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The Yearly Inflation Rate and Its Forecasting

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Abstract. The yearly inflation rate might not always be the appropriate measure of inflation, mainly due to the fact that it does not provide up-to-date information on the level of inflation. The harmonic analysis shows that the yearly inflation rate deforms and delays the information with respect to the monthly inflation rate and is thus delayed behind the true inflation in yearly levels. This conclusion can be extremely important in the forecasting of the inflation rate at its yearly levels, as well as in the process of economic decision making. The new method for constructing the yearly inflation rate forecast is proposed. Practical verification is made on the basis of the HCPI log yearly inflation rate. The advantage is that it is able to catch breaks and other instabilities in the future development of the forecast time series.

Keywords: Inflation Rate, Harmonic Analysis, Linear Filtration, Forecasting, Monetary Policy.

1. Introduction

Inflation is a very important macroeconomic indicator, which measures the change in the general level of prices of goods and services consumed by households. It plays a crucial role in monetary policy, specifically in the targeting of inflation through the setting of interest rates. It is used for the calculation of real interest rates, the increase of the real value of assets as well as the valorization of wages, pensions and social benefits.

Due to the widespread use of inflation and its significant role in the economy, it is of the utmost importance to find a good way to measure of inflation, as well as a method for inflation forecasting. In this paper we argue that the widely used measure of inflation, specifically the yearly inflation rate (introduced below), might not always be the appropriate way to measure it, mainly due to the fact that it does not provide up-to-date information on the level of inflation.

2. Monthly and Yearly Inflation Rate

Inflation is informally defined as the change in the consumer price index during the period of either one month or one year – this definition leads to either the monthly, or the yearly, inflation rate. The *monthly* time series of the *monthly* inflation rate can be defined as

$$IR_{m,t} \equiv \frac{CPI_t}{CPI_{t-1}}. \tag{1}$$

This definition implies that the time series of the monthly inflation rate is the growth rate (of the monthly time series of the consumer price index) with respect to the previous month. Similarly, the *monthly* time series of the *yearly* inflation rate can be defined as:

$$IR_{y,t} \equiv \frac{CPI_t}{CPI_{t-12}}. \tag{2}$$

This definition means that the time series of the yearly inflation rate is the growth rate (of the monthly time series of the consumer price index) with respect to the corresponding month of the previous year.[2]

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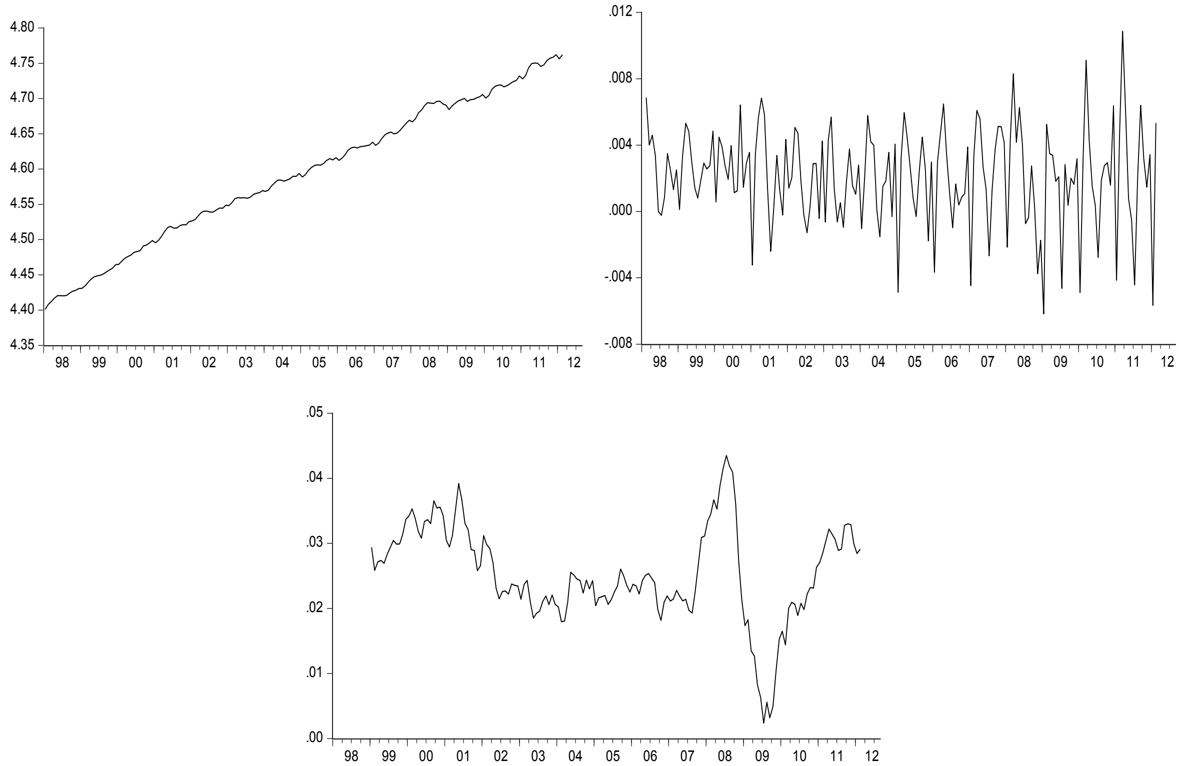
[2] The yearly inflation rate is defined as $(CPI_t - CPI_{t-12})/CPI_{t-12} = IR_{y,t} - 1 \approx \log IR_{y,t}$ and the monthly inflation rate as $(CPI_t - CPI_{t-1})/CPI_{t-1} = IR_{m,t} - 1 \approx \log IR_{y,t}$ ([1] and [2])

In Fig. 1 we present the development of the natural logarithm of the harmonized consumer price index - $HCPI_t$ - which is the indicator of inflation and price stability for the European Central Bank; with the logarithm of the monthly inflation rate $IR_{m,t}$ and the logarithm of yearly inflation rate $IR_{y,t}$ from Jan 1998 up to Feb 2012, being based on it.

The logarithm of the monthly inflation rate is characterised by a relatively strong seasonal pattern, in contrast with the logarithm of the yearly inflation rate. In this time series there may be clearly seen unstable behavior from 2007.



Source: data [5]

Fig. 1: The log $HCPI_t$, the log $IR_{m,t}$, the log $IR_{y,t}$ from January 1998 till February 2012.

3. The Effect of the Yearly Inflation Rate Time Delay

A crucial point to notice is that

$$\log IR_{y,t} = \log IR_{m,t} + \log IR_{m,t\text{-}1} + \log IR_{m,t\text{-}2} + ... + \log IR_{m,t\text{-}11}, \tag{3}$$

i. e., when coming from the log monthly inflation rate to the log yearly inflation rate, we take a moving sum of 12 numbers, which are spread uniformly from the time $t - 11$ to the time *t,* and assign the result to the time *t*. In other words: the aggregate information contained in the range of times from $t - 11$ to *t* is assigned to the endpoint of this range. The value of the log yearly inflation rate at time *t*, i.e., log $IR_{y,t}$, is thus a measure of the log inflation at its yearly level which effectively corresponds to time $t - 5{,}5$ (i.e. the center of the range $t - 11$ to *t*). This intuitively implies that the information in the log yearly inflation rate *must be delayed* behind the log monthly inflation rate, and the annualized log monthly inflation rate (12x $\log IR_{m,t} = \log IR_{anualized,t}$) which truly corresponds to time *t*. This point was elaborated on in a rigorous way with the help of the concept of the spectral time series analysis in [3] and [4].

The yearly inflation rate, along with the smoothed and annualized monthly inflation rate; computed on the basis of HICP from January 1998 to February 2012; are presented in Fig. 2. The smoothing of the annualized log monthly inflation rate is achieved by the Hodrick-Prescott filter. It is seen that the peaks and troughs, especially in the period of instability, are delayed in the log yearly inflation rate behind the smoothed annualized log monthly inflation rate.

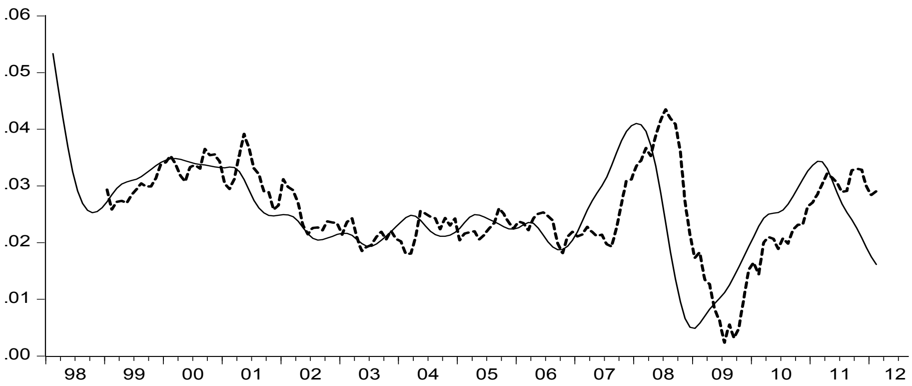


Fig. 2: The log $IR_{y,t}$ (dashed) and the smoothed log $IR_{annual,t}$

4. The Forecasting of the Yearly Inflation Rate

The yearly inflation rate is very frequently used in economic practice; more frequently than the monthly inflation rate and annualized monthly inflation rate. One of the arguments for the practical application of the yearly inflation rate is its relative smoothed shape in comparison with the annualized monthly inflation rate, which usually contains a strong seasonal pattern. As we mentioned above, the principle problem of the yearly inflation rate is the significant time delay in comparison with the monthly, and annualized monthly, inflation rate. In fact, the problem is only of a technical nature and can be solved by simply moving the yearly inflation rate back by six months. We know that this adjustment has not been implemented to date. It seems that the responsible people in the central institutions (for example in the central banks) do not perceive the seriousness of the problem. In the papers [3] and [4], we justified this issue in detail, but as yet, we have received no response; either positive or negative. In this rather provocative paper we will no longer draw attention to the problem of delayed information in the yearly inflation rate. Instead, we will use our knowledge for the proposal a new, nontraditional method of yearly inflation rate forecasting, with the horizons h = 1, 2, 3, 4, 5, 6.

The basic forecasting principle is extremely simple. It can be expressed in the following formula

$$\log IR_{y,T(h)} = \log IR_{anual,T\text{-}6+h\square smoothed} \quad \text{for } h = 1, 2, 3, 4, 5, 6, \tag{4}$$

where $\log IR_{y,T}(h)$ is the forecast of the log yearly inflation rate at time T for h months ahead and $\log IR_{anual,T\text{-}6+h\square smoothed}$ is the smoothed annualized log monthly inflation rate. The advantage of this approach is that it is based on the annualized monthly inflation rate computed from real data. It follows that it is able to catch breaks and other instabilities in the “future” six months development of the yearly inflation rate, and can thus be efficient, especially in the unstable time periods. The drawback of this method is the fact, that the annualized monthly inflation rate is strongly seasonal and must be smoothed. The smoothing of the ends of the time series is usually problematic and does not reflect reality. The solution is to forecast the annualized monthly inflation rate before the smoothing, and afterwards, the smoothed forecasted values to remove. The same solution is used in the X12ARIMA seasonal adjustment method.

5. The Practical Verification of the Proposed Method

The empirical verification of the proposed forecasting method is based on the recursive forecasting of the HICP yearly inflation rate. The forecasts with a horizon of 6 months start from the prediction threshold of September 2006, and repeat themselves with the prediction threshold of each subsequent month. The Hodrick-Prescott filter is used for smoothing the last six values of the actual annualized monthly inflation rate. Before that, however, it is necessary to calculate the annualized monthly inflation rate forecast for 12 months ahead, on the basis of the SARIMA models (until the prediction threshold April 2009 it is SARIMA(0,0,4)$(1,0,0)_{c,}$ and after that it is SARIMA(1,0,0)(1,0,1)). The accurate forecasts improve the quality of the smoothing of the time series ends considerably. The forecasts accuracy “ex post” is measured by the Mean Squared Errors, and by the Theil Inequality Coefficient. Its values lie between zero and one; zero indicates a perfect fit.

Fig. 3 shows some of the forecasts together with the real log yearly inflation rate time series. A period with significant breaks was deliberately chosen. It is clearly seen that the forecasts are able to capture instability, as well as fundamental changes in the behavior of the "future" development of the yearly inflation rate.

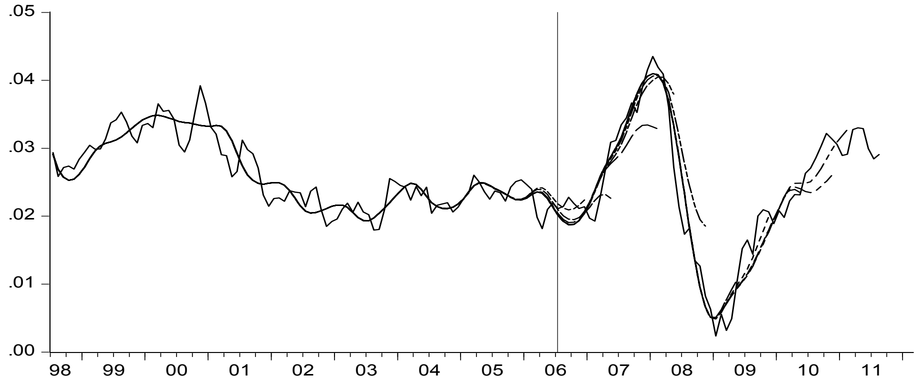


Fig.3: The $\log IR_{y,t}$, the smoothed $\log IR_{annual,t}$, the $\log IR_{y,T}(h)$ with the horizon of 6 months

Table 1 contains the Mean Squared Errors as well as the Theil Inequality Coefficients of recursive forecasts for 6 months. The values of the second measure vary, but they are very close to zero. It is interesting to compare the size of Theil Inequality Coefficients with the real values of the yearly inflation rate, which has been captured in Fig. 4. With decreasing values of the predicted time series, the Theil Inequality Coefficients have the tendency to grow, which means that the accuracy of the predictions decreases.

Table 1: The MSE and the Theil Inequality Coefficients of the recursive forecasts

Date	MSE	Theil	Date	MSE	Theil	Date	MSE	Theil
2006-09	0.0010	0.0229	2008-02	0.0050	0.0632	2009-07	0.0049	0.1713
2006-10	0.0024	0.0581	2008-03	0.0104	0.1323	2009-08	0.0033	0.0984
2006-11	0.0026	0.0630	2008-04	0.0140	0.1880	2009-09	0.0032	0.0898
2006-12	0.0020	0.0480	2008-05	0.0136	0.2021	2009-10	0.0034	0.0924
2007-01	0.0022	0.0502	2008-06	0.0150	0.2492	2009-11	0.0039	0.1017
2007-02	0.0040	0.0863	2008-07	0.0134	0.2627	2009-12	0.0047	0.1052
2007-03	0.0052	0.1078	2008-08	0.0089	0.2218	2010-01	0.0030	0.0675
2007-04	0.0079	0.1580	2008-09	0.0033	0.1124	2010-02	0.0014	0.0321
2007-05	0.0101	0.1960	2008-10	0.0026	0.1117	2010-03	0.0021	0.0463
2007-06	0.0103	0.1867	2008-11	0.0071	0.3073	2010-04	0.0030	0.0644
2007-07	0.0084	0.1424	2008-12	0.0040	0.2497	2010-05	0.0033	0.0685
2007-08	0.0072	0.1146	2009-01	0.0041	0.2971	2010-06	0.0048	0.0982
2007-09	0.0083	0.1271	2009-02	0.0028	0.2080	2010-07	0.0055	0.1067
2007-10	0.0083	0.1199	2009-03	0.0043	0.2243	2010-08	0.0052	0.0958
2007-11	0.0073	0.1001	2009-04	0.0039	0.2113	2010-09	0.0022	0.0385
2007-12	0.0046	0.0599	2009-05	0.0036	0.1422	2010-10	0.0029	0.0493
2008-01	0.0048	0.0632	2009-06	0.0050	0.2059	2010-11	0.0029	0.0478

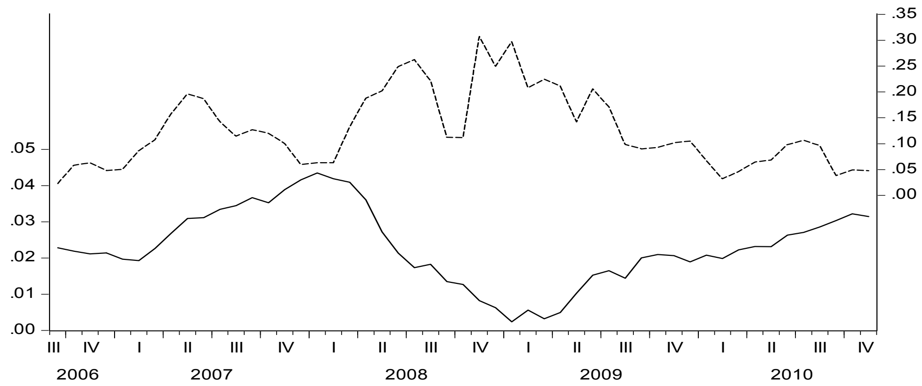


Fig. 4: The Theil Inequality Coefficients (dashed), the log$IR_{y,t}$

6. Conclusion

In this paper we argue that the principal property of the yearly inflation rate is its approximate six months time delay in comparison with the annualized monthly inflation rate. Unfortunately, this fact is not yet reflected in economic practice. We use it to suggest the new, nontraditional approach to yearly inflation rate forecasting. This method is verified for the case of the HICP yearly inflation rate. The recursive "ex post" forecasts are computed for the very unstable period. The accuracy of the "ex post" forecasts is measured by the Mean Squared Error, and the Theil Inequality Coefficients. It has been found that even in periods of great instability, the proposed method is very efficient and able to create relatively accurate forecasts, catching even the considerable breaks in the future development of the forecasted time series.

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8. References

[1] Arlt, J. (1998): Problém krátkodobé a dlouhodobé míry inflace. *Politická ekonomie* **46**: (5), pp. 667-674, 1998.

[2] Arlt, J., Arltová, M. (1999): The Problem of the Rate of Inflation. *Acta Oeconomica Pragensia* **7**: (4), pp. 7-12, 1999.

[3] Arlt, J., Bašta, M. (2008): Časové řady měsíční a roční míry inflace a jejich vlastnosti. *Politická ekonomie* **56**: (4), pp. 536-556, 2008.

[4] Arlt, J., Bašta, M. (2010): The Problem Of The Yearly Inflation Rate And Its Implications For The Monetary Policy Of The Czech National Bank. *Prague Economic Papers* **19**: (2) 99-117, 2010.

[5] ECB (2009): *Statistical Data Warehouse*. http://sdw.ecb.europa.eu/.