implications from the theoretical expectation hypothesis (EH) of interest rates in favour of the use of the longer end of yield curve. The EH states that long-term interest rates reflect current and future changes in short-term interest rates. If the changes in short-term interest rates can be used to explain and forecast future economic variables, the same should apply for the longer end of the yield curve. In addition, if longer-term interest rates contain information about future short-term interest rates, they may also reflect the future economic conditions and this can be captured in the ETP analysis. The Finnish data used in this study slightly restricts the use of interest rate data. Because trading at the longer end of the yield curve in Finnish financial markets is rather thin we end up using only interest rates with maturities under 12 months.

Following the original Mishkin's inflation-change equation, we match up the maturities of the two interest rates in the term spread variable with the corresponding ex post inflation rates. More specifically, using forecasting horizons of 3, 6 and 12 months, we consider term spreads between 3-month and 1-month interest rates, between 6-month and 1-month interest rates and between 12-month and 1-month interest rates. In order to find out the information content of the term structure of interest rates, we combine the ETP analysis and Mishkin's (1989, 1990a and b, 1991) inflation-change model resulting in an empirical forecasting regression equation

$$y_{t+k} = bR_t + c\,(i_{t-1}^{m} - i_{t-1}^{n}) + \varepsilon_{t+k}, \tag{16}$$

which will be tested in this paper. The left hand side of the equation (16) represents the inflation rate from different forecasting periods.

3.3. Term spread and real macroeconomic variables

Why might the term spread of interest rates by itself be useful in predicting future macroeconomic variables like changes in output or consumption? There are several possible explanations for the relationship (for a recent review, see Estrella, Rodrigues and Schich, 2000). Contrary to the case of inflation, where only two simple relationships is needed to establish a connection between term spreads and future changes in inflation, the prediction of real activity usually involves relationships between interest rates, and macroeconomic variables like out-

6 Frankel and Lown (1994) show that the spread between a five-year and short-term interest rates provides a better measure of the overall steepness of the yield curve, and so does better job of predicting the path of inflation.

put and inflation. Moreover, some of the explanations are less formal than the ones provided in the case of inflation.

Probably one of the most used and familiar explanations for the connection between term spread of interest rates and future values of real macroeconomic variables is the view based on countercyclical monetary policy. Suppose that government reacts to weak economic activity. First, the central bank increases the money supply and this results in a decline in short-term interest rates (both nominal and real interest rates). Long-term interest rates, however, tend to move less than the short-term interest rates for two reasons: (1) the monetary easing will raise long-term inflation expectations and (2) the central bank may be expected to move to contractionary policy in the future to gain a more neutral stance and to respond to future increases in inflation. Thus, the result is a steepening of the yield curve and, since real interest rates will remain low for a while, an increase in economic activity. The adoption of contractionary monetary policy has symmetrical effects. Market participants expect that tight monetary policy will temporarily raise short-term interest rates. If the current short-term interest rate is higher than the expected future short-term rate, according to the expectations hypothesis the long-term interest rate should rise less than the short-term rate. As a result, the yield curve is flattened and eventually the spending in economy reduces causing the economy to slow down. Thus, the positive relationship between interest rate spreads and future economic growth results from the expectations hypothesis and the temporary influence of monetary policy.

Another example of a theoretical reasoning for the relationship comes from financial theory. A consumption CAPM (capital asset prising model) implies that there is a positive functional relationship between the slope of the real yield curve and future real consumption growth. The relationship follows directly from the consumer's willingness to smooth consumption through time in order to obtain more utility, with a standard first-order condition of the form

$$u'(C_t) = \beta E_t \{u'(C_{t-1})(1 + \rho_{t+1})\},$$

where C is the level of consumption, u is the utility function, β is a subjective time-discount factor, ρ is the real one-period interest rate and E is the expectations operator.

Almost all the reasons have one similarity and that is the expectation of a positive relationship between the term structure of interest rates and real activity. This positive connection has been empirically verified in many studies. For example, Estrella and Hardouvelis (1991) document that the term spread between the 10-year Treasury bond rate and the 3-month Treasury bill rate is a useful predictor of future growth in output, consumption and investment, and the probability of a recession. Estrella and Mishkin (1997) confirm that these basic results continue to hold in a number of European countries as well as the United States. Davis and Fagan (1997) study the usefulness of several financial spreads as indicators of future output (and inflation) in EU countries and find that the yield spread performs best. However, they find relatively poor out-of-sample performance suggesting caution when using financial spreads for forecasting. On the contrary, Berardi (2001) shows that the yield curve forecasts future inflation and output growth relatively accurately. Hamilton and Kim (2000) and Estrella, Rodrigues and Schich (2000) also confirm that the term structure can explain and predict future values of macroeconomic variables.

The empirical ETP regression tested in this paper that connects the term structure of interest rates to stock market returns and to changes in future values of real macroeconomic variables, is of the form of equation (16), where y_{t+k} can be interpreted as the growth rate of a real economic variable like output, private consumption and industrial production.

4. DATA AND RESULTS FROM THE PRELIMINARY ANALYSIS

4.1. Data

The economic tracking portfolios analysis of this study is conducted on Finnish data. The data set consists of monthly observations and the largest sample period after data transformations runs from February 1991 to June 1999 (total of 101 observations)[7]. Notice that while this time period is interesting, it is also exceptional in the Finnish economy. During this period, there have been several major changes in economic and financial environment. For example, the foreign exchange regulations were gradually abolished by June 1991 and the Bank of Finland introduced new monetary policy guidelines in the form of inflation targeting in February 1993. These structural changes and also the decision to float Finnish markka in September 1992 may affect the analysis.

The set of target variables includes four macroeconomic variables suggested by financial theory and previous empirical work[8]. The variables are: industrial production growth (annualised k-month log changes in the industrial production index, IP), private consumption growth (annualised k-month log changes in private consumption expenditures, PCE), inflation (annualised k-month log changes in consumer price index, CPI) and output growth (annualised k-month log changes in gross domestic product, GDP[9]). Inflation and GDP are probably the most

7 Due to the small sample size we use the Newey-West (1987) procedure that takes into account the possibility that the covariance matrix calculated is not positive definite in all the ETP regressions. Furthermore, Lamont (2001) and Junttila (2003) note that the qualitative findings are not affected by the variation of the truncation lag between 12 and 24, so we choose the lag length of 12 in this study.

8 See e.g. Chen, Roll and Ross (1986), Campbell and Ammer (1993), Pesaran and Timmermann (1995), Ferson and Korajczyk (1995), Campbell (1996), Jagannathan and Wang (1996), Campbell and Cochrane (1999), Ferson and Harvey (1999) and Stock and Watson (2001).

9 Time series of private consumption and gross domestic product were originally quarterly data and they were re-scaled to monthly observations. We used a distribution procedure to expand the quarterly data to monthly frequently analysed variables while IP and PCE are slightly less considered previously. Especially the role of asset markets having effects on private consumption has been a hot topic in recent research, and practitioners and politicians have great interests towards the connection between PCE and stock market. This study is conducted on three different forecasting horizons, namely $k = 3$, 6 and 12 months.

Boudoukh, Richardson and Whitelaw (1994) point out that to the extent that expected inflation is correlated with aggregate economy, the correlation between inflation and expectations of dividend growth should vary across cyclical and noncyclical industries. Furthermore, the magnitude of this effect should depend upon the variability of expected growth rates of future cash flows, which will also depend on the characteristics of the industry. This gives enough reason to use industry stock portfolios as base assets. The starting industry portfolios consist of 16 stock portfolios sorted by industry. The market portfolio is also included in the analysis as an aggregate benchmark portfolio. All the stock returns are from Helsinki Stock Exchange (HEX). The starting industry portfolios are formed on the basis of their industry classification given by the HEX and are as follows: (1) banking and finance BAF, (2) insurance IAI, (3) investment INO, (4) transport TRA, (5) trade MER, (6) other services OTS, (7) metal and engineering MET, (8) forest industry WOO, (9) multi-business MUL, (10) energy ENE, (11) food industry DAI, (12) construction BUI, (13) telecommunications and electronics ITE, (14) chemicals CHE, (15) media and publishing MED and (16) other industries OTI. Stock returns[10] are measured as annualised changes in the log of the portfolio return index and they are zero-cost portfolios with returns calculated in excess of the risk-free interest rate, which is in this study the one-month Helibor-rate. Thus, the portfolio weights need not be restricted.

In line with the three forecasting horizons of the ETP model (three, six and 12 months), we choose three term spreads of interest rates as control variables. Spread3 is the term spread between 3-month interest rate and 1-month interest rate. Respectively, spread6 is the spread between 6-month interest rate and 1-month interest rate, and finally spread12 is the spread

data. In order to do this, we needed to specify the distribution procedure according to the unit root properties of the two time series. Using the tests developed by Dickey and Fuller (1979), Kwiatkowski, Phillips, Schmidt and Shin (1992) and Perron (1997), we defined the stationary properties of the time series and based on these results chose the distribution procedure.

10 In many previous studies (see e.g. a recent paper by Christoffersen, Ghysels and Swanson, 2000) researchers have used real asset returns and basically this is what Campbell's (1991) framework also indicates. Junttila (2003) has noted that because of the explicit interest for information about future inflation it is not beneficial to deflate the nominal returns. Even if one uses one price index for deflating procedure and another for calculating inflation, due to their strong correlation some spurious relationships may be introduced to the ETP analysis. In addition, Valckx (2001) and Cuthbertson, Hayes and Nitzsche (1999a and b) have shown that when examining excess asset returns it might be advantageous to presume that already from the beginning the decomposition of excess asset returns involves the inflation and nominal (excess) return innovation components separately.

between 12-month and 1-month interest rate. The interest rates in question are 1-month, 3-month, 6-month and 12-month Helibor rates[11].

4.2. Results from the preliminary analysis

Originally, Fisher (1930) meant the relationship between interest rates and expected inflation to be a long-run fundamental relation. Johansen (1988, 1991, 1995) has recently developed a cointegration methodology that is based on maximum likelihood estimation and this can be used to examine the existence of this long-run hypothesis. In this multivariate regression framework we can test the Fisher hypothesis in Mishkin's (1989, 1990a and b, 1991) inflation-change equation form and perhaps obtain preliminary indication of the power of yield curve as the basis for control variables in the ETP analysis.

Johansen's (1988, 1991, 1995) cointegration methodology[12] starts by considering a vector auto regressive VAR model, expressing the data generating process of a vector of N variables, X, as an unrestricted vector auto regression in the levels of the variables, i.e.

$$X_t = A_1 X_{t-1} + \dots + A_p X_{t-p} + \mu + \Phi D_t + \varepsilon_t, \quad t = 1, \dots, \mathrm{T}, \tag{17}$$

where each A_i represents an $(N \times N)$ parameter matrix. In the case of the Fisher hypothesis this parameter matrix reduces to (2×2) matrix, since X_t includes two variables, expected inflation and interest rate. Further, ε_t are independent p-dimensional Gaussian variables with mean zero and variance matrix Λ, μ describes a vector of constants and D_t is a vector of non-stochastic variables, such as seasonal or intervention dummies or variables that are weakly exogenous which can be excluded from the long-run relations in the cointegration space.

Equation (17) is expressed in first differenced form. Unless the difference operator is also applied to the error process and explicitly taken account of, differencing implies loss of information in the data. We can rewrite the model (17), and at the same time separate the short- and log-run effects in this system of equations, in an error correction form as

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \dots + \Gamma_{p-1} \Delta X_{t-p+1} + \Pi X_{t-1} + \mu + \Phi D_t + \varepsilon_t, \tag{18}$$

where $\Gamma_i = -(I - A_1 - \dots - A_i)$, $i = 1, \dots, p$. Π defines the long-run levels solution to (17) and the long-run adjustment matrix in (18). More specifically, if the rank of the matrix Π, r, is $0 < r < p$ it implies that there are $p \times r$ matrices α and β such that $\Pi = \alpha\beta'$. The columns of β

11 Naturally, the Helibor-rates do not exist after the end of 1998, because from the beginning of 1999 the Euribor-rates replaced national interest rates.
12 See also the work by Johansen and Juselius (1990).

compose the cointegration vectors that have the property that $\beta' X_t$ is stationary even though X_t itself is non-stationary. Connecting this to the Fisher hypothesis and Mishkin's inflation-change equation, changes in inflation expectations and term spreads of interest rates should not be integrated of different degree in order for the ex ante real interest rate to be even stationary in the long run (i.e. real interest rate should be generated by a stationary process).

Johansen's (1988, 1991, 1995) procedure is based on the maximum likelihood approach for estimating all the different cointegrating vectors among a set of variables. With this method one can test for the statistical significance of the cointegrating vectors and also construct likelihood ratio tests for testing structural linear restrictions on the cointegrating vectors. To put it shortly, starting with equation (17) the first step is to pick an autoregressive order p for the model. Next we run a regression of ΔX_t on $\Delta X_{t-1}, \ldots, \Delta X_{t-p+1}$ and saving the matrix for residuals, res_{1t}. For each t, res_{1t} has N elements. The third stage is the regression of X_{t-1} on ΔX_{t-1}, $\Delta X_{t-2}, \ldots, \Delta X_{t-p+1}$ and saving of the residuals, res_{2t} (again for each t, res_{2t} has N elements). The forth step is to calculate the squares of the canonical correlations[13] between res_{1t} and res_{2t}, calling them $\rho_1^2 > \rho_2^2 > \ldots > \rho_N^2$.

Now, if the number of time periods (observations) available in the data is T, the trace test statistic ($Trace$) for finding out the number of cointegrating vectors r is computed as

$$Trace = -T \sum_{i=k+1}^{N} \ln(1 - \rho_2^1). \tag{19}$$

The null hypothesis is $H_0 = r \leq k$, where r is the number of cointegration vectors. Another test for the cointegration is the maximal eigenvalue test, where the test statistic λ_{max} is calculated as

$$\lambda_{max} = -T \ln(1 - \rho_{k+1}^2). \tag{20}$$

In other words, the main hypothesis we shall consider is the hypothesis of r cointegrating vectors

$$H_2 : \Pi = \alpha\beta'. \tag{21}$$

The interpretation of all the long-run parameters is that $\beta' X_t$ describes the stationary relations among nonstationary variables, whereas α measures the short-run deviations from the long-run equilibrium relations, being also called the loadings of the long-run relationship in the error correction model (18). Thus, if the inflation-change equation applies, we will find one cointegrating vector among changes in inflation expectations and term spread of interest rates.

13 To put it shortly, canonical correlations between res_{1t} and res_{2t} mean that we seek those linear combinations of X_{t-1} that are maximally correlated with linear combinations of ΔX_t after conditioning on the lagged variables $\Delta X_{t-1}, \Delta X_{t-2}, \ldots, \Delta X_{t-p+1}$ (see e.g. Maddala and Kim, 1999, p. 167).

All the preliminary conclusions are based on the test values of trace test and maximal eigenvalue test[14] as well as on the graphs of the possible cointegrating vectors, on the analysis of eigenvectors and on the β's of the unrestricted VAR model[15]. The cointergation results clearly show that we are able to find three cointegrating vectors among three term spreads and 3-month, 6-month and 12-month inflation. In another words, the results support the inflation-change equation that term spreads of interest rates explain changes in inflation. The same amount of cointegrating vectors can be found in the analysis of three spreads and 3-month, 6-month and 12-month changes in industrial production. The test statistics support the same conclusion for the changes in output and private consumption as well, though the graphs and eigenvalue analysis gave somewhat weaker conclusions.

All this supports the intuitive framework in this study that term spreads of interest rates contain information about the corresponding changes in target macroeconomic variables, i.e. the term spread between 3-month and 1-month interest rates moves together with 3-month change in target variable, term spread between 6-month and 1-month interest rates moves together with 6-month change in target variable and term spread between 12-month and 1-month interest rates cointegrate with 12-month changes in target variable. Thus, the preliminary results from cointegration analysis encourage us to continue with our approach.

We also looked at the correlation coefficients between term spread variables and changes in target macroeconomic variables and industry portfolio returns in order to obtain some hints about the relationships between these variables. The correlations between industry portfolios and macroeconomic variables are highly dependent on the target variable and also on the forecasting horizon: the highest coefficients, above 0,5, appear in the cases of PCE and GDP and usually these occur with the longest horizon, 12 months. It seems indeed that the stock market is looking forward towards the future economic conditions, even up to a year. As expected (and in relation to previous research results), the correlation coefficients of industry returns and term spread variables with respect to inflation (CPI) are all negative.

One of the basic assumptions in ETP analysis is the linear relationship between base assets and control variables. The correlation coefficients between industry returns and term spreads seem rather low when compared to the coefficients between spreads and target variables. Nearly all the coefficients are close to 0,2–0,25. This may be viewed as the first indication of the weakness of term spreads as control variables in ETP analysis.

14 It has been discovered that Johansen's likelihood ratio tests easily lead to too high a cointegration rank in finite samples, and therefore the critical values were computed using the response surface estimates in Cheung and Lai (1993).

15 The detailed preliminary results and all the other results not reported in this version of the paper are available from the author upon request.

5. EMPIRICAL RESULTS

5.1. In-sample results

The results from the whole sample regressions, reported in Tables 1, 2 and 3, show that the forecasting performance of individual industry portfolios is somewhat dependent on the target macroeconomic variable and much more dependent on the forecasting horizon. Almost every portfolio is included at least once in the analysis, but it is hard to find certain industries or groups of industry portfolios whose returns would clearly explain at least one of the target macroeconomic variables. The significance of the portfolio returns also varies with forecasting horizon. The explanatory power, measured as the adjusted R^2, seems to grow with longer horizons. Overall, the whole picture from the in-sample ETP analysis at this stage is somewhat mixed.

The whole sample analysis started from a model that included all industry portfolios, the market portfolio and one term spread variable which was chosen on the basis of the forecasting horizon[16]. The statistically significant parameter values from this regression are reported in Table 1. In line with a priori expectations, the results show that only some of the numerous explanatory variables obtain statistically significant parameter values. The market portfolio is found significant in less than half of the cases indicating that industry portfolio returns have more accurate information about future economic activity. With IP, there seems to be some groups of industry portfolios that are consistently significant through different forecasting horizons, e.g. energy and buildings industries; this is not so apparent with other target macroeconomic variables. Interestingly, the signs of the portfolio weights in the case of inflation are not all negative. It seems to be dependent on the industry whether the effect is positive or negative. The role of the control variables is strong, because they are highly significant in ten out of 12 cases.

Next step in the in-sample analysis was to drop out all insignificant variables from the regression. Thus, the parameter values reported in Table 2 refer to industry portfolios that were included in the analysis and all the other industry portfolios were excluded[17]. In the cases of CPI and IP, there are certain industry portfolios (e.g. transportations and merchandise industries, information technology and buildings industries) that are more important to the ETP analysis, regardless of the forecasting horizon. Clearly they play a key role when forecasting the

16 Throughout the analysis we used only one term spread variable in each of the regressions. With forecasting horizon of three months, we chose the term spread between 3-month and 1-month interest rates as control variable; when $k = 6$ we used term spread between 6-month and 1-month interest rates; respectively, when $k = 12$ the control variable was the spread between 12-month and 1-month interest rate.

17 In other words, own specific model was constructed for each of the target variables and each of the forecasting horizons and only statistically significant industry portfolios were included in the ETP analysis.

TABLE 1. The whole sample (starting from 1991:2) OLS-parameter estimates from an ETP model that uses all the available industry portfolios and control variables. Standard errors have been computed using the Newey-West procedure (Newey and West, 1987) with 12 lags in all cases. Only the parameter estimates significant at lower than or equal to 10 % risk level have been reported.*

		TARGET VARIABLES											
		PCE			GDP			CPI			IP		
		k=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12
BASE ASSETS	HEX	-	0,251	-	-	-0,560	-	-0,100	-0,110	-	-	-	-
	BAF	-	-	-	-	-	-	-	-	-	-	-	-
	IAI	-0,061	-	-	-0,199	-	-	-	0,026	-	-0,033	-	-
	INO	-	-	-0,100	0,298	-	-	-	-0,034	-	-	-0,051	-
	TRA	-	-	-	-0,204	-0,292	-0,101	-0,053	-0,069	-0,066	-	-0,215	-0,424
	MER	-	-	0,392	-	0,429	0,449	0,078	0,105	-	-	0,290	0,493
	OTS	-	-	-	-	-0,084	-	-0,009	-	-0,027	-0,043	-0,112	-0,173
	MET	-	-	-0,196	0,503	-	-	-	-	0,055	-	-	-
	WOO	-	-	-	-	0,225	-	0,020	-	-	-	-	-
	MUL	-	-	-	-	-	-	-	-	-	-	-	-
	ENE	-	-	0,145	-	-	-	-0,058	-	-0,066	-0,085	-0,103	-0,120
	DAI	0,023	-	-	-	0,227	-	0,025	-	0,027	0,041	-	-
	BUI	-	-	-	-0,270	0,192	-	-	-	-	0,078	0,124	0,204
	ITE	-	-	-	-	0,297	-	0,048	0,038	-	-	-	-
	CHE	-0,080	-	-0,167	-	-	-0,118	-0,038	-	-	-	-	-
	MED	-	-	0,062	0,091	-	-	0,016	-	-	-	-	-0,185
	OTI	-	-	-	0,231	-0,378	-	-	0,031	-	0,061	0,171	-
CONTROL VARIABLES	SPREAD3	0,920			4,552			-			-		
	SPREAD6		1,04			0,670			-0,252			-0,281	
	SPREAD12			1,193			0,487			-0,344			-0,483
CONSTANT		0,602	1,467	3,355	0,849	2,575	4,747	0,292	0,665	1,423	-	0,595	1,201
ADJ. R2		0,072	0,287	0,541	0,265	0,127	0,429	0,100	0,182	0,319	0,166	0,209	0,255

*** The target variables are changes in future values of macroeconomic variables: GDP, *k* = 3 thus implies to the future 3-month change in GDP value; GDP, *k* = 6 implies to the future 6-month change in GDP value; GDP, *k* = 12 implies to the future 12-month changes in GDP value; the other variables interpreted respectively. Industry stock portfolios are current values of excess stock returns and control variables are one period lagged values. The grey area in the table indicates that the variable is not included in the analysis: e.g. only the spread between 3-month and 1-month interest rates (SPREAD3) is a control variable in regressions where forecasting horizon is 3 months.**

future behaviour of inflation and industrial production. As with the cases of PCE and GDP, the results are more mixed and seem to be dependent on the horizon.

The relationship between industry portfolio returns and changes in future values of PCE and GDP seems to be positive, whereas the relationship is in most parts negative in the cases of CPI and IP (some portfolio weights are negative and some are positive). The negative connection between stock market and inflation is quite expected, but the negative relation of stock returns with respect to industrial production is a little surprising. Thus, it seems that the relationship is not only dependent of the nominal vs. real aspect of the target variable, but also on something else. Control variables are still significant even though in few cases the shortest term spread seems to lack explanatory power. Also, the overall explanatory power of the mod-

TABLE 2. The whole sample (starting from 1991:2) OLS-parameter estimates from an ETP model that uses statistically significant industry portfolios and control variables. Standard errors have been computed using the Newey-West procedure (Newey and West, 1987) with 12 lags in all cases. Only the parameter estimates significant at lower than or equal to 10 % risk level have been reported.*

		TARGET VARIABLES											
		PCE			GDP			CPI			IP		
		k=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12
BASE ASSETS	HEX		0,092	0,207	-0,280			-0,026	-0,076	-0,055			0,269
	BAF	0,023											
	IAI	-0,042			-0,092				0,043		-0,026		
	INO			-0,118	0,181				-0,045			-0,046	
	TRA				-0,312		-0,105	-0,032	-0,040	-0,070		-0,165	-0,374
	MER	0,094	0,102	0,357			0,420	0,054	0,079	0,043		0,252	0,426
	OTS							-0,008		-0,020	-0,035	-0,116	-0,155
	MET			-0,178	0,519	0,168				0,048			
	WOO												
	MUL						-0,087				0,027		-0,104
	ENE			0,157				-0,061		-0,049	-0,066	-0,125	-0,106
	DAI					0,102		0,017		0,031			
	BUI				-0,204						0,083	0,101	0,254
	ITE	0,038			0,163			0,014	0,026	0,048			
	CHE	-0,080		-0,151									
	MED					0,122		0,009			-0,039	-0,072	-0,164
	OTI		-0,053			-0,268		0,024			0,065	0,181	
CONTROL VARIABLES	SPREAD3	0,951			4,361			-			-		
	SPREAD6		1,094			0,550			-0,275			-0,276	
	SPREAD12			1,169			0,541			-0,363			-0,515
CONSTANT		0,607	1,422	3,207	0,723	2,332	4,699	0,301	0,638	1,392	0,291	0,583	1,239
ADJ. R2		0,179	0,365	0,582	0,291	0,165	0,472	0,110	0,246	0,365	0,222	0,265	0,305

*** The target variables are changes in future values of macroeconomic variables: GDP, *k* = 3 thus implies to the future 3-month change in GDP value; GDP, *k* = 6 implies to the future 6-month change in GDP value; GDP, *k* = 12 implies to the future 12-month changes in GDP value; the other variables interpreted respectively. Industry stock portfolios are current values of excess stock returns and control variables are one period lagged values. The grey area in the table indicates that the variable is not included in the analysis: e.g. only the spread between 3-month and 1-month interest rates (SPREAD3) is a control variable in regressions where forecasting horizon is 3 months.**

el with fewer variables is better, but not as much as one would expect: the adjusted R^2 have improved but only slightly.

It seems that reducing the number of explanatory variables improves the goodness of the ETP model and next we run the regression including only the seven industry portfolios that Junttila and Kinnunen (2002) used[18] in their ETP analysis (from now on referred as JK industry portfolios). The parameter values and adjusted R^2 are reported in Table 3. Once again there is

18 Junttila and Kinnunen (2002) used seven industry portfolios that proved to be effective in the ETP analysis when conducted on Finnish data. The industries used were (1) metal and engineering MET, (2) wood WOO, (3) information technology and electronics ITE, (4) multibusinesses MUL, (5) other services OTS, (6) banking and finance BAF and (7) insurance and investment IAI.

TABLE 3. The whole sample (starting from 1991:2) OLS parameter estimates from an ETP model that uses industry portfolios from Junttila and Kinnunen (2002) and all control variables. Standard errors have been computed using the Newey-West procedure (Newey and West, 1987) with 12 lags in all cases. Only the parameter estimates significant at lower than or equal to 10 % risk level have been reported.

		TARGET VARIABLES											
		PCE			GDP			CPI			IP		
		k=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12	*k*=3	*k*=6	*k*=12
	HEX	-	0,224	-	-	-0,315	-	-	-0,071	-	-	-	-
	BAF	0,025	-	-	-	-	-	-	-	-	-	-	-
	IAI	-0,044	-	-	-	-	-	-	-	-	-	-	-0,094
	OTS	-	0,067	0,146	-0,129	-	0,130	-	0,022	-0,024	-	-	-
BASE	MET	-	-	-	0,272	0,183	-	-	-	0,037	-	-	-
ASSETS	WOO	-	-	-	-	-	-	-	-	-	-	-	-
	MUL	-	-	-	-	-	-	-	-	-0,031	0,051	0,049	-
	ITE	-	-	-	-	0,124	-	-	-	-	-	-	-
CONTROL	SPREAD3	0,975			4,206			-0,154			-		
VARIABLES	SPREAD6		1,103			0,632			-0,274			-0,350	
	SPREAD12			1,376			0,670			-0,393			-0,591
CONSTANT		0,596	1,345	2,751	1,277	2,684	3,965	0,344	0,676	1,517	-	-	1,127
ADJ, R2		0,113	0,339	0,477	0,192	0,178	0,337	-0,022	0,160	0,305	-0,001	0,030	0,123

*** The target variables are changes in future values of macroeconomic variables: GDP, *k* = 3 thus implies to the future 3-month change in GDP value; GDP, *k* = 6 implies to the future 6-month change in GDP value; GDP, *k* = 12 implies to the future 12-month changes in GDP value; the other variables interpreted respectively. Industry stock portfolios are current values of excess stock returns and control variables are one period lagged values. The grey area in the table indicates that the variable is not included in the analysis: e.g. only the spread between 3-month and 1-month interest rates (SPREAD3) is a control variable in regressions where forecasting horizon is 3 months.**

a rather small role for the market portfolio in the analysis, whereas the control variables are highly significant. As the other ETP models in this study demonstrate, the goodness of the ETP model seems to improve with longer forecasting horizons which is clearly an indication of the prediction characteristics of the excess stock returns. But as the adjusted R^2 and the large number of insignificant portfolio weights indicate, the choice of industry portfolios is not optimal in this third ETP model, because the model where all the included portfolios are statistically significant is better in terms of goodness.

5.2. Out-of-sample results

Since in terms of usefulness for forecasting and policy purposes a model with good in-sample properties does not give much ground for practitioners and politicians to work on, next we test the out-of-sample forecast performance of the ETP model using a 5-year moving window regression. The choice of a 5-year moving window was based on the fact that it is commonly known that many financial practitioners use the previous 60 months data in their forecasting and performance analyses. Lamont (2001) notes that this may not be long enough to account for the business cycle effects but due to the short time period we used the 5-year window in this study. The data may also be problematic in this kind of analysis due to the heavy volatility of the returns on base assets and of the yields of the interest rates. The time period considered includes both a severe recession and a beginning of a technology boom, all within a ten year (rather short) period. Figure A1 in the Appendix shows the forecasts of the two models with fewer variables included (the figures of the model including all industry portfolios and term spreads are not reported).

In order to put the results obtained from out-of-sample ETP analysis into perspective we compare them to results obtained from two benchmark models. One of the most commonly used model in the research for macroeconomic conditions is a vector autoregressive (VAR) model. Another almost equally popular is a model that uses interest rates in the form of term structure as explanatory variables. The VAR model constructed here is of the form

$$y_{t+k} = \alpha + \beta y_t + \chi y_{t-i} + \upsilon_t, \tag{22}$$

where y_t are the macroeconomic target variables specified in this study, y_{t-i} are the lagged values of target variables, $i = 1,\ldots, 3$ and υ_t are the error terms. The VAR model accounts for all the analysed macroeconomic variables. Hence, it does not consider the use of financial information (in the form of stock returns) in the forecasting regression. The term structure model for macroeconomy uses term structure of interest rates on the right hand side of a regression equation, in other words,

$$y_{t+k} = \rho + \sigma\,(i_t^m - i_t^n) + \varsigma_{t+k}, \tag{23}$$

where y_{t+k} are the changes in future macroeconomic variables specified in this study, $i_t^m - i_t^n$ is the term spread between two interest rates that differ in their maturities and ς_{t+k} are the error terms.

Table 4 reports the root mean squared errors (RMSEs) from the three above discussed ETP models with and without control variables relative to two benchmark models. The RMSEs of the benchmark models are also calculated using a 5-year moving window. The ETP forecasts are evaluated by dividing the RMSEs of ETP model by the RMSEs of the benchmark model. If the resulting value is smaller than unity the ETP model provides better forecasts of the future economic conditions and if it is greater than unity the benchmark model works better in predicting the future macroeconomic values (see e.g. Davis and Fagan, 1997). Another measure of the forecasting performance of the ETP models and the benchmark models used in this study is the mean absolute error (MAE). The statistics of the MAEs of ETP models divided by the benchmark models, MAE_{ETP} / $MAE_{BENCHMARK}$ are reported in Table 5. Once again, if the re-

TABLE 4. Relative root mean squared error statistics (RMSE = root mean squared errors) from the 5-year rolling regression of three ETP models with and without control variables using two benchmark models, VAR and a term structure model.**

(1) Model with all industry portfolios and control variables*

Forecast	ETP/VAR				ETP/Term spread model			
horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	1,015	1,098	1,911	2,825	1,744	1,884	3,498	3,155
6	1,363	1,484	1,142	2,455	3,797	2,797	3,472	3,890
12	1,560	0,538	1,497	1,489	3,255	1,088	3,512	2,804

(2) Model with all industry portfolios, control variables excluded*

Forecast	ETP/VAR				ETP/Term spread model			
horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	1,249	1,128	1,852	2,692	2,146	1,935	3,391	3,006
6	1,508	1,432	1,077	2,419	4,203	2,699	3,273	3,833
12	1,496	0,507	1,451	1,446	3,122	1,026	3,402	2,724

(3) Model with industry portfolios from Junttila and Kinnunen (2002) and control variables

Forecast	ETP/VAR				ETP/Term spread model			
Horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	0,699	0,731	0,548	1,130	1,201	1,253	1,004	1,262
6	0,448	0,725	0,291	0,786	1,248	1,367	0,884	1,246
12	0,554	0,412	0,565	0,648	1,156	0,834	1,325	1,221

(4) Model with industry portfolios from Junttila and Kinnunen (2002), control variables excluded

Forecast	ETP/VAR				ETP/Term spread model			
horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	0,770	0,739	0,582	1,080	1,322	1,267	1,065	1,206
6	0,545	0,727	0,311	0,747	1,519	1,371	0,946	1,184
12	0,635	0,435	0,552	0,580	1,325	0,879	1,293	1,092

(5) Model with significant industry portfolios and significant control variables*

Forecast	ETP/VAR				ETP/Term spread model			
horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	0,796	0,814	1,245	1,491	1,367	1,395	2,279	1,664
6	0,275	0,735	0,351	1,274	0,768	1,385	1,066	2,019
12	0,436	0,212	0,464	1,447	0,910	0,429	1,087	2,725

(6) Model with significant industry portfolios, control variables excluded*

Forecast	ETP/VAR				ETP/Term spread model			
horizon	PCE	GDP	CPI	IP	PCE	GDP	CPI	IP
3	0,855	0,834	1,183	1,434	1,469	1,431	2,166	1,601
6	0,330	0,725	0,335	1,221	0,919	1,367	1,018	1,934
12	0,329	0,151	0,435	1,441	0,687	0,306	1,020	2,714

*** Due to the great volatility in the time series of interest rates and stock returns (possible structural breaks in the time series) which caused the forecasts of macroeconomic variables to explode, the ETP analysis was conducted using sample period starting from 1992:10.**
**** The relative forecast error statistics are calculated by dividing the RMSEs from ETP models with the RMSEs from benchmark models.**

TABLE 5. Relative mean absolute forecast errors (MAE = mean absolute error) from the 5-year rolling regression of three ETP models with and without control variables with respect to two benchmark models, VAR and a term structure model.**

(1) Model with all industry portfolios and control variables*

Forecast Horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,449	4,381	1,829	2,147	2,272	5,005	3,055	7,695
6	1,033	3,290	1,611	2,271	2,732	3,837	2,632	9,790
12	1,296	1,144	2,441	1,433	1,787	1,185	1,816	5,580

(2) Model with all industry portfolios, control variables excluded*

Forecast Horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,487	4,527	1,691	2,025	2,463	5,172	2,825	7,255
6	1,137	3,150	1,511	2,197	3,009	3,674	2,468	9,471
12	1,334	0,969	2,213	1,434	1,840	1,003	1,646	5,585

(3) Model with industry portfolios from Junttila and Kinnunen (2002) and control variables

Forecast Horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,713	0,681	0,497	1,098	1,312	1,210	1,014	1,226
6	0,422	0,712	0,325	0,848	1,185	1,355	0,878	1,340
12	0,575	0,377	0,634	0,622	1,074	0,749	1,310	1,207

(4) Model with industry portfolios from Junttila and Kinnunen (2002), control variables excluded

Forecast Horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,713	0,681	0,497	1,069	1,312	1,210	1,014	1,194
6	0,422	0,712	0,325	0,806	1,185	1,355	0,878	1,272
12	0,575	0,377	0,634	0,550	1,074	0,749	1,310	1,066

(5) Model with significant industry portfolios and significant control variables*

Forecast Horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,753	0,830	1,095	1,581	1,385	1,475	2,233	1,767
6	0,275	0,630	0,392	1,246	0,771	1,198	1,060	1,967
12	0,402	0,226	0,520	1,466	0,750	0,450	1,075	2,842

(6) Model with significant industry portfolios, control variables excluded*

Forecast horizon	ETP/VAR PCE	GDP	CPI	IP	ETP/term spread PCE	GDP	CPI	IP
3	0,805	0,830	1,027	1,543	1,481	1,475	2,095	1,724
6	0,299	0,642	0,372	1,205	0,841	1,221	1,006	1,903
12	0,284	0,149	0,474	1,434	0,531	0,296	0,980	2,781

*** Due to the great volatility in the time series of interest rates and stock returns (possible structural breaks in the time series) which caused the forecasts of macroeconomic variables to explode, the ETP analysis was conducted using sample period starting from 1992:10.**
**** The relative forecast error measures in this table were calculated by dividing the mean absolute errors from each ETP model by the mean absolute errors from benchmark model.**

sulting value is smaller than unity, the results support the use of ETPs in forecasting future economic activity.

The results from the ETP model that uses all available industry portfolios and a market portfolio as base assets (model (1) and (2) in Tables 4 and 5) show that increasing the number of variables clearly causes inaccuracy in out-of-sample forecasts. Both benchmark models perform better than the ETP model with all industry portfolios. This is a clear indication of the different information content of different industry portfolios concerning future macroeconomic variables. In this model, the exclusion of the control variables has quite remarkable effect since the RMSE test statistics jump up in most cases: when they should be below one in order for the ETP model to work better, they are clearly above unity some being even over three. This is not so noticeable in MAEs, but for example forecasts of future values of PCE are more accurate with control variables than without. What is also worth notice is that the term spread variables seem to become more important (in the sense that they improve the accuracy of the forecasts) with shorter horizons.

The ETP models using JK portfolios and significant industry portfolios (models (3), (4), (5) and (6) in Tables 4 and 5) obtain much more precise forecasts of the changes in macroeconomic variables than the ETP model with all industry portfolios. The relative RMSEs and the MAEs are much smaller and in a large number of cases even below unity, which supports the performance of the ETP models. Both JK portfolio ETP and significant portfolio ETP outperforms the benchmark VAR in the case of PCE, and they forecast almost as accurately as the benchmark term spread model. Changes in inflation are also modelled better by ETP framework. Changes in industrial production seem to be hardest to model with ETP, both benchmark models do a better job. Since it looks like that the term spread benchmark model outperforms the VAR benchmark model and the omission of control variables from ETP model has some effect in the case of IP, it seems that interest rates and term spreads have an important role in forecasting changes in future values of industrial production. Changes in future values of GDP are also modelled better by the simple term spread benchmark indicating the importance of interest rates with respect to output as well.

Nevertheless, the ETP model works rather nicely, especially when all the included stock portfolios are statistically significant. Since the ETP model with JK portfolios is not far behind in performance from the other "small" ETP model we may conclude that smaller models definitely perform outstandingly in out-of-sample when compared to large and complex models. This statement is also supported by the fact that all ETP models have larger number of variables compared to benchmark models, especially to the term spread model, and this may be one factor that weakens the out-of-sample performance of the ETP models. However, they still seem to outperform the benchmark models in many cases. The term spreads seem to have only marginal effect in the analysis with smaller models: in most cases the forecast errors grow when we exclude the control variables from the model but the influence seems to be relatively small.

6. CONCLUSIONS

This study uses the economic tracking portfolio (ETP) approach for predicting future economic state, thus assessing the information content of stock portfolios about changes in future macroeconomic variables. Important part of the ETP framework is the choice of control variables in the regression analysis since control variables are likely to improve the accuracy of the portfolios containing information about specific target variables. In attempt to contribute to earlier research, we use the term structure of interest rates as control variable from the basis of Mishkin's (1989, 1990a and b, 1991) modification of the Fisherian relationship between interest rates and inflation, namely the inflation-change equation, and assessing the relationship between real macroeconomic variables and term spreads in the ETP framework, we test the forecasting power of different term spread variables.

The results in overall show the importance of using more specific industry portfolios instead of the market portfolio. Some industry portfolios are highly significant in the forecasting regressions, some on the other hand are dropped out totally; different stock portfolios contain information about different target macroeconomic variables. Regardless of the target variable or the forecasting horizon, some industry portfolios obtain negative and some positive parameter estimates, a fact that cannot be captured by using only the aggregate market portfolio.

In-sample results show the importance of term spreads as control variables. There seems to be strong role for term spreads in addition to stock returns in explaining and forecasting future macroeconomic variables. In ten out of twelve cases the term spread was statistically significant. Moreover, the number of industry portfolios needs to be restricted in some way since smaller models with fewer base assets have more explanatory power. In out-of-sample analysis the role of control variables slightly weakens. They seem to have a positive effect when forecasting horizons are shorter, but with longer horizons the importance is only marginal. This may also be due to the fact that numerous variables cause inaccuracy in parameter estimates and the number of base assets can be quite high when using industry portfolios.

Indeed, the use of term spreads in forecasting future economic activity seems to have noticeable role since the benchmark model that includes only the term spread variable outperforms the ETP model in few cases. But not only is the ETP model more accurate with most macroeconomic variables and forecasting horizons, it is more widely applicaple. The term spread benchmark model works only for predicting changes in industrial production when the

ETP model can help predict changes in future values of output, private consumption and inflation (and in the case of industrial production the ETP model is quite close to the benchmark term spread model).

The results in this study have been obtained using small open economy data. Whether these results apply to international setting is another question that needs to be examined since no country in a modern world economy is independent of the influences of other countries. Among others, Canova and De Niccolo (1995) conclude that the relationship between stock returns and domestic output growth becomes stronger when foreign influences are considered. Thus, the next step in this research is to expand the data to international markets which opens up the use of other structurally defined relationships as control variables. The information content of relations like purchasing power parity and interest rate parity is an interesting empirical question that will be examined in the future work. Furthermore, the ETP framework analyses changes, unexpected returns and innovations and the use of structurally defined relationships may produce new 'news' variables to be considered in the forecasting equation. ■

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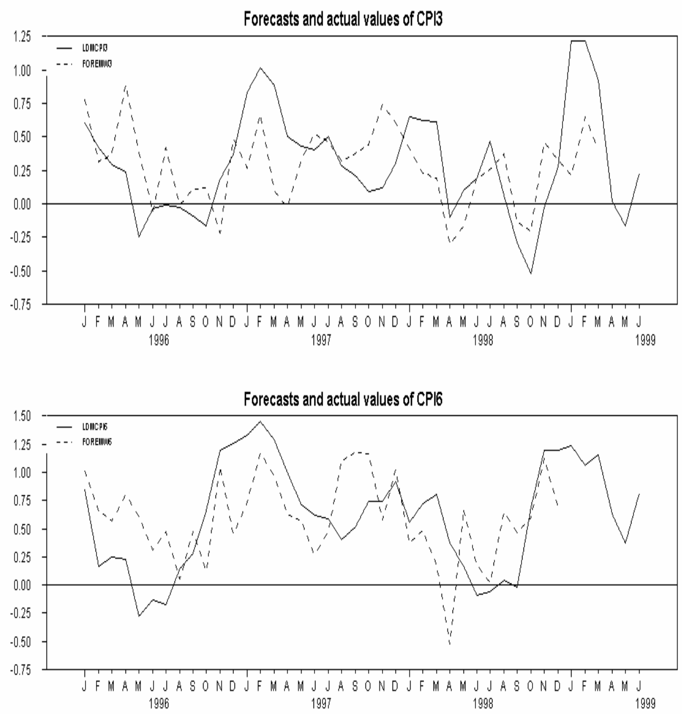
APPENDIX.

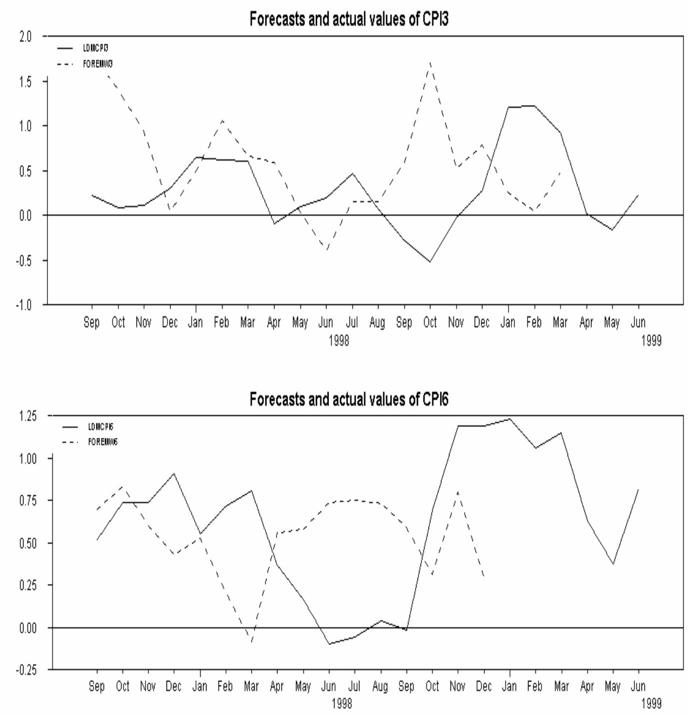
FIGURE A1.

Out-of-sample forecasts of the ETP models using JK portfolios and significant industry portfolios, and actual values of future macroeconomic variables with forecasting horizons of 3, 6 and 12 months*. Forecasts are obtained from a rolling estimation procedure with a 5-year moving window.

JK-model



Model with significant porfolios



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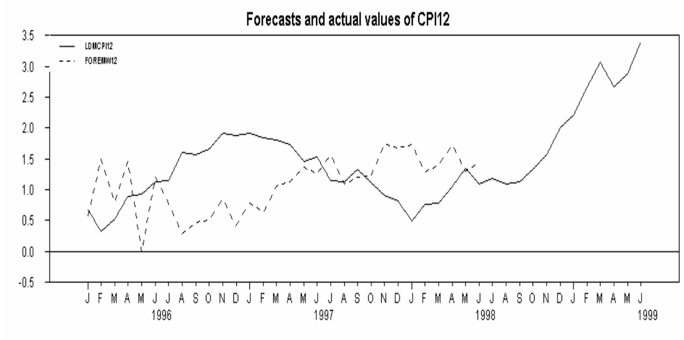

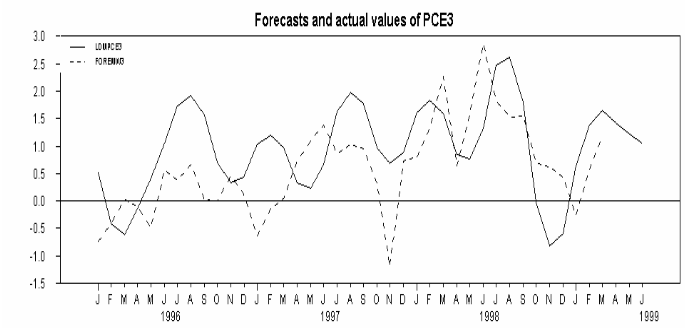

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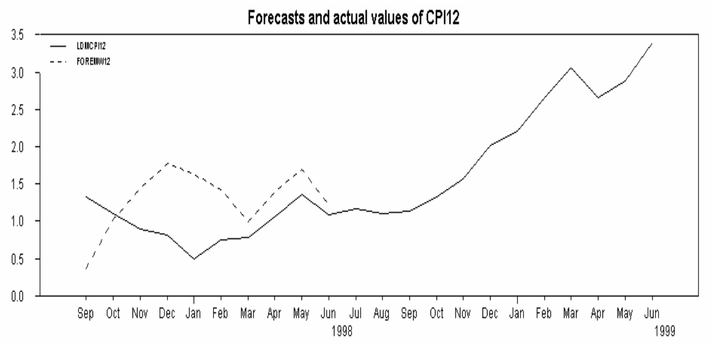

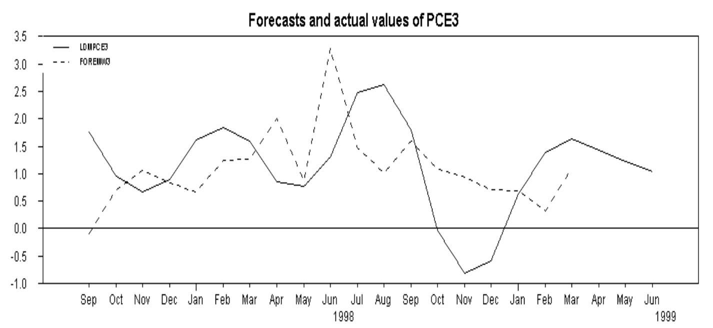

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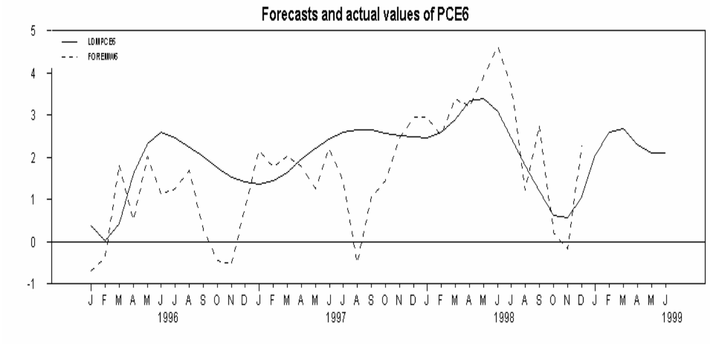
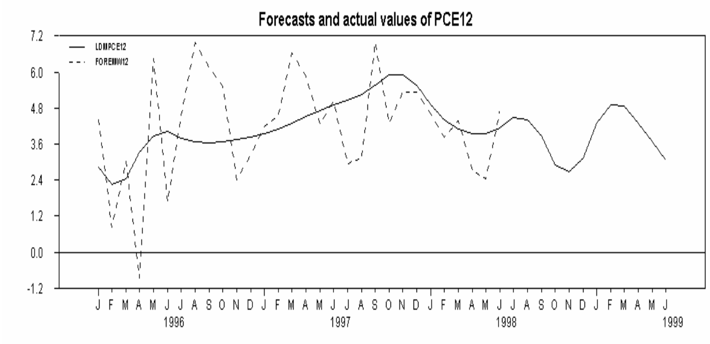
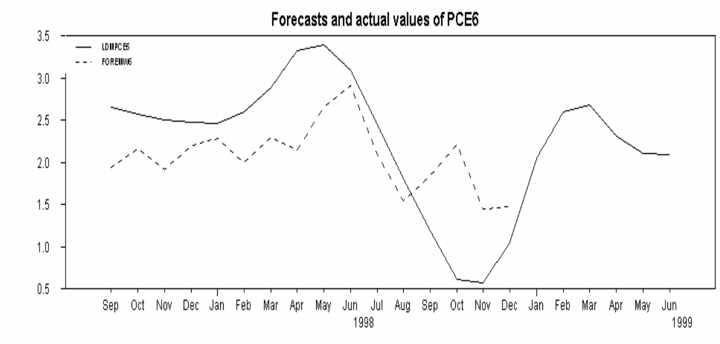
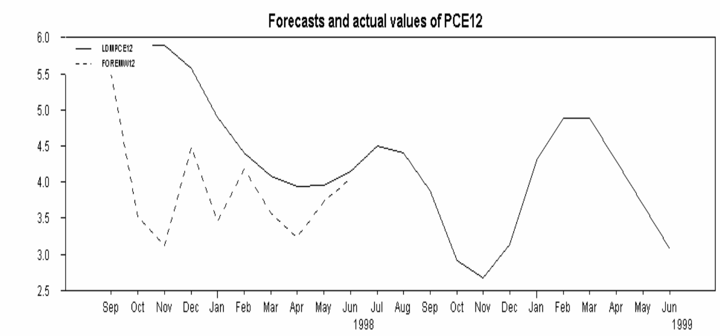




Model with significant porfolios





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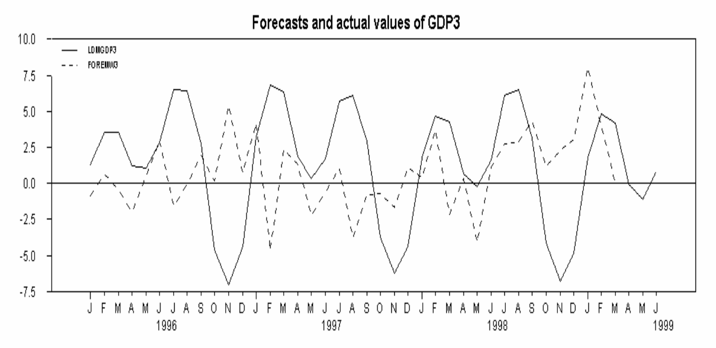
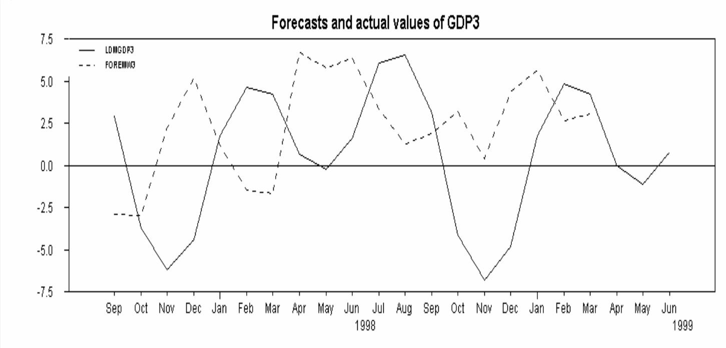
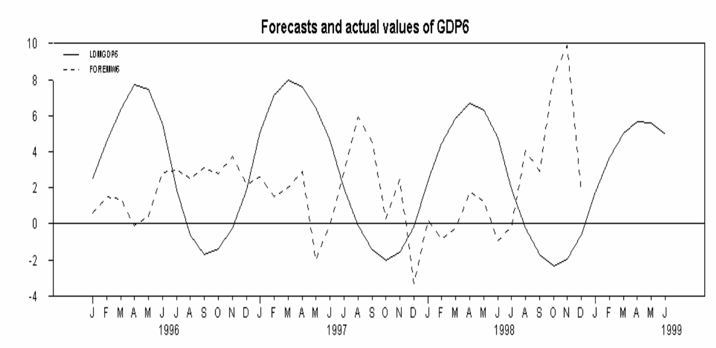
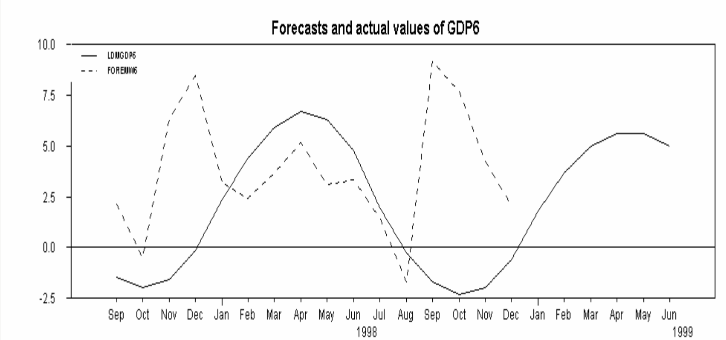
Model with significant portfolios









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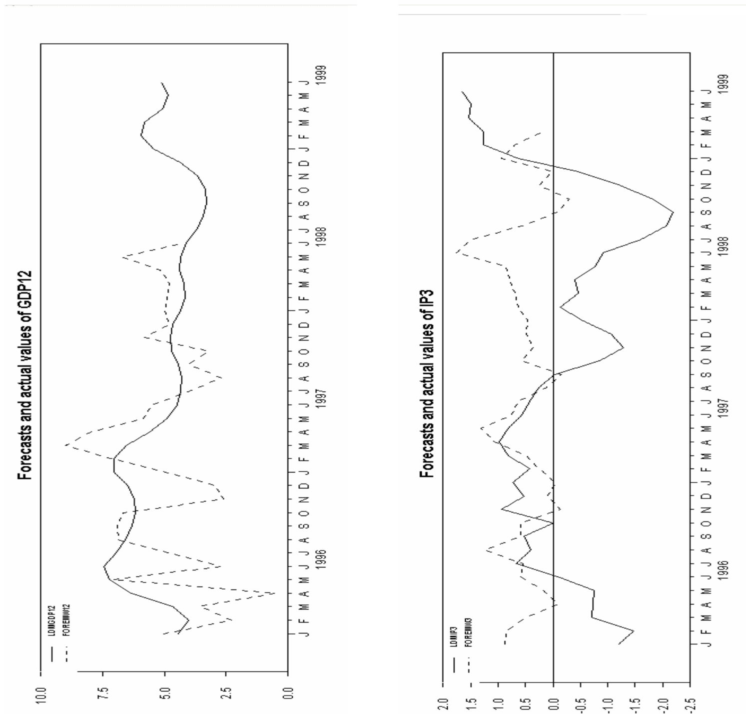
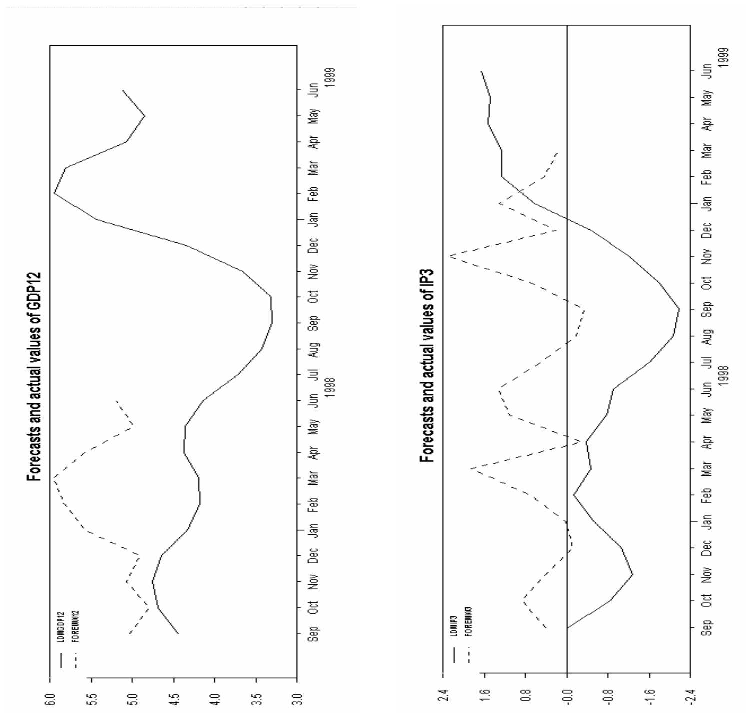


Model with significant portfolios



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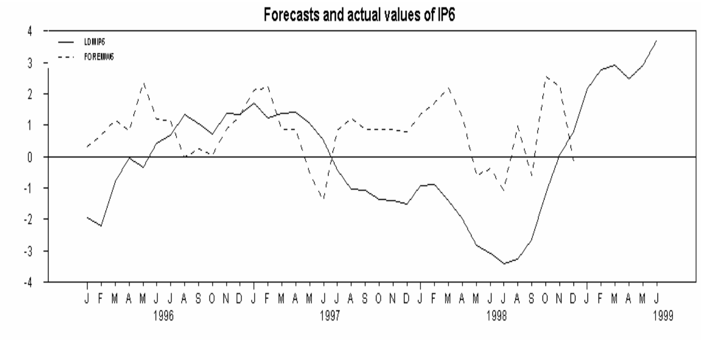
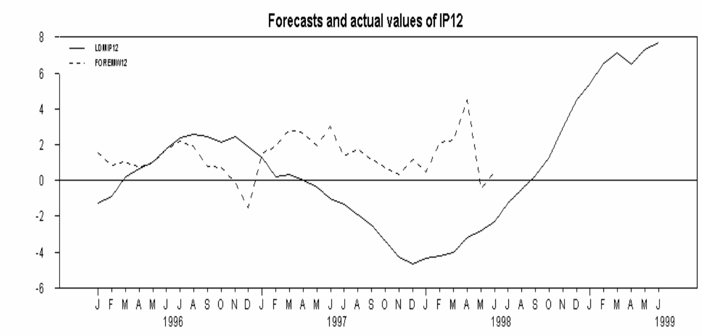
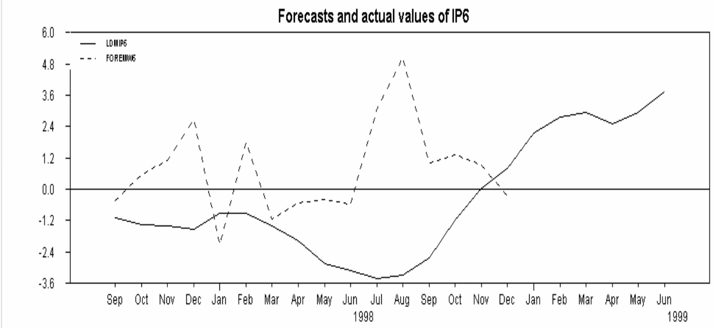
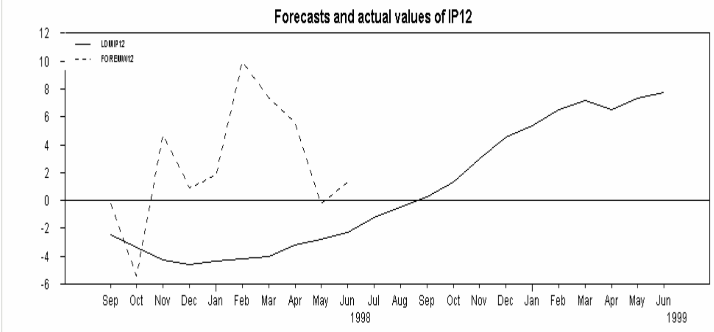
JK-model





Model with significant portfolios





****The JK model is an ETP model with industry portfolios from Junttila and Kinnunen (2002) including the control variables and the model with significant portfolios is an ETP model included only the statistically significant industry portfolios.****