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Forecasting Thailand's Core Inflation

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Abstract

This paper develops an approach for forecasting in Thailand core inflation. The key innovation is to anchor the projections derived from the short-term time-series properties of core inflation to its longer-run evolution. This involves combining a short-term model, which attempts to distill the forecasting power of a variety of monthly indicators purely on goodness-of-fit criteria, with an equilibrium-correction model that pins down the convergence of core inflation to its longer-run structural determinants. The result is a promising model for forecasting Thai core inflation over horizons up to 10, 24, and 55 months, based on a root mean-squared error criterion as well as a mean absolute error criterion.

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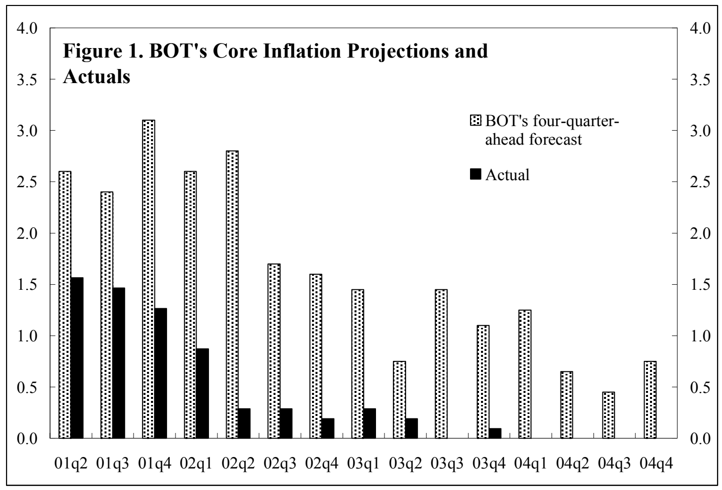
I. INTRODUCTION

Forecasting inflation is a key task for a central bank with an inflation-targeting framework, such as the Bank of Thailand (BOT). Under inflation targeting, the conduct of policy is informed by the general direction of future inflation, with due disregard for transitory fluctuations in the inflation rate or the price level. The BOT combines judgment and the output of a structural econometric model to produce quarterly forecasts of core inflation—the bank's intermediate target—over the next eight quarters. These forecasts are published in a quarterly Inflation Report and widely discussed in the press.

Forecasting with precision Thailand's core inflation has proved difficult. A comparison of the BOT's published forecasts with expost realizations of quarterly core inflation rates shows that forecast errors have been persistent and one-sided (Figure 1).



This paper develops an alternative approach for forecasting Thai core inflation. The key innovation is to anchor the projections derived from the short-term time-series properties of core inflation with its longer-run evolution. This involves combining a short-term model, which attempts to distill the forecasting power of a variety of high-frequency indicators purely on goodness-of-fit criteria, with an equilibrium-correction model that pins down the convergence of core inflation to its longer-run structural determinants. As such, the approach attempts to bridge the gap between an analysis that focuses purely on the time-series properties of a variable at the expense of an economic interpretation of its dynamics and an analysis that focuses exclusively on a structural representation at the expense of forecasting power. The approach in this paper could be applicable to other countries that have adopted an inflation-targeting framework.

The starting point is to select a parsimonious specification of an unrestricted model of the data-generating process driving Thailand's core inflation. This has been done following the General-to-Specific methodology (Hendry, 2001) as implemented in the PcGets software. PcGets selects a data-congruent model even though the precise formulation of the econometric relationship among the variables of interest is not known a priori.[2]

[2] A congruent model will have as main attributes constant parameters and conditionally homoscedastic, serially uncorrelated, and normally distributed errors.

Starting from a general model that is data congruent, PcGets eliminates statistically insignificant variables, with diagnostic tests checking the validity of these "reductions" to preserve the data congruency of the final specification. The General-to Specific process of streamlining an initial unrestricted model follows either a "liberal strategy," which minimizes the non-deletion probability of relevant variables, or a "conservative strategy," which minimizes the non-deletion probability of irrelevant variables.

Both strategies have been followed in this paper, with an additional innovation. The common components of the variables discarded by PcGets (extracted through a principal component analysis) are then reintroduced as a potentially significant regressor in the PcGets-reduced model. The augmented model is then subject again to the PcGets selection process to assess whether the principal components add to the forecasting power.

The last enhancement of the forecasting model adds to the final selection an equilibrium-correction term (ECM term) that captures the long-run determinants of Thai core inflation. The ECM (identified through cointegration analysis) adds an economic interpretable element to the model and pins down the long-term forecast. As such, it reduces the chances of a structural bias in the forecasts.

The result of this hybrid approach is a model for forecasting inflation over horizons up to 10, 24 and 55 months that is promising, based on a root mean-squared error criterion as well as a mean absolute error criterion. The parsimonious model formulated generates out-of-sample forecasts that appear to be broadly satisfactory. Reliance on monthly variables in the model allows for a prompt update of core inflation forecasts and—thus—could help in monetary policy evaluation in the context of IMF surveillance work on Thailand.

The paper is organized as follows. Section II documents the variables used in the model selection and data transformation. Section III describes the best-performing model. It shows that the progressive addition of an error correction term, the lagged core inflation, and the principal components of an array of excluded variables improve the forecasting accuracy of the model. Section IV concludes and presents possible extensions of the paper's approach by focusing on quarterly data and a larger dataset.

II. DATA

The dependent variable in the forecasting regressions is the series of seasonally adjusted, monthly percent changes in Thailand's consumer price index, purged of its raw food and energy components. This series is referred to as "core inflation" and corresponds to the policy target chosen by the BOT in July 2000, when it officially embraced an inflation-targeting framework. Although the BOT aims at keeping *quarterly* core inflation in the range of 0–3½ percent, *monthly* changes are the focus of this paper's modeling exercise in order to capitalize on information embedded in a variety of high-frequency indicators. The exercise is later repeated with quarterly inflation rates to cross-check the robustness of the results.

A group of potential explanatory variables available at a monthly frequency has been selected before the specification search. These include commodity and asset prices, indicators of cost pressures in product or labor market (such as industry selling price indexes, wages, unit labor costs, and import prices), and measures of pressure on the demand side (such as the money supply and other financial indicators).

Appropriate transformations of the raw data have been made to produce approximately uniform variability in the series over the sample range. All data are seasonally adjusted. Since we are dealing with series in terms of their month-on-month growth rates, "log-differences" of all variables used (except the nominal interest rate) have been taken.[3] Table 1 gives the names, description, units, sources, and transformation of the time series considered in the econometric applications.

Data availability and required transformations limit the period used for model estimation and testing to May 1995 to October 2003. For example, some variables of interest (namely, the retail petroleum price index, the producer price index, and the farm price index) are not available prior to January 1995. The introduction of lags in explanatory variables further limits the sample period. The final sample period, however, is broadly consistent with that used to estimate the BOT's quarterly structural model, which takes 1994Q1 as the starting point. [4]

III. Modeling Core Inflation

A. Short-Run Dynamics

The specification search for a strong forecasting performance involved a comparison among four alternative models. Model 1 is obtained from the PcGets elimination of statistically irrelevant variables from a General Unrestricted Model (GUM). Model 2 is Model 1 with additional explanatory variables: seven principal components (with three lags) capturing the common comovements in the variables that appeared in the general model but were rejected in the reduction. Model 3 is Model 2 with the three lags of core monthly inflation. Finally, Model 4 is Model 3 augmented by an equilibrium-correction term.

These models are compared in terms of their out-of-sample forecasting accuracy. Forecasting performance is measured by their root mean-squared error (RMSE) and mean absolute error (MAE). On both criteria Model 4 outperforms the others (Table 2).

Model 4 performs well in terms of diagnostic tests (Table 3). Figure 2 shows that the parameters in Model 4 are constant. Empirically, the residuals are normally distributed, homoscedastic, and serially uncorrelated, and the null hypothesis of no omitted variables is easily accepted for a wide variety of variables. Figure 3 plots the fitted and actual values of monthly core inflation and illustrates how well Model 4 explains the data. Figure 4 records the residuals density and the residual correlogram of Model 4, pointing to lack of serial correlation and near-white-noise properties. Figure 5 shows the out-of-sample forecasting

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[3] However, in cointegration analysis, the logarithm of the levels of the consumer price index (net of the food and energy components), an import price index, and the average wage are used.

[4] Within the framework of this model, the BOT has chosen the following variables to forecast core inflation: lagged core inflation, an estimate of the GDP gap, the import price index, the raw food consumer price index, and an error-correction term.

power is very good and consistent with the long lead needed to conduct of a forward-looking monetary policy.

At the root of Model 4's strong performance lies the fact that it supplements the (statistical) short-run analysis of its competitors with a consideration of the (economic) long-run effects of the error-correction term. In other words, it captures the economically meaningful view that inflation is ultimately determined by pressures in labor costs and the nominal exchange rate, while its shorter-run evolution may be also influenced or described by other variables.

In order to put in perspective the performance of Model 4, it is useful to present its genesis as a progressive enhancement of the simpler Models 1, 2, and 3.

Model 1—the starting model—is produced by reduction of a general model involving all the 20 variables in Table 1, with three lags. The choice of lagged variables has been informed by preliminary unit root tests, and ensures that all variables are stationary. In the reduction process leading to Model 1, PcGets follows the "liberal strategy" so as to keep as many variables as possible and avoid loss of information (Appendix I reports key statistics for this model as well as the individual parameter values).

Model 2 adds to Model 1 the seven first principal components of variables that PcGets excludes, to capture the information content of the variables dropped out.[5] In the case of Model 1, principal components are extracted from 10 variables. These variables are the percent changes in: the capacity utilization rate (*dlcu*), the nominal effective exchange rate (*dlneer*), the world export unit value for manufactures (*dlmuv*), and housing price (*dlacomm*), reserve money (*dlrm*), the import price index (*dlpmb*), a world commodity price index (*dlcomm*), the average wage (*dlavwag*), and stock price index (*dlstp*). Seven stationary principal components are enough to explain 95 percent of comovements in all these variables. To match Model 1's lag structure, three lags of the principal components are included, and another PcGets regression with the conservative strategy is run.[6] The resulting model is Model 2 (details are in Appendix II).

Model 3 adds lags of the endogenous variable to allow for persistence in core inflation (details are in Appendix III).

B. Long-Run Dynamics

Model 4 is the final stage in this search process. It augments Model 3 with an equilibrium-correction term lagged once. The rationale for this addition is as follows. Model 1, 2, and 3 are statistical models that ignore the long-run determinants of inflation and simply aim at capturing the best possible description of the short-run dynamics of this variable. As such,

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[5] Basically, principle component regression is used for solving possible multicollinearity problems that may lead to the insignificance of individual variables—and hence, their elimination in the PcGets search.

[6] Since there are lots of variables here, I use the "conservative strategy" to get rid of the least significant variables and arrive at as parsimonious a parametrization as possible.

they are statistically useful but not necessarily informative from an economic point of view. To remedy this limitation, the equilibrium-correction term gives an economic underpinning to the forecast, at least over the longer run.

The equilibrium-correction term is derived through cointegration analysis. Once unit root tests assured that the variables of interest have the same order of integration, Johansen's maximum likelihood procedure tests for cointegration among (the log of): the consumer price index excluding its food and energy subcomponents (*lccpi*), the import price index (*lpbm*), and the average wage (*lavwag*). Using the estimated cointegrating equation, an error-correction term is calculated and added to Model 3.

Table 4 lists fourth-order augmented Dickey-Fuller statistics for the three variables mentioned above (*lccpi*, *lpmb*, and *lavwag*). The deviation from unity of the estimated largest root appears in parentheses below each Dickey-Fuller statistic. This deviation should be approximately 0 if the series has a unit root. Unit root tests are given for the original variables (all in logs), and for their changes.

Table 4 suggests that all variables appear to be integrated of order 1. Notwithstanding their nonstationarity, these variables may still be linked by a linear relationship that could be recovered through cointegration analysis.

Cointegration analysis aims at capturing the presence of a long-run relationship between a group of nonstationarity economic time series. The (log of) the price index excluding food and energy (*lccpi*), the (log of) the import price index (*lpmb*), and the (log of) the average wage (*lavwag*) forms such a group and—on economic grounds—one would expect a relationship linking them in the long run. Figure 6 is suggestive of this relationship.

To establish the existence of a statistical long-run relationship among these three variables, the Johansen's (1988) procedure is run on a four-order vector autoregression (VAR), based on a preliminary analysis showing that it is statistically acceptable to simplify the specification to a first-order VAR (see Table 5).

Table 6 reports standard statistics and estimates for Johansen's procedure applied to this first-order VAR. The maximal eigenvalue and trace eigenvalue statistics strongly reject the null hypothesis of no cointegration in favor of at least one cointegrating relationship. There is some evidence of the existence of two cointegrating relationship, but it is weak and has been safely ignored.

Table 7 reports the coefficient of the cointegrating vector (*beta*, in the table), and standardized adjustment coefficients (*alpha*, in the table). The coefficient appears in the first part of the second column in Table 7 under the header "A." The null hypothesis of zero coefficients for the import prices and wages is strongly rejected, supporting the idea that *lpmb* and *lavwag* are indeed cointegrated with *lccpi*. The relevant Chi-square statistics with two degrees of freedom equals to 31.822, with a *p*-value of 0.0000.

The coefficients *alpha* in the lower portion of second column (under the header "A") of the table measure the feedback effects of the (lagged) disequilibrium in the cointegrating relation onto the variables in the VAR. A test of weak exogeneity of a given variable checks whether or not the column corresponding to *alpha* in Table 7 (under the header "B") is 0. If so, disequilibrium in the cointegrating relationship does not feed back onto the associated variable. Restriction test on alpha shows that the corresponding variables *lpmb* and *lavwag* are weakly exogenous.[7] Weak exogeneity implies that the cointegrating vector and the feedback coefficients enter only the price index equation. Thus, modeling the long-run equilibrium process for inflation can be limited to the specification of a single equation linking consumer prices to import prices and wages.

From the cointegration analysis and the exogeneity result, one obtains:

$$Equilibrium\ Correction\ Term_t = lccpi_t + 0.10755 lpmb_t + 0.31963 lavwag_t.$$

The equation demonstrates that the import price index and average wage are cointegrated with the core inflation. The import price index coefficient is lower that that of average wage. This equation implies an equilibrium-correction term that captures the long-run dynamics of Thailand’s core inflation, namely its convergence to a long-run equilibrium.

Added to a forecasting model, this term allows discrepancies between the log-level of the consumer price index (net of food and energy) and its long-run determinants to affect core inflation, while ensuring that in the long run the level of price index remains in line with its structural determinants. In other words, the addition of the equilibrium-correction term to the forecasting model anchors the forecasts over a long horizon to the long-run evolution of the price level. Thus, Model 4 supplements the forecasting exercise based on the statistical properties of the time series for Thailand’s core inflation in Model 3 with an economic underpinning.

The superior performance of Model 4 is supported by additional evidence on the performance of the alternative Models 1, 2, and 3. These are best discussed in reverse order, moving from the model closest to Model 4 to less comprehensive specifications.

As discussed earlier, by dropping the equilibrium-correction term lagged once (*ecm*(1)) from Model 4, we get Model 3. Although the Chow test (Figure 7) shows that the parameters in Model 3 are still constant, its root mean-squared error rises from 0.002642 to 0.002799 (Figure 8), suggesting a weaker forecasting power.

By dropping the core inflation lagged three times (*ccpi*(3)) from Model 3, we get Model 2. The relevant Chow test for stability of coefficients shows that the parameters are constant (Figure 9), while its root-mean squared error rises from 0.002799 to 0.002951 (Figure 10).

Finally, by dropping the (lagged) principal components (*PC*) of the variable eliminated in the reduction process from Model 2, we obtain Model 1. Although the Chow test (Figure 11) shows that parameters are constant in this case too, its root mean-squared error rises from 0.002951 to 0.004288 (Figure 12). Overall, the progressive enhancements from Model 1 to Model 4 improve the forecasting power by some 62 percent ((0.004288/0.002642 -1)*100).

[7] The relevant chi-square test statistics equal to 4.0697 with a *p*-level of 0.1307.

C. Robustness Checks

The forecasting power of Model 4 can be tested by extending the forecast horizon. This is done in two ways: first, the model is used to produce 24-month-ahead dynamic forecasts; second, the model is used to produce 55-month-ahead forecasts—a horizon chosen to test the model's ability to predict a sharp decrease of core inflation in April 1999. Figures 13 and 14 show the Chow test for parameter stability in the first case and its forecast performance. The Chow tests show that the parameters are stable. The forecasting performance is also good. For the second exercise, Figure 15 shows the relevant Chow test, which confirms parameter constancy. Figure 16 illustrates the forecasting performance, which remains satisfactory. It is noteworthy that Model 4 successfully predicts the sharp drop of Thailand's core inflation in early 1999. Table 8 compares root mean-squared error and the mean absolute error for Model 4 at forecasting horizons of 10, 24, and 55 months.

IV. Conclusions

This paper develops three points:

First, it implements an empirical statistical model to identify short-run factors that may be useful in forecasting Thailand's core inflation—with clear implications for the conduct of monetary policy in the inflation-targeting regime. We try to let data speak by General-to-Specific modeling approach. In addition, principal components are introduced to "pick up" the information that is discarded in the standard implantation of a General-to-Specific approach.

Second, the paper makes use of an equilibrium-correction term to catch the long-run effect of the main economic determinants of Thailand's consumer price index. Combining the short- and the long-run analysis, we obtain a forecasting model with out-of-sample predictive accuracy regarding core inflation—10, 24, and 55 months ahead. The results suggest that several indicators available at a monthly frequency contain information that helps forecasting core inflation.

Third, the paper illustrates that the combination of the General-to-Specific approach, principal component analysis, and equilibrium correction modeling is a promising way to forecast Thai core inflation. Within the time-horizon used in this paper, however, Model 4 dominates the others in terms of forecasting accuracy. Overall, the multi-pronged approach in this paper could be successfully applied for similar analysis of other countries.

Future enhancements of the model should consider its application to quarterly (rather than monthly) data, so as to match the time horizon of the BOT's quarterly model. It is expected that greater data availability at the quarterly frequency would lead to an even more robust estimation of the model's parameters and—as a result—improve the forecasting power.

In future research, it would also be promising to expand the dataset by including more variables to improve the model's structure and performance. In particular, the second moments of key variables (for example, asset prices) could be considered in the specification of an unrestricted general model to be subject to the GETS reduction.

Table 1. Data Description and Transformation

Series Name	Series Description	Unit of Series	Underlying Series Source	Transformation
Core inflation	Core CPI	Index (1998=100)	CEIC	Dlog for equation building; Log for CI analysis
Commodity Price (*comm*)	World commodity price index	Index (1984=100)	WEO	Dlog
Farm Price (*fpi*)	Farm price index	Index (1995=100)	BOT	Dlog
Nominal effective exchange rate (*neer*)	Nominal effective exchange rate	Index (1997=100)	APD EER Databank	Dlog
Oil price(*oil*)	World petroleum spot price	U.S. dollar	WEO	Dlog
Import price (*pmb*)	Import price (in baht) index	Index (1995=100)	BOT	Dlog for equation building; Log for CI analysis
Producer price (*ppi*)	Producer Price Index	Index (1995=100)	BOT	Dlog
Raw food price (*rfcpi*)	Thai Raw Food CPI	Index (1998=100)	BOT	Dlog
Retail oil Price (*rppi*)	Retail petroleum price index	Value	BOT	Dlog
Accommodation price (*accom*)	CPI: accommodation	Index (1998=100)	THA	Dlog
Stock price (*sti*)	Stock price index (SET)	Index (1975=100)	CEIC	Dlog
Average Wage (*Avwag*)	Average Wage	Thai baht	THA	Dlog for equation building; Log for CI analysis
Lending rate (*lr*)	Prime rate: minimum loan rate (MLR)	Percent	CEIC	--
Policy rate (*pr*)	14-day repo rate (policy rate)	percent	CEIC	--

Table 1. Data Description and Transformation (concluded)

Series Name	Series Description	Unit of Series	Underlying Series Source	Transformation
Capacity utilization (*cu*)	Capacity utilization rate	Percent of total	BOT	Dlog
Currency (*Cur*)	Uses of base: currency held by private sector	Thai baht	CEIC	Dlog
M1 (*m1*)	M1 money supply	Thai baht	CEIC	Dlog
M2 (*m2*)	M2 money supply	Thai baht	CEIC	Dlog
M2a (*m2a*)	M2 money supply	Thai baht	CEIC	Dlog
Reserve money (*Res*)	Reserve money	Thai baht	IFS	Dlog
Export unit value (*Muv*)	World export unit value for manufactures	Index (1995=100)	WEO	Dlog

Note: (1) Variable of average wage is extrapolated from quarterly to monthly; (2) CEIC is the name of Dataset; BOT is Bank of Thailand; SET is Stock Exchange of Thailand; WEO is World Economic Outlook database.

Table 2. RMSE and MAE of Four Models

	Model 1 1/	Model 2 2/	Model 3 3/	Model 4 4/
RMSE	0.004288	0.002951	0.002799	0.002642
MAE	0.003330	0.002037	0.001975	0.001826

1/ Estimated from 1995m5 to 2002m12. Benchmark model with all variables by GETs .
2/ As in the benchmark model, but adds PC (3).
3/ As in the Model 2, but adds Dlccpi (3).
4/ As in the Model 3, but adds ECM (1).

Table 3. Diagnostic Statistics for the Single-Equation Inflation Model 4

Log-likelihood	497.885	DW	2
AIC	-13.0962	SC	-12.3836
HQ	-12.8086	FPE	2.08564e-006
AR 1–6 Test:	F (6, 60) = 1.5064 [0.1916]		
ARCH 1–6 Test:	F (6, 54) = 1.0491 [0.4044]		
Normality Test:	Chi^2(2) = 0.21747 [0.8970]		
Hetero test:	F (52, 13) = 0.25576 [0.9998]		
RESET test:	F (1, 65) = 1.7212 [0.1942]		

Note: AR 1-*n* tests for autocorrelation up to *n*th lag performed through an auxiliary regression of residuals on original variables and lagged residuals. Normality test has a null hypothesis that distribution of residuals has skewness and kurtosis corresponding to the normal distribution. ARCH 1-*n* tests for autoregressive conditional heteroscedasticity up to *n*th lag in the residuals through auxiliary regression of squared residuals on constant and lagged squared residuals. See Hendry and Doornik (2001) for a description of the tests. Probabilities are reported in parentheses.

Table 4. ADF (4) Statistics for Testing for a Unit Root in Various Time Series

Null order	Variables		
	lccpi	*lpmb*	*lavwag*
I (1)	-1.33	-2.46	-2.55
	(-0.01)	(-0.09)	(-0.05)
I (2)	-2.60	-3.05	-3.87*
	(-0.36)	(-0.53)	(-0.76)

Note: For a variable of *lccpi*, *lpmb,* and *lavwag*, the augmented Dickey-Fuller (1981) statistic ADF is the *t* ratio on coefficient of lagged variable. And the figures in ( ) are the estimated coefficients on the lagged variable. The sample is 1995m5-2003m10 for all. Here the asterisks * and ** denote rejection at the 5 percent and 1 percent critical value. The critical value for this table is calculated from Mackinnon (1991).

Table 5. *F* and Related Statistics for the Sequential Reduction from the Fourth-Order VAR to the First-Order VAR

Equation	T	p	Log-likelihood	SC	HQ	AIC
LAG (4)	102	39	988.23211	-17.609	-18.206	-18.612
LAG (3)	102	30	981.67139	-17.888	-18.348	-18.660
LAG (2)	102	21	971.57321	-18.098	-18.420	-18.639
LAG (1)	102	12	950.09020	-18.085	-18.269	-18.394

Table 6. Standard Statistics and Estimates of Cointegration Analysis to First-Order VAR Cointegration Analysis, 1995 (5) to 2003 (10)

Eigenvalue	Loglik for Rank	
	899.3273	0
0.57794	943.3207	1
0.086977	947.9614	2
0.040881	950.0902	3

Rank	Trace test [Prob]	Max test [Prob]	Trace test (T-nm)	Max test (T-nm)
0	101.53 [0.000]**	87.99 [0.000]**	98.54 [0.000]**	85.40 [0.000]**
1	13.54 [0.096]	9.28 [0.269]	13.14 [0.110]	9.01 [0.292]
2	4.26 [0.039]*	4.26 [0.039]*	4.13 [0.042]*	4.13 [0.042]*

Table 7. Coefficients of Cointegrating Vectors Beta and Corresponding Adjustment Coefficients Alpha

	Number of Cointegrating Vectors = 1	
	A	B
Restrictions	Unrestricted Cointegrating Vectors	Weak Exogeneity of Import Price Index and Average Wage
Beta	1.0000	-0.081232
	(0.0000)	(0.0088259)
	-0.10755	0.0092235
	(0.018019)	(0.0018954)
	-0.31963	0.025566
	(0.046475)	(0.0055536)
Alpha	-0.079961	1.0000
	(0.0071052)	(0.0000)
	-0.24127	0.0000
	(0.13542)	(0.0000)
	-0.040756	0.0000
	(0.066144)	(0.0000)

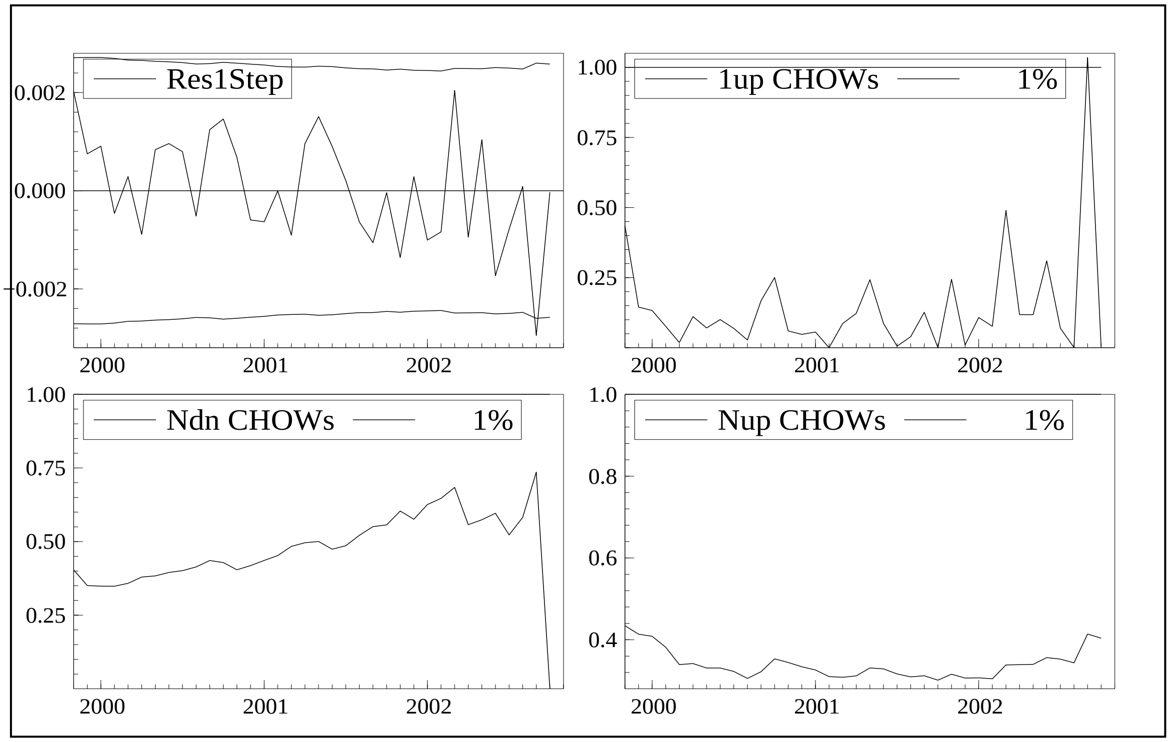
Note: Standard errors reported in parentheses.

Table 8. Comparison of Forecasting Performance by Model 4 in Different Time Horizons

	2003m1–2003m10	2001m11–2003m10	1999m4–2003m10
RMSE	0.002642	0.002265	0.001931
MAE	0.001826	0.001617	0.001475

Note: The forecasting accuracy improves with the extension of time horizon, which demonstrates the strength of Model 4.

Figure 2. Chow Test of Model 4



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 3. Actual and Fitted Value of Model 4

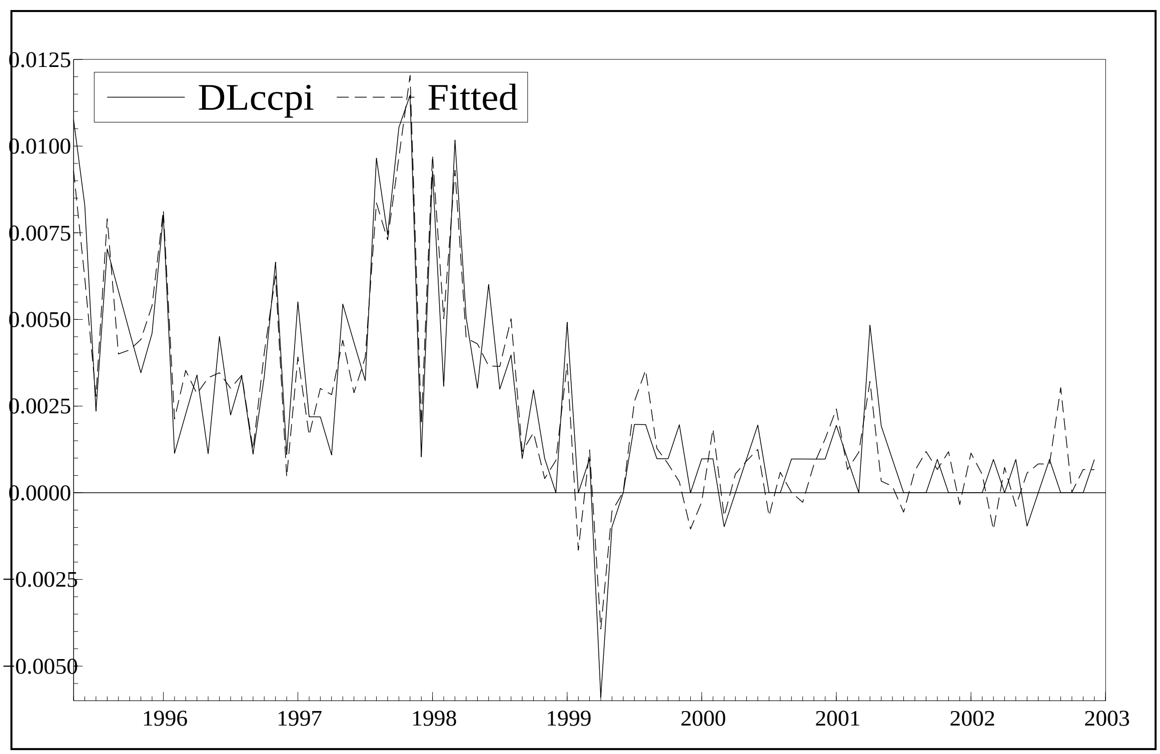


Figure 4. Residual Density and the Residual Correlogram of Model 4

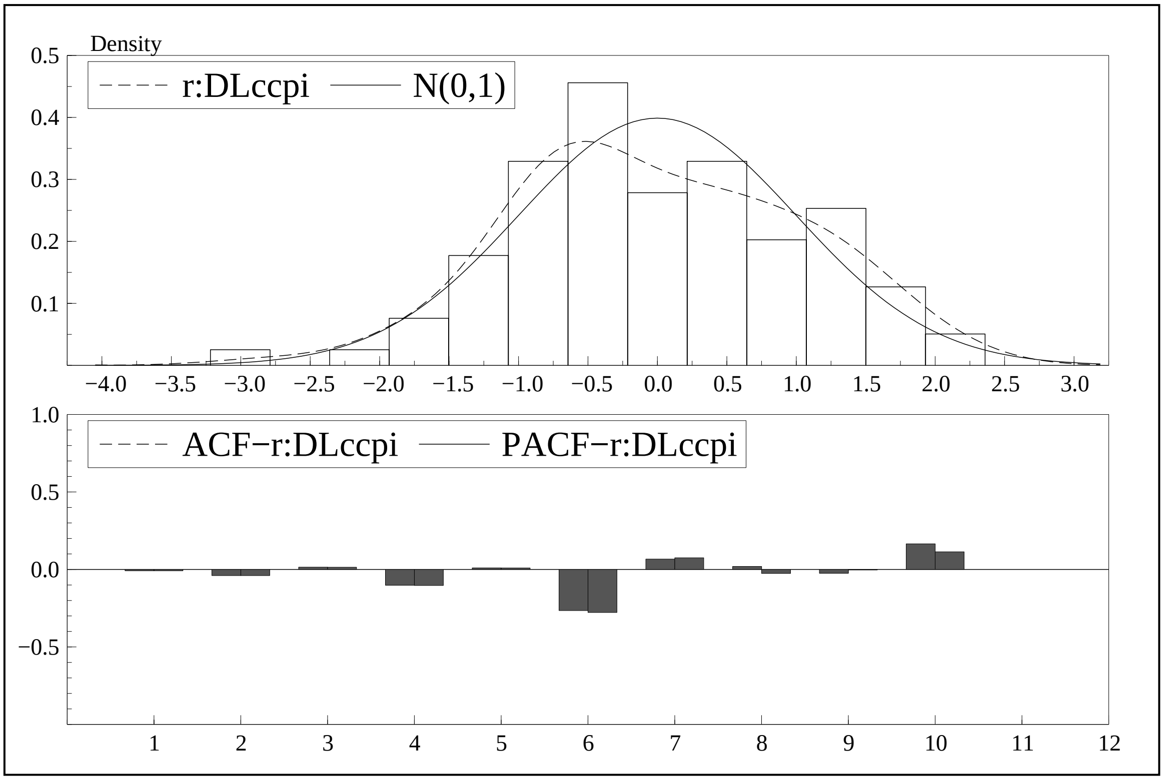


Figure 5. Forecasting Performance of Model 4

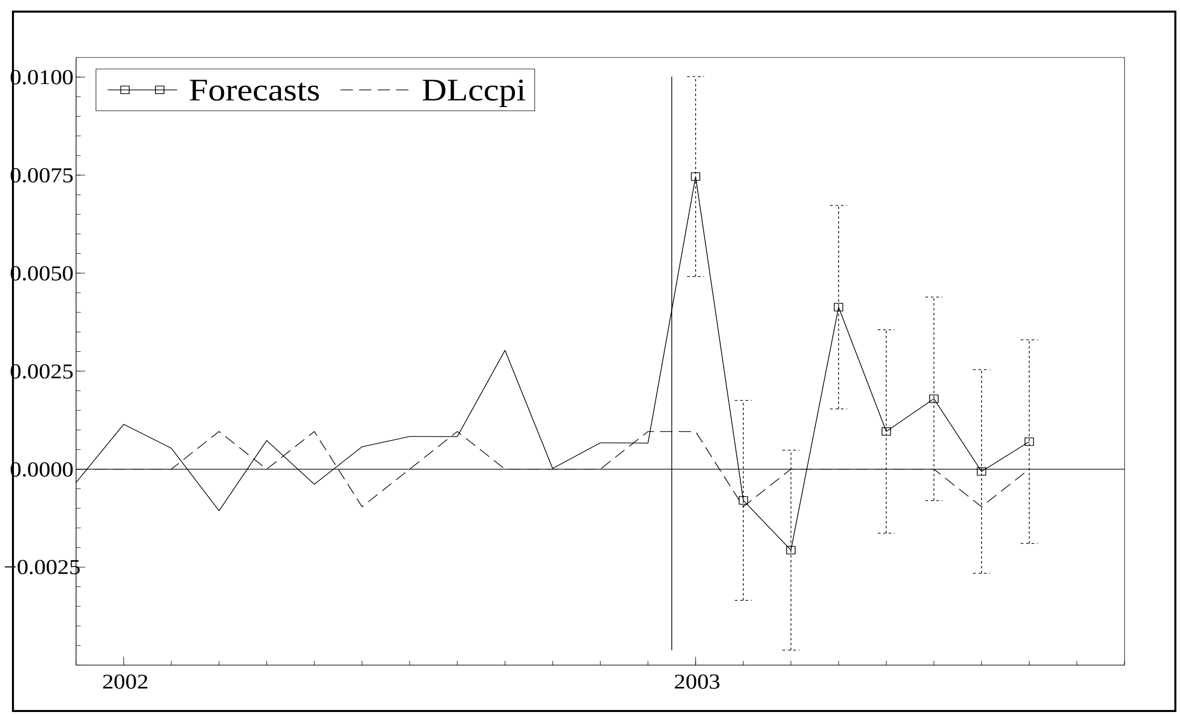


Figure 6. Cointegration Relations of Core Inflation, Import Price Index, and Average Wage

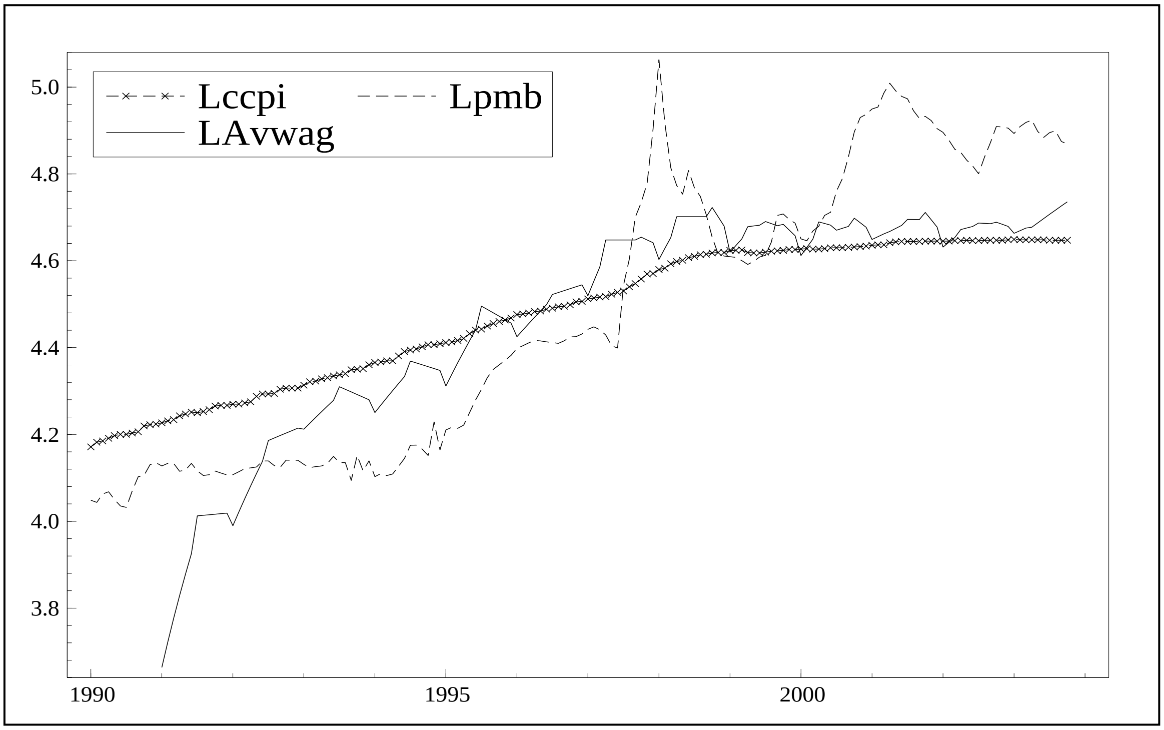
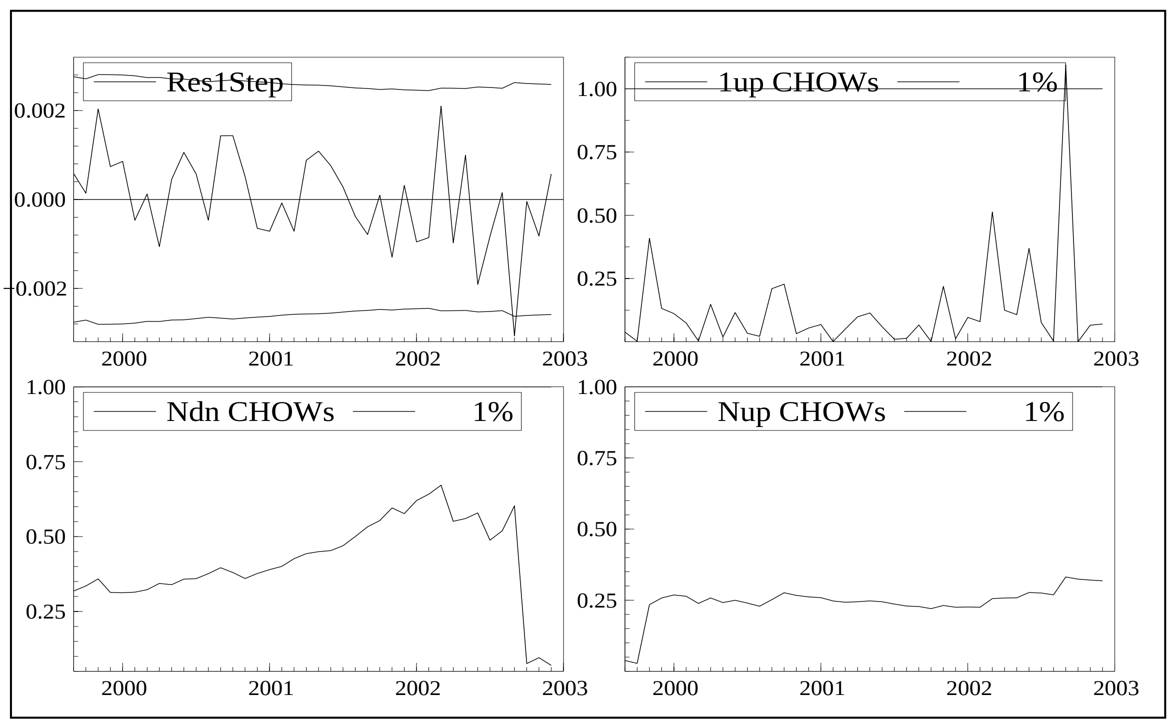


Figure 7. Chow Test of Model 3



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 8. Forecasting Performance of Model 3

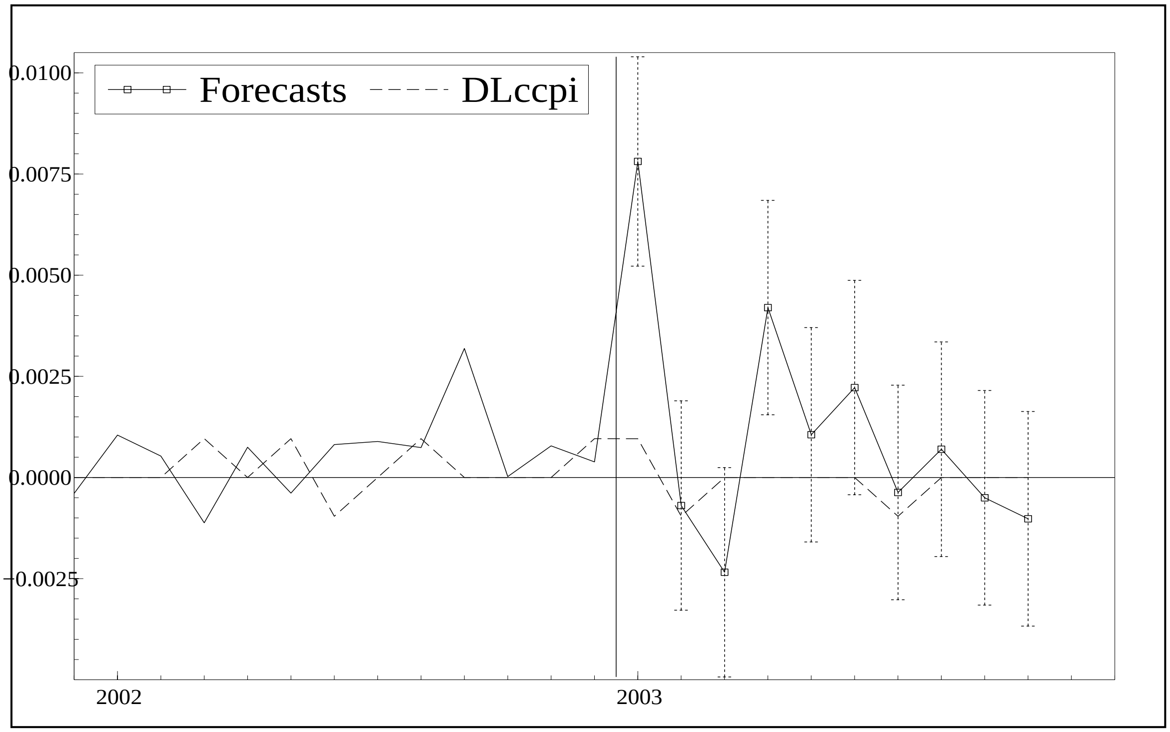
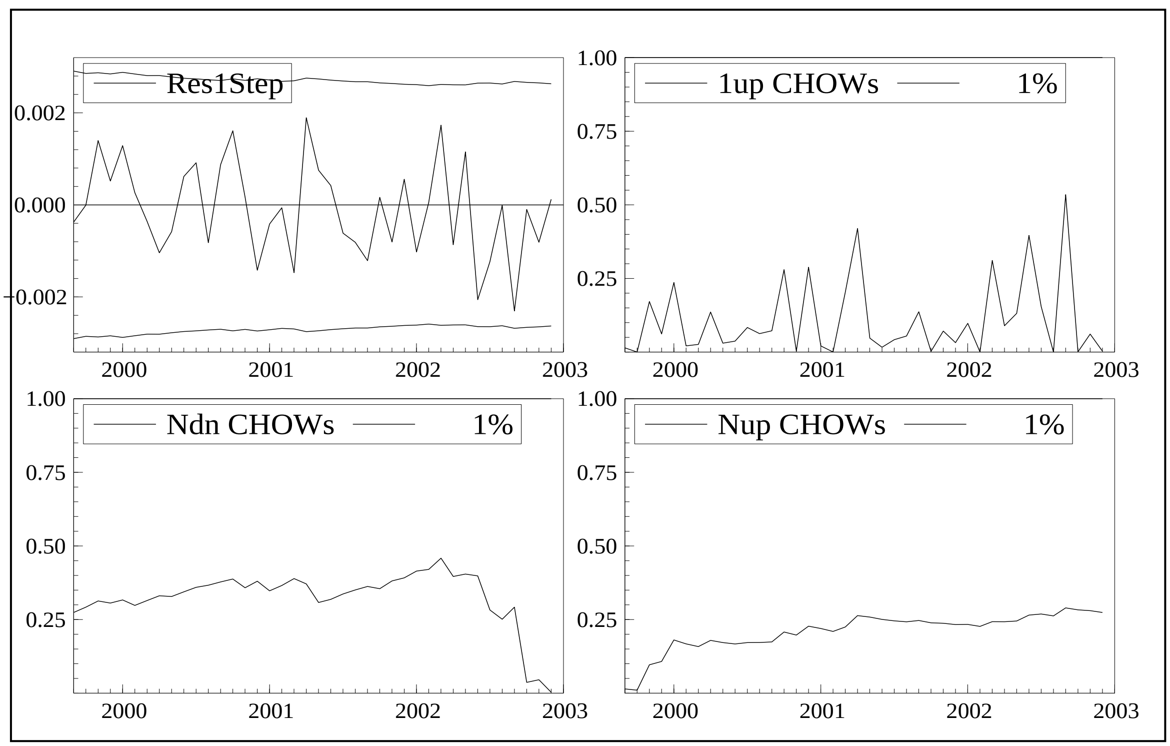


Figure 9. Chow Test of Model 2



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 10. Forecasting Performance of Model 2

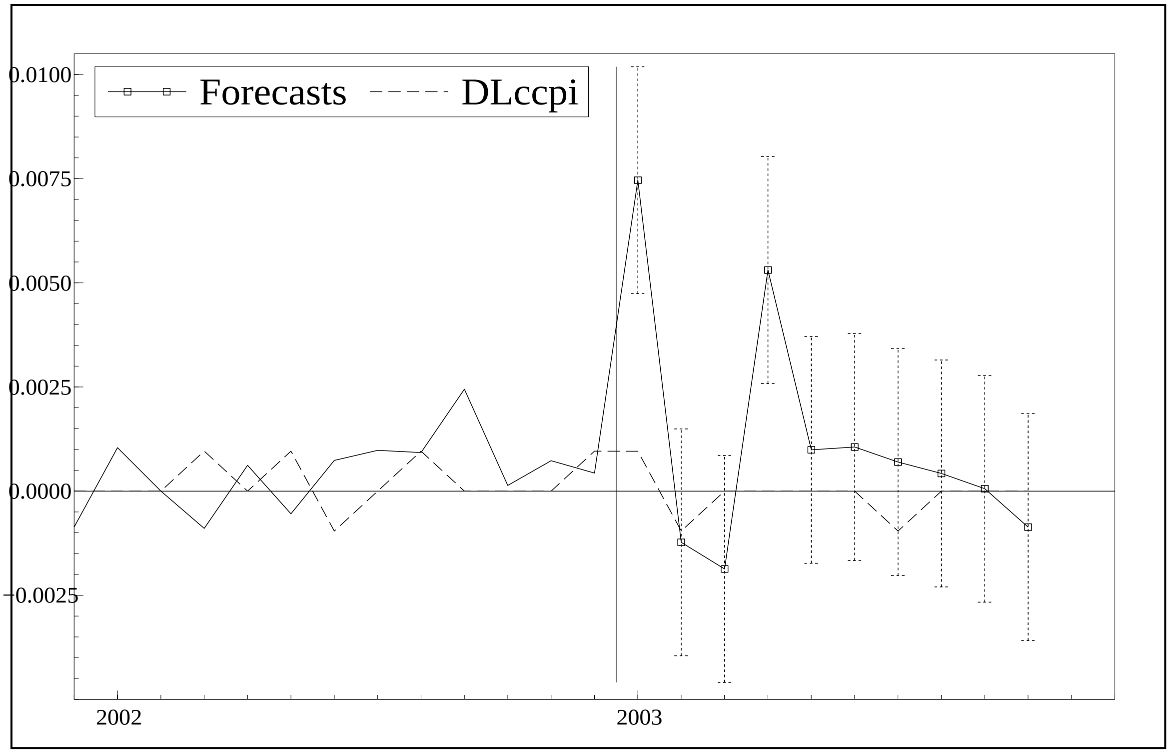
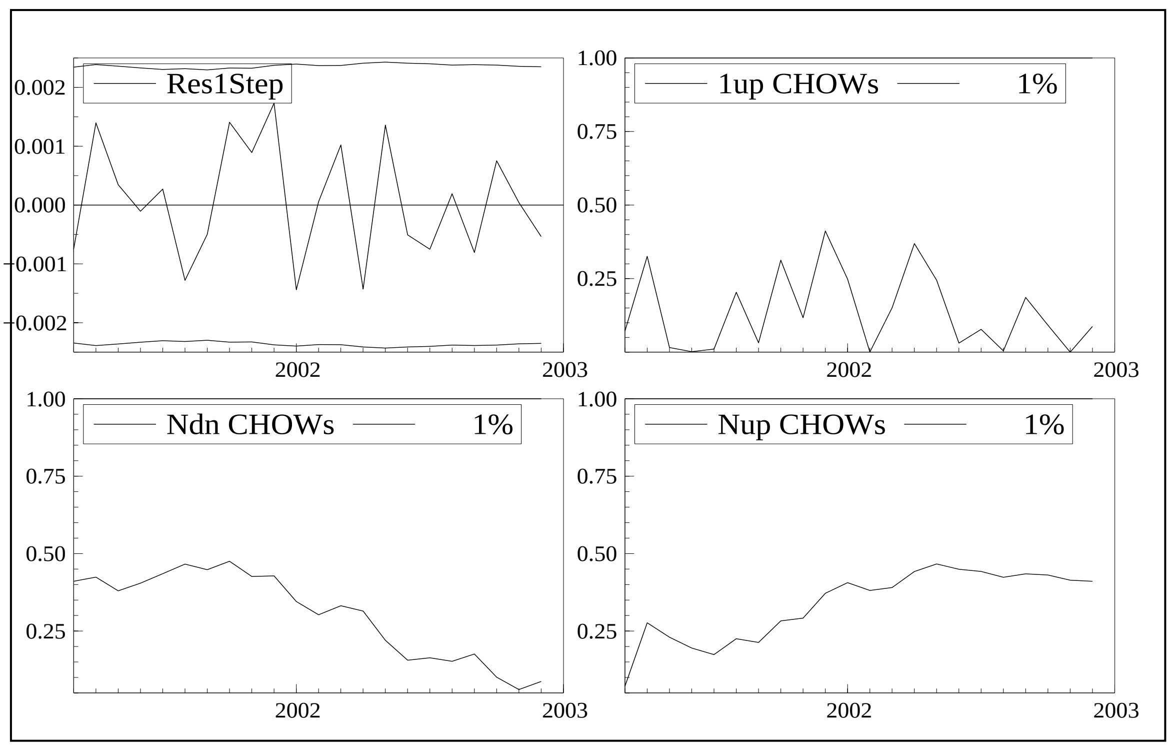


Figure 11. Chow Test of Model 1



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 12. Forecasting Performance of Model 1

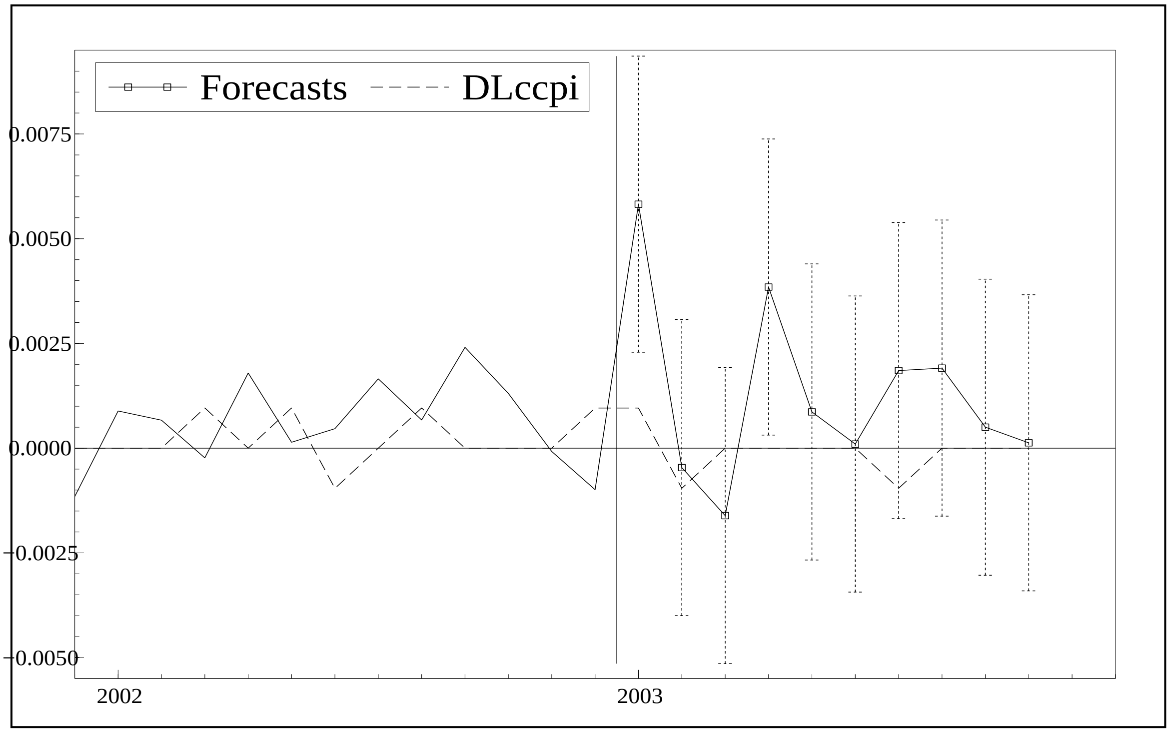
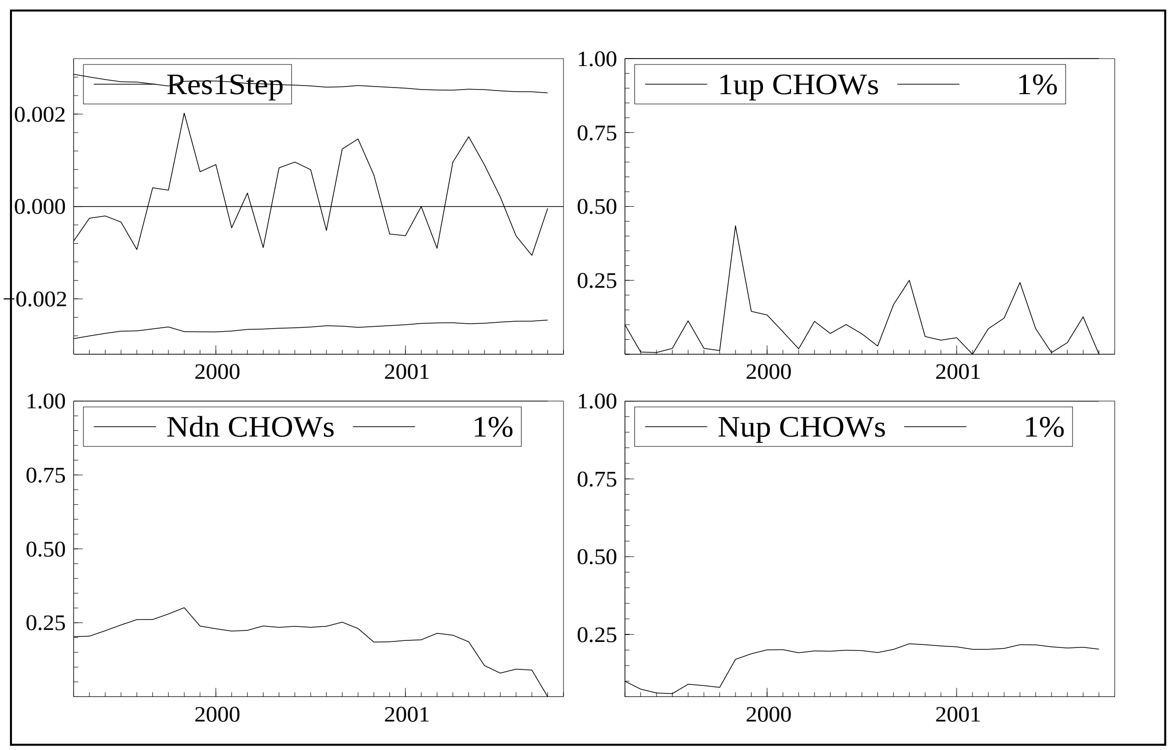


Figure 13. Chow Test of Model 4 (1995m5–2001m10)



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 14. Forecasting Performance of Model 4 (2001m11–2003m10)

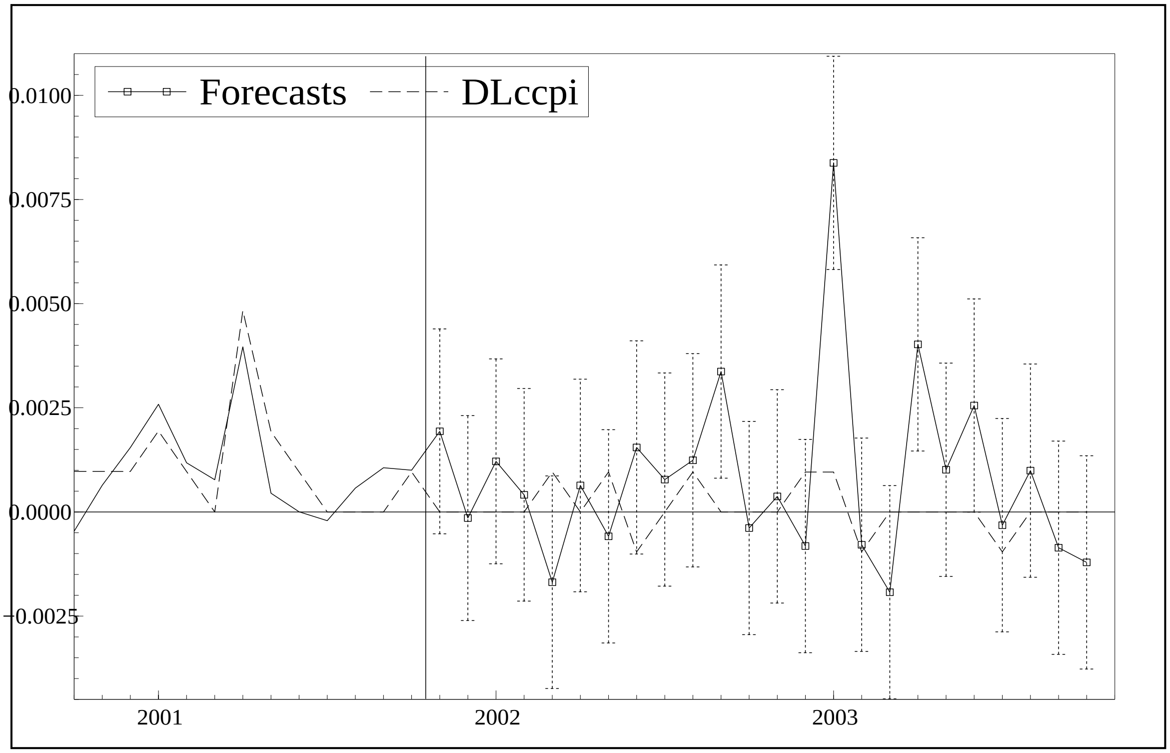
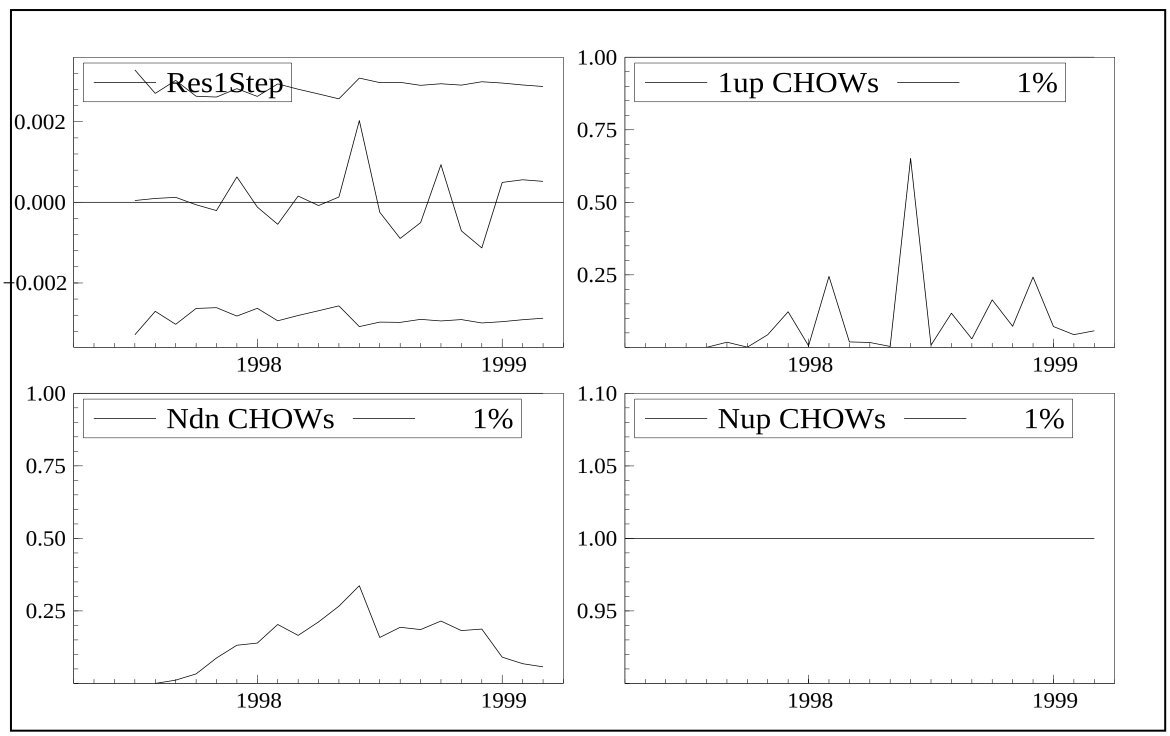
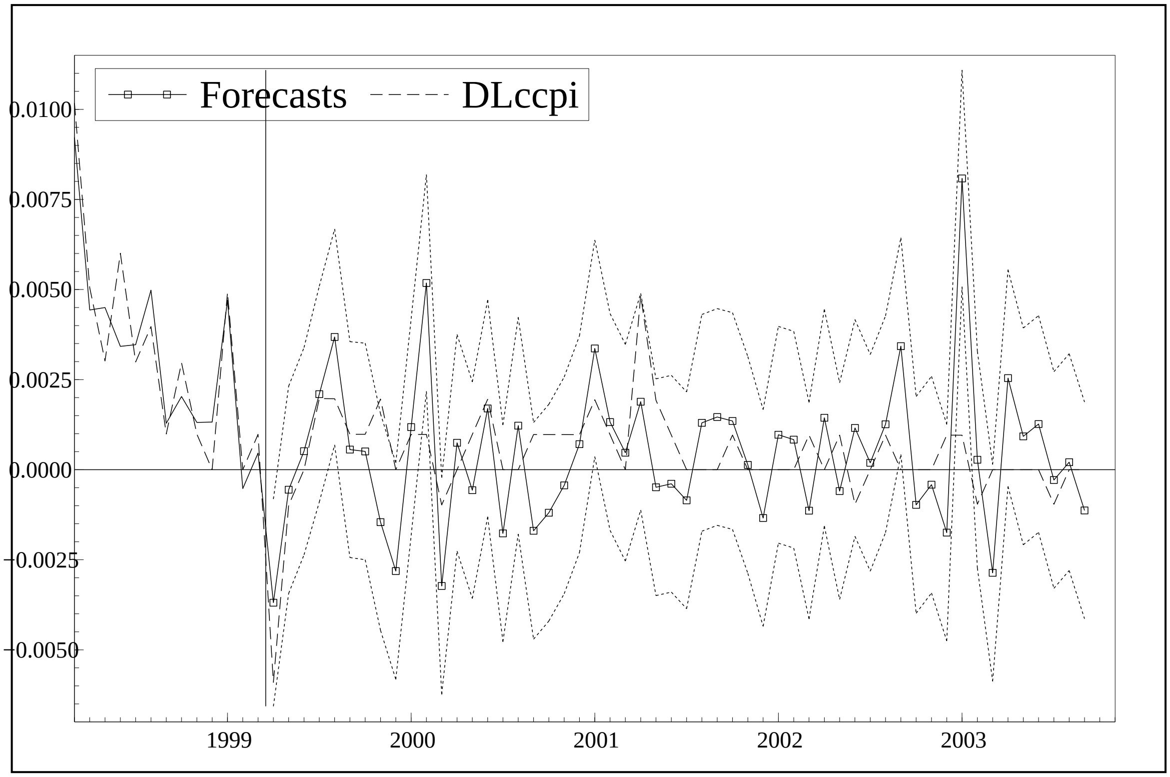


Figure 15. Chow Test of Model 4 (1995m5–1999m3)



Note: Res 1 Step:1-step residuals +/- 2 standard error (SE); 1up CHOWS: 1-step Chow test; N dn CHOWS: break-point Chow test; N up CHOWS: Forecast Chow test.

Figure 16. Forecasting Performance of Model 4 (1999m4–2003m10)



Model 1

Log-likelihood	511.332	DW	2.19
AIC	-13.2147	SC	-12.2827
HQ	-12.8385	FPE	1.89184e-006

AR 1-6 test:	F (6, 52) = 0.88669 [0.5114]
ARCH 1-6 test:	F (6, 46) = 0.083283 [0.9976]
Normality test:	Chi^2(2) = 2.6681 [0.2634]
Hetero test:	Chi^2(68) = 73.100 [0.3143]
RESET test:	F (1, 57) = 6.2165 [0.0156]*

Model 2

Log-likelihood	494.308	DW	2.05
AIC	-13.0402	SC	-12.3550
HQ	-12.7637	FPE	2.20182e-006

AR 1-6 test:	F(6,61) = 0.77938 [0.5893]
ARCH 1-6 test:	F(6,55) = 1.3837 [0.2376]
Normality test:	Chi^2(2) = 0.24367 [0.8853]
hetero test:	F(50,16) = 0.38839 [0.9945]
RESET test:	F(1,66) = 0.42917 [0.5147]

Model 3

Log-likelihood	495.87	DW	2.14
AIC	-13.0742	SC	-12.3889
HQ	-12.7976	FPE	2.12831e-006

AR 1-6 test:	F(6,61) = 1.7402 [0.1269]
ARCH 1-6 test:	F(6,55) = 0.94691 [0.4695]
Normality test:	Chi^2(2) = 0.54596 [0.7611]
Hetero test:	F (50,16) = 0.26410 [0.9998]
RESET test:	F (1,66) = 1.4396 [0.2345]

Model 4

Log-likelihood	497.885	DW	2
AIC	-13.0962	SC	-12.3836
HQ	-12.8086	FPE	2.08564e-006

AR 1–6 test:	F (6,60) = 1.5064 [0.1916]
ARCH 1–6 test:	F (6,54) = 1.0491 [0.4044]
Normality test:	Chi^2(2) = 0.21747 [0.8970]
Hetero test:	F (52,13) = 0.25576 [0.9998]
RESET test:	F (1,65) = 1.7212 [0.1942]

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