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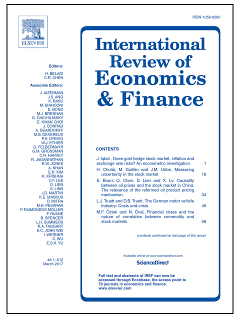

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Stock Market and Exchange Rate Information in the Taylor Rule: Evidence from OECD Countries

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Stock Market and Exchange Rate Information in the Taylor Rule: Evidence from OECD Countries

Abstract

We analyze the effects of stock market and exchange rate information in a forward-looking Taylor rule for monthly data from 14 OECD countries during the years 1999 - 2016. Especially the stock market information in the form of dividend but also the currency market information in the form of real exchange rate are revealed to be relevant in Taylor rule for many of the countries examined by helping to strengthen the role of inflation and real economic activity deviations in the policy rule. In many cases the rule also seems to be opportunistic, i.e., the inflation target has been time-varying.

Keywords: Monetary policy, Stock market, Currency market

JEL codes: E44, E52, E58

1. Introduction

There is ample evidence that many of the modern central banks would seem to have followed the Taylor (1993) rule as the rule of thumb in their monetary policy actions, in one form or the other. From the point of view of the central banks' monetary policy target functions e.g. the role of financial markets is especially connected to the question of whether the financial market performance is or should be an actual policy target variable, or whether it merely reflects the future performance of the macroeconomy, and hence, the behaviour of the more traditional policy variables in the Taylor rule, i.e. the real economic activity and inflation. The set of papers attempting to scrutinize the role of financial and also currency market (that is the second focus in this paper[1]) information in the formulation of the Taylor rule is somewhat limited. One of the most recent attempts is the paper by Castro (2011), who, compared to our approach, introduces a much more complicated financial market indicator variable to the traditional Taylor rule. Some details of the Castro (2011) approach are given in section 2, but there are also some other previous papers that have attempted to use more simple measures for the market performance, like Chadha, Sarno and Valente (2004) and Fuhrer and Tootell (2008).

After the studies by Taylor (2001) and Clarida (2001) there has been a long debate whether and how the stock and other financial market information and exchange rates should explicitly be taken into account in formulating the monetary policy. While presumably asset prices should be used as indicator variables for the real economy, during the last two decades it has been actually more or less obvious that the central banks have started to take into account the apparent increase in financial instability, and in many studies asset booms and busts have been found to be important factors in macroeconomic fluctuations in both developing and industrial countries[2]. Chadha et al. (2004) introduced empirically both the asset prices and exchange rates to the standard interest rate rule for the United States, the United Kingdom and Japan since 1979. In the empirical analysis they used GMM estimation and without any theoretical, model based derivations, specified the monetary policy rule as a forward-looking Taylor rule augmented by the dividend-price ratio calculated using the Datastream composite stock price indices for each country, and the log-real effective exchange rate. Their main findings on the role of asset prices and exchange rate were that monetary policy makers may have used asset prices and exchange

[1]See for example Molodtsova, Nikolsko-Rzhevskyy and Papell (2011), who implicitly study whether using the real exchange rate in the Taylor rule helps to outperform the random walk model in out-of-sample forecasting attempts.

[2]For an early contribution on these findings see Borio, Kennedy and Prowse (1994), and for similar conclusions on the role of exchange rates in central banks' reaction functions see Clarida, Gali and Gertler (1998) and Taylor (2001).

rates not only as part of their information set for setting interest rates, but also to set interest rates to offset deviations of asset prices or exchange rates from their equilibrium levels.

Also Fuhrer and Tootell (2008) examined the role of financial market information, specifically equity prices, in affecting the U.S. monetary policy steering rate directly. Alternatively, they considered financial market information as an instrument for forming the forecasts of the traditional policy variables, which were in their study a vector of variables consisting of quarterly percentage changes in real GDP, a gap variable measured by either the unemployment rate or a Hodrick-Prescott detrended real GDP gap, and a four-quarter moving average of inflation, measured in three different ways. They also estimated a forward-looking Taylor rule using Generalized Method of Moments (GMM). More specifically, they distinguished the Federal Open Market Committee's (FOMC) reaction to forecasts of traditional goal variables, which may depend on equity prices, from the FOMC's independent reaction to changes in equity prices. They used actual forward-looking variables examined by the FOMC before each action (the "Greenbook" forecasts) and found little evidence to support the proposition that the FOMC responds to stock values, except as filtered through a forecast of accepted monetary policy goal variables.

Finally, according to Castro (2011) the Taylor rule type monetary policy rules might be nonlinear for the part of financial market effects. He analysed whether the rule can be augmented with a financial conditions index containing information from some asset prices and financial variables. His results indicated that the monetary policy behaviour of the European Central Bank and Bank of England is best described by a nonlinear rule, but the behaviour of the Federal Reserve can be best described by a linear rule. In addition, his findings indicated that only the European Central Bank is reacting to financial conditions.

First, our analysis will focus the standard linear representation similar to the original Taylor rule, but we will allow for the interest rate smoothing and also for the possibility of opportunistic rules with a time-varying inflation target, as has been found in some of the recent studies on monetary policy rules. Second, the main new contribution in our study is to introduce two very simple forms of information from the stock and currency markets, i.e., the dividend yield and the real exchange rate as *additional information* variables that may have affected the monetary policy decisions of central banks, especially in turbulent time periods in the overall economies. In the first stage, this is based on adding these information as additional regressors to the regression analysis of the standard Taylor rule containing also the interest rate smoothing (i.e. lagged values of the interest rate) and time-varying inflation target. Third, we will use real-time data for the aggregate economic target variables in the policy rule, and based on the previous findings in the literature, the financial market information contains forecasting power for these variables. Hence, we are able to examine whether the role of these additional stock and currency market information is actually more of the 'instrument type', i.e., does their inclusion to the set of instrument variables in a GMM regression of the Taylor rule improve or strengthen the role of original economic target variables Using real-time data from 1999 to 2016 for 14 OECD countries we clearly find that for all the other countries except the three big countries (in terms of their role in the global economy) outside the euro area – i.e. Japan, the UK and the U.S. – especially the role of stock but also of the currency market information seems to be essential when analysing the responsiveness of the interest rate on real activity and inflation deviations from their target values[3]. Furthermore, for many countries the inclusion of financial market information to the estimation of the Taylor rule reveals that for the part of inflation effects the rule has been opportunistic, i.e., the inflation target has been time-varying.

The structure of this paper is the following. In section 2 we give the theoretical motivation for the role of stock and currency market information in the Taylor rule. Section 3 gives the description of the data, some descriptive statistics and finally, the proposed specifications of the Taylor rule that we em-

[3]Actually in the forward looking opportunistic Taylor rule the financial market information proved to be important also for the case of Japan.

pirically analyse. Section 4 reports our empirical results based on real-time data from 14 OECD countries, and finally, section 5 gives conclusions.

2. The theoretical model

2.1. Stock market performance and currency market information as additional explicit policy targets

Usually in macroeconomic modelling the stock market performance has in many cases been treated as a forward looking variable that is able to forecast the future real economic activity or other aggregate variables out of sample. However, in some of the previous studies e.g. the performance of stock market has been introduced to the Taylor rule simply as an additional policy variable. For example Castro (2011) starts from a linear representation of the Taylor rule (later abbreviated as TR) in the form

$$i_t^* = \overline{r} + \pi^* + \beta(\pi_t - \pi^*) + \gamma(y_t - y_t^*),$$

that gives the nominal short-term target interest rate (i^*) as the sum of equilibrium real interest rate ($\overline{r}$) and target inflation (π^*), and the policy reactions (β and γ) to inflation deviations ($\pi_t - \pi^*$) and deviations of output (y_t) from its (time-varying) trend or potential value (y_t^*), respectively. In addition, many of the modern studies scrutinizing the policy relevant representations of the original TR use the Clarida et al. (1998, 2000) suggestion that the rule should actually be forward looking. This allows the central bank to take various other variables (like stock and/or currency market prices and/or returns) into account when forming its inflation forecasts. Hence, Clarida et al. argue that the desired level of the nominal interest rate depends actually on the deviation of expected inflation k periods ahead (in annual terms) from its target value and the expected output gap p periods ahead, resulting the TR to be given as

$$i_t^* = \overline{r} + \pi^* + \beta\left[E(\pi_{t+k} \mid \Omega_t) - \pi^*)\right] + \gamma E\left[(y_{t+p} - y_{t+p}^*) \mid \Omega_t\right], \tag{1}$$

where E denotes the expectations operator and Ω_t is a vector of other relevant information for the central bank at the time of interest rate decision making. When inflation expectations rise, and if the monetary policy is supposed to be stabilizing in terms of affecting actually the real rate of interest (that affects the rate of inflation via its effects on economic activity in general), the coefficient on the inflation gap (β) should be greater than one and the coefficient on the output gap (γ) should be positive. Furthermore, nowadays the usual procedure in examining the monetary policy reaction functions is to try to control also for the observed serial correlation in the actual interest rates. This indicates that the central banks are assumed to practise so called interest rate smoothing, and hence, the lagged values of the instrument rate are added to the TR, implying that the central bank adjusts the interest rate gradually towards the desired level. In this case the dynamics of the adjustment of the current level of interest rate towards its target is given by

$$i_t = \left(1 - \sum_{j=1}^{n} \rho_j\right) i_t^* + \sum_{j=1}^{n} \rho_j i_{t-j}, \quad \text{where } 0 < \sum_{j=1}^{n} \rho_j < 1. \tag{2}$$

Here the sum of ρ_j captures the degree of interest rate smoothing and n the number of lags. After defining $\alpha = \overline{r} - (\beta - 1)\pi^*$ and $\overline{y} = y_{t+p} - y^*_{t+p}$ and inserting equation (2) into (1) with an assumption that the central bank is able to control interest rates only up to an independent and identically distributed stochastic error (u_t) yields the following equation:

$$i_t = \left(1 - \sum_{j=1}^{n} \rho_j\right) \left[\alpha + \beta E(\pi_{t+k} \mid \Omega_t) + \gamma E(\overline{y}_{t+p} \mid \Omega_t\right] + \sum_{j=1}^{n} \rho_j i_{t-j} + u_t. \tag{3}$$

Castro (2011) uses this form of the TR and extends it to include an additional vector of other explanatory variables ($\boldsymbol{x}$) that might have a role to play in interest rate setting by introducing a general term $\theta' E(\boldsymbol{x}_{t+q} \mid \Omega_t)$ to the set of terms in square brackets in (3). Here θ is a vector of coefficients associated with the additional variables targeted by the monetary policy actions. After eliminating the unobserved forecast variables, the extended policy rule can be written in terms of realized variables as

$$i_t = \left(1 - \sum_{j=1}^{n} \rho_j\right) [\alpha + \beta\pi_{t+k} + \gamma_{t+p}\overline{y} + \theta' \boldsymbol{x}_{t+q}] + \sum_{j=1}^{n} \rho_j i_{t-j} + \varepsilon_t, \qquad (4)$$

where the error term ε_t is a linear combination of the forecast errors of inflation, output, the vector of additional exogenous variables and the disturbance term u_t. Like e.g. Clarida et al. (1998, 2000), Chadha et al. (2004), Qin and Enders (2008), Fuhrer and Tootell (2008), and Castro (2011) all stress out, these kind of regression equations should be estimated by the generalized method of moments (GMM), because they involve unobserved values for some of the variables in the equation. For central banks, actually none of the variables in square brackets in equation (4) are observed at the time of interest rate decision making. To implement the GMM procedure, the following orthogonality conditions are imposed regarding the variables in (4):

$$E\left\{ i_t - \left(1 - \sum_{j=1}^{n} \rho_j\right) \left[\alpha + \beta\pi_{t+k} + \gamma\overline{y}_{t+p} + \theta' \boldsymbol{x}_{t+q}\right] + \sum_{j=1}^{n} \rho_j i_{t-j} \mid v_t \right\} = 0, \qquad (5)$$

where v_t is a vector of (instrumental) variables that the central bank has in its information set at the time it chooses the interest rate, and that are orthogonal to the ε_t term. As Castro (2011), among others notes, the set of instruments has usually included for example lagged variables that help predict inflation, the output gap, and the additional exogenous variables, together with other contemporary variables that should not be correlated with the disturbance term u_t. In practice, the estimation of equation (5) involves the reduced form

$$i_t = \phi_0 + \phi_1\pi_{t+k} + \phi_2\overline{y}_{t+p} + \varphi' \boldsymbol{x}_{t+q} + \sum_{j=1}^{n} \rho_j i_{t-j} + \varepsilon_t, \qquad (6)$$

where the regression parameter vector is related to the parameter vector in (5) via a representation $(\phi_0, \phi_1, \phi_2, \varphi)' = (1 - \sum_{j=0}^{n} \rho_j)(\alpha, \beta, \gamma, \theta)'$, so the original parameter vector and the standard errors related to equation (5) can be recovered based on the delta method.

In what follows in the empirical analyses of this paper, we will consider only the role of stock and currency market information supposed to be contained in the variable (vector) $\mathbf{x}$ in the augmented Taylor rule. Put it more precisely, we want to analyze the role of these additional variables either as direct policy variables, referring to the vector $\mathbf{x}$ in equation (6) above, or alternatively, as merely instrumental variables, and hence, belonging to the information vector v in equation (5). First of all, the role of stock market performance is measured by the dividend yield[4]. Furthermore, we also examine the potential role of currency market infromation in the form of real exchange rate. Because in addition to the traditional TR variables (inflation and real activity deviations) it clearly is a possible macroeconomic policy target variable, too, we analyze its role either as a strict target variable or an instrumental variable in the estimation of TR representations. Details of the background for the potential role of stock and currency market information specifically in the form of dividend yield and real exchange rate are given next.

2.2. Adding the stock and currency market information to the Taylor rule

One possibility to scrutinize the role of additional variables in the original standard Taylor (1993) rule is to introduce them as potential instrumental variables affecting indirectly the interest rate decision via their effect on inflation and output gap as predictive (leading indicator) variables. In some of the previous studies regarding the augmentation of the Taylor rule the dividend yield[5]

[4]Note that even though we have otherwise followed the paper by Castro (2011) closely in deriving the augmented representation of the Taylor rule, especially for this part we depart strongly from one of the main ideas in his paper. He uses a much more complex measure for the financial market performance, that is, a financial conditions index (FCI) designed to capture misalignments in the financial markets more generally. More specifically, he constructs a new and extended FCI from the weighted average of the real effective exchange rate, real share prices and real property prices plus credit spread and futures interest rate spread. Furthermore, he uses a Kalman filter procedure for the purposes of calculating the time varying weights of each of the asset components in the FCI. We are more interested in revealing the roles of a simple (single) stock market performance measure and the real exchange rate in affecting monetary policy decisions.

[5]See, e.g. Chadha et al (2004).

has been considered as a potential information variable for the macro variables in the right hand side of the TR, but in none of them have the author(s) explicitly attempted to derive an actual regression equation for the analysis of its effects. In this paper, we utilize a recent paper by Junttila and Korhonen (2011) that explicitly derives a forecasting model for inflation, real economic activity and real exchange rate, where in addition to the short-term interest rate the main forecasting variable is the dividend yield for future inflation and real economic activity, and the relative (in relation to the foreign market) dividend yield for the real exchange rate. Their forecasting model starts from the traditional Gordon (1962) growth model that gives the fundamental value of equity (stock price, P_t^S) based on

$$P_t^S = \frac{D_t}{i_t - g_t^e - \pi_t^e}, \tag{7}$$

where the current stock price is dependent on the dividend stream (D_t) realized

at time t, the nominal interest rate (i_t) at time t, the expected growth rate of economy (g_t^e, reflecting also the growth possibilities of future real yields on stock investments), and the expected inflation rate (π_t^e) at time t. It is straight forward to write equation (7) in terms of the dividend yield ($d_t = D_t/P_t^S$), i.e., in the form[6] $d_t = i_t - g_t^e - \pi_t^e$. The next step is to use some relevant partial equilibrium conditions for the macroeconomic and financial market variables (that are at least partly referred to also in e.g. Stock and Watson 2003), that is, the Fisher (1930) equation, the Euler equation for the real interest rates, and the purchasing power parity (PPP) together with the uncovered interest rate parity (UIP) condition in a two-country context that enable to construct a three-equation model for the relevant three asset market related variables, i.e.,

[6] This valuation formula already includes all the main relevant variables for our stock market extension of the Taylor rule analysis, i.e., the dividend yield $\frac{D_t}{P_t^S}$(obtained dividing equation (7) by P_t^S), nominal interest rate i_t,expected growth of economy g_t^e and expected inflation π_t^e.

the dividend yield, nominal interest rate and the real exchange rate[7]. The final forecasting system in Junttila and Korhonen (2011) for expected values of the main interesting macro variables in the current study, that is, the real growth and inflation, and for the real exchange rate) is comprised of

$$
\begin{aligned}
g_t^e &= \frac{\rho}{1-\lambda} - \frac{d_t}{1-\lambda} \\
\pi_t^e &= i_t - \frac{\rho}{1-\lambda} + \frac{\lambda d_t}{1-\lambda} \\
q_t &= \alpha - \lambda \left(\frac{d_t^* - d_t}{1-\lambda} \right).
\end{aligned}
\tag{8}
$$

The system of equations (8) gives us the background to include specifically the dividend yield and also the real exchange rate as additional variables to the empirical analysis of the augmented Taylor rule in this paper. However, at this point it is worth to mention some other studies that yield similar kinds of outcomes as (8) especially in terms of the predicted signs for the correlations between the dividend yield and the two most relevant macro variables regarding the augmentation of the standard Taylor rule, i.e., inflation and real growth.[8] As one can see from the above forecasting system (8), the proposed relationships here are a negative correlation between the (expected) economic growth and dividend yield and a positive correlation between the (expected) inflation and dividend yield.

Empirical research on the so called 'Fed model' (see Asness 2000, 2003) has previously also found a clearly positive correlation between inflation and dividend yield, but a recent paper by Wei (2010) gives also an elegant theoretical

[7] The complete derivation of this system is given in Junttila and Korhonen (2011). Basically the first equation in the system resembles one simple form of a stock market valuation model, the second one a standard Taylor rule (stacking the target values for inflation and real growth to a single constant term, that originally describes only the rate of time preference in an Euler equation for the real interest rate), and finally, the third equation is the standard representation of the real interest rate parity.

[8] Our main reference paper by Junttila and Korhonen (2011) does not discuss these other studies in details, and most of them are connected to the analysis of monetary policy effects, so to our mind it is essential to take a look at these results at this point in the current study.

background for the proposed positive relationship. Prior to her study, three hypotheses had been put forward to explain the positive correlation between inflation and dividend yield. The first one states that the monetary authority's tightening response to inflation damages the real economy, and especially lowers the corporate profits. Hence, the growth rate of real dividends declines in response to inflation, driving up the dividend yields. On the other hand, Brandt and Wang (2003) have presented a model in which inflation makes investors more risk averse, and this drives up the required equity premium, and hence, the real discount rate. Finally, already Modigliani and Cohn (1979) have proposed a concept of so called inflation illusion[9], according to which the stock market investors fail to understand the effect of inflation on nominal dividend growth rates and extrapolate historical nominal growth rates in periods of higher inflation. From the perspective of a rational investor, this implies that stock prices are undervalued when inflation is high and overvalued when it is low. The model presented by Wei (2010) is based on a modern structural, dynamic stochastic general equilibrium (DSGE) approach, and she finds that this kind of fully rational model can also theoretically generate a positive correlation between dividend yields and inflation as observed in the data. The main idea there is that a technology shock to an economy moves both inflation and dividend yields in the same direction, resulting in a positive correlation between the two.

The proposed negative correlation between the real growth of economy and dividend yield has not been discovered in many papers prior to Junttila and Korhonen (2011). In addition to his own theoretical and empirical findings in favor of this alleged relationship e.g. Ritter (2005) refers to papers by Dimson et al. (2002) and Siegel (1998), too. Ritter finds in his calculations for 16 countries over the 1900 - 2002 period that the simple correlation coefficient between total real return (including the dividend yield) on equities and the

[9]See more recently e.g. Campbell and Vuolteenaho (2004) for a VAR analysis on inflation illusion.

GDP growth rate is -0.37 (with a p-value of 0.16) rather than the -0.27 value that Dimson et al. (2002) reported. Siegel (1998) has argued that part of the negative correlation between real stock returns and real economic growth might be due to the fact that high economic growth may have been impounded into prices at the start of the analyzed periods. However, Ritter (2005) states perhaps more intuitively, that there is a general tendency for markets to assign higher price per earnings and price per dividend multiples (and hence, lower dividend yields) when economic growth is expected to be high, which has the effect of lowering realized returns because more capital must be committed by investors to receive the same dividends. More recently, Bekaert and Engstrom (2010) have performed an in-depth vector autoregessive analysis regarding the above mentioned 'Fed model' and received as a side product also some implications in favor of the proposed negative correlation between real economic growth and the dividend yield. They use a dynamic version of the Gordon (1962) growth model and the VAR approach building on the seminal work of Campbell and Shiller (1988), and find that the high correlation between expected inflation and the dividend yield is almost entirely due to the positive correlation between expected inflation and two plausible proxies for rational time-varying risk premiums, i.e., a measure of economic uncertainty (the uncertainty among professional forecasters regarding real GDP growth) and a consumption-based measure of risk aversion. When the economic uncertainty is high, the real economic activity is typically low (see also Ritter 2005), so at least part of the negative correlation between the expected future real growth and the dividend yield comes from this channel. Furthermore, the analysis and empirical results of Bekaert and Engstrom (2010) actually indicate that the examination of the relationship between the dividend yield and future inflation and future economic activity should be conducted based on a system approach, and this is also the idea behind the derivation of the three-equation system given in (8).

The third alleged correlation in system (8) is the one between the contemporaneous values of the real exchange rate and the difference between the foreign and domestic dividend yields. Based on previous studies, this is perhaps the most difficult to connect to any kind of modern general equilibrium models theoretically, so in addition to the obtained partial equilibrium result, the main motivation for this proposed relationship comes from previous purely empirical findings. By definition, the dividend yield variable is comprised of the (somewhat constant) dividend stream in the numerator and much more volatile equity price in the denominator of the definition, so the main differences in domestic and foreign dividend yields have to stem from the differences in domestic and foreign stock market valuations at each point of time. In a recent, purely empirical study regarding the transmission of the ongoing financial and sovereign debt crises to the EMU countries for the part of stock, fixed income and currency markets, Grammatikos and Vermeulen (2012) find that the correlation between stock market values and exchange rates is very much dependent on the tranquility of the general economic conditions. They also point out that the early theoretical literature on this relationship does not actually agree on the sign of the correlation between the stock prices and the exchange rate. One stream of the literature represents the view that developments in the current account determine more or less exclusively the exchange rates (see e.g. Dornsbusch and Fisher 1980), and according to the so called 'harmful to exports' hypothesis exchange rate movements have an effect on firm competitiveness, that affects the stock prices through the future profitability of firms. In this case, e.g. when the euro exchange rate appreciates, this makes European products more expensive to foreign customers, so both exports and profits decrease. Hence, this theory predicts a negative relationship between stock prices and exchange rates, and in terms of the dividend yield analysis, a positive relationship between the domestic dividend yield and exchange rate. Correspondingly, in view of the main interesting variable, that is, the difference between the foreign and domestic dividend yields in the third equation of (8), this fits to our hypothesized negative relationship between the dividend yield spread and the real exchange rate, when the dividend yield spread is defined as the foreign dividend yield minus the domestic dividend yield.

The second view on the stock vs. currency market relationship is based on the portfolio balance models (see originally Branson 1983, and Frankel 1983), proposing that the exchange rate is a variable equating the supply and demand of financial assets. Hence, these models predict a positive relationship between stock prices and exchange rates, because exchange rate appreciations are correlated with positive stock market returns. In this case rising stock prices increase the value of the equity market, which is associated with an exchange rate appreciation, and this view has generally been termed the 'signal of economic strength' hypothesis.

Grammatikos and Vermeulen (2012) use daily data from 15 EMU countries from 2003 to 2010 and analyze the relationship between stock market returns and exchange rate separately for Northern and Southern, big and small countries, and also separately for financial and non-financial firms' stock returns. Their main findings are that during tranquil times the coefficient of European financial firms' stock returns on euro-dollar exchange rate changes is in line with the 'harmful to exports' hypothesis. The effect is the strongest for North countries and the weakest for small Euro area countries. For both the North and South country groups the effect is also economically large. However, during the crisis period this relationship changes drastically. For all country groups the coefficient on exchange rate changes to positive and the result is equally strong for both the financial and non-financial firms' stock returns. Hence, in sum, the role of a strong euro during the crisis period appears to have changed from 'harmful to exports' to a 'signal of economic growth'.

3. Description of the data, descriptive statistics and the proposed specifications

We started our empirical analyses from descriptive statistics and a set of unit root tests. The original and transformed set of data that we are interested in is comprised of the 3-month money market interest rate [10] (i), deviation of

[10] Most of the studies that estimate Taylor rules use an overnight interbank rate, such as EONIA or the effective Federal funds rate, as the policy instrument. However, for example

real economic activity, measured by the deviation of the log of industrial production index in levels ($\overline{y}$) or as an annual growth rate ($\widetilde{y}$) from the time varying trend value, deviation of annual CPI-inflation from trend value ($\widetilde{\pi}$), actual CPI-inflation (π), log of the real effective exchange rate index (q), deviation of the log of real effective exchange rate index from its trend value ($\overline{q}$), the domestic dividend yield (d), deviation of the domestic dividend yield from its trend value ($\widetilde{d}$), and finally, the difference between the foreign (d^*) and domestic dividend yield ($d^* - d$), where the foreign market is the U.S. market for all the other analysed 13 OECD countries.

One point that is much emphasized in the literature related to the estimation of monetary policy rules is the possible bias following from the use of revised data. Typically, macroeconomic variables such as industrial production and consumer price index are not observed immediately, but with some lag. In addition, these variables are often subject to subsequent revisions. Orphanides (2001) points out that the monetary policy rules estimated from revised data may provide misleading results, since the revised data do not correctly reflect the information that the central bankers have at the time they are making the monetary policy decisions. Instead, he argues that real-time data on macroeconomic variables should be used when evaluating monetary policy based on, for example, a Taylor rule.

In our analysis, we have used real-time series of industrial production index and consumer price index obtained from OECD's Main Economic Indicators real-time database [11]. The database contains monthly vintages of industrial

Castro (2011) conducts robustness tests using 3-month money market rates, and finds that results are not significantly altered. Sauer and Sturm (2007) do similar robustness checks for the Eurozone, and come to the same conclusion. Also Belke and Klose (2011), Belke and Polleit (2007) and Surico (2003) use 3-month money market rate as the policy instrument. These previous studies lend support to our choice to use the 3-month money market interest rate as the dependent variable in the estimation of the Taylor rules for the OECD countries, too.

[11] http://stats.oecd.org/mei/

production index and consumer price index starting from February 1999. The real-time series of industrial production index is constructed by extracting the latest value of each vintage corresponding to the observation period. Hence, for example the latest value in the data vintage of February 2004 corresponds to the February 2004 observation in our real-time series. The real-time series for inflation is constructed by subtracting from the log of the most recent value in each vintage the log of the value 12 months earlier in the same vintage, and multiplying the obtained number by 100. The growth rate for industrial production index, where it is used, is constructed in a similar manner. Typically, the publication lag for industrial production index is three months, and for consumer price index one month. Obviously, since the financial market variables are not subject to publication lag or subsequent revisions, there is no need to consider any real-time adjustments. The time series of nominal 3-month money market interest rate, dividend yield and real effective exchange rate index were obtained from Thomson Reuters Datastream.

Since in our empirical analysis we use the deviations of variables from their trend values, a some kind of detrending method is required. A popular way of detrending macroeconomic time series is the Hodrick-Prescott filter. However, according to Hamilton (2016), using the Hodrick-Prescott filter may induce spurious dynamic relations that have no basis in the underlying data generating processes. Hamilton (2016) proposes a simple alternative: In each period, four most recent observations are used to form a h-period linear forecast of the variable in question. The resulting series serves as a proxy for the trend. We apply this detrending procedure to the constructed real-time series of inflation and industrial production index to obtain the trends of these variables. We also apply the procedure to the log of the real effective exchange rate, since we consider the deviation of that variable from its trend value in our analysis, too.

Hamilton (2016) suggests that one should use $h = 8$ for quarterly data and $h = 24$ for monthly data. Although the data we use is of monthly frequency, we decided to use $h = 8$ since our sample is relatively short, and using $h = 24$ would discard a big number of observations from the beginning of the sample.

We did some robustness checks using also $h = 24$, but this did not change the main results significantly. Hence, in obtaining the time-varying trend values of each variable, we have used this simple linear projection method proposed by Hamilton (2016). The countries in our data set are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the UK, and finally, the U.S. The original full sample of data are monthly observations from 1999:2 - 2016:9. It is worth noting that, because of the detrending method that we use, a total of 11 observations are discarded from the beginning of the sample in each country.

[TABLE 1 HERE]

From Table 1 we see that in terms of stationarity/nonstationarity properties there are clearly some problems in the time series data of the Taylor rule variables. First of all, like observed among others also in Enders et al. (2010), the interest rate series in all countries seem to behave like unit root processes, and this might indicate that further analyses of the Taylor rule (TR) should be executed using differenced values of the interest rate series. However, it is well known that the power of unit root tests in small samples is rather weak. Furthermore, almost all the deviation (i.e., gaps calculated against the time-varying trend values) series seem stationary. This is simply due to the fact that the detrending method extracts the stationary component of the series. So basically, the Taylor rule regression equation would seem to contain a mixture of stationary and nonstationary time series right from the beginning, and this is problematic, as we know from the vast amount of unit root and cointegration literature starting from the Engle and Granger (1987) and Johansen (1988) presentations. However, in our analyses part of the effects of the permanent component in the interest rate will be taken into account by using a smoothing version of the TR, that is, by introducing the lagged value(s) of the interest rate to the regression equation. Obviously, the more permanent the interest rate time series is, the closer will be the coefficient on lagged interest rate be to one in the right-hand-side of the TR regression equation.

Furthermore, from Table 1 we also see that in addition to the unit root properties of actual inflation series, especially in the time series of the proposed new variables (dividend yields and real exchange rates) there also seems to be indications that they might actually behave like unit root processes, so in this respect, too, we had to introduce and test various forms of transformations regarding the proposed augmented version of the Taylor rule right from the beginning of our empirical analyses. First of all, as already mentioned, we always included the lagged value of the interest rate to the equation. Second, we considered the real activity variable either as a deviation of the log level of industrial production from its trend value, or as the deviation of the annual change in the monthly value (growth) of that same index. Third, we analysed the role of actual annual inflation and its deviation from the trend value separately, so in the latter case, we wanted to allow for the possibility of the so called 'opportunistic' monetary policy in terms of inflation reactions, like e.g. in Bunzel and Enders (2010). Also the possibility that the actual inflation process might be nonstationary was considered in the model transformations. Finally, the potential role for the new alleged financial market variables, namely the dividend yield and real exchange rate, had to be taken into account in view of their possible unit root properties, too. Hence, we considered the following main set of possibilities when seeking for the best possible (in terms of econometric 'performance') form of the augmented Taylor rule[12] for each of the analysed countries:

[12]This form has been analyzed for example in Bunzel and Enders (2010), and the first empirical results reported in Table 2 were obtained from simple OLS estimations with heteroscedasticity and autocorrelation consistent (Newey-West) standard errors. The next stage of or analysis will utilize forward-looking TR formulations and GMM estimation, but the potential role for the new additional variables in the TR will be revealed to a degree already from these simple first stage estimations.

1) The original, simple Taylor rule without additional variables:

$$i_t = \alpha_0 + \alpha_1 \pi_t + \alpha_2 \overline{y}_t + \rho i_{t-1} + \varepsilon_t,$$

where in addition to the notations given above, α_0 is the constant term, α_1 and α_2 are regression parameters for the actual inflation and real activity deviation from its trend value, ρ is the regression coefficient (smoothing parameter[13]) for the lagged interest rate, and ε_t is the error term. Furthermore, for the inflation variable we alternatively considered the difference of it and for the real activity variable we scrutinized also the deviation of annual growth rate from its trend;

2) An 'opportunistic' Taylor rule with a time-varying inflation target:

$$i_t = \alpha_0 + \alpha_1 \pi_t + \alpha_2 \overline{y}_t + \alpha_3 \widetilde{\pi}_t + \rho i_{t-1} + \varepsilon_t,$$

where in addition to the notations given above, $\widetilde{\pi}_t$ describes the deviation of inflation from its trend value, and α_3 is its regression coefficient. Also for this representation we considered the other possibilities for measuring the real activity and inflation variables as in case 1);

3) An augmented (and possibly 'opportunistic') Taylor rule, where the augmentation considers the currency and stock market information as additional policy variables;

$$i_t = \alpha_0 + \alpha_1 \pi_t + \alpha_2 \overline{y}_t + \alpha_3 \widetilde{\pi}_t + \alpha_4 q_t + \alpha_5 d_t + \rho i_{t-1} + \varepsilon_t,$$

where the new notations denote q_t as the log of real effective exchange rate, d_t as the dividend yield, and α_4, α_5 are their regression coefficients, respectively. We also considered the role of these additional information in the form of deviations from their trend values and also by replacing the exchange rate variable by the difference between foreign and domestic dividend yields, as suggested by the system of equations (8) given in section 2. In addition, in the empirical analyses

[13]Based on obtained parameter estimates the actual policy response coefficients regarding inflation (g_π) and real activity deviation (g_y) can be calculated from (1-ρ)g_π =α_1 and (1-ρ)g_y =α_2, and based on this same idea it would be possible to calculate the 'policy response coefficients' for the potential additional new variables in the TR, too.

we will especially focus on the role of additional financial market information as instruments variables in the GMM estimation of the forward looking Taylor rule.

4. Empirical results

4.1. Results for the contemporaneous Taylor rule using real time data

Table 2 reports the results from OLS regressions with Newey-West standard errors for the real-time values of the policy variables in the Taylor rule. For each country we report the best (in terms of the goodness of fit) obtained form of the regression equation, where the selection criteria were based on the significance of the obtained parameter estimates, and the Schwarz information criterion. The results in Table 2 give us the first-stage indication on the role of stock and currency market information in the Taylor rule. It seems that only in the cases of Japan and the U.S. the information from financial markets is not relevant in the contemporaneous Taylor rule when the simple currency and stock market information are included as actual additional policy variables. In all the other cases the dividend yield and/or the log of real exchange rate and/or the dividend yield spread is/are relevant in terms of improving the econometric fit of the Taylor rule, as measured by the Schwarz information criterion. Both the currency and stock market information would seem to have an important role in Belgium, Canada, France, Italy, the Netherlands, Sweden and the UK. In addition, only the stock market information is relevant in Austria, Denmark, Finland, Germany, and Norway.

Perhaps the most striking finding in these results is that the sign of the estimated coefficient on dividend yield is negative in all cases where the aforementioned variable enters the Taylor rule, that is, for all the other countries except Japan and the U.S. This indicates a loosening monetary policy reaction as the prices in the stock market decrease, i.e., when the dividend yield increases. According to our results, the monetary policy for example in Norway and the UK has not followed the Taylor rule principle, because the traditional policy variables would seem to have no role to play in affecting the short-term interest rate at all. Also, in small EMU countries like Austria, Belgium, and the Netherlands, the estimated coefficients of the traditional Taylor rule policy variables are not statistically significant. However, this is true for the core EMU economies like Italy and France, too. For Germany, the parameter estimate on the real growth deviation is significant at 5 % level, but on the differenced inflation it is not significant. This seems somewhat strange considering the historically hawkish attitude of German policymakers towards high inflation, and the allegedly big influence of Germany's economic outlook in the monetary policy of the European Central Bank. These results might indicate that central banks simply do not consider contemporaneous values of policy variables when making monetary policy decisions, but are rather forward-looking. For the part of all the Euro area countries we naturally have to remember that the common monetary policy from the beginning of 1999 has most likely not been guided by the development of smaller union countries, but more likely it has been based on the economic performance of the big core countries like France, Germany and Italy in our data set. Hence, in what follows when we discuss the results based on a forward-looking TR representation, it is useful to divide the reporting of results into subgroups of the analyzed countries based on viewing e.g. the smaller and larger members of the Euro area separately. But already from these first-stage results we clearly see that the information from currency and stock markets might have a strong role to play in the empirical analysis of the Taylor rule for these countries.

Finally, one thing worth to mention already from these results is the strong influence of the lagged interest rate in the estimated Taylor rules. In our sample, as seen from the unit root tests reported in Table 1, the short-term rates seem to exhibit unit root behavior. This in turn clearly shows up in the values of the estimates for the coefficient on the lagged interest rate (ρ) which is very close to one in all countries, and for Belgium, the estimated coefficient is in fact above one. This is not surprising, since high values of the estimated smoothing parameter have also been found in the earlier literature. Moreover, we have to keep in mind that in monthly data, the role of sluggish interest rate adjustment tends to be even more apparent than for example in quarterly data. Furthermore, our sample covers the period when the short-term nominal interest rates have more or less been stuck at zero or below it, which partly contributes to the dominating role of the lagged interest rate in the estimated Taylor rules[14].

[TABLE2 HERE]

4.2. Results for the forward looking Taylor rule

4.2.1. The core EMU countries

In Table 3a we report the results from GMM-estimation[15] of a forward looking Taylor rule for the core EMU countries France, Germany and Italy. We used two forward looking time horizons, i.e., 3 and 12 months. In contrast to the results reported in section 4.1, here we especially wanted to focus on the role of stock and currency market variables as additional instruments in the GMM-estimation of the forward looking Taylor rule, because the forward-looking specification is the more relevant one in case of including the financial market information to the Taylor rule analysis based on our background model

[14] Note that we analyzed also the role of stock and currency market information in a model, where we controlled for the effects of zero lower bound interest rate era after the 2008 - 2009 crisis by introducing a dummy variable to all the OLS regressions for the country-specific Taylor rules. For most countries the dummy variable proved not to be statistically significant in the contemporaneous Taylor rule regressions. However, in the case of the forward looking rules discussed in the next section the coefficient on the zero interest rate era dummy was negative and statistically significant for most countries. This indicates that it captured well the more or less permanently lower mean (zero) value of the short-term interest rates since the onset of 2008 - 2009 crisis (after the Lehman Brothers bankruptcy in September 2008). However, more importantly, its inclusion to the regression model did not have almost any role on either the significance or signs of the parameter estimates for our main interesting additional regressors, i.e., the dividend yield and the real exchange rate. These additional results not reported in this paper are available from the authors upon request.

[15] We acknowledge that the GMM estimation with HAC standard errors does not control for contemporaneous correlation in the error terms across countries, but because most of the previous studies analyzing the forward-looking Taylor rules have used this estimation procedure, we will use it also in our analysis.

(8)[16]. In the standard Taylor rule the set of instruments always includes a constant, 3 lags (for 3-month horizon) or 12 lags (for 12 months horizon) of the policy variables (inflation and real activity deviation), and always two lags of differenced values of the interest rate. In the lower panel of all the Tables 3a-3d we report the effects of additional instruments in the GMM estimation, where the possibilities for the form of additional financial market based information are the contemporaneous values of the domestic dividend yield (d_t), the dividend yield difference against the US market ($d_t^* - d_t$), the log of real effective exchange rate (q_t), and the deviation of the log of effective exchange rate from its time-varying trend values ($\widetilde{q}_t$). In addition to the role of individual variables from the stock or currency markets, we also scrutinized their joint effects, i.e., including e.g. the domestic dividend yield and the log of real effective exchange rate together into the set of instruments.

Based on the results reported in Table 3a we see that there clearly is a role for the financial market information in the formulation of the forward looking Taylor rule already for the three big core countries of the Euro area. The parameter estimates for the policy variables remain more or less the same in terms of their statistical significance, but in 5 out of 6 cases (the exception being the 12-month horizon rule for Germany) the sum of squared residuals value improves, so there is at least marginal improvement in these cases when the financial market information is included as additional instrumental variable information to the GMM regressions. Furthermore, according to the Hansen J-test statistics the inclusion of financial market variables improves the validity of the instrument set in terms of increasing the p-values associated with the test statistics, although only marginally in some cases. A three-month horizon rule for France is the only case for which the null hypothesis of instrument validity is rejected at 10 % significance level, even after including the financial market

[16]Here we follow the usual practice in most of the previous studies (see e.g. Castro 2011) by estimating all the forward looking Taylor rule regressions using the Generalized Method of Moments (GMM) approach.

variables as instruments.

Regarding the interpretation of the policy variable parameter estimates, the change in future inflation would seem to have been informative for the 12-month horizon in France at 10 % percent significance level, whereas the future level of inflation has been relevant in Germany at 12-month horizon at 1 % significance level. Future deviations of real activity from its time varying trend have been important in the Taylor rule at the short horizon in every core country at 1 % level. However, the important new finding is here that in all cases the best fitting Taylor rule requires the inclusion of some form of financial market information, either in the form of dividend yield, log of real exchange rate, or both the dividend yield and the log of real exchange rate or its deviation from the time-varying trend value.

[TABLE 3a HERE]

4.2.2. The small EMU countries

The GMM estimation results for the forward-looking rules in small EMU countries (Austria, Belgium, Finland and the Netherlands) are presented in Table 3b. Again, adding financial market variables into the instrument set reduces the value of the sum of squared residuals in all but one case, this being the 12-month horizon rule for the Netherlands. Also, the p-values associated with the J-test statistics increase for all countries except Finland. An interesting finding is now that the set of best additional instruments includes here the difference between the US and domestic dividend yields in most countries.

When looking at the estimated coefficients on policy variables in the rules without additional financial market instruments, we can see that inflation (in levels or in first differences) is a statistically significant regressor at least at 10 % level at some horizon in every country except the Netherlands. The same applies for the output gap. This result is quite interesting in the light of the fact that the ECB has stated that its main policy goal is to maintain steady inflation in the Euro area, and it has not explicitly announced to be targeting the real economy growth or fluctuations. As a whole, our results for the small euro area countries indicate that also their real activity has been targeted to a degree in the conduct of the ECB interest rate policies.

When the financial market variables are added into the set of instruments, the magnitudes of the estimated coefficients stay more or less the same. However, in many cases the estimated coefficients become more precise, i.e. their associated p-values become smaller. Furthermore, with additional instruments, the coefficient on output gap is significant at least at 10 % level now also for the Netherlands for both horizons. For Finland, the sign of the coefficient of output gap changes to positive, which seems theoretically more reasonable. Of course, when analyzing these results, one must remember that none of the countries reported in Table 2 has conducted autonomous monetary policy during the sample period. Hence, it might not be meaningful to talk about economically reasonable coefficient signs, since it is likely that the monetary policy of ECB has been conducted more in terms of the big economies than the small economies analyzed in this section.

All in all, from these results we can conclude that for the small EMU countries, the role of additional financial market information in the set of instrumental variables is clearly even more important than for the big countries. Again, we have to note that it would be somewhat mysterious to claim that the ECB monetary policy actions would have so much taken into account the behaviour of the stock market returns or real exchange rates of the small EMU member countries. Nevertheless, in general in our sample the financial market information from the small union countries has had some role to play in determining the level of short-term interest rates during the analyzed time period of 1999:2 - 2016:9.

[TABLE 3b HERE]

4.2.3. The big countries outside the EMU

Results for the big OECD countries outside the EMU (Japan, the UK and the U.S.) are reported in Table 3c. For these countries the main conclusions regarding the role of financial market information are more or less the same than for the big core EMU countries. Including financial market variables improves the validity of the GMM instrument set as measured by the p-value associated with the Hansen J-test in all cases except for the Japanese 3-month horizon Taylor rule, and both 3 and 12-month horizon rules for the U.S. The result regarding the U.S. is in line with e.g. the results of Fuhrer and Tootell (2008) who found that the Fed has not reacted to financial market information as measured by equity prices. Instead, the Fed seems to have reacted to future levels of the traditional Taylor rule variables, that is, inflation and output gap especially at 12-month horizon.

Japan is a somewhat problematic country in our sample, since the Bank of Japan has conducted zero interest rate policy during more or less the whole of our sample period, and therefore the variation in the short-term rates has been minimal. This can also be seen from the sum of squared residuals computed from the estimated Taylor rules that incorporate interest rate smoothing. Nevertheless, we obtain statistically significant parameter estimates for output gap in the 3-month horizon rule, and for both the output gap and differenced inflation in the 12-month horizon rule. The estimated negative signs of the coefficients on the differenced inflation in the 12-month rule could perhaps be motivated by the fact that during our sample period, Japan has experienced deflation while the short-term rates have already been stuck at zero level, making the relationship between inflation and short-term rate rather perverse. Adding financial market variables into the instrument set improves the J-test statistic for both the 3- and 12-month horizon rules, but the sum of squared residuals is in fact marginally higher for the 3-month rule.

For the UK data the results remain pretty much the same after including the financial market information to the instrument set. In other words, the main interest in short-term interest rate policy has been in focusing on future output gap at short-term horizon. Future inflation does not seem significant in explaining the current short-term rate, which is somewhat puzzling since the Bank of England has publicly announced an inflation targeting policy. Again, as in the case of Japan, this result could be possibly motivated by noting that the Bank of England has kept the policy rates essentially at zero from 2009 onwards, which might in part distort the conventional relationship between inflation and monetary policy.

It is worth to note that although the inclusion of financial market variables into the instrument set improves the J-test statistic, the sum of squared residuals actually increases in 3 out of 6 estimated rules, implying a worse fit. Hence, in the case of big countries outside the EMU, it might be not straightforward to claim that including financial market information in the instrument set better explains the monetary policy decisions.

[TABLE 3c HERE]

4.2.4. The small countries outside the EMU

In our data set the small OECD countries (in terms of their international role in the global economy in general) outside the EMU are Canada, Denmark, Norway and Sweden. In these data the role of additional financial market information in view of affecting also to the role of fundamental policy variables in the Taylor rule is also rather strong. Additional financial market variables in the instrument set improve the J-test statistics in all cases. In addition, the sum of squared residuals decreases in most cases. In the estimated rules without financial information in the instrument set, it seems that in all countries except Denmark, the future inflation or its difference at 12-month horizon has had a significant role in central banks' monetary policy decisions. Also, it is worth mentioning that in all countries except Norway, the future output gap has a notable role according to our results. When we add the financial market information into the set of instruments, the parameter estimate on the output gap becomes significant at 5 % level also in Norway at 12-month horizon.

Excluding Denmark, all the central banks of the countries analyzed in Table 3d have declared publicly to have been low inflation targeters during the analyzed time period. Our results partly verify these claims. For Canada, the estimated sign of the coefficient on the future change in inflation is negative, which does not seem reasonable.

[TABLE 3d HERE]

4.3. Results for the forward looking opportunistic Taylor rule

Tables 4a - 4d report the empirical results from GMM estimation with Newey-West HAC standard errors for the forward-looking opportunistic Taylor rule, again at 3- and 12-month horizons. The fundamental regression equation is now $i_t = \alpha_0 + \alpha_1 \pi_{t+k} + \alpha_2 \widetilde{\pi}_{t+k} + \alpha_3 \overline{y}_{t+p} + \rho i_{t-1} + \varepsilon_t$, where α_0 is the constant term, α_1, α_2 are the regression parameters for the actual future inflation (π_{t+k}), and its deviation from the time-varying trend value ($\widetilde{\pi}_{t+k}$), indicating the opportunistic monetary policy rule regarding the inflation target, and α_3 is the regression parameter on the future real activity deviation from its trend value ($\overline{y}_{t+p}$). In Tables 4a - 4d we consider only the version of the TR where the actual inflation is in levels on the RHS of regression equation. ρ is the regression coefficient (smoothing parameter) for the lagged interest rate, and ε_t is the error term. For all the other notations and explanations see Table 3a.

[TABLE 4a HERE]
[TABLE 4b HERE]
[TABLE 4c HERE]
[TABLE 4d HERE]

Table 4a reports the results for the core EMU countries (France, Germany and Italy). Based on viewing the statistical significance of the parameter estimates on the standard policy variables, the opportunistic Taylor rule, i.e., a rule reacting on the deviations of the perceived future inflation from its time-varying trend, has been valid for 12-month horizon in Germany and Italy. The estimated coefficient is negative for Germany, implying that when the German inflation has exceeded its target level (the proxy of which we take to be the time-varying trend of inflation), the ECB's policy stance has actually been more passive regarding inflation. Again, this is a result that is difficult to justify on the grounds of the ECB's announced mandate and the overall role of Germany in originally formulating the European Monetary System (EMS). For Italy, the estimated coefficient is positive, which seems more reasonable.

However, the results for the TR without financial market instruments change quite a bit when the information from stock and currency markets is included to the estimation of the opportunistic Taylor rule. With added financial market information, the opportunism is still observed for Germany (with a more precise estimate) but not for Italy. Instead, the deviation of inflation from its time-varying trend is now significant for France at 12-month horizon, too. As in the case of forward-looking rules without the inflation deviation term, the role of future output gap is prominent at both shorter and longer horizons. An exception is Germany, for which the output gap is significant only at the short horizon.

In Table 4b we present the estimation results of the opportunistic rule for the small EMU countries (Austria, Belgium, Finland, and the Netherlands). For some of these countries there are clear signs of opportunistic rule already for the standard version without the financial market information, too. The inclusion of financial market information does not considerably change the results, except perhaps for the Netherlands, where the estimated coefficient on inflation gap becomes more precise after the inclusion of financial market variables into the instrument set. Regarding the signs and magnitudes of the estimated coefficients, it is rather striking that the absolute values of the estimates of the inflation gap term for Austria and Belgium are quite large. Furthermore, it is curious that the ECB's monetary policy stance towards inflation in Austria seems to be linked only to the longer-term inflation, while the opposite is true for Belgian inflation. For Finland and the Netherlands, the inflation gap is significant at 12-month horizon. Again, as in the case of estimated forward-looking rules without the inflation deviation term, adding financial market variables into the instrument set improves the validity of instruments in almost all cases. Also the fit as measured by the SSR is enhanced in all but one case, this being the 3-month horizon rule for Finland.

Table 4c gives the empirical results from analyzing the opportunistic rule for the big countries outside the EMU, i.e. Japan, the UK and the U.S. For these countries, there is only little evidence of opportunistic monetary policy rules. For the standard case without additional financial market information, none of the countries seem to have followed an opportunistic monetary policy rule. The results suggest that the monetary policy has focused on the future inflation at 12-month horizon in Japan and the U.S., but not in the U.K., as also implied by the results in Table 3c. When adding the financial market variables into the set of GMM instruments, we obtain some evidence that the Bank of Japan might have conducted opportunistic monetary policy at 12-month horizon, as the coefficient on the inflation gap becomes statistically significant at 10 % level. Also, the inclusion of financial market information makes the coefficients on the output gap statistically significant at both horizons. This might imply that the Bank of Japan has indeed utilized financial market information, in the form of dividend yield and real exchange rate, to forecast the future real economic activity when making its monetary policy decisions. For the U.K. and the U.S., the inclusion of financial market information does not seem to change the results notably. Again, it needs to be stressed out that obviously the extreme actions of quantitative easing, and the almost zero-level of steering rates in all the countries here, too, during the global financial market turmoil, might adverse the obtained results strongly. Hence, the inclusion of money supply variable to the analysis, or alternatively, controlling of this extreme period by sub-sample analysis or an estimation procedure utilizing time varying parameters would be an appropriate solution in the future analyses of these data.

Table 4d reports the results for the small countries outside the EMU. Without the additional financial market variables in the instrument set, there is some evidence for an opportunistic monetary policy rule in Denmark and Norway at

12-month horizon. However, it is worth noting that the estimated coefficient on the actual inflation in levels, is not significant for Denmark. This makes the result difficult to interpret. When we add the financial market variables into the set of instruments, the results change quite drastically. With added instruments, the estimated rules suggest that the central banks of Denmark and Norway have followed an opportunistic rule also at the shorter horizon. Also for Sweden there is strong evidence in support of the opportunistic rule at longer horizon. In the case of this country set, the adding of financial market variables does not in fact seem to improve the validity of the instrument set as much as in the case of forward-looking rules without the inflation deviation term, as the p-values associated with the Hansen J-test statistic decrease in 4 out 8 cases, whereas for the forward-looking rules without inflation deviation the p-values increased in all cases.

5. Conclusions

Since the onset of the current global financial market and aggregate economic crisis the contents of the actual information set that the central banks use when formulating their monetary policy targets and actions has been under special attention. In this paper we have analysed the role of fairly simple forms of stock and currency market information in this respect. In our analysis the background for the inclusion of this information especially in the form of dividend yield and real exchange rate data stems from a system of partial equilibrium conditions. According to our results the central banks of the analysed 14 OECD countries, where one subset of them forms an essential part of the EMS and the European Central Bank (ECB) during the analysed time period of 1999-2016 might have indeed taken into account the financial market information for example in these forms as instrumental variables when formulating their monetary policy actions. Especially in small OECD countries, irrespective of whether they are members of the ECB system or not, the role of the standard Taylor rule policy variables, i.e., inflation and real economic activity deviations is highly sensitive to the inclusion of the financial market variables as instrumental variables in the analysis of the Taylor rule. Especially the role of stock market seems to be highly relevant in this respect. In addition, the recent monetary policy actions in many OECD countries actually would seem to have been opportunistic to a degree, indicating that it is not reasonable to assume that the inflation target actually would have remained constant, at least not in the short term policy actions.

In our empirical analyses we have mainly used a forward-looking Taylor rule specification with real-time data, that is more appropriate than e.g. the standard ex post form especially when the analysis involves financial market information. We have also included the interest rate smoothing term (i.e., the lagged values of the interest rate) to the rule, and in many cases the parameter estimate value of it is one or even slightly higher than one, indicating the dominating role of past levels of interest rates in monetary policy actions. For the main part this result is naturally dictated by the most recent data, where the interest rate changes in most of the analysed OECD countries have been almost zero for clearly over 3 years now. Also Bunzel and Enders (2010) obtained the smoothing parameter values (clearly) over one for the one period lagged interest rate for an earlier time period, but the inclusion of the second lag in their analysis retained the alleged stationarity properties of the interest rate process, because the sums of the lagged parameter values were always below one. However, our results might also indicate that first of all, especially for the most recent data periods the analysis of the augmented Taylor rule should be executed using recursive or rolling estimation techniques. Furthermore, also the role of nonlinearities for example in the time series processes of the additional instrumental variables or in their effects on the traditional Taylor rule policy variables and their parameter coefficients should be taken into account. These are the subjects of our further analyses, but already based on the results obtained from these simple forward-looking (and opportunistic) linear Taylor rule examinations, the role of financial and currency market information seems to be highly important in the real-time data from some of the OECD countries.

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Table 1:
Descriptive Statistics

Table 1 presents sample means, standard deviations and the results from the augmented Dickey-Fuller-tests (ADF, H_0: unit root) and Kwiatkowski-Phillips-Schmidt-Shin-tests (KPSS, H_0: stationarity), and the significance levels for both these test statistics are denoted by = 10 %, = 5 %, and = 1 %. The analyzed variables are: i = the nominal 3-month money market interest rate, $\widetilde{y}$ = deviation of the real growth (measured by annual change of the industrial production index) from its trend value, $\widetilde{\pi}$ = deviation of annual CPI-inflation from its trend value, $\overline{y}$ = deviation of the level of real economic activity (log of industrial production index) from its trend value, π = actual CPI-inflation, q = log of the real effective exchange rate index, $\overline{q}$ = deviation of the log of real effective exchange rate index from its trend value, d = the domestic dividend yield, $\widetilde{d}$ = deviation of the domestic dividend yield from its trend value, and d^* = the foreign (US) dividend yield. The trends of the variables in question have been obtained by Hamilton's (2016) linear projection method with $h = 8$ and $p = 4$.

Country/Variable	i	$\widetilde{y}$	$\widetilde{\pi}$	$\overline{y}$	π	q	$\overline{q}$	d	$\widetilde{d}$	$d^* - d$
Austria										
Mean	2.13	0.00	0.00	0.00	1.83	4.65	0.00	2.36	0.00	-0.46
Stdev	1.64	5.31	0.73	5.04	0.88	0.02	1.45	0.86	0.72	0.67
ADF	-1.16	-5.34***	-5.35***	-4.07***	-2.63*	-2.96**	-2.8*	-2.48	-2.96**	-2.28
KPSS	2.74**	0.36*	0.24	0.27	0.16	0.48**	0.21	1.34***	0.45*	0.33
Belgium										
Mean	2.13	0.00	0.00	0.00	1.92	4.59	0.00	3.29	0.00	-1.39
Stdev	1.64	5.47	1.04	6.65	1.23	0.04	2.07	1.78	1.63	1.63
ADF	-1.16	-3.85***	-2.51	-3.50***	-2.90**	-1.93	-3.73***	-4.76***	-2.63*	-3.85***
KPSS	2.74***	0.09	0.37*	0.51**	0.26	1.68***	0.20	0.23	0.14	0.39
Canada										
Mean	2.33	0.00	0.00	0.00	1.91	4.48	0.00	2.43	0.00	-0.54
Stdev	1.57	4.12	0.88	3.63	0.90	0.11	5.33	0.62	0.40	0.20
ADF	-1.59	-3.90***	-3.06**	-3.52***	-2.73*	-1.78	-3.84***	-1.87	-3.76***	-3.13**
KPSS	2.85***	0.20	0.97***	0.22	0.73**	2.32***	0.29	3.20***	0.42*	1.28***
Denmark										
Mean	2.39	0.00	0.00	0.00	1.86	4.59	0.00	1.78	0.00	0.12
Stdev	1.78	5.33	0.72	4.70	0.90	0.03	2.02	0.48	0.43	0.42
ADF	-0.86	-4.89***	-3.05**	-4.62***	-1.68	-1.95	-4.17***	-2.23	-3.21**	-2.74*
KPSS	2.67***	0.23	0.61**	0.59**	1.32***	1.09***	0.20	0.76***	0.44*	2.29***
Finland										
Mean	2.13	0.00	0.00	0.00	1.61	4.63	0.00	3.46	0.00	-1.56
Stdev	1.64	6.94	0.97	5.55	1.29	0.03	2.35	1.30	0.95	0.95
ADF	-1.16	-4.74***	-3.26**	-3.72***	-2.62*	-2.77*	-4.14***	-2.36	-4.64***	-2.31
KPSS	2.74***	0.55**	0.23	0.21	0.27	1.63***	0.43*	1.77***	0.32	0.91***
France										
Mean	2.13	0.00	0.00	0.00	1.40	4.60	0.00	3.23	0.00	-1.33
Stdev	1.64	3.64	0.72	3.73	0.85	0.04	2.10	0.79	0.62	0.53
ADF	-1.16	-4.37***	-1.95	-3.89***	-1.86	-1.20	-3.72***	-2.56	-3.98***	-2.53
KPSS	2.74***	0.32	0.96***	0.68**	0.91***	1.15***	0.49**	1.49***	0.31	0.38*
Germany										
Mean	2.13	0.00	0.00	0.00	1.46	4.62	0.00	2.54	0.00	-0.64
Stdev	1.64	5.39	0.65	4.96	0.80	0.04	2.46	0.76	0.54	0.42
ADF	-1.16	-3.15**	-2.73*	-3.74***	-2.44	-1.84	-1.97	-2.38	-3.58***	-2.32
KPSS	2.74***	0.09	0.64**	0.51**	0.50**	1.79***	0.51**	2.25***	0.43**	0.57**

table 1 continues

table 1 continues

Country/Variable	i	$\widetilde{y}$	$\widetilde{\pi}$	$\overline{y}$	π	q	$\overline{q}$	d	$\widetilde{d}$	$d^{*}-d$
Italy										
Mean	2.13	0.00	0.00	0.00	1.70	4.60	0.00	3.55	0.00	-1.65
Stdev	1.64	5.05	2.55	4.17	2.50	0.04	2.25	1.33	1.06	1.15
ADF	-1.16	-3.54***	-12.34***	-3.83***	-12.49***	-1.90	-3.62***	-2.50	-3.45**	-2.25
KPSS	2.74***	0.29	0.83***	0.47**	1.00***	0.81***	0.28	0.78***	0.20	0.58**
Japan										
Mean	0.27	0.00	0.00	0.00	0.04	4.56	0.00	1.47	0.00	0.42
Stdev	0.25	8.26	0.89	6.80	1.04	0.16	7.67	0.61	0.33	0.30
ADF	-2.14	-3.37**	-2.37	-3.96***	-2.53	-1.53	-3.26**	-1.32	-3.96***	-2.10
KPSS	0.50**	0.15	0.58**	0.36*	0.87***	2.74***	0.29	3.27***	0.34	0.71**
Netherlands										
Mean	2.13	0.00	0.00	0.00	1.95	4.61	0.00	3.17	0.00	-1.27
Stdev	1.64	4.25	0.78	3.87	1.04	0.04	2.22	0.97	0.86	0.77
ADF	-1.16	-4.81***	-4.42***	-5.42***	-1.69	-2.15	-3.94***	-3.03**	-3.33**	-2.70*
KPSS	2.74***	0.31	0.56**	0.45*	1.39***	0.67**	0.23	0.48**	0.14	0.66**
Norway										
Mean	3.67	0.00	0.00	0.00	2.01	4.55	0.00	3.26	0.00	-1.36
Stdev	2.15	4.61	1.04	3.65	1.10	0.05	4.25	1.13	0.90	0.77
ADF	-1.91	-8.01***	-3.75***	-5.79***	-4.35***	-2.53	-3.54***	-2.54	-3.47***	-2.82**
KPSS	2.54***	0.28	0.17	0.34	0.18	0.55**	0.33	2.31***	0.64	1.21***
Sweden										
Mean	2.30	0.00	0.00	0.00	1.17	4.65	0.00	2.90	0.00	-1.00
Stdev	1.61	6.12	1.01	4.83	1.20	0.05	4.11	0.89	0.72	0.56
ADF	-1.15	-3.71***	-3.94***	-3.11**	-2.66*	-2.10	-2.75**	-2.81*	-3.92***	-3.09*
KPSS	2.68***	0.25	0.42*	0.64**	0.48**	1.50***	0.48**	1.80***	0.50**	0.48**
UK										
Mean	3.10	0.00	0.00	0.00	2.40	4.75	0.00	3.34	0.00	-1.45
Stdev	2.21	2.67	0.96	2.49	1.11	0.10	4.90	0.61	0.48	0.38
ADF	-0.93	-4.85***	-2.60*	-4.10***	-1.70	-1.26	-2.63*	-2.51	-3.62***	-2.15
KPSS	3.21***	0.22	0.46	0.38*	0.57**	2.79***	0.27	1.05***	0.38*	0.98***
US										
Mean	1.82	0.00	0.00	0.00	2.16	4.68	0.00	1.90	0.00	NA
Stdev	2.02	3.35	1.24	3.10	1.29	0.08	4.40	0.50	0.31	NA
ADF	-1.75	-3.71***	-2.18	-4.12***	-1.52	-1.49	-2.81*	-1.59	-3.73***	NA
KPSS	2.44***	0.11	0.79***	0.39*	0.88***	2.41***	0.31	3.40***	0.45*	NA

Table 2:
Results from the estimation of the linear Taylor rule using real-time data

The results are based on OLS-estimation with Newey-West HAC standard errors. The dependent variable is the nominal 3-month interest rate (i_t), and the fundamental regression equation (for the augmented model, that nests the original simple Taylor rule rule, too), is $i_t = \alpha_0 + \alpha_1\pi_t + \alpha_2\overline{y}_t + \alpha_3\widetilde{\pi}_t + \alpha_4 q_t + \alpha_5 d_t + \rho i_{t-1} + \varepsilon_t$,where α_0 is the constant term, $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$ are the regression parameters for the actual inflation (π_t), real activity deviation from its trend value $(\overline{y}_t)$, the deviation of inflation from its trend value (indicating the 'opportunistic' Taylor rule) $(\widetilde{\pi}_t)$, the log of real effective exchange rate (q_t), and the dividend yield (d_t),respectively. ρ is the regression coefficient (smoothing parameter) for the lagged interest rate, and ε_t is the error term. For the part of augmentation variables (the stock and currency market information), we also tested for versions involving the deviation of the log of real effective exchange rate from its trend value $(\overline{q}_t)$, the deviation of the dividend yield from its trend value $(\widetilde{d}_t)$, and the difference between foreign and domestic dividend yields $(d_t^* - d_t)$. Δ refers to the use of differenced values of the variable in question, except for the real activity variable, where it indicates the annual growth rate of the monthly index value. For the variables in question, the trend value is obtained by Hamilton's (2016) linear projection method with $h = 8$ and $p = 4$. For each country we report the best fitting Taylor rule, in terms of the econometric fit, i.e., based on the Schwarz information criterion, and the significance of the estimated regression parameters. The Newey-West procedure uses six lags in the Bartlett lag window. The reported goodness of fit statistics are the values for the Schwarz information criteria (SIC), the coefficient of determination (R^2) and the Breusch-Godfrey LM-test value (with p-value in parentheses) for testing general form of autocorrelation in the residuals. Below the values for regression coefficients we give the p-values for the null of zero coefficient in parentheses.

Variables/Country	Aus	Bel	Can	Den	Fin	Fra	Ger	Ita	Jap	Net	Nor	Swe	UK	US
Traditional policy variables in the Taylor rule														
Constant	0.255	-3.342	0.149	0.245	0.339	-3.776	0.330	-4.823	0.004	-4.739	0.556	0.430	-4.059	0.045
	(0.006)	(0.111)	(0.021)	(0.027)	(0.000)	(0.014)	(0.002)	(0.034)	(0.214)	(0.013)	(0.004)	(0.000)	(0.028)	(0.093)
π_t	-	-	-	-	-	0.024	-	-0.001	0.002	-0.016	-0.021	0.054	0.014	-0.025
						(0.250)		(0.701)	(0.485)	(0.277)	(0.331)	(0.002)	(0.367)	(0.144)
$\Delta\pi_t$	0.051	0.035	0.036	0.171	0.042	-	0.061	-	-	-	-	-	-	-
	(0.148)	(0.242)	(0.038)	(0.078)	(0.194)		(0.225)							
$\overline{y}_t$	0.005	-0.002	0.007	0.013	0.009	0.005	-	0.003	0.002	-	-	0.009	-	-
	(0.112)	(0.471)	(0.090)	(0.000)	(0.000)	(0.177)		(0.451)	(0.000)			(0.010)		
$\widetilde{\pi}_t$	-	-	-	-	-	-	-	-	-	-	-	-	-	-
$\Delta\overline{y}_t$	-	-	-	-	-	-	0.007	-	-	0.002	0.009	-	0.001	0.014
							(0.029)			(0.274)	(0.106)		(0.932)	(0.005)
i_{t-1}	0.982	1.013	0.973	0.973	0.966	0.957	0.973	0.998	0.977	1.000	0.963	0.935	0.949	0.991
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Variables in the augmented Taylor rule														
q_t	-	0.762	-	-	-	0.927	-	1.104	-	1.120	-	-	0.969	-
		(0.097)				(0.021)		(0.011)		(0.007)			(0.020)	
$\overline{q}_t$	-	-	0.008	-	-	-	-	-	-	-	-	0.011	-	-
			(0.005)									(0.016)		
d_t	-0.099	-0.061	-	-0.114	-0.080	-0.138	-0.112	-0.075	-	-0.127	-0.122	-0.125	-0.131	-
	(0.002)	(0.000)		(0.018)	(0.000)	(0.000)	(0.001)	(0.001)		(0.000)	(0.001)	(0.000)	(0.027)	
$d_t^* - d_t$	-	-	0.197	-	-	-	-	-	-	-	-	-	-	-
			(0.032)											
Model Statistics														
R^2	0.993	0.994	0.987	0.991	0.994	0.994	0.993	0.993	0.973	0.994	0.988	0.991	0.994	0.987
SIC	-1.026	-1.065	-0.574	-0.587	-1.108	-1.048	-1.053	-0.946	-3.388	-1.199	0.012	-0.806	-0.510	-0.118
LM-test	30.688	25.550	5.477	10.742	18.922	28.336	28.392	32.530	17.086	14.708	8.282	26.978	21.818	7.926
	(0.000)	(0.000)	(0.019)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.005)

Table 3a:

Results from the estimation of the forward looking Taylor rule for the core EMU countries

We report the results from GMM-estimation with Newey-West HAC standard errors. The fundamental regression equation is now $i_t = \alpha_0 + \alpha_1 \pi_{t+k} + \alpha_2 \overline{y}_{t+p} + \rho i_{t-1} + \varepsilon_t$,where the dependent variable is the nominal 3-month interest rate (i_t), α_0 is the constant term, and α_1, α_2 are the regression parameters for the actual future inflation (π_{t+k}) and future real activity deviation from its trend value $(\overline{y}_{t+p})$. ρ is the regression coefficient (smoothing parameter) for the lagged interest rate, and ε_t is the error term. We analyze two forward looking horizons ($k, p = 3$ and 12 months), and use actual realized future values in place of e.g. generated, or questionnaire based expected values for the traditional policy variables. The upper panel reports the GMM-results for the standard TR, where the set of instruments includes a constant, 3 lags (for 3-month horizon) or 12 lags (for 12 months horizon) of the policy variables (inflation and real activity deviation), and always two lags of differenced values of the interest rate. In the lower panel we report the effects of additional instruments in the GMM estimation, where the possibilities for the form of additional information are the contemporaneous values of the domestic dividend yield (d_t), the dividend yield difference against the US market $(d_t^* - d_t)$, the log of real effective exhcange rate (q_t), and the deviation of the log of effective exchange rate from its trend values $(\widetilde{q}_t)$. In addition to the role of individual variables from the stock or currency markets, we also scrutinized their joint effetcs, i.e., including e.g. the domestic dividend yield and the log of real effective exchange rate together into the set of instruments. We also examined the role of using differenced values of inflation in the rule, and report the paramater estimates if that specification proved better in terms of econometric fit. In the lower panel the reported results on additonal stock and currency market instruments are based on the best fitting Taylor rule in terms of the significance of the estimated regression parameters, the value of the test statistics and its p-value for the Hansen's J-test regarding the validity of overidentifying restrictions on the set of instruments, and the value of the sum of squared residuals (SSR). The Newey-West procedure uses again always six lags in the Bartlett lag window. Below the values for regression coefficients we give the p-values for the null of zero coefficient in parentheses, and the significance levels for the parameter estimates are denoted by $= 10$ %, $= 5$ %, and $= 1$ %.

Variables/Country	Fra		Ger		Ita	
Horizon (k, p in months)	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets						
Constant	-0.014	-0.024*	-0.076***	-0.169**	0.015	0.024
	(0.634)	(0.061)	(0.006)	(0.0187)	(0.744)	(0.141)
π_{t+k}	0.001	-	-0.007	0.179***	0.020	-0.002
	(0.988)		(0.859)	(0.000)	(0.775)	(0.782)
$\Delta\pi_{t+k}$	-	-0.228*	-	-	-	-
		(0.052)				
$\overline{y}_{t+p}$	0.033***	-0.001	0.026***	-0.008	0.045***	-0.027***
	(0.000)	(0.816)	(0.000)	(0.167)	(0.000)	(0.000)
i_{t-1}	1.007***	1.003***	1.033***	0.945***	0.970***	0.978***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	11.686**	12.580	3.7927	16.652	6.292	13.180
	(0.039)	(0.961)	(0.579)	0.952	(0.279)	(0.948)
SSR-value	4.742	5.456	4.327	5.148	6.180	6.145
Forward looking TR with additional instruments from the stock and currency markets						
Constant	-0.015	-0.020**	-0.075***	-0.219***	0.002	0.016
	(0.562)	(0.041)	(0.007)	(0.000)	(0.942)	(0.104)
π_{t+k}	0.034	-	-0.005	0.196***	-0.004	0.006
	(0.147)		(0.904)	(0.000)	(0.943)	(0.212)
$\Delta\pi_{t+k}$	-	-0.230**	-	-	-	-
		(0.045)				
$\overline{y}_{t+p}$	0.032***	-0.002	0.026***	-0.008**	0.036***	-0.010***
	(0.000)	(0.629)	(0.000)	(0.032)	(0.000)	(0.000)
i_{t-1}	0.981***	0.998***	1.031***	0.957***	0.995***	0.975***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	12.316	13.596	3.7839	18.655	6.463	15.786
	(0.091)	(0.968)	(0.706)	(0.985)	(0.486)	(0.997)
Best set of addit. instrum.	d_t and q_t	d_t	$\widetilde{q}_t$	d_t	d_t and $\widetilde{q}_t$	d_t
SSR-value	4.426	5.396	4.276	5.405	4.702	4.899

Table 3b:
Results from the estimation of the forward looking Taylor rule for the small EMU countries

For the notations and explanations see Table 3a.

Variables/Country	Aus		Bel		Fin		Net	
Horizon (k, p in months)	3	12	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets								
Constant	-0.015	-0.284***	-0.058*	-0.051	0.110	-0.105*	-0.003	-0.002
	(0.831)	(0.000)	(0.052)	(0.155)	(0.307)	(0.081)	(0.962)	(0.925)
π_{t+k}	-0.056	0.175***	-0.000	-	0.103	0.124***	-0.094	-0.009
	(0.442)	(0.000)	(0.994)		(0.347)	(0.001)	(0.387)	(0.717)
$\Delta\pi_{t+k}$	-	-	-	-0.122*	-	-	-	-
				(0.083)				
$\overline{y}_{t+p}$	0.027***	-0.007	0.010**	0.015**	0.019*	0.000	0.007	0.007
	(0.007)	(0.300)	(0.016)	(0.012)	(0.065)	(0.979)	(0.638)	(0.121)
i_{t-1}	1.059***	0.973***	1.025***	1.010***	0.855***	0.954***	1.077***	0.998***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	2.029	14.549	4.242	13.919	4.249	12.865	4.658	12.950
	(0.845)	(0.910)	(0.515)	(0.929)	(0.514)	(0.955)	(0.459)	(0.953)
SSR-value	6.158	6.309	5.142	5.484	10.548	5.770	6.991	5.126
Forward looking TR with additional instruments from the stock and currency markets								
Constant	-0.004	-0.173***	-0.055**	-0.077***	0.011	-0.113**	0.022	-0.051
	(0.949)	(0.000)	(0.023)	(0.000)	(0.586)	(0.046)	(0.510)	(0.134)
π_{t+k}	-0.052	0.091***	0.006	-	-0.006	0.078***	-0.035*	0.038
	(0.355)	(0.000)	(0.724)		(0.768)	(0.001)	(0.090)	(0.185)
$\Delta\pi_{t+k}$	-	-	-	-0.175***	-	-	-	-
				(0.000)				
$\overline{y}_{t+p}$	0.029***	0.008*	0.010***	0.012***	0.018***	0.007*	0.013*	0.013**
	(0.000)	(0.051)	(0.008)	(0.000)	(0.000)	(0.063)	(0.072)	(0.017)
i_{t-1}	1.046***	0.995***	1.017***	1.023***	0.996***	0.992***	1.021***	0.984***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	2.852	14.977	5.214	20.015	7.365	12.309	6.487	10.688
	(0.898)	(0.941)	(0.634)	(0.980)	(0.392)	(0.976)	(0.485)	(0.994)
Best set of addit. instrum.	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	q_t	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$
SSR-value	5.816	5.360	4.980	5.340	4.687	5.056	5.375	5.619

Table 3c:
Results from the estimation of the forward looking Taylor rule for the big countries outside the EMU

For the notations and explanations see Table 3a.

Variables/Country	Jap		UK		US	
Horizon (k, p in months)	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets						
Constant	-0.011	-0.009**	-0.003	0.030	-0.070	-0.209***
	(0.452)	(0.018)	(0.929)	(0.615)	(0.445)	(0.000)
π_{t+k}	-	-	0.006	-0.007	-	0.097***
			(0.661)	(0.709)		(0.000)
$\Delta\pi_{t+k}$	-0.017	-0.025*	-	-	0.195	-
	(0.726)	(0.054)			(0.611)	
$\overline{y}_{t+p}$	0.002*	0.002**	0.041***	-0.013	0.030*	0.017**
	(0.071)	(0.020)	(0.000)	(0.221)	(0.079)	(0.017)
i_{t-1}	1.040***	1.034***	0.990***	0.991***	1.027***	0.982***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	6.174	9.710	2.516	11.144	2.995	12.423
	(0.290)	(0.993)	(0.774)	(0.982)	(0.701)	(0.963)
SSR-value	0.342	0.329	7.010	8.698	11.793	9.736
Forward looking TR with additional instruments from the stock and currency markets						
Constant	-0.007	-0.007**	-0.003	-0.077	-0.057	-0.129***
	(0.547)	(0.047)	(0.925)	(0.400)	(0.220)	(0.000)
π_{t+k}	-	-	0.004	0.021	-	0.061***
			(0.769)	(0.435)		(0.000)
$\Delta\pi_{t+k}$	-0.042	-0.025**	-	-	0.234	-
	(0.162)	(0.049)			(0.247)	
$\overline{y}_{t+p}$	0.003***	0.002**	0.044***	0.004	0.032***	0.021***
	(0.001)	(0.013)	(0.000)	(0.825)	(0.004)	(0.000)
i_{t-1}	1.028***	1.027***	0.991***	1.007***	1.019***	0.976***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	6.557	9.918	2.769	9.072	5.114	14.137
	(0.476)	(0.995)	(0.905)	(0.997)	(0.529)	(0.944)
Best set of addit. instrum.	d_t and q_t	$\widetilde{q}_t$	d_t and q_t	d_t	q_t	d_t
SSR-value	0.350	0.321	7.113	8.466	12.064	8.605

Table 3d:

Results from the estimation of the forward looking Taylor rule for the small countries outside the EMU

For the notations and explanations see Table 3a.

Variables/Country	Can		Den		Nor		Swe	
Horizon (k, p in months)	3	12	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets								
Constant	0.087	0.009	0.066	-0.045	-0.016	-0.141*	0.101*	-0.107*
	(0.083)	(0.805)	(0.153)	(0.623)	(0.829)	(0.312)	(0.060)	(0.052)
π_{t+k}	-0.079	-	0.029	0.017	-	0.087***	0.091	0.102***
	(0.245)		(0.541)	(0.764)		(0.000)	(0.121)	(0.005)
$\Delta\pi_{t+k}$	-	-0.133***	-	-	0.101	-	-	-
		(0.006)			(0.257)			
$\overline{y}_{t+p}$	0.038***	0.034***	0.025***	0.028***	0.001	-0.004	0.032***	0.018**
	(0.001)	(0.000)	(0.003)	(0.001)	(0.961)	(0.580)	(0.000)	(0.036)
i_{t-1}	1.019***	0.977***	0.933***	0.997***	1.009***	0.987***	0.899***	0.979***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	6.145	15.676	4.217	9.890	6.485	14.794	4.059	9.735
	(0.292)	(0.869)	(0.519)	(0.991)	(0.262)	(0.902)	(0.541)	(0.993)
SSR-value	8.510	7.736	6.326	7.555	14.084	13.298	7.419	8.070
Forward looking TR with additional instruments from the stock and currency markets								
Constant	0.082	0.016	0.065	-0.018	-0.070	-0.206***	0.085**	-0.032
	(0.270)	(0.367)	(0.144)	(0.471)	(0.259)	(0.002)	(0.017)	(0.395)
π_{t+k}	-0.082	-	0.024	0.008	-	0.085***	0.061**	0.039**
	(0.220)		(0.512)	(0.609)		(0.000)	(0.027)	(0.018)
$\Delta\pi_{t+k}$	-	-0.125***	-	-	0.119	-	-	-
		(0.001)			(0.274)			
$\overline{y}_{t+p}$	0.035***	0.028***	0.026***	0.018***	-0.001	0.021**	0.035***	0.025***
	(0.000)	(0.000)	(0.002)	(0.000)	(0.966)	(0.029)	(0.000)	(0.001)
i_{t-1}	1.024***	0.973***	0.938***	0.993***	1.025***	1.009***	0.921***	0.985***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	6.082	15.974	4.300	13.762	6.544	14.898	3.881	10.225
	(0.530)	(0.915)	(0.636)	(0.966)	(0.478)	(0.924)	(0.793)	(0.996)
Best set of addit. instrum.	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	$d_t^* - d_t$	d_t and $d_t^* - d_t$	d_t and q_t	d_t	d_t and q_t	d_t and q_t
SSR-value	8.426	6.954	6.171	6.295	14.887	13.819	7.471	7.631

Table 4a:
Results from the estimation of the forward looking opportunistic Taylor rule for the core EMU countries

We report the results from GMM-estimation with Newey-West HAC standard errors. The fundamental regression equation is now $i_t = \alpha_0 + \alpha_1\pi_{t+k} + \alpha_2\widetilde{\pi}_{t+k} + \alpha_3\overline{y}_{t+p} + \rho i_{t-1} + \varepsilon_t$,where α_0 is the constant term, α_1, α_2 are the regression parameters for the actual future inflation (π_{t+k}), and its deviation from the trend value ($\widetilde{\pi}_{t+k}$, indicating the opportunistic monetary policy rule regarding the inflation target), and α_3 is the regression parameter on the future real activity deviation from its trend value $(\overline{y}_{t+p})$. Here we consider only the version of the TR where the actual inflation is in levels on the RHS of regression equation. ρ is the regression coefficient (smoothing parameter) for the lagged interest rate, and ε_t is the error term. For all the other notations and explanations see Table 3a .

Variables/Country	Fra		Ger		Ita	
Horizon (k, p in months)	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets						
Constant	0.007	-0.413***	-0.041	-0.239***	-1.410	0.134**
	(0.955)	(0.001)	(0.609)	(0.003)	(0.412)	(0.035)
π_{t+k}	-0.020	0.413***	-0.043	0.210***	0.981	-0.079*
	(0.922)	(0.000)	(0.481)	(0.000)	(0.386)	(0.058)
$\widetilde{\pi}_{t+k}$	0.023	-0.085	0.028	-0.087*	-0.933	0.074*
	(0.890)	(0.176)	(0.733)	(0.089)	(0.414)	(0.060)
$\overline{y}_{t+p}$	0.032***	-0.031***	0.027***	-0.005	0.078***	-0.026***
	(0.002)	(0.003)	(0.000)	(0.486)	(0.008)	(0.000)
i_{t-1}	1.013***	0.895***	1.043***	0.951***	0.873***	0.987***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	11.635**	12.878	5.278	15.515	3.126	13.482
	(0.020)	(0.937)	(0.260)	(0.839)	(0.537)	(0.919)
SSR-value	4.794	12.559	4.483	4.818	23.175	6.100
Forward looking TR with additional instruments from the stock and currency markets						
Constant	-0.039	-0.391***	-0.051	-0.343***	-1.364	1.129
	(0.636)	(0.000)	(0.531)	(0.000)	(0.414)	(0.359)
π_{t+k}	0.053	0.344***	-0.045	0.233***	0.950	-0.779
	(0.473)	(0.000)	(0.435)	(0.000)	(0.389)	(0.355)
$\widetilde{\pi}_{t+k}$	-0.026	-0.121**	0.019	-0.107**	-0.901	0.769
	(0.786)	(0.013)	(0.813)	(0.046)	(0.415)	(0.342)
$\overline{y}_{t+p}$	0.034***	-0.020***	0.028***	0.001	0.077***	-0.036*
	(0.001)	(0.014)	(0.000)	(0.901)	(0.007)	(0.078)
i_{t-1}	0.979***	0.932***	1.050***	0.981***	0.875***	1.080***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	12.044*	15.641	4.710	14.623	3.163	3.915
	(0.061)	(0.901)	(0.581)	(0.908)	(0.675)	(0.562)
Best set of addit. instrum.	$d_t$and q_t	d_t and $\widetilde{q}_t$	d_t and q_t	d_t	q_t	q_t
SSR-value	4.517	8.067	4.646	5.524	22.377	14.464

Table 4b:

Results from the estimation of the forward looking opportunistic Taylor rule for the small EMU countries

For the notations and explanations see Tables 4a and 3a.

Variables/Country	Aus		Bel		Fin		Net	
Horizon (k, p in months)	3	12	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets								
Constant	-0.012	-0.516***	0.291**	-0.177	0.057	-0.146***	0.074	0.088
	(0.932)	(0.000)	(0.035)	(0.181)	(0.542)	(0.002)	(0.586)	(0.087*)
π_{t+k}	-0.066	0.312***	-0.203**	0.090	-0.004	0.150***	-0.124	-0.097
	(0.309)	(0.000)	(0.014)	(0.103)	(0.979)	(0.000)	(0.201)	(0.188)
$\widetilde{\pi}_{t+k}$	0.001	-0.201***	0.283***	0.010	0.059	-0.079***	0.113	0.087*
	(0.992)	(0.000)	(0.005)	(0.816)	(0.514)	(0.001)	(0.416)	(0.053)
$\overline{y}_{t+p}$	0.031***	-0.010**	0.017***	-0.006	0.017*	0.003	0.003	-0.003
	(0.001)	(0.046)	(0.000)	(0.507)	(0.057)	(0.512)	(0.852)	(0.674)
i_{t-1}	1.066***	0.958***	1.050***	0.985***	0.969***	0.949***	1.077***	1.033***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	2.898	13.326	5.386	6.360	4.951	13.574	4.174	13.513
	(0.575)	(0.924)	(0.250)	(0.999)	(0.292)	(0.916)	(0.383)	(0.918)
SSR-value	6.620	6.199	8.297	6.273	4.737	4.958	6.925	5.700
Forward looking TR with additional instruments from the stock and currency markets								
Constant	-0.031	-0.527***	0.283**	-0.133	0.013	-0.163***	-0.113	0.048
	(0.785)	(0.000)	(0.036)	(0.078)	(0.814)	(0.000)	(0.205)	(0.164)
π_{t+k}	-0.071	0.285***	-0.159**	0.072**	-0.068	0.109***	-0.105	-0.047***
	(0.273)	(0.000)	(0.035)	(0.035)	(0.239)	(0.000)	(0.132)	(0.008)
$\widetilde{\pi}_{t+k}$	0.035	-0.265***	0.268***	-0.005	0.064	-0.091***	0.170	0.059**
	(0.707)	(0.000)	(0.007)	(0.881)	(0.372)	(0.000)	(0.140)	(0.020)
$\overline{y}_{t+p}$	0.029***	0.003	0.016***	-0.000	0.018*	0.012***	0.001	0.003
	(0.000)	(0.486)	(0.000)	(0.908)	(0.078)	(0.000)	(0.963)	(0.514)
i_{t-1}	1.047***	0.989***	1.015***	0.981***	1.048***	0.987***	1.034***	1.011***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	5.691	13.936	7.338	9.626	4.604	13.300	4.943	12.983
	(0.749)	(0.948)	(0.290)	(0.996)	(0.466)	(0.961)	(0.551)	(0.952)
Best set of addit. instrum.	d_t and $d_t^* - d_t$	d_t and $d_t^* - d_t$	d_t and q_t	d_t and $d_t^* - d_t$	d_t	d_t and $\widetilde{q}_t$	d_t and q_t	q_t
SSR-value	5.691	5.628	7.374	5.123	6.172	4.310	5.776	5.132

Table 4c:

Results from the estimation of the forward looking opportunistic Taylor rule for the big countries outside the EMU

For the notations and explanations see Tables 4a and 3a.

Variables/Country	Jap		UK		US	
Horizon (k, p in months)	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets						
Constant	-0.021	-0.009	-0.050	0.063	0.083	-0.278***
	(0.274)	(0.200)	(0.488)	(0.467)	(0.733)	(0.001)
π_{t+k}	-0.010	0.030***	0.027	-0.021	-0.128	0.129***
	(0.604)	(0.000)	(0.427)	(0.482)	(0.481)	(0.001)
$\widetilde{\pi}_{t+k}$	0.013	0.001	-0.038	0.024	-0.008	-0.032
	(0.633)	(0.863)	(0.429)	(0.577)	(0.953)	(0.359)
$\overline{y}_{t+p}$	0.002	0.002	0.047***	-0.018	0.044**	0.016**
	(0.390)	(0.200)	(0.000)	(0.147)	(0.010)	(0.028)
i_{t-1}	1.085***	1.022***	0.987***	0.993***	1.092***	0.982***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	4.593	10.004	2.106	10.120	4.409	12.002
	(0.332)	(0.986)	(0.716)	(0.985)	(0.353)	(0.957)
SSR-value	0.434	0.419	7.213	8.885	17.492	9.806
Forward looking TR with additional instruments from the stock and currency markets						
Constant	-0.001	-0.008*	-0.048	0.008	-0.070	-0.254***
	(0.926)	(0.085)	(0.443)	(0.925)	(0.326)	(0.001)
π_{t+k}	0.006	0.017***	0.022	-0.002	-0.007	0.119***
	(0.376)	(0.002)	(0.441)	(0.950)	(0.858)	(0.001)
$\widetilde{\pi}_{t+k}$	-0.010	-0.009*	-0.034	0.007	-0.071	-0.033
	(0.427)	(0.080)	(0.407)	(0.838)	(0.143)	(0.267)
$\overline{y}_{t+p}$	0.003**	0.003***	0.049***	0.009	0.035***	0.016**
	(0.012)	(0.000)	(0.000)	(0.441)	(0.001)	(0.012)
i_{t-1}	1.006***	1.015***	0.990***	0.996***	1.029***	0.979***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	5.872	12.099	2.269	10.460	5.208	12.469
	(0.438)	(0.979)	(0.893)	(0.992)	(0.518)	(0.963)
Best set of addit. instrum.	d_t and $\widetilde{q}_t$	d_t and q_t	d_t and q_t	d_t and $d_t^* - d_t$	d_t and q_t	q_t
SSR-value	0.311	0.316	7.292	8.399	11.574	9.222

Table 4d:

Results from the estimation of the forward looking opportunistic Taylor rule for the small countries outside the EMU

For the notations and explanations see Tables 4a and 3a.

Variables/Country	Can		Den		Nor		Swe	
Horizon (k, p in months)	3	12	3	12	3	12	3	12
Traditional forward looking TR without additional instruments from the stock and currency markets								
Constant	0.864	0.023	-0.061	-0.144	0.349	-0.272***	0.110	-0.117**
	(0.285)	(0.900)	(0.696)	(0.121)	(0.445)	(0.000)	(0.194)	(0.022)
π_{t+k}	-0.546	-0.008	0.221	0.074	-0.518**	0.136***	0.293	0.140***
	(0.196)	(0.925)	(0.322)	(0.186)	(0.036)	(0.000)	(0.296)	(0.002)
$\widetilde{\pi}_{t+k}$	0.433	0.014	-0.155	-0.114*	0.271	-0.063**	-0.166	-0.078
	(0.305)	(0.837)	(0.369)	(0.092)	(0.155)	(0.025)	(0.432)	(0.117)
$\overline{y}_{t+p}$	0.038*	0.033***	0.039**	0.041***	-0.016	-0.001	0.042	0.023***
	(0.051)	(0.002)	(0.036)	(0.000)	(0.734)	(0.764)	(0.115)	(0.009)
i_{t-1}	1.080***	0.983***	0.841***	0.992***	1.192***	0.996***	0.788***	0.966***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	1.250	15.925	3.165	13.180	3.155	16.372	3.137	8.617
	(0.870)	(0.820)	(0.531)	(0.928)	(0.532)	(0.990)	(0.535)	(0.995)
SSR-value	13.972	7.620	13.508	9.275	54.392	13.200	13.940	7.441
Forward looking TR with additional instruments from the stock and currency markets								
Constant	0.428*	-0.044	0.167**	-0.153**	0.573**	-0.493***	0.105***	-0.123***
	(0.087)	(0.628)	(0.012)	(0.032)	(0.018)	(0.000)	(0.001)	(0.000)
π_{t+k}	-0.264*	0.025	-0.154**	0.081**	-0.379***	0.199***	0.016	0.146***
	(0.059)	(0.559)	(0.024)	(0.035)	(0.005)	(0.000)	(0.709)	(0.000)
$\widetilde{\pi}_{t+k}$	0.181	-0.010	0.199***	-0.117*	0.300***	-0.138***	0.070	-0.130***
	(0.167)	(0.838)	(0.004)	(0.074)	(0.009)	(0.002)	(0.175)	(0.000)
$\overline{y}_{t+p}$	0.032***	0.018**	0.012***	0.042***	-0.033**	0.022**	0.031***	0.026***
	(0.002)	(0.015)	(0.005)	(0.000)	(0.043)	(0.013)	(0.005)	(0.000)
i_{t-1}	1.028***	0.985***	1.042***	0.992***	1.054***	1.024***	0.937***	0.965***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
J-statistics	5.449	15.415	6.694	13.573	7.733	16.058	4.337	9.492
	(0.488)	(0.908)	(0.350)	(0.939)	(0.258)	(0.885)	(0.631)	(0.996)
Best set of addit. instrum.	d_t and $d_t^* - d_t$	d_t and q_t	d_t and $\widetilde{q}_t$	d_t	d_t and $d_t^* - d_t$	d_t and q_t	d_t and $d_t^* - d_t$	d_t and $\widetilde{q}_t$
SSR-value	8.656	6.187	6.419	9.335	22.582	14.769	6.987	7.023

HIGHLIGHTS of the article:

'Stock Market and Exchange Rate Information in the Taylor Rule: Evidence from OECD Countries'

by Kari Heimonen, Juha Junttila & Samu Kärkkäinen

- Stock market and exchange rate information is relevant in the estimation of the Taylor rule
- Results from the small and big countries inside and outside the euro area are different
- Monetary policy rule for the inflation target is opportunistic in some countries