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Identifying leading indicators of real activity and inflation for Turkey, 1988-2010: A pseudo out-of-sample forecasting approach

by
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This paper develops a set of leading indicators for industrial production growth and changes in consumer price inflation by accounting for changes in the policy regime that have occurred for the Turkish economy over the sample period 1988-2010. The choice of indicators is based on a pseudo out-of-sample forecasting exercise that is implemented by Leigh and Rossi (2002), and Stock and Watson (2003), amongst others. Our findings provide evidence on the factors determining changes in real activity and inflation over an extended sample period that encompasses episodes of volatile inflation and output growth as well as the recent experience of disinflation and normalisation for the Turkish economy.

Keywords: Real activity, inflation, leading indicators, out-of-sample forecasting, combination forecasts, inflation targeting, Turkey.

JEL classification: E1, E32, E37, E58, F43, O52

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1. Introduction

In this paper, we develop a set of leading indicators to predict changes in real activity and inflation at the monthly level for Turkey. Our study builds on the analysis of Leigh and Rossi (2002) who examine the forecasting performance of 42 candidate indicators for output growth and inflation over the period 1986-2002 in Turkey. However, unlike their analysis, we examine the efficacy of a large set of variables for forecasting industrial production growth and inflation changes by accounting for changes in the policy regime that have occurred in Turkey over the extended sample period 1988-2010.

Following the approach in Leigh and Rossi (2002), and Stock and Watson (2003), we use pseudo out-of-sample forecasting techniques to examine the efficacy of up to 51 real and financial candidate indicators for forecasting industrial production growth and changes in inflation over the period 1988-2010. To account for the alternative policy regimes in effect, we consider three sub-samples of our sample period, namely, the sub-samples comprising 1988-2000, 1996-2005 and 2001-10, respectively. The first sub-sample of 1988-2000 is characterised by the 1994 financial crisis and the volatile inflation and output growth of the 1990s. The second sub-sample 1996-2005 is motivated by the run-up to the crisis of 2000-01 together with the crisis itself and its immediate aftermath, when Turkey transited from a managed floating exchange rate regime to floating exchange rates. Following the crisis of 2000-01, Turkey also implemented a wide set of reforms as part of an IMF-sponsored stabilisation plan, including banking and financial sector reform, a move to central bank independence, and the adoption of fiscal discipline. Finally, the third sub-sample 2001-10 is motivated by the transition to an inflation targeting regime as well as the period of disinflation and normalisation for the Turkish economy.

The notion of developing a leading indicator to predict real activity goes back to the work of Mitchell and Burns (1938). In a comprehensive analysis, Stock and Watson (1999) examine the cyclical behaviour of the main US macroeconomic time series over the period 1946-96. They categorise the behaviour of 71 economic time series into leading, lagging and coincident indicators. In another contribution, Stock and Watson (2003) provide an analysis for the role of asset prices in forecasting output and inflation for seven OECD countries over the period 1959-99. As those authors note, much of the research on using asset prices for forecasting purposes was motivated by the apparent instability in forecasts of output and inflation based on the performance of monetary aggregates or the (non-expectational) Phillips curve during the 1970s and early 1980s. Among their salient results is that asset prices are more useful for forecasting inflation than output. While the behaviour of individual forecasts tends to be unstable, combination forecasts appear to work well in circumventing the instability problems.

The literature on developing leading indicators for emerging economies is more recent.[1] Up until the last decade, high levels of volatility, structural shifts and changes in policy regimes have made identifying leading indicators for emerging economies difficult. Chauvet (2000) derives leading indicators for inflation in Brazil over two periods, the first

corresponding to the post "Real Plan" period of 1994-99 and the second corresponding to a longer period of 1980-99 to account for changes in policy regimes in Brazil. Chauvet (2001) develops an indicator of Brazilian GDP at the monthly frequency by using a Markov switching dynamic factor model based on a set of variables that display coincident movements with changes in real GDP across three different periods. Chauvet and Morais (2008) however use a time-varying autoregressive probit model for predicting recessions in Brazil. Atabek et al. (2005) develop a composite leading indicator for the Turkish economy using the OECD methodology for the period 1988-2003.

Understanding the role of alternative institutional arrangements on aggregate economic activity is also more recent. Altug et al. (2012) examine the impact of alternative institutional arrangements such as overall governance and central bank independence on average business cycle characteristics for a large set of developed, emerging, and transition economies. Carvalho Filho de (2011) examines the role of inflation targeting in affecting economic performance for emerging economies during the recent global financial crisis. Kara (2006) provides a discussion of the process by which Turkey has moved from a regime of implicit inflation targeting to a full fledged inflation targeting regime. However, none of these studies examine the issue of identifying leading indicators under alternative policy regimes. In their study, Leigh and Rossi (2002) state that one of their objectives is to identify the variables most useful for forecasting inflation and real activity during the transition to an inflation targeting regime. However, since their sample ends in 2002, it does not permit a thorough identification of leading indicators during the period of transition to this regime which occurred during 2002-06, or under the formal inflation targeting regime itself after 2006.

In our analysis, we determine both individual leading indicators that are useful for forecasting industrial production growth and changes in consumer price inflation across different horizons. We also examine combination forecasts such as the trimmed mean and median of all the forecasts. Following Leigh and Rossi (2002), we also consider the median of the top five forecasts for predicting each variable. We uncover an important role for asset prices that capture expectational phenomena and policy interest rates in predicting IP growth and changes in CPI inflation at different horizons for the second and third sub-samples. This role however is more pronounced for changes in inflation than it is for IP growth, especially after the transition to formal inflation targeting in 2006. By contrast, changes in nominal and real monetary aggregates, and business sentiment indicators tend to be among the important predictors of IP growth and inflation changes in the first sub-sample. By focussing on the three sub-samples characterised by alternative policy regimes, our results provide evidence on the changing dynamics of the Turkish economy for the period 1988-2010.

The remainder of this paper is organised as follows. Section 2 presents the methodology while Section 3 describes the data. The results regarding the bivariate forecasts are presented in Section 4, which also provides a discussion of the results in view of the Turkish experience. Section 5 describes the combination forecasts and Section 6 concludes.

2. Methodology

Our methodology follows Stock and Watson (2003), and Leigh and Rossi (2002). Our goal is to develop forecasting models for changes in real activity and inflation using a

sample of monthly observations. We measure real activity by the industrial production index (IP) and the price level by the consumer price index (CPI). In contrast to real GDP, the choice of industrial production as a measure of real activity is due to its availability on a monthly basis.[2] The forecasting models examine the role of a candidate predictor, X_t, for forecasting the variable of interest h period ahead y_{t+h}^h. We consider horizons of h = 1, ..., 12 for both variables, though we report results only for h = 3, 6, 9, 12. The model that we examine can be written as follows:

$$y_{t+h}^h = \mu + \alpha(L)y_t + \beta(L)X_t + \epsilon_{t+h}^h, \quad (1)$$

where $\alpha(L)$ and $\beta(L)$ are lag polynomials. All the forecasting models include the own lags of the dependent variable, y_t. They differ with respect to the candidate predictor that is considered. This approach differs from the standard approach of estimating one-step predictions and then iterating forward to obtain the h-step ahead forecasts. By keeping the estimation and forecast period the same, this approach has the advantage of reducing the specification error in the one-step ahead model.

The dependent variables were transformed to be stationary. We ran Augmented Dickey Fuller (ADF) tests for the entire sample period of 1988:1-2010:12. We fail to reject the null hypothesis of a unit root for the log of industrial production and the CPI. However, we also find evidence against the stationarity of the inflation series itself in that we are not able to reject the null hypothesis of a unit root for the log difference for the CPI. This suggests that the appropriate variable for the forecasting exercise is changes in inflation, and not inflation itself. Leigh and Rossi (2002) reject the null hypothesis of a unit root in the log difference of the CPI at the 1% level based on the ADF test. However, they find that the pseudo out-of-sample forecasting results tend to be more accurate for the second differences of the (log of the) CPI (the first difference of inflation) and report only those results. This is also the approach that we follow in this paper. The variable to be forecasted, y_t, is thus defined as the growth rate of industrial production or alternatively, changes in CPI inflation, both measured at annual rates. The multi-step forecasts investigate the predictability of the log of the level of the variable, after imposing the $I(1)$ or $I(2)$ transformations. For IP growth, this is $y_{t+h}^h = (1200/h) \log (IP_{t+h}/IP_t)$ and for CPI inflation, it is $y_{t+h}^h = (1200/h) \log (CPI_{t+h}/CPI_t) - 1200 \log (CPI_t/CPI_{t-1})$.

Previous studies have considered second differenced versions of the CPI, as inflation has tended to be a persistent process. However, there is recent evidence suggesting that both inflation and inflation *persistence* have become low and stable processes in part of the sample period that we study. Indeed, for the period 2001:1-2010:12, we find evidence against the null hypothesis of a unit root for the log difference of the CPI. Oliveira and Petrassi (2010) examine the persistence of CPI inflation for 23 industrial and 17 emerging economies in a sample that begins in 1995 and find that even countries that experienced near "hyperinflation" such as Argentina, Brazil, Bolivia, Peru, Mexico, Turkey, Israel and Poland have witnessed a decline in the persistence of their inflationary processes.[3] Even if this phenomenon holds for Turkey, using changes in CPI inflation as the relevant variable to be forecasted improves the forecasting performance in the disinflationary period since 2002.

The approach used in this paper is based on the pseudo out-of-sample forecasting proposed by Stock and Watson (2003).[4] The model estimation and selection are recursive in that they use all available prior data as the forecasting exercise proceeds through time. We

conduct our pseudo out-of-sample forecasting exercise for three separate periods to account for changes in the policy regime in Turkey over the greater sample period 1988-2010. We take the first sub-sample to correspond to the period 1988:1-2000:12, the second sub-sample to correspond to 1996:1-2005:12, and the third sub-sample to correspond to the period 2001:1-2010:12. Thus, for the first sub-sample the pseudo out-of-sample forecasting exercise begins in 1993:1 and continues until 2000:12; for the second sub-sample it begins in 2001:1 and continues until 2005:12; and, for the third sub-sample, it begins in 2006:1 and continues until 2010:12. Thus, the first forecast for each sub-sample is approximately based on five years of data, after accounting for differencing and initial conditions, while the subsequent forecasts are based on samples that increase over time. At each stage of the forecasting exercise, the lag lengths in the benchmark model and the model with the candidate indicator for IP growth and changes in inflation are chosen to minimise the Akaike Information Criterion (AIC). The lag lengths of the polynomial for lagged values of the dependent variable, $\alpha(L)$, are chosen to be between zero and twelve while the lag lengths for the polynomial for the candidate indicator, $\beta(L)$, are chosen to be between one and twelve. We iteratively add exogenous variables including all their possible lagged values up to twelve lags and choose the optimal lag length by using AIC. To identify a leading indicator, we compare the mean squared forecast error (MSFE) of the autoregressive specification comprising own lags only with that of the specification which also includes the candidate exogenous variable and its lags. A leading indicator is identified if the relative MSFE of the specification which includes the candidate indicator together with the own lags of the variable compared to the specification which includes the own lags only of the variable itself is less than one.

3. Data

The universe of variables that are available for constructing leading indicators is potentially very large. Our choice of variables depends on: *i)* whether there are theoretical/empirical reasons for their predictive content; *ii)* their availability at the monthly frequency; and, *iii)* their sample length. We use indicators of real activity, monetary aggregates, asset prices, and responses from a survey of future economic conditions conducted by the Central Bank of the Republic of Turkey (CBRT). Table 1 provides a list of the variables used in our study, their sample period and their sources.[5] A further description of the data is available in Annex A.

Our series include variables measuring:

- activity in the economy including capacity utilisation, electricity production, production of agricultural machines, production of buses, the unemployment rate, total employment, exports, imports, intermediate goods imports and VAT revenue;
- prices such as Consumer Price Index (CPI), Producer Price Index (PPI), the oil price index and the US CPI;
- measures of nominal and real monetary aggregates, including broad monetary aggregates and reserves at the central bank;
- asset prices including various interest rates, the return, price-earnings ratio and dividend yield on the Istanbul Stock Exchange ISE100 index, the spread between the Turkish sovereign rate and US T-bill rate, the return on foreign currency denominated Turkish bonds, the dollar and the real exchange rate, and the price of gold;

Table 1. **Series descriptions and sources**

Acronym	Description	Sample period	Source
lipi	Log of Index of Industrial Production	1988:1-2010:12	IFS[1]
cur	Capacity Utilisation Rate	1991:2-2010:12	Turkstat[2] and CBRT[3]
grelpr	Log of Gross Electricity Production	1988:1-2010:12	OECD[4]
trac	Log of Production of Agricultural Machinery	1988:1-2010:12	AMA[5]
bus	Log of Production of Buses	1988:1-2010:12	AMA
unemp	Unemployment Rate	2001:1-2010:12	Turkstat
totemp	Log of Total Employment	2001:1-2010:12	Turkstat
exp	Log of Exports (in 2003 prices)	1988:1-2010:12	Turkstat
imp	Log of Imports (in 2003 prices)	1988:1-2010:12	Turkstat
inimp	Log of Intermediate Goods Imports (in 2003 prices)	1996:1-2010:12	Turkstat
lvat	Log of VAT Revenue	2001:1-2010:12	RTMF[6]
rlvat	Log of Real VAT Revenue (in 2005 prices)	2001:1-2010:12	–
lcpi	Log of Consumer Price Index (2005=100)	1988:1-2010:12	IFS
lppi	Log of Producer Price Index (2005=100)	1988:1-2010:12	IFS
lop	Log of Oil Price (UK Brent - in USD)	1988:1-2010:12	IFS
rlop	Log of Real Oil Price (UK Brent - in 2005 prices)	1988:1-2010:12	–
uscpi	Log of US CPI (2005=100)	1988:1-2010:12	FRED[7]
lml	Log of Money Supply: M1 (in TRY)	1988:1-2010:12	CBRT
lm2	Log of Money Supply: M2 (in TRY)	1988:1-2010:12	CBRT
lm2y	Log of Money Supply: M2 + FX Deposits (in TRY)	1988:1-2010:12	CBRT
lm3	Log of Money Supply: M3 (in TRY)	1988:1-2010:12	CBRT
lm3y	Log of Money Supply: M3 + FX Deposits (in TRY)	1988:1-2010:12	CBRT
rlm1	Log of Real Money Supply: M1 (in 2005 prices)	1988:1-2010:12	–
rlm2	Log of Real Money Supply: M2 (in 2005 prices)	1988:1-2010:12	–
rlm2y	Log of Real Money Supply: M2+ FX Deposits (in 2005 prices)	1988:1-2010:12	–
rlm3	Log of Real Money Supply: M3 (in 2005 prices)	1988:1-2010:12	–
rlm3y	Log of Real Money Supply: M3 + FX Deposits (in 2005 prices)	1988:1-2010:12	–
onir	Interest Rate: Overnight (% p.a.)	1988:1-2010:12	OECD
dr	Interest Rate: Discount (% p.a.)	1988:1-2010:12	IFS
depo3m	Interest Rate: 3-Month Deposit (% p.a.)	1988:1-2010:12	CBRT
traucrate	Interest Rate: Treasury Auction Rate (% p.a.)	1988:1-2010:12	OECD MEI[8]
ex-rate	Log of Average USD/TRY Nominal Exchange Rate	1988:1-2010:12	IFS
rex-rate	Log of Real Effective Exchange Rate	1988:1-2010:12	CBRT
ise100	Log of Stock Price	1988:1-2010:12	CBRT
rise100	Log of Real Stock Index (in 2005 prices)	1988:1-2010:12	–
is-pe	Price-Earnings Ratio on ISE100	1996:1-2010:12	ISE[9]
divpr	Dividend Yield on ISE100	1988:1-2010:12	ISE
embi+	Log of JP Morgan EMBI Index for Turkey	1999:7-2010:12	WB[10]
irspread	Spread: Sovereign interest rate - US T-bill Rate	1996:6-2010:12	WB
gold	Log of Gold Price (in USD)	1988:1-2010:12	IFS
rgold	Log of Real Gold Price	1988:1-2010:12	–
lover	Log of Overdrafts	1988:1-2010:12	CBRT
lirescb	Log of Central Bank's Gross FX Reserves	1988:1-2010:12	CBRT
lires-gold	Log of International Reserves: Gold	1988:1-2010:12	CBRT
lires	Log of Gross International Reserves	1988:1-2010:12	CBRT
prosp-exp	Balance of responses on export possibilities	1988:1-2010:12	OECD MEI
stocks-fin	Balance of responses on monthly stocks of finished goods	1988:1-2010:12	OECD MEI
emp-tend	Balance of responses on 3-month trend for total employment	1988:1-2010:12	OECD MEI

Table 1. **Series descriptions and sources** *(cont.)*

Acronym	Description	Sample Period	Source
new-orders	Balance of responses on 3 month trend for new orders from the domestic market	1988:1-2010:12	OECD MEI

Sources:
1. IFS: IMF International Financial Statistics.
2. Turkstat: Turkish Statistical Institute.
3. CBRT: Central Bank of the Republic of Turkey.
4. OECD: OECD Statistics.
5. AMA: Automotive Manufacturers' Association.
6. RTMF: Republic of Turkey Ministry of Finance.
7. FRED: Federal Reserve Bank of St. Louis Economic Database.
8. OECD MEI: OECD Main Economic Indicators.
9. ISE: Istanbul Stock Exchange.
10. WB: World Bank Global Economic Monitor.

- survey responses obtained from the Central Bank of the Republic of Turkey Business Tendency Survey (BTS) for prospects for exports, future employment trends, the stocks of finished goods and new orders for the domestic market.[6]

The variables that we use are similar to those examined by Stock and Watson (2003), and Leigh and Rossi (2002). However, our study also includes core variables seeking to measure real activity in the economy. In this respect, our study has more in common with Chauvet (2001), who considers different measures of industrial production, capacity utilisation, real wages, compensated hours, retail sales, employment, the unemployment rate, fuel consumption and electricity consumption. The variables in our study can also be categorised in terms of whether they represent supply, demand, policy or expectational factors. Variables such as the capacity utilisation rate, the PPI, imports, especially imports of intermediate goods, and production of certain durable goods may represent supply side influences. Exports and the CPI may be indicative of demand side influences while revenue from the value-added tax may reflect effects from both the demand and supply sides.[7] Policy variables are represented by interest rates, monetary aggregates or international reserves while market expectations are captured through variables measuring the return on the stock market, the return on foreign currency denominated Turkish bonds, or the spread between Turkish and US bonds. Finally, as in Atabek et al. (2005) or Chauvet and Morais (2008), we include survey measures of business sentiment on alternative aspects of real activity. Of these measures, the survey response about the next 3-month trend for total employment represents a supply-side variable in that it measures expectations about future output, which depends on future employment. By contrast, the survey responses regarding prospects for exports, stocks of finished goods and new orders in the domestic market represent demand side variables.[8]

Several transformations are applied to the explanatory variables. The first issue has to do with seasonal variation. As shown in Annex A, some of the variables were available from the source in seasonally adjusted form. For the remainder, we conduct tests of seasonality by regressing (a suitably differenced version of) the series on seasonal dummies. For those series that exhibit seasonal variation, we implement deseasonalisation using the TRAMO-SEATS procedure, which decomposes the observed series into trend, cyclical, seasonal and irregular components using an autoregressive integrated moving average (ARIMA) model-based approach. The impact of unusual events (such as moving

holiday effects like Muslim festivals of Sacrifice and Ramadan) and calendar effect variables such as trading day, leap year effect, and national holidays are also removed using the adjustments suggested in Atabek et al. (2009). In some cases, logarithms are taken of the original variables which are structured in levels. Differencing or second differencing is used to remove trends from persistent variables. For some variables such as interest rates or dividend yields, it is unclear whether they should be included as levels or in difference form. Hence, we include both versions for such variables. Real and nominal versions of various quantities are also included in our analysis. Models with nominal rigidities such as the New Keynesian model (see for example, Gali, 1999) predict that nominal quantities may have an effect over and above those of real variables.

4. Results

In this section, we describe the selection of leading indicators for IP growth and changes in inflation for the three different forecast periods. We also provide a discussion of the results in light of the existing literature and the developments in the Turkish economy over the relevant sample period. Prior to analysing the results in these tables, it is important to note that some of the improvements in forecasting performance may have to do with sampling variability as opposed to statistical significance of the leading indicators. It is possible to formally test the null hypothesis that the relative MSFE is equal to one versus the alternative that it is less than one using the Clark and McCracken (2001) approach. Alternatively, standard errors can be computed for the MSFE using the approach in Diebold and Mariano (1994), for example. However, there are conceptual and computational issues regarding both approaches.[9]

4.1. *IP growth*

The pseudo out-of-sampling forecasting results pertain to the sub-samples of 1988-2000, 1996-2005, and 2001-2010, with the respective corresponding forecast periods being 1993:1-2000:12, 2001:1-2005:12, and 2006:1-2010:12. From now on, we will primarily refer to the relevant forecast period when describing our results. The results for the 2006:1-2010 forecast period are given in Table 2 while Tables A.1 and A.2 provide the results for the two earlier forecast periods. Since some of the indicators are available for shorter samples, the results for the first two forecast periods are based on a slightly smaller set of potential indicators.

1993:1-2000:12 forecast period

There are few indicators that lead to significant improvements at most horizons. Of these indicators, changes in the foreign exchange reserves at the central bank (difference of "liresch") provide an improvement in the forecast of IP growth relative to the autoregressive benchmark of up to 7% at the 3-month horizon as well as inducing more minor improvements at the remaining horizons. Changes in the supply of nominal and real M1 (differences of "lm1" and "rlm1") induce improvements of 10-11% at horizons from 3 to 6 months. There is some evidence for the role of changes in the supply of nominal and real M2, as well as changes in real M2Y and M3 (differences of "lm2", "rlm2", "rlm2y", and "rlm3") for providing improvements in the forecasts of IP growth relative to the autoregressive benchmark at different horizons but such improvements are minor. There is also some evidence for the role of asset prices in the short run in that the nominal return on the ISE100 (differences of "ise100") leads to improvement of 8% at the 3-month horizon.

Table 2. **IP growth: Pseudo out-of-sample forecasting accuracy, 2006:1-2010:12**

Forecast horizon		*h* = 3	*h* = 6	*h* = 9	*h* = 12
Univariate autoregression		Root mean squared forecast error			
		25.79	19.08	15.98	13.92
Bivariate forecasts		MSFE relative to univariate autoregression			
Indicator	Transformation				
cur	d	1.01	**0.99**	1.00	1.00
grelpr	d	1.05	1.05	**0.98**	1.00
trac	d	1.08	**0.96**	1.01	1.02
buses	d	1.09	1.10	1.03	1.00
unemp	–	1.63	1.43	1.29	1.16
unemp	d	1.30	1.18	1.16	1.01
totemp	d	1.60	1.14	1.07	1.01
exp	d	1.45	1.17	1.01	**0.93**
imp	d	1.20	1.15	1.02	1.01
inimp	d	1.15	1.11	1.03	1.00
lvat	d	1.14	1.07	1.02	1.04
lvat	2d	1.11	1.19	1.05	1.01
rlvat	d	1.04	1.10	1.07	1.10
lcpi	d	1.25	1.19	**0.98**	1.00
lcpi	2d	1.09	1.15	1.02	1.01
lppi	d	1.08	1.01	1.02	1.05
lppi	2d	1.07	1.01	1.03	**0.98**
lop	d	1.20	1.05	1.09	1.07
lop	2d	1.05	**0.99**	1.00	1.00
rlop	d	1.18	1.03	1.08	1.08
uscpi	d	1.73	1.16	1.64	**0.99**
uscpi	2d	1.34	1.02	1.01	1.00
lm1	d	1.05	1.05	1.08	1.15
lm1	2d	1.00	**0.99**	1.01	**0.99**
lm2	d	1.22	1.05	1.10	1.13
lm2	2d	1.13	1.01	1.00	1.00
lm2y	d	1.21	1.08	1.05	1.06
lm2y	2d	1.18	1.00	1.00	**0.99**
lm3	d	1.24	1.09	1.03	1.06
lm3	2d	1.09	1.06	1.01	1.00
lm3y	d	1.22	1.08	1.06	1.05
lm3y	2d	1.22	1.01	1.01	1.00
rlm1	d	1.02	**0.99**	**0.99**	1.10
rlm2	d	1.17	1.06	1.03	1.02
rlm2y	d	1.23	1.06	1.01	1.14
rlm3	d	1.16	1.04	**0.97**	1.01
rlm3y	d	1.23	1.06	1.04	1.12
onir	–	1.19	1.13	1.06	1.03
onir	d	1.16	1.09	**0.95**	1.00
dr	–	1.19	1.12	1.11	1.10
dr	d	1.07	1.00	1.00	1.00
depo3M	–	1.22	1.11	1.07	1.02
depo3M	d	1.21	1.10	1.06	1.00
traucrate	–	1.24	1.13	1.02	1.01
traucrate	d	1.21	1.14	1.02	**0.99**
ex-rate	d	1.23	1.03	1.03	1.01
rex-rate	d	1.25	1.00	1.01	1.01
ise100	d	1.03	1.01	**0.96**	1.00
rise100	d	1.03	1.00	**0.93**	1.01
ise-pe	–	**0.99**	1.01	**0.99**	**0.98**

Table 2. **IP growth: Pseudo out-of-sample forecasting accuracy, 2006:1-2010:12** *(cont.)*

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		25.79	19.08	15.98	13.92
Bivariate forecasts		MSFE relative to univariate autoregression			
ise-pe	d	**0.97**	**0.98**	1.00	**0.99**
divpr	–	1.16	1.34	1.47	1.27
divpr	d	1.17	1.00	1.00	1.00
embi+	d	1.07	**0.93**	**0.96**	**0.97**
irspread	–	1.10	1.02	**0.98**	**0.92**
irspread	d	1.11	**0.99**	**0.98**	**0.98**
gold	d	1.40	1.50	1.27	1.08
gold	2d	1.04	1.03	1.03	1.00
rgold	d	1.39	1.45	1.17	1.07
lover	–	1.25	1.08	1.06	1.11
lover	d	1.23	1.05	1.01	1.04
lirescb	–	1.34	1.33	1.18	1.07
lirescb	d	1.12	**0.99**	1.02	1.00
lires-gold	–	1.28	1.32	1.32	1.30
lires-gold	d	1.15	**0.99**	1.02	1.01
lires	–	1.52	1.77	1.94	1.39
lires	d	1.05	**0.96**	1.02	1.01
prosp-exp	–	1.04	**0.98**	**0.93**	1.05
stock-fin	–	1.38	1.19	1.30	**0.96**
emp-tend	–	1.26	1.12	**0.91**	**0.96**
new-orders	–	1.06	1.10	**0.94**	**0.93**

Note: Bold indicates a relative MSFE < 1.

The survey responses to the question regarding new orders in the domestic market ("new-orders"), which represents a demand-side variable, leads to an improvement of 13% at the 3-month horizon. Changes in nominal and real oil prices (differences of "lop" and "rlop") lead to improvements relative to the autoregressive benchmark of 12-13% at a horizon of a year, attesting to supply-side influences on the economy over the longer run.

2001:1-2005:12 forecast period

In this case, changes in the Treasury auction rate (difference of "traucrate") is the only indicator that provides improvements relative to the autoregressive benchmark at all horizons, such improvements being around 30% at 9 to 12 months. Asset prices such as the nominal and real return on the ISE100 (differences of "ise100" and "rise100") and changes in the nominal and real gold price (differences of "gold" and "rgold") matter for forecasting IP growth at a horizon of a year and less. The very substantial reductions in the MSFE of IP growth attributed to the nominal and return on the ISE100 relative to the autoregressive benchmark can be rationalised by the large fluctuations observed in the price of the ISE100 observed during the 2000-01 crisis.

Trade-related variables such as prospects for exports ("prosp-exp") provide improvements of 17-21% in the relative MSFE of IP growth at 6 to 9 month horizons, respectively, while changes in intermediate inputs provide an improvement of 11% at a horizon of 9 months. It is worth noting that Atabek et al. (2005) include imports of intermediate goods in their composite leading indicator for Turkey constructed over the period 1985-2003. The role for imports of intermediate goods arises from the structure of Turkish manufacturing, which is heavily dependent on such imports. (See, for example,

Yükseler and Türkan, 2008.) Thus, an increase in intermediate goods imports today translates into higher IP growth 9 months ahead.

2006:1-2010:12 forecast period

There is no single variable that provides an improvement relative to the autoregressive benchmark for all horizons for this forecast period. However, among the variables that matter, there is more evidence for the role of asset prices. As an example, the EMBI+ return (difference of "embi+") provides improvements to the IP growth forecast at several horizons, with the greatest improvement occurring at a 6-month horizon (7%). Likewise, changes in the interest spread rate on short-term Turkish government bonds relative to US government bonds (difference of "irspread") leads to an improvement of 8% at the one-year horizon. There is also evidence for the role of the nominal and real return on the ISE100 (difference of "rise100") and of changes in the overnight interest rate (difference of "onir"), these variables leading to improvements between 4-7% at the 9-month horizon.

There is also a role for indicators of business sentiment from the CBRT Business Tendency Survey as well as for changes in exports, especially at horizons of 9 months to a year, attesting to the role of indicators related to the real economy. However, we observe that the forecasting power of indicators such as the survey responses regarding as future employment tendencies ("emp-tend"), prospects for exports ("prosp-exp"), and new orders in the domestic market ("new-orders") has diminished substantially in the last forecast period relative to the previous one. This may have to do with the experience of the 2008-09 financial crisis, which was largely external to the Turkish economy.

4.2. Changes in CPI inflation

As in the case for IP growth, we examine the determinants of changes in CPI inflation for three separate forecast periods. The results for the 2006:1-2010:12 forecast period are in Table 2, while Tables A.3 and A.4 contain the results for the earlier two forecast periods.

1993:1-2000:12 forecast period

There are multiple indicators that lead to improvements in the forecasts of inflation changes at all horizons relative to the autoregressive benchmark. The indicators that lead to some of the greatest improvements are given by the level and changes of producer price inflation (first and second differences of "lppi"), which induce improvements around 15-43% in forecasts of inflation changes at horizons 6 months to a year, and the survey responses to questions on prospects for exports ("prosp-exp"), stock of finished goods ("stock-fin"), employment trends ("emp-tend"), and prospects for new orders ("new-orders"), which induce improvements around 25-50% in forecasts of inflation changes at horizons of 6 months to a year. Changes in all of the real monetary aggregates (differences of "rlm1", "rlm2", "rlm2y", "rlm3", and "rm3y") lead to improvements of 15-25% at horizons 6 months to a year. Changes in exports (differences of "exp") also lead to improvements of 20-30% at horizons of 6 months to a year. Finally, there is some role for changes in the discount rate (difference of "dr") and the dividend-price ratio on the ISE1000 ("div-pr"), especially at longer horizons.

The impact of these variables is evidence for the monetary factors that lie behind the high and chronic inflation of the 1990s in Turkey together with the high pass-through from producer to consumer prices. The strong role attributed to the responses to the survey questions also suggests that current and past developments were embedded in private agents' expectations about the future course of the economy, which tend to have strong predictive power for changes in inflation six months or more into the future.

2001:1-2005:12 forecast period

For this forecast period, there still exist variables that help to predict inflation changes at multiple horizons but their forecasting power is lower. Interestingly, consumer price inflation in the US (differences of "uscpi") has the strongest impact of inflation changes in Turkey at a horizon of a year, leading to a 34% reduction in the MSFE relative to the autoregressive benchmark. This most likely reflects the impact of low global interest rates in the post-2001 period, which have played a strong role in the disinflation process in Turkey during 2002-05.

Of the remaining variables, the growth rates (and their changes) of nominal and real monetary aggregates continue to matter as the variables that help to improve the forecasting performance of changes in CPI inflation at almost all horizons. In particular, changes in the growth rate of nominal M2 and M2Y (second difference of "lm2" and "lm2y") and the growth rates of nominal M2Y and real M2, M2Y, M3, and M3Y (differences of "lm2", "rlm2", "rlm2y", "rlm3", and "rlm3y") lead to improvements of 8-12% in the relative MSFE of changes of CPI inflation at different horizons. Other variables that improve the forecast of changes in CPI inflation include changes in interest rates such as the discount rate and the Treasury auction rate (differences of "dr" and "traucrate") as well as the real return on the ISE100 (difference of "rise100"). We also find some role for changes in the growth rate of the nominal gold price (second difference of "gold") at longer horizons.

2006:1-2010:12 forecast period

Table 3 shows that the level of PPI inflation is the variable that leads to the greatest improvement in the forecasts of inflation changes at 9 months to a year for the last forecast period, pointing to the relatively strong pass-through from producer to consumer prices. As we discuss below, since imported intermediate and final inputs account for a significant fraction of inputs for Turkish manufacturing, this finding also points to the role of capital inflows and exchange rate appreciation that Turkey experienced during the 2006-10 period. The growth in VAT revenue and its change (first and second difference of "lvat") also appear as important predictors, leading to improvements of 30-35% at a horizon of a year. Since indirect taxes, especially taxes on imports, are an important source of tax revenue in Turkey, this finding again suggests a relationship between fiscal revenues and capital inflows, on the one hand, and inflationary pressures, on the other, for the Turkish economy at longer horizons.

Asset prices also play a much more prominent role for this forecast period. However, their effects tend to occur at longer horizons. The price-earnings ratio on the ISE100 ("ise-pe") leads to improvements in the relative MSFE of inflation changes of 40% or more at horizons of nine months to a year. The overnight interest rate ("onir"), the three-month deposit rate ("depo3M"), and the discount rate ("dr") are associated with reductions in the MSFE of changes in CPI inflation relative to the autoregressive benchmark of 34-60% at horizons of nine months to a year while the level of the Treasury auction rate ("traucrate") leads to improvements of 15% at a horizon of one year.

Likewise, the level of overdrafts at the central bank ("lover") are associated with 20-60% improvements in the relative MSFE of changes in inflation at horizons of six months to a year. Aside from these variables, there is some evidence for the effect of monetary aggregates such as changes in M2Y and M3Y (difference of "lm2y" and "lm3y") at horizons of one year, suggesting that overall credit conditions continue to matter for inflation changes at relatively longer horizons.

Table 3. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 2006:1-2010:12**

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		5.44	5.09	5.75	6.63
Bivariate forecasts		MSFE relative to univariate autoregression			
Indicator	Transformation				
lipi	d	1.69	2.02	1.50	1.53
lipi	2d	2.23	2.18	1.58	1.05
hp-ipi	–	4.03	5.83	4.72	4.96
cur	d	2.37	2.51	1.54	1.38
grelpr	d	1.31	3.58	4.19	4.05
trac	d	1.01	1.04	1.07	1.00
buses	d	1.31	1.42	1.32	1.24
unemp	–	1.69	2.62	3.69	4.68
unemp	d	1.96	2.38	1.98	1.73
totemp	d	1.52	1.39	1.09	**0.90**
exp	d	2.11	3.08	3.90	3.74
imp	d	3.49	4.45	3.40	2.90
inimp	d	3.46	4.96	4.61	4.29
lvat	d	1.57	1.40	**0.93**	0.65
lvat	2d	1.40	1.18	**0.98**	0.69
rlvat	d	1.85	2.03	1.38	1.32
lppi	d	1.01	**0.63**	**0.38**	**0.18**
lppi	2d	1.04	1.35	1.06	1.03
lop	d	1.00	1.70	3.53	3.71
lop	2d	**0.99**	1.00	1.00	1.07
rlop	d	1.03	2.44	3.42	3.49
uscpi	d	1.84	7.37	8.13	8.79
uscpi	2d	1.01	1.00	**0.99**	1.04
lm1	d	1.57	1.27	1.24	1.12
lm1	2d	1.00	1.53	1.35	**0.99**
lm2	d	1.24	1.87	1.53	1.34
lm2	2d	1.38	1.38	**0.92**	**0.94**
lm2y	d	1.67	1.48	1.16	**0.77**
lm2y	2d	1.73	1.75	1.70	1.43
lm3	d	1.76	1.89	1.29	**0.90**
lm3	2d	1.76	1.91	1.51	1.28
lm3y	d	1.64	1.49	1.11	**0.76**
lm3y	2d	1.69	1.73	1.68	1.51
rlm1	d	1.49	1.88	1.81	1.72
rlm2	d	1.15	1.41	1.18	**0.99**
rlm2y	d	1.25	1.27	1.14	**0.97**
rlm3	d	1.10	1.28	1.13	1.13
rlm3y	d	1.20	1.26	1.18	1.06
onir	–	1.59	1.02	**0.63**	**0.40**
onir	d	1.69	1.43	1.13	1.10
dr	–	1.40	1.54	**0.86**	**0.66**
dr	d	1.39	1.92	1.77	2.74
depo3M	–	1.90	1.47	**0.91**	**0.59**
depo3M	d	1.81	1.57	1.14	1.10
traucrate	–	1.77	1.52	1.15	**0.85**
traucrate	d	1.44	1.37	1.25	1.39
ex-rate	d	1.11	1.69	1.41	1.02
rex-rate	–	1.65	1.84	1.65	1.48
ise100	d	1.69	1.21	**0.99**	1.01
rise100	d	1.10	1.00	**0.98**	1.56
ise-pe	–	**0.99**	**0.78**	**0.56**	**0.45**

Table 3. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 2006:1-2010:12** *(cont.)*

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		5.44	5.09	5.75	6.63
Bivariate forecasts		MSFE relative to univariate autoregression			
ise-pe	d	1.06	1.13	**0.99**	**0.93**
divpr	–	1.07	1.25	1.53	1.94
divpr	d	**0.99**	1.01	1.00	1.00
embi+	d	1.61	1.75	1.31	1.15
irspread	–	1.81	2.17	1.78	1.53
irspread	d	1.39	1.58	1.83	1.69
gold	d	**0.96**	4.61	4.59	1.27
gold	2d	1.05	1.02	1.04	1.03
rgold	d	1.20	4.24	4.53	1.26
lover	–	1.00	**0.80**	**0.53**	**0.40**
lover	d	1.01	1.03	**0.96**	1.07
lirescb	–	2.19	3.01	2.68	2.77
lirescb	d	1.55	2.88	1.72	2.03
lires-gold	–	1.10	1.07	1.04	1.34
lires-gold	d	**0.96**	1.04	1.03	1.02
lires	–	1.83	2.27	3.06	3.35
lires	d	1.83	2.31	2.64	1.95
prosp-exp	–	4.98	5.29	5.46	4.91
stock-fin	–	4.54	6.88	7.13	5.53
emp-tend	–	7.98	7.97	5.16	4.27
new-orders	–	4.44	6.02	3.95	3.21

Note: Bold indicates a relative MSFE < 1.

4.3. *Discussion*

It is worth comparing these results with those of others and relating them to developments in the Turkish economy during the 1988-2010 period. Our results indicate that the factors that account for both IP growth and changes in CPI inflation appear to have changed in the two forecast periods after 2001, namely, 2001-05 and 2006-10, relative to the first forecast period before 2001, 1993-2000.

IP growth

The indicators that provide an improvement on forecasts obtained from the autoregressive benchmark tend to change by the forecast period. In the first forecast period, we attribute a significant role to supply-side factors such the price of oil as well as to monetary factors such as changes in reserves and monetary aggregates while in the second forecast period, the Treasury auction rate emerges as an important predictor. The survey responses on different indicators of the future course of the economy from the CBRT Business Tendency Survey tend to matter for the first and second forecast periods.[10] By contrast, asset prices tend to be important predictors during the second and third forecast periods.

Comparing these results with those of Leigh and Rossi (2002), we confirm the importance of asset returns and various interest rates for forecasting IP growth in the different forecast periods. However, we find that variables that are useful predicting IP growth at one horizon typically do not matter at other horizons. For the 2006-10 forecast period, we also attribute significant roles to the return on foreign-currency denominated

Turkish bonds represented by Turkey's EMBI+ return as well as the interest rate spread on Turkish bonds relative to US bonds for forecasting future IP growth. The predictive power of the EMBI+ return for Turkey points to the role of capital inflows in stimulating real activity in Turkey since 2001. As is well known, the Emerging Markets Bond Index (EMBI) for Turkey tracks total returns for its traded external or foreign currency denominated debt instruments. Along with other emerging economies, Turkey has witnessed declines in its risk premia in international capital markets during the recent decade. Combined with the increases in global liquidity overall, this has led to large increases in capital inflows to emerging economies such as Turkey.

The role of capital flows in affecting economic performance is studied by Calvo, Liederman and Reinhart (1999). Using a structural VAR analysis, Çulha (2006) finds that the relative role of "push" versus "pull" factors in determining inflows to Turkey has shifted after the 2000-01 crisis, with "pull" factors such as domestic interest rates, stock prices, inflation, domestic credit, etc., becoming more important. Çulha finds that while 22.5% of the variance on capital flows (measured as portfolio and short-term flows) can be accounted for by shocks to the real interest rate over the 1992:1-2001:12 period in Turkey, this quantity falls to 0.5% during 2002:1-2005:12. Likewise, the contribution of shocks to the Istanbul Stock Exchange Index ISE100 increases to 26.14% in the latter period relative to 0.97% in the earlier period. These findings appear to coincide with our findings in that changes in the EMBI index for Turkey as well as the indicators related to the stock market, figure among the most important indicators for predicting IP growth in the two forecast periods after 2001.

The fact that the interest rate spread on Turkish debt relative to US short-term also appears as another important predictor of IP growth in the forecast period 2006-10 shows that the changes in Turkey's cost of borrowing contributed to growth in real activity over this period. More generally, the role of various asset returns in affecting real economic activity is consistent with the process of normalisation experienced in Turkey during the latter half of the 2000s. As is well known, the period since 2002 has been characterised by falling interest rates, falling risk premia, and high rates of growth responding to an environment of economic and political stability in Turkey.[11]

Aside from the role of asset prices, the role of reserves of the central bank and various monetary indicators in forecasting IP growth are also worth commenting on. For the 1993-2000 forecast period, changes in the foreign exchange reserves of the central bank together with various monetary aggregates matter for forecasting IP growth. This is consistent with the results of Leigh and Rossi (2002), who attribute a strong role for variables in predicting IP growth in the short-term as well as at some longer horizons. They attributed variables such as changes in the foreign exchange reserves of the central bank and commercial banks or the ratio of the foreign exchange reserves of commercial banks to the central bank's foreign exchange reserves. By contrast, there is no such role for reserves or monetary aggregates during the 2001-05 or 2006-10 forecast periods. We can understand these results by noting that large declines in real economic activity and crises during the pre-2001 period were typically accompanied by capital flight and the loss of foreign exchange reserves by both commercial banks and the central bank.[12]

CPI inflation

In the first forecast period corresponding to 1993-2000, the changes in the growth of nominal monetary aggregates together with the growth rates of real monetary aggregates figure as important determinants of changes in CPI inflation. This is consistent with the

results of Leigh and Rossi (2002). They find that the growth rates of monetary aggregates such as reserve money (M2Y, M3, M3Y), as well as changes in the growth rate of M1 lead to increases in the forecasting performance for changes in CPI inflation of 7-12% relative to the autoregressive benchmark. Likewise, they find that the growth rate of foreign exchange reserves of the central bank and commercial banks, the gross international reserves at the central bank, including the reserves of gold, and the first and second differences in the ratio of foreign-exchange denominated deposits to the M2Y monetary aggregate are associated with improvements in the forecasting performance of changes in CPI inflation on the order of 6-13%. It is well known that inflationary finance associated with monetising fiscal deficits was widely practiced in the pre-2001 period.[13] Furthermore, Turkey typically experienced large increases in inflation as a result of the 1994 and 2000-01 financial crises, which were also accompanied by runs on the Turkish lira and a major decline in reserves of the central bank and the banking system as Turkey tried to maintain a managed floating exchange rate system.[14]

By contrast, the second and third forecast periods since 2001 have been characterised by fiscal discipline and a floating exchange rate regime adopted as part of the comprehensive reform package put into effect in May 2001. Furthermore, Turkey transited from an implicit inflation targeting regime to a formal inflation targeting regime in 2006, where the central bank has made achieving and maintaining price stability as its primary goal. As a consequence, the results in Table 3 for the third forecast period corresponding to 2006-10 suggest that short-term nominal interest rates such as the overnight interest rate, the discount rate, the three-month deposit rate as well as the return on the ISE100 have predictive power for inflation changes at a horizon of one year. The strong role for US consumer price inflation on the Turkish disinflation process displayed in Table A.4 for the forecast period 2001-05 suggests that the low inflation and low interest rates worldwide have also had a significant effect on inflationary dynamics in Turkey.

Various authors have stressed the role of exchange rate pass-through in determining inflationary dynamics for Turkey. Leigh and Rossi (2004) examine exchange rate pass-through for Turkey over the period 1994-2003 using a five-variable vector auto-regression (VAR) that includes oil price changes, IP growth, changes in the nominal exchange rate relative to US dollar, and wholesale and consumer price index inflation. They find that exchange rate pass-through is greater for the wholesale price index (WPI) compared to the consumer price index (60% versus 45% in a year). Likewise, they find that about 40% of the variance of the WPI inflation is accounted for by exchange rate shocks compared to 30% of the variance for CPI inflation, with another 20% of the variance of CPI inflation being explained by innovations to WPI inflation. Using a methodology similar to Leigh and Rossi (2004), Kara (2005) examines the impact of exchange rate pass-through by taking into account the changes in the exchange rate regime in the pre- and post-May 2001 periods. To account for the structure of production in the Turkish economy where imported inputs are used in both intermediate and final goods production processes, Kara (2005) considers a VAR with the output gap, import prices denominated in Turkish lira, private manufacturing prices, and core CPI inflation measures, which he estimates over the periods 1995:2-2001:4 and 2001:5-2004:9, respectively. He finds that the pass-through is much stronger for private manufacturing prices in both sub-periods, and that the magnitude and duration of pass-through has changed following the reforms undertaken in May 2001, including the adoption of a floating exchange rate regime.

These findings suggest that exchange rate pass-through is stronger for wholesale compared to consumer prices. Our results also indirectly confirm this fact in that what determines the dynamics of CPI inflation appears to be PPI inflation (or its changes). Indeed over both the forecast periods 1993-2000 and 2006-10, PPI inflation and its changes lead to significant reductions in the MSFE for changes in CPI inflation compared to the autoregressive benchmark. There is less evidence in this regard for the 2001-05 forecast period but this may have to do with the impact of the 2000-01 crisis, where the inflationary process was highly volatile. Thus, while our results do not attribute a direct role to exchange rate changes in determining the dynamics of inflation, we nevertheless show that pass-through from producer price inflation to consumer price inflation is an important determinant of the inflationary process in Turkey.

A variety of authors have argued that the output gap also figures as an important indicator of inflationary pressures in Turkey. Sarikaya et al. (2005) use a multivariate Kalman filtering approach to estimate potential output and the output gap. They argue that the output gap has contributed to the disinflation that occurred during 2002-04, and the importance of the output gap has been rising since 2001. In our analysis, we use a HP-filtered version of the output gap ("hp-ipi"), which is also the approach followed by Leigh and Rossi (2002). While we do not derive output gap measures based on a more economically meaningful approach, our use of three different forecast periods may help to capture the time variation in the determinants of inflation and output dynamics uncovered by Sarikaya et al. (2005). We fail to uncover a significant role for the output gap in predicting inflation changes, especially in the 2001-05 and 2006-10 forecast periods. There is some evidence that the output gap helps to reduce the MSFE of inflation changes relative to the autoregressive benchmark for the forecast period of 1993-2000 (see Table A.4). These results are, on the whole, consistent with those of Leigh and Rossi (2002), who uncover a minor role for the output gap on inflation changes for the forecast period 1992-2002. Sarikaya et al. (2005) find that the impact of interests rates on inflation and the output gap has risen considerably in the period after 2001, signifying a more important role for interest rate policy in "expectations management and output dynamics". Taken together, these results are not inconsistent with our conclusions regarding the enhanced role of interest rates and expectational phenomena in determining the dynamics of both output growth and inflation in the two forecast periods since 2001.

We conclude this section with some comments on identifying a set of leading indicators for the global financial crisis of 2008. While our analysis does not specifically examine this crisis, it is worth discussing some results in this regard. Frankel and Saravelos (2010) seek to determine leading indicators for the 2008-09 crisis for a broad cross section of countries. They find that the level of reserves in 2007 to be a "consistent and statistically significant leading indicator of who got hit by the 2008-09 crisis", a result which is also consistent with the earlier literature. They further argue that the level of reserves appears as a robust indicator of alternative measures of crisis incidence whereas exchange rate overvaluation matters when the crisis is defined in terms of the behaviour of the currency. One of the noteworthy findings of our study is that alternative measures of reserves have little predictive power for IP growth in the forecast period 2006-10. While Turkey suffered one of the largest declines in real activity compared to a variety of countries during 2008-09, it did not pursue a fixed exchange rate regime in contrast to other countries that displayed significant declines in real economic activity such as the Baltic countries. This may explain why our study does not attribute a greater importance to reserves in predicting real activity.

5. Combination forecasts

The lack of uniform predictability of bivariate relations has prompted researchers to examine the efficacy of combination forecasts. The notion behind combining forecasts based on individual variables is that the combined forecast will pool the information contained in the individual forecasts, and therefore, should be more efficient. Stock and Watson (2003) argue that the "optimal" combination forecasts discussed by Bates and Granger (1969), and Granger and Ramanathan (1984) often fail to perform better than simple combinations of forecasts such as their mean or median. Hence, they advocate using the trimmed mean and the median of the individual forecasts, which eliminate the impact of outliers on the resulting combination forecast. We also follow a suggestion of Leigh and Rossi (2002) and consider a two-stage forecast comprised of the median of the top five forecasts.

The approach to generating the combination forecasts is as before. We accumulate five years of data prior to any forecasting of the relevant series and start the forecasting exercise five years out in the relevant sub-samples to simulate a real-time forecasting situation. We then calculate the trimmed mean, where the lowest and the highest forecasts are trimmed to mitigate the influence of outliers, and median of all the individual forecasts as well as the median of the top five forecasts for each forecast horizon. Using this procedure, we generate a sequence of pseudo forecast errors $y_{t+h}^{h} - \hat{y}_{t+h}^{h}$ and compare the mean squared forecast error (MSFE) of the candidate indicator with the MSFE of the benchmark autoregressive specification. Notice that the top five indicators may change by forecasting horizon since there are less than five indicators which outperform the autoregressive benchmark at all horizons.

Tables 4 and 5 show that the relative performance of the forecasts appears to vary by the indicator that is being predicted. The median of the top five forecasts results in maximum reductions of 20% for IP growth for the first forecast period and 36% for the second forecast period. By contrast, the improvement in the relative MSFE of IP growth is lower when the third forecast period is considered. This is most likely due to the effect of the global financial crisis of 2008-09. Unlike the earlier crises that erupted due to domestic causes in a globalised environment, this crisis was due to external factors and hence, relatively difficult to predict based on primarily domestic indicators.

There is an opposite pattern for changes in CPI inflation. The improvement in the relative MSFE of inflation changes is at most 16% for the second forecast period, regardless of the horizon. By contrast, there are significant reductions in the MSFE of the forecast relative to the autoregressive benchmark for the first and third forecast periods, especially at longer horizons. In particular, there are improvements of nearly 75% for the forecast of inflation changes in the third forecast period at a horizon of a year. No doubt this phenomenon reflects the decline in inflation that occurs over the period 2006-10, which pertains to a period of disinflation and normalisation for the Turkish economy. The superior predictability of changes in CPI inflation using the combination forecasts is also demonstrated by Leigh and Rossi (2002). However, they obtain improvements in the range of 15-20% relative to the autoregressive benchmark over the forecast period of 1992-2002, attesting to the role of past inflation (or indexation) in determining current inflation performance during the period of high and volatile inflation for Turkey.

Figures 1 and 2 plot cumulated IP growth and cumulated changes in CPI inflation over three, six, nine and twelve months over the forecast period 2006-10. These figures also

Table 4. **IP growth: Pseudo out-of-sample forecasting accuracy, combination forecasts**

Forecast horizon	$h = 3$	$h = 6$	$h = 9$	$h = 12$
Combination forecasts		Relative MSFE		
1993:1-2000:12				
Trimmed mean of all forecasts	0.93	0.97	0.98	1.00
Median of all forecasts	0.97	0.99	0.98	1.00
Median of top 5 forecasts	0.80	0.87	0.88	0.95
2001:1-2005:12				
Trimmed mean of all forecasts	0.85	0.93	1.36	1.31
Median of all forecasts	0.98	1.01	1.00	0.99
Median of top 5 forecasts	0.78	0.86	0.64	0.67
2006:1-2010:12				
Trimmed mean of all forecasts	1.05	0.99	0.99	0.99
Median of all forecasts	1.09	1.00	1.00	1.00
Median of top 5 forecasts	0.98	0.96	0.89	0.92

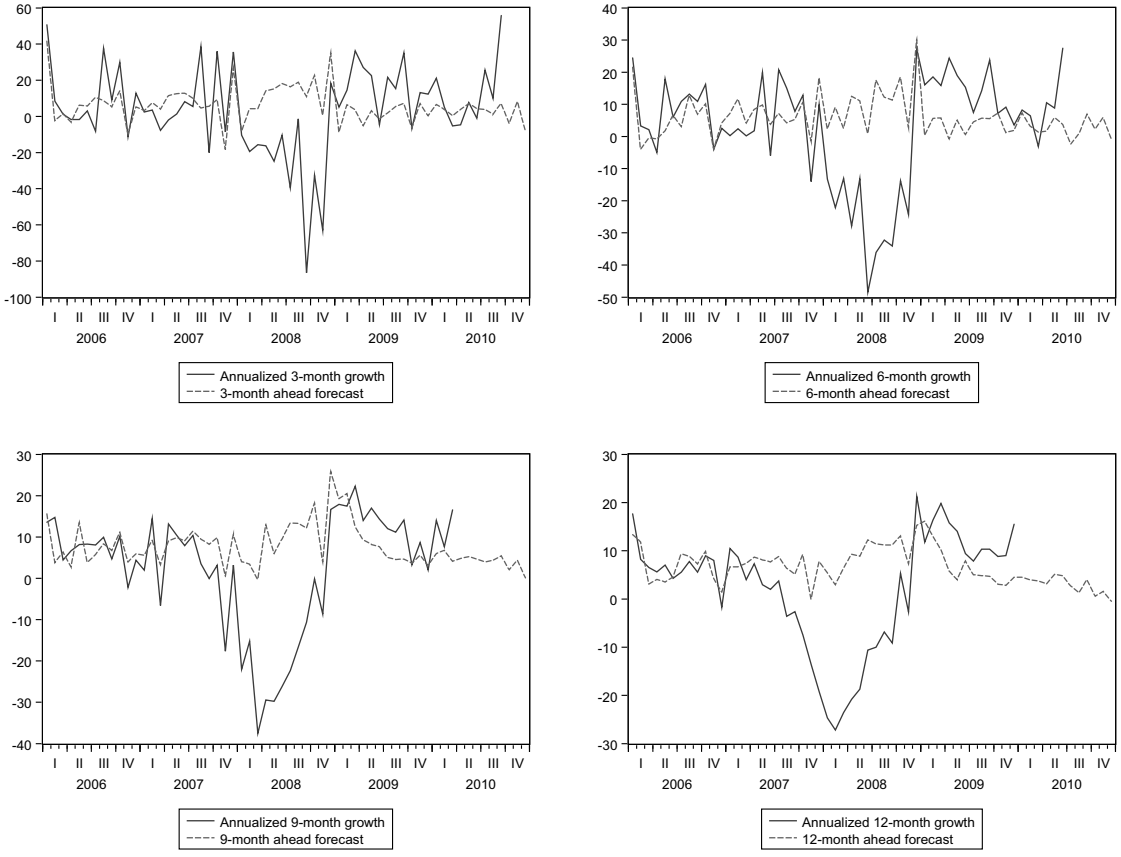
Table 5. **CPI inflation: Pseudo out-of-sample forecasting accuracy, combination forecasts**

Forecast horizon	$h = 3$	$h = 6$	$h = 9$	$h = 12$
Combination forecasts		Relative MSFE		
1993:1-2000:12				
Trimmed mean of all forecasts	0.89	0.85	0.86	0.84
Median of all forecasts	0.98	0.98	0.97	0.98
Median of top 5 forecasts	0.68	0.54	0.47	0.42
2001:1-2005:12				
Trimmed mean of all forecasts	0.97	0.97	0.97	1.00
Median of all forecasts	1.00	0.98	0.98	1.00
Median of top 5 forecasts	0.87	0.87	0.86	0.84
2006:1-2010:12				
Trimmed mean of all forecasts	1.06	1.10	0.90	0.78
Median of all forecasts	0.99	1.04	0.84	0.81
Median of top 5 forecasts	0.98	0.72	0.43	0.26

show the two-stage combination forecasts of IP growth and changes in inflation three, six, nine and twelve months ahead.[15] We observe that the forecasts of IP growth over the forecast periods 1993-2000 and 2006-10 tend to be less accurate than for the remaining forecast period given in Figure A.2. This finding is in line with the results in Table 4, which show that the greatest improvements in the relative MSFE for IP growth using the median of the top five forecasts is for the 2001-05 forecast period, and it is most likely due to the existence of the 1994 financial crisis and 2008-09 global crisis.[16]

There are also differences in the efficacy of the combination forecasts for cumulated changes in CPI inflation, depending on the forecast period that is considered. Figure 2 shows that the combination forecasts tend to predict the future cumulated changes in inflation quite accurately over the forecast period 2006-10, especially at 9- to 12-month horizons. This is also evident from Table 5, which shows that the combination forecast induce the greatest improvements relative to the autoregressive benchmark at longer

Figure 1. **IP growth, 2006:1-2010:12**



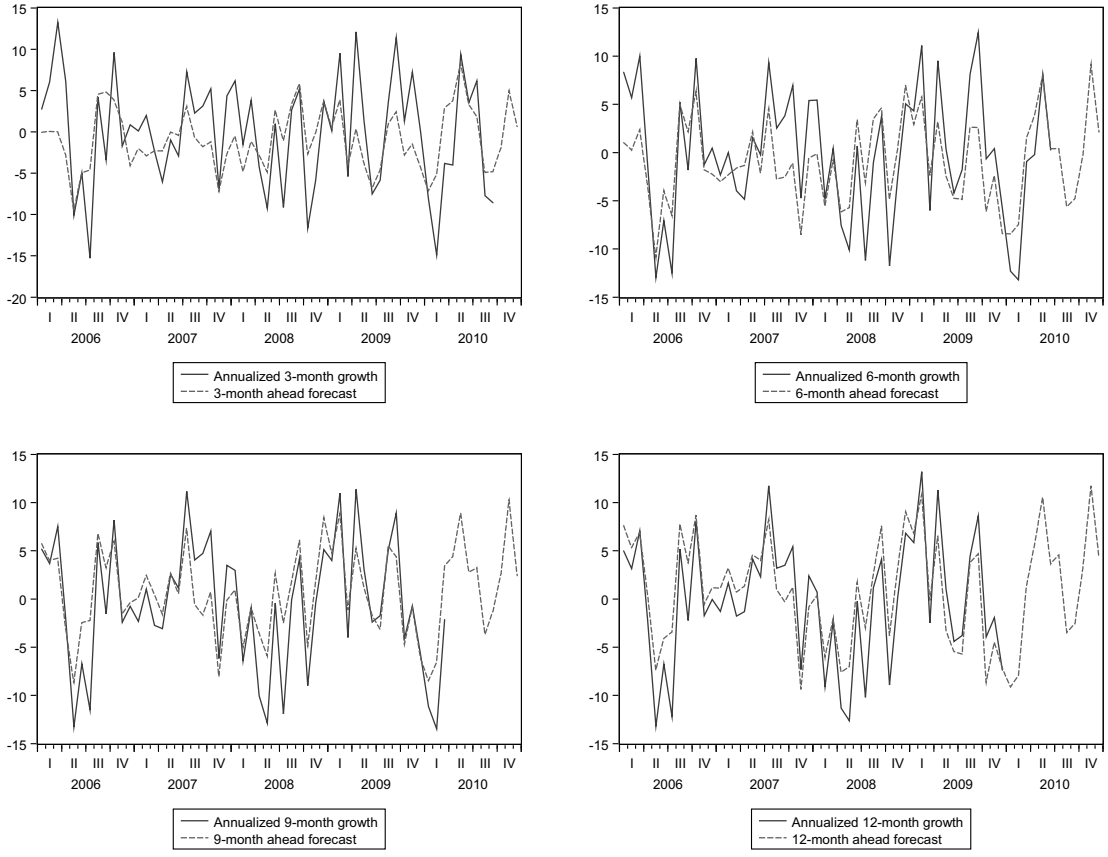
horizons. Figure A.3 shows that aside from the changes in inflation associated with the 1994 crisis, the combination forecasts also track fairly accurately the changes in inflation over the forecast period 1993-2000. The worst performance for the combination forecasts occurs for the forecast period 2001-05. As Figure A.4 shows, the combination forecasts that use data from 1996-2000 and beyond to forecast the disinflation in the 2002-06 period fare very poorly, especially in the earlier years. This finding highlights the importance of accounting for the changes in the policy regimes that occurred in May 2001.

6. Conclusion

In this paper, we have presented a systematic approach to identifying leading indicators for real activity and inflation in Turkey over the extended sample period 1988-2010. To our knowledge, our paper is the first to consider such a long sample and to examine the efficacy of a large number of candidate indicators across three different sub-samples that include two financial crises as well as a major globally induced recession. Our findings suggest that the types of indicators leading to improvements in the forecasts of IP growth and changes in inflation relative to an autoregressive benchmark have changed across the three separate forecast periods considered in this study.

Our results provide evidence of the changing dynamics of the Turkish economy in a period that includes significant policy reforms and institutional changes. In the first

Figure 2. **Changes in CPI inflation, 2006:1-2010:12**



forecast period, changes in monetary aggregates and business sentiment are important predictors of both changes in real activity and inflation. For the latter two forecast periods, we uncover a major role for asset prices that incorporate expectational phenomena and interest rates that reflect the policy stance in predicting IP growth and CPI inflation at different horizons. However, our results indicate that the gains to forecasting changes in inflation in the last forecast period beginning in 2006 using expectational and policy variables are much greater than the gains in forecasting IP growth. These results reflect the experience of a transition to a formal inflation targeting regime, which occurred formally in 2006. These findings are also indicative of a change in the dynamics of inflation from the first two forecast periods to the last forecast period, with expectational phenomena becoming much more important for the latter. They thus point to the importance of developing forward-looking models in understanding the impact of alternative policy choices on the behaviour of the Turkish economy.

One of the key issues in understanding macroeconomic performance in Turkey has to do with the role of capital flows. We fail to attribute a significant role to exchange rate changes for predicting either IP growth and changes in inflation across the different forecast periods that we consider. However, as we discuss in the text, the impact of producer price inflation and its changes together with changes in revenue from value-added taxes is indirect evidence for the role of capital inflows and the ensuing import surge

for determining changes in consumer price inflation in Turkey, especially for the last forecast period since 2006. Taken together, our results suggest that the factors that have determined both real activity and inflation performance in the 2001-post period and especially after 2006 are driven by expectational phenomena that are manifested in the behaviour of alternative financial variables and that also help to determine capital inflows to Turkey. The role that interest rates play also suggests that the decline in inflation that occurs after 2002 is achieved by anchoring expectations and maintaining credibility under an inflation targeting regime.

In this paper, we have only considered linear time series methods. Other approaches involve using nonlinear methods with regime shifts to account for the changes in the policy regimes observed in the Turkish economy over the period 1988-2010. While models with regime shifts have typically been used to model cyclical dynamics for developed and emerging economies by many studies,[17] whether they can adequately capture the changing dynamics inflation remains an unanswered question.

Notes

1. There is a large literature involved in identifying early-warning indicators of banking and currency crises (see, for example, Goldstein and Turner, 1996; or Kaminsky and Reinhart, 1999). This literature arose in response to the experience of banking and currency crises, abrupt reversals in capital flows due to "Sudden Stop" phenomena, and issues of debt sustainability and proper fiscal management that emerging economies faced in the 1980s and 1990s. Uluceviz and Yildiran (2010) analyse whether, and how international interbank loans affected the probability of crises in the period 1980-2002.
2. This is consistent with the practice of the OECD for developing composite leading indicators of economic activity. See the OECD publication *OECD System of Composite Leading Indicators* (2008).
3. They examine a variety of empirical specifications to capture inflation dynamics, including models with lags of inflation with and without an output gap, New Keynesian Phillips curves with foreign exchange rates, and reduced forms derived from structural specifications that allow for some form of wage rigidity. They attribute their finding to the anchoring of expectations under inflation targeting regimes adopted by many industrial and emerging economies, and the commitment to price stability pursued by the Federal Reserve, the European Central Bank and other monetary authorities.
4. An alternative methodology is to use in-sampling techniques based on examining cross-correlations of a set of indicators with the variables in question, say, IP growth and CPI inflation, and Granger causality tests. As various authors have argued, however, such in-sampling techniques can lead to over-fitting in the sample at hand and provide little guidance regarding future predictive performance (see, for example, Stock and Watson 2003). Chauvet (2000) also emphasises the role of out-of-sample techniques for developing a leading indicator of inflation in Brazil that can be used as an aid in real-time monitoring of monetary policy.
5. We start our sample in 1988:1 to account for the availability of the indicators of the *CBRT Business Tendency Survey*, as discussed below.
6. The *CBRT Business Tendency Survey* (BTS) was initiated in 1987 and it includes the assessments of senior managers in the manufacturing industry. The monthly survey of which we make use initially contained a total of 28 questions but these were reduced to 22 questions after a harmonisation of the BTS with international standards in 2006. See *www.tcmb.gov.tr/ikt-yonelim/BTS-Methodology.pdf*.
7. The implementation of the value-added tax in Turkey is in the form of a "credits" system. That is, a tax is levied on the total value of sales at each stage of production and a credit for any VAT is paid on inputs in production. See, for example, Metcalf (1995) or Price WaterhouseCoopers (2004).
8. Atabek et al. (2005) conduct a wider search regarding the role of survey responses contained in the entire CBRT Business Tendency Survey. In this study, we use the four variables that they find to be most important for constructing a composite leading indicator (CLI) for the Turkish economy over the period 1988-2003.

9. As Stock and Watson (2003) note, the Clark-McCracken null distribution is computed under the assumption of constant lags in the out-of-sample forecasting exercise whereas in our approach, the lags change as the model is re-estimated with the accumulation of additional data. With regards to computing standard errors for the MSFE, this typically requires a long time series of predictions based on regression estimates.
10. This latter finding is in line with that of Atabek et al. (2005), who make use of these indicators in the construction of their composite leading indicator for the Turkish economy over the period 1986-2003.
11. Çulha (2006) provides another indicator of this normalisation process based on the impact of an increase in US interest rates on capital flows to Turkey. He argues that in the period 1992:1-2001:12, an increase in US interest rates was accompanied by an increase in capital flows to Turkey, as low US interest rates coincided with the periods in which Turkey itself experienced financial crises (or there were contagionary effects of the East Asian and Russian crises). By contrast, in the period after 2002, an increase in US interest rates is accompanied by a capital outflow from Turkey, as predicted by standard economic analysis.
12. In the pre-2001 period, Turkey followed a crawling peg or managed floating exchange rate regime. The IMF-supported Exchange Rate Based Stabilisation programme adopted in 2000 sought to anchor inflationary expectations through a nominal exchange rate target. However, with the collapse of this programme in the aftermath of the severe banking and financial crisis in February 2001, Turkey moved to a regime of floating exchange rates.
13. For a discussion of the factors that led to the 1994 financial crisis, including policy mistakes, see Özatay (1996).
14. See, for example, Özatay and Sak (2002) for a discussion of the events surrounding the 2000-01 crisis in Turkey.
15. The relevant graphs for the forecast periods 1993-2000 and 2001-05 are in Figures A.1-A.4.
16. Figure A.2 also shows that data from 1996-2000 and beyond are much worse at predicting the recovery after 2002, especially at longer horizons. This finding is due to the changes in the policy regime after 2002, which led to a surge in real activity and growth for the Turkish economy.
17. As a recent example, see Altug and Bildirici (2012).

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ANNEX A

In this Annex, we describe the variables used in our study and the data sources in more detail. SA denotes series that were seasonally adjusted at the source, NSA denotes series that are available in seasonally unadjusted form.

IPI: Seasonally adjusted IPI series. Base year = 2005. SA

CUR: Capacity Utilisation Rate (CUR) of the Manufacturing Industry. Prior to 2007, only Turkstat was publishing the series CUR – Public and Private Enterprises and the combined total CUR series. Following the memorandum signed by Turkstat and Central Bank of the Republic of Turkey (CBRT), CBRT started publishing the new CUR series after 2007 after eliminating the Public and Private Enterprises differentiation. For the pre-2007 period, we use the CUR series provided by Turkstat, for the post-2006 period we use the series provided by the CBRT. NSA

GRELPR: Monthly gross electricity production data. OECD Monthly Economic Indicators. SA

TRAC: Monthly production of tractors as provided by Automotive Manufacturers Association (AMA). NSA

BUS: Monthly production of buses as provided by Automotive Manufacturers Association (AMA). NSA

UNEMP: Prior to 2005, only quarterly unemployment rate series was published. After 2005, monthly series was released on unemployment. To generate monthly series for the pre-2005 period, we interpolated the quarterly unemployment rates by using compounded monthly growth rates for each quarter, thus generating monthly series for 2001-2010. NSA

TOTEMP: Prior to 2005, only quarterly total employment series was published. After 2005, monthly series was released. To generate monthly series for the pre-2005 period, we interpolated the quarterly total employment by using compounded monthly growth rates for each quarter, thus generating monthly series for the 2001-2010. NSA

EXP: Total Exports deflated by Export Unit Value Index. Base year = 2003. NSA

IMP: Total Imports deflated by Import Unit Value Index. Base year = 2003. NSA

INIMP: Total Intermediate Goods Imports deflated by Import Unit Value Index. Base year = 2003. NSA

VAT: Total monthly VAT revenue series was obtained from General Directorate of Budget and Fiscal Control of the Ministry of Finance. NSA

CPI: Consumer Price Index. Base year = 2005. NSA

PPI: Producer Price Index. Base year = 2005. NSA

OP:	UK Brent Market Oil Price (in USD). NSA
USCPI:	Seasonally adjusted US CPI. Base year = 2005. SA
M1:	Weekly monetary aggregates provided by CBRT. If the data correspond to the last day of the month, these data are used. Otherwise, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
M2:	Weekly monetary aggregates provided by CBRT. If data correspond to the last day of the month, this datum is used. Otherwise, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
M2Y:	M2 + FX deposits. Weekly monetary aggregates provided by CBRT. If the data correspond to the last day of the month, these data are used. Otherwise, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
M3:	Weekly monetary aggregates provided by CBRT. If the data correspond to the last day of the month, these data are used. Otherwise, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
M3Y:	M3 + FX deposits. Weekly monetary aggregates provided by CBRT. If the data correspond to the last day of the month, these data are used. Otherwise, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
ONIR:	Overnight Interbank Interest Rates. OECD Monthly Economic Indicators. NSA
DR:	End of Period Discount Rate. NSA
DEPO3M:	Averages of maximum deposit rates as reported by banks to be effective during the month of reporting and weighted by volume of deposits and number of days of maturity. NSA
TRAUCRATE:	Yearly annualised interest rates of Treasury discounted auctions. NSA
EX-RATE:	Period average market rate of USD in terms of TRY. NSA
REX-RATE:	CPI based real exchange rate. Base year = 2003. NSA
ISE100:	ISE National-100 index. Daily ISE100 closing values are used and the last day of each month is treated as the monthly value for the respective index value. In case the last day is missing, we linearly interpolate the neighbouring data to set the last day of the month datum. NSA
IS-PE:	Price-earning ratio on the ISE National-100 index. Net earnings are calculated based on quarterly financial tables. NSA
DIVPR:	Dividend yield on ISE100. NSA
IRSPREAD:	Sovereign Bond Interest Rate Spreads, basis points over US Treasuries. NSA
EMBI+:	J.P. Morgan Emerging Markets Bond Index for Turkey. The regular EMBI index covers U.S.dollar-denominated Brady bonds, loans and Eurobonds. The EMBI+ expands upon J.P.Morgan's original Emerging Markets Bond Index (EMBI), which was introduced in 1992 and covered only Brady bonds. NSA
GOLD:	London price of troy ounce of gold. NSA
OVER:	Overdrafts. NSA
IRESCB:	Central bank's gross foreign exchange reserves. NSA
IRES-GOLD:	Central bank's international gold reserves. NSA

IRES:	Central bank's gross international reserves. NSA
PROSP-EXP:	Central Bank of the Republic of Turkey's (CBRT) Business Tendency Survey question related to export possibilities (Question 2). NSA
STOCKS-FIN:	Central Bank of the Republic of Turkey's (CBRT) Business Tendency Survey question related to stocks of finished goods (Question 11). NSA
EMP-TEND:	Central Bank of the Republic of Turkey's (CBRT) Business Tendency Survey question related to employment (Question 12). NSA
NEW-ORDERS:	Central Bank of the Republic of Turkey's (CBRT) Business Tendency Survey question related to new orders from the domestic market. (Question 13). NSA

Table A.1. **IP growth: Pseudo out-of-sample forecasting accuracy, 1993:1-2000:12**

Forecast horizon		*h* = 3	*h* = 6	*h* = 9	*h* = 12
Univariate autoregression		Root mean squared forecast error			
		23.2	13.28	10.25	8.56
Bivariate forecasts		MSFE relative to univariate autoregression			
Indicator	Transformation				
grelpr	d	1.00	1.03	1.02	**0.98**
trac	d	1.01	1.08	1.11	1.17
buses	d	**0.99**	1.03	1.01	1.01
exp	d	**0.98**	1.10	1.03	**0.96**
imp	d	1.02	1.19	1.21	1.20
lcpi	d	1.14	1.72	1.67	1.13
lcpi	2d	1.19	1.22	1.11	1.10
lppi	d	1.20	1.19	1.41	1.20
lppi	2d	1.08	1.15	1.05	**0.94**
lop	d	1.09	**0.93**	1.02	**0.87**
lop	2d	1.02	1.00	1.01	1.00
rlop	d	1.09	**0.93**	1.05	**0.88**
uscpi	d	1.03	1.04	1.09	1.05
uscpi	2d	1.04	**0.99**	1.03	**0.98**
lm1	d	**0.89**	**0.89**	1.01	1.02
lm1	2d	1.00	**0.95**	1.24	**0.98**
lm2	d	1.11	**0.97**	**0.96**	1.10
lm2	2d	1.11	1.01	1.00	1.01
lm2y	d	1.09	1.07	**0.99**	1.05
lm2y	2d	1.01	1.01	1.00	1.00
lm3	d	1.08	1.02	1.09	1.03
lm3	2d	1.01	1.04	1.01	1.01
lm3y	d	1.10	1.07	1.03	1.10
lm3y	2d	1.01	1.01	**0.99**	1.00
rlm1	d	**0.90**	1.05	**0.96**	1.01
rlm2	d	**0.95**	1.03	1.09	1.16
rlm2y	d	1.06	1.04	**0.97**	1.05
rlm3	d	**0.97**	1.01	1.24	1.16
rlm3y	d	1.04	1.03	1.00	1.04
onir	–	1.13	1.11	**0.99**	1.10
onir	d	1.25	1.17	**0.97**	1.08
dr	–	1.24	1.16	1.29	1.37
dr	d	1.18	1.01	1.04	1.02
depo3M	–	1.05	1.05	1.14	1.13
depo3M	d	**0.95**	**0.99**	1.00	1.04
traucrate	–	1.42	1.38	1.59	1.53
traucrate	d	1.36	1.06	1.28	1.05
ex-rate	d	1.14	1.06	1.15	1.05
rex-rate	d	1.01	**0.98**	1.02	1.11
ise100	d	**0.92**	1.03	1.04	1.02
rise100	d	**0.96**	1.06	1.06	1.04
divpr	–	1.01	1.03	1.06	**0.99**
divpr	d	1.10	1.06	1.00	1.03
gold	d	1.09	1.46	1.43	1.19
gold	2d	1.16	1.03	1.07	1.00
rgold	d	1.08	1.32	1.33	1.50
lover	–	1.10	1.18	1.19	1.29
lover	d	1.10	1.12	1.24	1.22
liresch	–	1.03	1.18	1.38	1.42
liresch	d	**0.93**	**0.95**	**0.98**	**0.99**

Table A.1. **IP growth: Pseudo out-of-sample forecasting accuracy, 1993:1-2000:12** *(cont.)*

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		23.2	13.28	10.25	8.56
Bivariate forecasts		MSFE relative to univariate autoregression			
lires-gold	–	1.32	1.80	2.56	3.19
lires-gold	d	1.09	1.14	1.26	1.28
lires	–	1.05	1.20	1.36	1.32
lires	d	**0.97**	1.01	1.03	1.02
prosp-exp	–	**0.99**	1.04	1.02	1.16
stock-fin	–	1.01	1.03	1.07	1.20
emp-tend	–	**0.95**	1.01	1.05	1.18
new-orders	–	**0.87**	1.01	**0.96**	1.04

Note: Bold indicates a relative MSFE < 1.

Table A.2. **IP growth: Pseudo out-of-sample forecasting accuracy, 2001:1-2005:12**

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		19.81	12.63	11.12	10.51
Bivariate forecasts		MSFE relative to univariate autoregression			
Indicator	Transformation				
cur	d	1.05	1.03	1.15	1.06
grelpr	d	1.31	1.30	1.07	**0.96**
trac	d	1.15	1.18	1.21	1.17
buses	d	1.15	1.06	1.00	1.02
exp	d	1.32	1.51	1.11	1.01
imp	d	1.04	1.01	1.05	1.15
inimp	d	1.01	1.14	**0.89**	1.68
lcpi	d	1.22	1.88	2.11	1.84
lcpi	2d	1.14	1.59	1.30	1.36
lppi	d	1.37	1.75	1.86	1.69
lppi	2d	1.13	1.60	1.23	1.25
lop	d	1.40	1.16	1.09	**0.97**
lop	2d	1.41	1.02	1.04	1.01
rlop	d	1.52	1.08	1.06	**0.97**
uscpi	d	1.17	1.22	1.49	1.12
uscpi	2d	**0.99**	1.01	**0.98**	1.01
lm1	d	1.19	1.36	1.15	1.11
lm1	2d	1.04	1.15	**0.98**	1.04
lm2	d	1.52	1.89	2.49	1.90
lm2	2d	1.17	1.01	**0.98**	1.14
lm2y	d	1.90	3.08	3.05	2.83
lm2y	2d	2.26	2.38	1.95	1.77
lm3	d	1.82	2.29	2.27	1.78
lm3	2d	1.28	1.28	1.31	1.25
lm3y	d	2.03	2.89	3.10	2.60
lm3y	2d	2.19	2.17	1.85	2.11
rlm1	d	**0.98**	1.00	1.01	1.03
rlm2	d	1.53	1.72	1.93	1.41
rlm2y	d	1.65	1.83	2.42	1.91
rlm3	d	1.95	2.31	2.43	2.63
rlm3y	d	2.31	2.67	3.38	2.73

Table A.2. **IP growth: Pseudo out-of-sample forecasting accuracy, 2001:1-2005:12** *(cont.)*

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		19.81	12.63	11.12	10.51
Bivariate forecasts		MSFE relative to univariate autoregression			
onir	–	7.14	18.26	6.27	7.00
onir	d	7.15	5.12	2.24	9.10
dr	–	1.06	**0.95**	1.20	1.15
dr	d	1.04	1.03	1.03	1.09
depo3M	–	1.13	2.82	3.52	2.58
depo3M	d	1.31	3.85	2.64	2.64
traucrate	–	1.41	1.62	1.64	1.44
traucrate	d	**0.83**	**0.98**	**0.71**	**0.68**
ex-rate	d	2.70	3.05	4.21	4.31
rex-rate	d	3.50	3.77	4.07	5.66
ise100	d	1.10	1.00	1.08	**0.52**
rise100	d	**0.94**	1.09	1.07	**0.65**
divpr	–	1.22	1.84	2.12	2.08
divpr	d	4.38	7.03	6.74	2.70
irspread	–	1.99	2.15	2.88	2.76
irspread	d	1.47	**0.99**	1.19	1.52
gold	d	**0.98**	**0.86**	1.50	1.16
gold	2d	1.02	1.01	1.06	**0.86**
rgold	d	**0.98**	**0.90**	1.06	**0.89**
lover	–	1.07	1.12	1.25	1.26
lover	d	1.10	1.00	1.05	**0.98**
lirescb	–	1.95	1.38	1.54	1.96
lirescb	d	1.93	1.20	1.01	1.19
lires-gold	–	1.15	1.25	1.45	1.31
lires-gold	d	1.19	1.23	**0.94**	**0.99**
lires	–	1.27	1.48	1.61	2.02
lires	d	1.16	1.11	**0.98**	1.02
prosp-exp	–	1.18	**0.83**	**0.79**	1.11
stock-fin	–	1.00	**0.94**	**0.97**	1.01
emp-tend	–	**0.93**	**0.98**	**0.96**	1.08
new-orders	–	1.17	**0.98**	**0.87**	1.12

Note: Bold indicates a relative MSFE < 1.

Table A.3. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 1993:1-2000:12**

Forecast Horizon		*h* = 3	*h* = 6	*h* = 9	*h* = 12
Univariate Autoregression		Root Mean Squared Forecast Error			
		23.63	21.16	23.67	21.66
Bivariate Forecasts		MSFE Relative to Univariate Autoregression			
Indicator	Transformation				
lipi	d	1.04	1.03	1.04	1.06
lipi	2d	1.01	1.01	1.02	1.02
hp-ipi	–	1.05	1.05	**0.96**	1.05
grelpr	d	1.01	1.00	1.01	1.01
trac	d	1.01	1.00	**0.99**	1.00
buses	d	1.23	1.38	1.22	1.24
exp	d	1.07	**0.80**	**0.70**	**0.72**
imp	d	**0.96**	1.14	1.05	1.07
lppi	d	**0.91**	**0.85**	**0.57**	**0.84**
lppi	2d	1.06	**0.89**	**0.70**	**0.83**
lop	d	1.01	1.01	**0.99**	1.01
lop	2d	1.02	**0.99**	**0.91**	**0.96**
rlop	d	1.01	1.01	1.00	1.01
uscpi	d	1.02	1.00	1.01	1.01
uscpi	2d	**0.99**	**0.99**	**0.99**	**0.99**
lm1	d	1.15	1.01	1.00	1.02
lm1	2d	1.15	1.05	**0.99**	1.04
lm2	d	1.17	1.21	1.12	1.06
lm2	2d	1.30	1.47	1.13	1.02
lm2y	d	1.13	**0.99**	**0.93**	1.01
lm2y	2d	1.01	**0.98**	**0.98**	1.00
lm3	d	1.06	2.01	1.57	1.07
lm3	2d	1.14	2.10	1.51	1.04
lm3y	d	1.16	1.00	**0.96**	1.03
lm3y	2d	1.05	**0.99**	**0.98**	1.02
rlm1	d	**0.94**	**0.85**	**0.81**	**0.83**
rlm2	d	**0.96**	**0.97**	**0.95**	**0.77**
rlm2y	d	**0.99**	**0.74**	**0.91**	**0.74**
rlm3	d	**0.92**	**0.97**	**0.81**	**0.78**
rlm3y	d	**0.92**	**0.76**	**0.76**	**0.77**
onir	–	2.02	1.33	1.43	1.39
onir	d	1.28	1.05	1.01	1.08
dr	–	1.15	1.03	1.01	1.00
dr	d	1.12	**0.98**	**0.83**	**0.89**
depo3M	–	1.41	1.18	1.09	1.10
depo3M	d	1.14	1.03	1.06	**0.97**
traucrate	–	2.65	1.57	1.27	1.85
traucrate	d	2.08	1.31	1.19	1.42
ex-rate	d	1.69	1.17	1.42	1.04
rex-rate	–	1.69	1.46	1.41	1.23
ise100	d	1.05	1.00	1.05	1.01
rise100	d	1.08	1.02	**0.95**	1.00
div-pr	–	1.01	**0.99**	1.01	**0.92**
div-pr	d	1.18	1.06	**0.99**	**0.97**
gold	d	1.04	1.19	1.08	1.11
gold	2d	1.03	1.01	**0.99**	1.01
rgold	d	1.02	1.32	1.22	1.08
lover	–	1.06	**0.97**	**0.90**	**0.93**
lover	d	**0.99**	1.04	1.04	1.05
liresch	–	1.43	1.49	1.45	1.76

Table A.3. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 1993:1-2000:12** *(cont.)*

Forecast Horizon		*h* = 3	*h* = 6	*h* = 9	*h* = 12
Univariate Autoregression		Root Mean Squared Forecast Error			
		23.63	21.16	23.67	21.66
Bivariate Forecasts		MSFE Relative to Univariate Autoregression			
lirescb	d	1.05	1.04	1.00	1.03
lires-gold	–	1.12	1.03	**0.99**	**0.99**
lires-gold	d	1.17	1.02	**0.95**	**0.99**
lires	–	1.16	1.24	1.12	1.51
lires	d	**0.99**	**0.99**	1.00	1.01
prosp-exp	–	1.16	**0.74**	**0.77**	**0.83**
stock-fin	–	**0.97**	**0.78**	**0.61**	**0.73**
emp-tend	–	1.03	**0.74**	**0.63**	**0.66**
new-orders	–	1.08	**0.69**	**0.64**	**0.53**

Note: Bold indicates a relative MSFE < 1.

Table A.4. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 2001:1-2005:12**

Forecast horizon		*h* = 3	*h* = 6	*h* = 9	*h* = 12
Univariate autoregression		Root mean squared forecast error			
		15.2	13.12	13.31	13.65
Bivariate forecasts		MSFE relative to univariate autoregression			
Indicator	Transformation				
lipi	d	1.05	1.02	**0.98**	1.00
lipi	2d	1.02	1.00	1.00	**0.98**
hp-ipi	–	1.04	1.09	1.12	1.11
cur	d	1.09	1.00	**0.99**	**0.99**
grelpr	d	1.02	1.03	**0.99**	1.00
trac	d	1.10	1.06	1.24	1.28
buses	d	1.16	1.00	1.06	1.16
exp	d	1.28	1.23	**0.96**	1.03
imp	d	1.13	1.00	**0.89**	1.01
inimp	d	1.11	1.03	1.10	1.11
lppi	d	1.15	1.11	1.45	1.52
lppi	2d	1.03	1.03	1.09	1.04
lop	d	1.13	1.05	**0.99**	1.08
lop	2d	1.01	1.02	**0.98**	1.00
rlop	d	1.04	1.05	**0.99**	1.07
uscpi	d	1.26	1.05	**0.98**	**0.66**
uscpi	2d	1.12	1.02	**0.96**	1.01
lm1	d	1.01	1.12	1.19	1.18
lm1	2d	1.16	1.07	1.00	1.01
lm2	d	**0.98**	1.25	1.75	1.52
lm2	2d	**0.95**	1.00	**0.91**	**0.97**
lm2y	d	1.23	**0.99**	**0.92**	1.12
lm2y	2d	**0.90**	**0.94**	**0.88**	**0.95**
lm3	d	**0.96**	**0.97**	1.16	1.06
lm3	2d	**0.98**	**0.98**	**0.96**	1.02
lm3y	d	1.42	**0.98**	1.00	1.10
lm3y	2d	**0.98**	**0.96**	**0.98**	**0.96**
rlm1	d	1.02	1.01	1.39	1.13
rlm2	d	**0.94**	**0.90**	**0.97**	**0.94**
rlm2y	d	**0.93**	**0.92**	**0.91**	1.04
rlm3	d	1.03	**0.95**	**0.90**	**0.96**
rlm3y	d	**0.90**	**0.94**	**0.91**	1.03

Table A.4. **CPI inflation: Pseudo out-of-sample forecasting accuracy, 2001:1-2005:12** *(cont.)*

Forecast horizon		$h = 3$	$h = 6$	$h = 9$	$h = 12$
Univariate autoregression		Root mean squared forecast error			
		15.2	13.12	13.31	13.65
Bivariate forecasts		MSFE relative to univariate autoregression			
onir	–	1.72	**0.96**	**0.98**	1.11
onir	d	2.35	1.04	1.01	1.23
dr	–	**0.96**	**0.95**	1.09	1.42
dr	d	1.07	**0.98**	**0.90**	1.03
depo3M	–	2.02	1.57	1.41	1.28
depo3M	d	1.77	1.64	1.51	1.30
traucrate	–	1.37	1.28	1.47	1.77
traucrate	d	1.02	**0.90**	1.18	**0.97**
ex-rate	d	1.88	1.53	1.21	1.46
rex-rate	–	1.31	2.16	2.53	3.62
ise100	d	1.16	1.00	**0.96**	1.00
rise100	d	1.11	1.00	**0.90**	**0.99**
divpr	–	1.03	1.15	1.74	1.89
divpr	d	2.43	3.51	6.54	6.59
irspread	–	1.25	1.18	1.41	1.37
irspread	d	1.07	1.09	1.20	1.35
gold	d	1.20	**0.94**	**0.99**	1.40
gold	2d	1.34	1.05	0.88	**0.92**
rgold	d	1.30	**0.92**	1.02	1.51
lover	–	1.03	1.23	1.39	1.46
lover	d	1.09	1.01	1.02	1.09
lirescb	–	1.03	1.33	1.50	1.61
lirescb	d	1.12	1.16	0.95	1.17
lires-gold	–	1.00	1.31	1.54	2.07
lires-gold	d	1.04	1.29	1.53	1.95
lires	–	1.30	1.59	1.84	1.86
lires	d	1.12	1.36	1.49	1.36
prosp-exp	–	1.10	**0.96**	1.29	1.49
stock-fin	–	1.13	1.24	1.33	2.13
emp-tend	–	1.11	**0.97**	1.00	1.25
new-orders	–	1.38	1.18	1.25	1.24

Note: Bold indicates a relative MSFE < 1.

Figure A.1. **IP growth, 1993:1-2000:12**

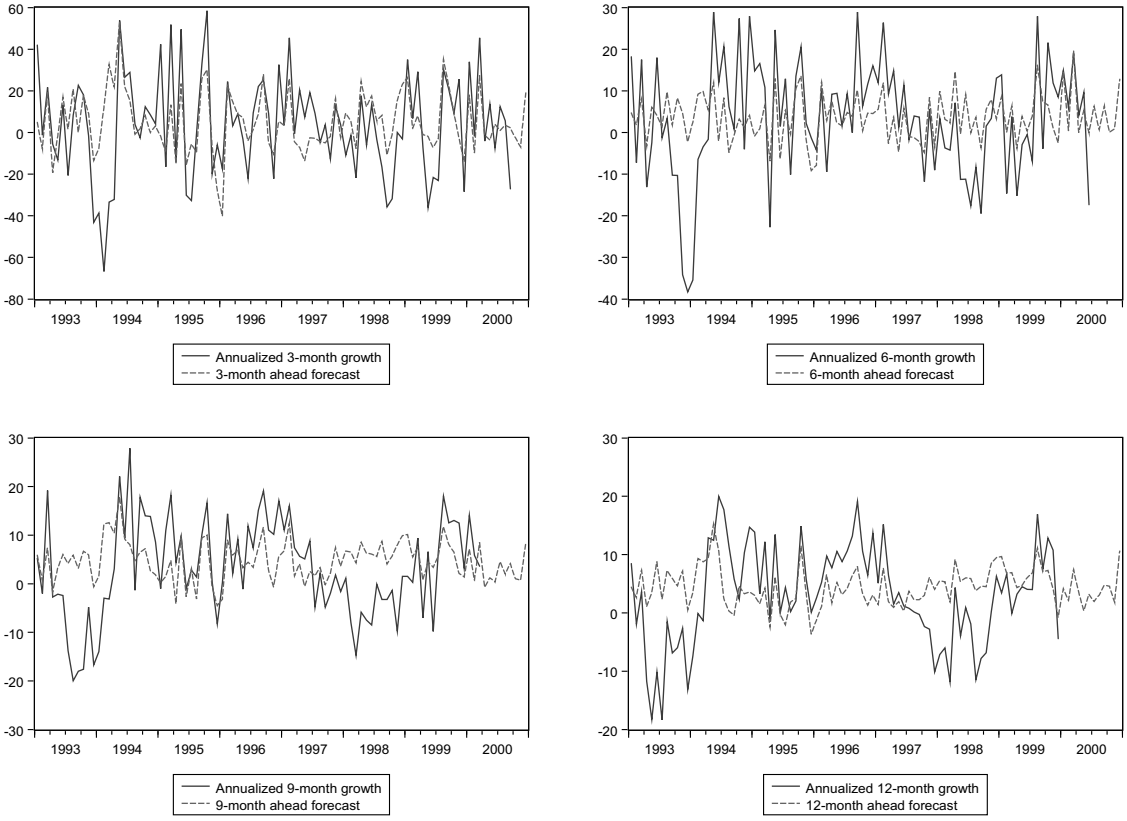

Figure A.2. **IP growth, 2001:1-2005:12**

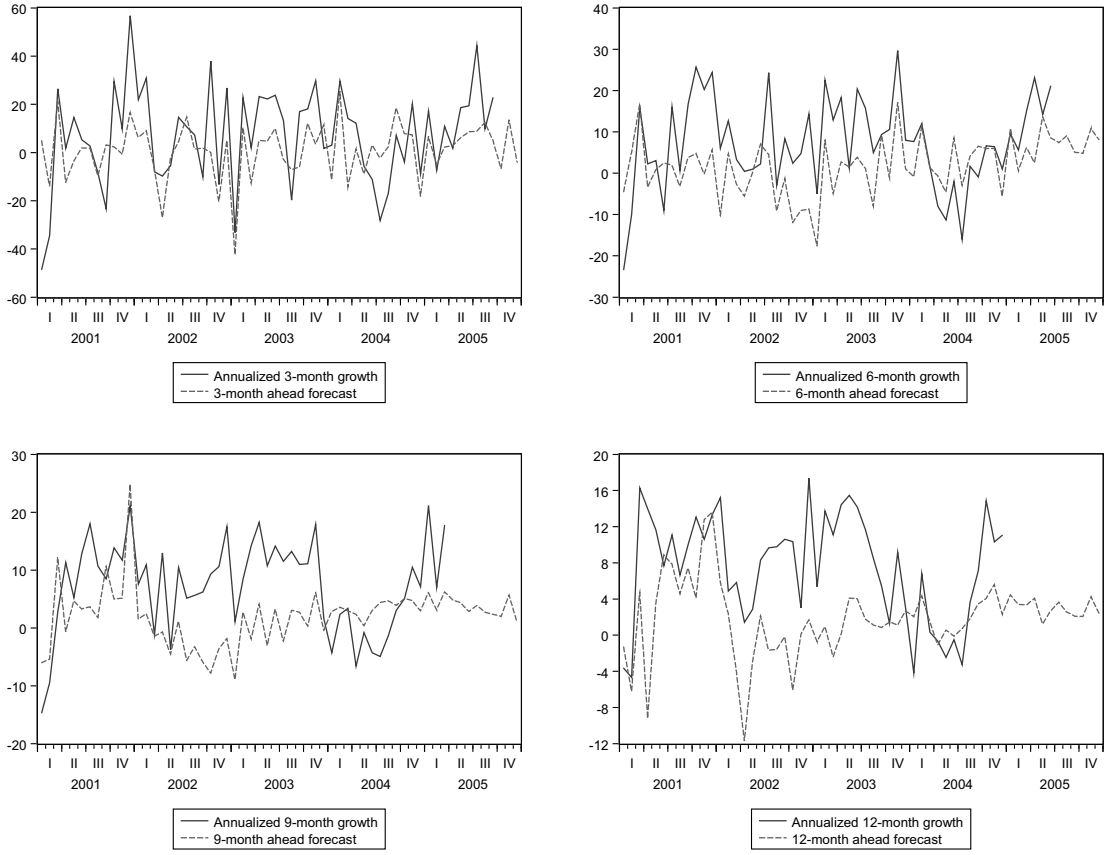

Figure A.3. **Changes in CPI inflation, 1993:1-2000:12**

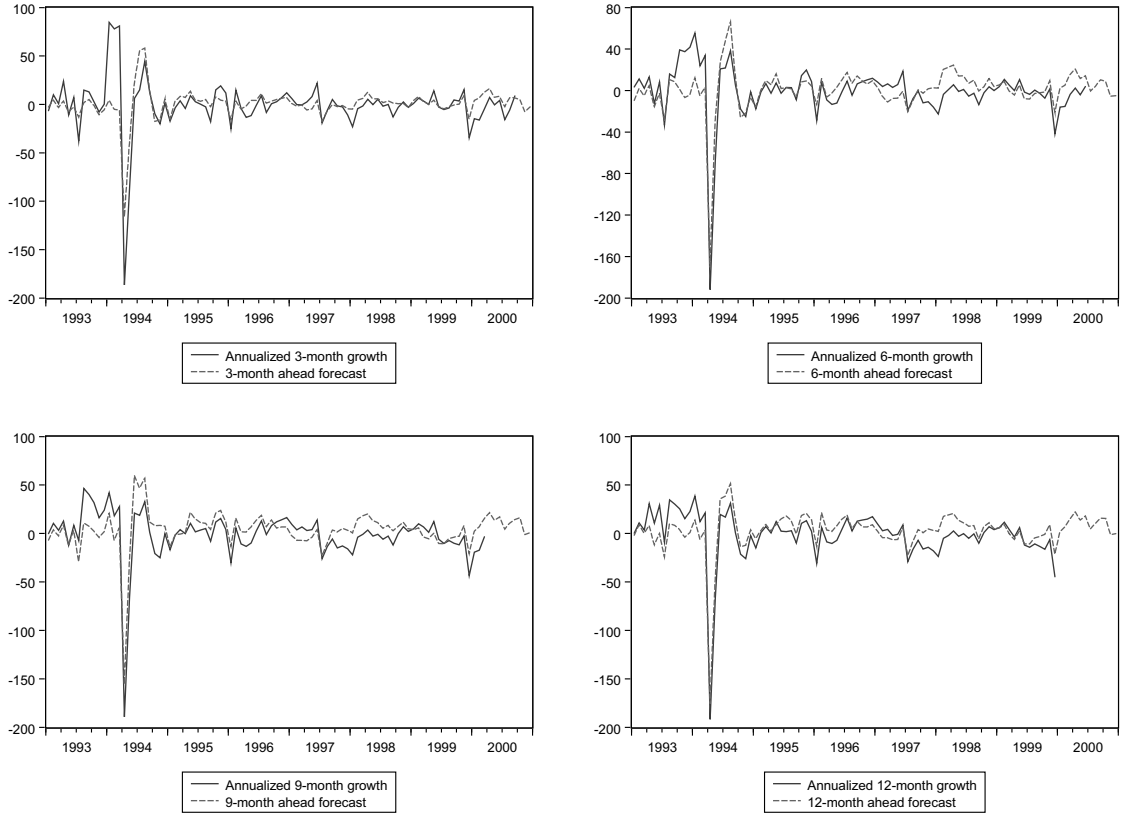

Figure A.4. **Changes in CPI inflation, 2001:1-2005:12**