

HOW FAR CAN WE FORECAST? FORECAST CONTENT HORIZONS FOR SOME IMPORTANT MACROECONOMIC TIME SERIES

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Abstract

For stationary transformations of variables, there exists a maximum horizon beyond which forecasts can provide no more information about the variable than is present in the unconditional mean. Meteorological forecasts, typically excepting only experimental or exploratory situations, are not reported beyond this horizon; by contrast, little generally-accepted information about such maximum horizons is available for economic variables. In this paper we estimate such *content horizons* for a variety of economic variables, and compare these with the maximum horizons which we observe reported in a large sample of empirical economic forecasting studies. We find that there are many instances of published studies which provide forecasts exceeding, often by substantial margins, our estimates of the content horizon for the particular variable and frequency. We suggest some simple reporting practices for forecasts that could potentially bring greater transparency to the process of making and interpreting economic forecasts.

Key words: diffusion index, forecast content, forecast skill, macroeconomic forecast
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1. Introduction

Macroeconomic forecasts are made at a variety of horizons, typically from one month (or quarter) to a number of years into the future. The information content of these forecasts in general falls with increasing horizon, and beyond a certain point, forecasts of (stationary transformations of) the quantities of interest convey no more information about future values than does the unconditional mean of the series. This point, called the ‘content horizon’ by Galbraith (2003), varies substantially across data series.

This maximum horizon at which forecasts have positive content (in this sense or by related measures such as forecast skill, used in the meteorological literature; see for example Murphy and Winkler 1987) has been investigated to some degree for measures of national output such as Gross Domestic Product (GDP) and to a lesser degree for consumer-price inflation; see Öller (1985), Galbraith (2003), Brisson et al. (2003). Such information on the limitations of forecasts is useful in interpreting forecasts at longer horizons, and for forecasters can serve as a criterion for evaluation and development of technique. Perhaps most importantly, it may suggest bounds on the forecast horizons which will be reported, as is typically the case in meteorological forecasting (for example, daily temperature forecasts are usually issued to the public at horizons not exceeding seven days; meteorologists work with horizons up to approximately ten days for this variable). Nonetheless, there is very little information of this type for macroeconomic variables other than GDP and inflation; by contrast, maximum horizons are quite widely known for meteorological variables such as daily maximum temperature.¹

The present study attempts to extend knowledge of the content horizon to a broader set of such variables, using both US and Canadian data. In addition to consumer price inflation and real GDP growth, we examine short-term and long-term interest rates, growth in real personal disposable income, the federal government surplus/deficit as a proportion of GDP, the current account balance as a proportion of GDP, and the balance on goods and services trade; for the US, we also consider the growth rate of the monthly industrial production index. In each case, we estimate the content horizon for simple univariate autoregressive forecasts, as well as for multivariate forecasts produced by diffusion index (dynamic factor) models.

After estimating the maximum content horizon attainable with the different forecasting methods, we compare this horizon with the maximum reported forecasting horizon in a set of published macroeconomic forecasting studies. We find numerous cases in which the maximum published forecast horizon substantially exceeds

¹Granger (1996) also makes this point, noting that ‘In some sciences there seems to be a horizon beyond which useful forecasting is not possible; in weather forecasting there seems to be [a horizon of] four or five days, for example. It is unclear if economics has similar boundaries as variables differ in their forecastability...’.

our estimate of the content horizon from the best available technique. While this is not necessarily indicative of misleading or inefficient forecasts—the long-horizon forecasts may closely resemble the unconditional means of the series—it is suggestive of potential for improvement either in forecast technique or reporting; in particular, it is clear that economic forecasters do not adhere in general to maximum reporting horizons which approximate the content horizon, as is roughly the case in meteorological forecasting.

Section 2 of the paper describes the techniques that we will use both for forecasting and to estimate forecast content at different horizons, given a particular forecasting technique. Section 3 describes the US and Canadian data and the implementation of the different forecasting techniques on each of the time series of interest, and estimates the content horizon for each. In section 4, we compare these horizons with the maximum published horizons from a number of published sources.

2. Forecasting methods and the content horizon

We begin by defining forecast content and the content horizon, which are our primary objects of interest in this study. This discussion follows Galbraith (2003). The concept of forecast content is similar to that of *forecast skill* used in evaluating meteorological forecasts, although the reference forecast used in meteorological evaluations differs to some degree among authors; see for example Murphy and Winkler (1987). Meteorologists routinely track the skill of their forecasts over time; see for example Ghelli (2004) on the forecast skill of temperature forecasts from the European Centre for Medium Range Weather Forecasting.

2.1 Forecast content horizons

We treat approximately-stationary transformations of each of the variables of interest. We observe $\{y_t\}_{t=1}^T$, a sequence of T observations on the covariance stationary process y , and we forecast the value y_{T+s} , $s > 0$, using these observations; label the forecast $\tilde{y}_{T+s|T}$, so that the mean squared forecast error is $E(\tilde{y}_{T+s|T} - y_{T+s})^2$. The sample mean $\bar{y} = T^{-1} \sum_{t=1}^T y_t$ also provides a possible forecast of any future value, but one which of course does not exploit any conditioning information.

The *forecast content* is defined as the proportionate reduction in MSE available from the use of conditioning information in a forecasting model than the unconditional mean alone, and is specific to a forecast of a particular series, model type, and time aggregation. The forecast content at s is described by the content function,

$$C(s) = 1 - \frac{MSE_{\tilde{y}(s)}}{MSE_{\bar{y}(s)}}, \quad s = 1, \dots, S, \quad (2.1.1)$$

where $MSE_{\tilde{y}(s)}$ is the expected squared error of the model-based s -step forecast, and $MSE_{\bar{y}(s)}$ is the corresponding expected squared error of the unconditional mean as

a forecast of the process. Of course, forecast content can also be defined relative to another loss function. We use the MSE as a representative loss function, and also because analytical results on forecast content for AR forecasting models are available in that case. Having defined the forecast content, the forecast content horizon is defined as the horizon s_0 beyond which $C(s) \leq 0$; we will also refer to the δ -level content horizon, beyond which the forecast content is less than δ (we use $\delta = 0.02, 0.05, 0.10$ in Tables 1 and 2 below.)

Although analytical expressions are available for computing (2.1.1) given the parameters of a pure autoregressive process (Galbraith 2003),² and although we will report these results, the present paper is also concerned with general multivariate forecasting methods, for which no analytical solutions exist. We must therefore also use non-parametric estimates of the forecast content function, which can be computed using sample estimates of the mean squared errors.

2.2 Forecasting methods

Forecast content is a measure of the value of conditioning information for a forecast at a given horizon. Different forecast methods exploit conditioning information differently, and so may produce different content and content horizons. Our interest here is not in the relative merits of different forecasting methods, but in obtaining the maximum possible horizon at which conditioning information can be valuable. We therefore need to investigate a variety of different methods in order to estimate the maximum content horizon attainable, given existing forecasting tech-

²For a stationary $AR(p)$ process with error distribution $\varepsilon_t \sim IN(0, \sigma_\varepsilon^2)$, we have

$$C(s) = 1 - \frac{B_{[1,1]}}{\nu} + o(T^{-1}), \quad (2.1.2)$$

where $B_{[1,1]}$ is the top-left element of the matrix

$$B = \sum_{j=0}^{s-1} A^j M A'^j + T^{-1} \sum_{j=0}^{s-1} \sum_{k=0}^{s-1} A^j M A'^k \cdot \text{tr}[(A^{s-j-1} \Gamma)' (\Gamma^{-1} A^{s-k-1})], \quad (2.1.3)$$

$$\nu = \sum_{i=0}^{\infty} a_i^2 \left(1 - 2T^{-1} \sum_{h=s}^{T+s-1} \rho(h) \right) + T^{-1} \left(\sum_{i=0}^{\infty} a_i \right)^2, \quad (2.1.4)$$

and where M is the $(p+1) \times (p+1)$ matrix with 1 in the upper-left corner and zeroes elsewhere, $\Gamma = E(Y_t Y_t')$, $\rho(h)$ is the autocorrelation function at lag h , and A is the $(p+1) \times (p+1)$ matrix such that $Y_t = A Y_{t-1} + \varepsilon_t$, with $\varepsilon_t = (\varepsilon_t, 0, \dots, 0)'$.

nology and data constraints, for a particular time series. We consider univariate and multivariate methods, and examine the behavior of the forecast content functions as we vary the forecasting model. We use y_t to represent an observation on any one of the processes of interest discussed in Section 3 below.

(i) Autoregressive models

The AR model is a univariate linear model. In spite of its simplicity, it is often competitive with much more elaborate forecasting models; Stock and Watson (1999a), for example, find the AR the best-performing forecasting model overall in a set of linear and non-linear univariate models. We will therefore report results for each process using these benchmark forecasts. The AR(p) model is of the form

$$\alpha(L)(y_t - \mu) = \epsilon_t \quad \text{or} \quad y_t = \alpha_0 + \sum_{j=1}^p \alpha_j y_{t-j} + \epsilon_t, \quad (2.2.1)$$

where $\alpha(L)$ is a p -th order polynomial in the lag operator, ϵ_t is an iid disturbance, α_0 is a constant and α_i is the autoregressive parameter at lag i . Where the forecast horizon exceeds 1, forecasts are computed by the standard iterated method rather than by direct projection on the available lags.

As we have noted, the forecast content of an autoregressive process may be characterized analytically, taking into account the uncertainty associated with parameter estimation. We report below both this analytical result, which applies to a true AR model of known order estimated on the full sample, and therefore tends to produce relatively high estimates of forecast content, as well as the ‘empirical’ measure based on a sequence of pseudo-out-of-sample forecasts.

The availability of these analytical results makes the pure autoregression an important benchmark to include, despite the fact that we might in general expect the best multivariate model to produce lower MSE and higher content horizon than the AR. As well, the empirical performance of the AR model class is remarkably competitive on economic data; see for example the large-scale comparison in Stock and Watson (1999a), and Brisson et al. (2003), who find that general multivariate models such as dynamic factor (diffusion index) models tend not to produce appreciable increases in the content horizon for their series of interest (although they do find reductions in MSE at points inside the content horizon).

(ii) Diffusion index (dynamic factor) models

This class of models will be our general device for incorporating multivariate information. The diffusion index model is a dynamic factor model, exploited by Stock and Watson (2002a) for forecasting in (e.g.) the form:

$$y_t = \beta' F_{t-1} + \varepsilon_{t-1}, \quad (2.2.4)$$

where F_{t-1} is the set of factors obtained by exploiting a large set of conditioning variables available for forecasting, represented by the N - dimensional time series $\{X_{t-1}\}_{t=1}^T$, modelled using the factor structure

$$X_{t-1} = \Lambda_{t-1}F_{t-1} + e_{t-1}. \quad (2.2.5)$$

Factor extraction begins by standardizing the matrix X to mean zero and variance one (X may contain lags of the series). The factors F are estimated using the q eigenvectors associated with the q greatest eigenvalues of this matrix, as (up to scale) $\hat{F} = X\hat{\Lambda}$, where $\hat{\Lambda}$ is the matrix of eigenvectors associated with the q largest eigenvalues. The estimated moment matrix is scaled by the number of series N , i.e. to $N^{-1}(X'X)$, for consistent estimation of an assumed true number of factors; an information criterion is known to estimate this population number of factors consistently. See Stock and Watson (2002a,b) for a complete exposition of the model.

This model class is an attractive representative of the class of multivariate models for several reasons. In addition to the fact that it tends to produce results comparable with the best theory-based regression models for forecasting, while allowing for automatic implementation in cases where no strong theory-based forecasting model is available, it is also useful that the diffusion index information may be complementary with autoregressive information, in that a model with both elements may gain relative to either class of model alone; see Stock and Watson (1999b, 2002a/b), Brisson et al. (2003). We also consider such combined diffusion+AR forecasts in the set examined below.

The diffusion forecasts are produced and evaluated in a sequence of pseudo-out-of-sample results. A large multivariate data set is required to implement these forecasts; see section 3.1 and Appendix 1.

(iii) Forecast combination

In addition to these methods, we explore fixed-weight combinations of forecasts made from diffusion index (or diffusion index with AR components) and pure autoregressive models; see Li and Tkacz (2004) for a general treatment of possible forecast combination methods. These forecasts are indicated as ‘combined’ in the figures, and often have the highest forecast content. The present implementation uses equally weighted forecasts, implicitly assigning equal variance to each component forecast. These weights may differ substantially from those of the optimal forecast where the two inputs forecasts have substantially different associated forecast variance, but equal weighting has generally been found to perform remarkably well and robustly; see Li and Tkacz (2004) and Stock and Watson (2004).

3. Data and forecast results

3.1 Data

Professional economic forecasters produce forecasts of a wide range of variables, although some variables are of general interest and are forecast by almost all public- and private-sector forecasters. Similarly, academic forecasters have produced many studies of different quantities, although some such as output growth and inflation are particularly widely studied. Although many of these studies use fairly long horizons, the content of forecasts at longer horizons, in the sense described above, remains an open question for most of these variables.

In this study we forecast each of the variables mentioned in the introduction, but use a much larger set of variables in the dynamic factor (diffusion index) models used for forecasting. Appendix 1 indicates the data available, at quarterly, monthly, and higher (weekly or bi-weekly) frequencies; the data sets begin in the first quarter or month of 1969 and end in the first quarter, or third or fourth month, of 2004. For forecasting at the quarterly frequency, monthly (and higher-frequency exchange rate data) are aggregated to the quarterly level. The numbers of series available for factor forecasts are 91 (Canadian monthly data), 229 (Canadian quarterly data), 143 (US monthly data) and 203 (US quarterly data); there are 423 sample points in the monthly data sets, and 141 in the quarterly sets.

The order of integration of each of these series was assessed, and for approximately stationary series, no transformations were performed on the data. Non-stationary series were transformed to represent either monthly, quarterly or annual growth rates, which typically correspond to the values of interest to users of forecasts of integrated time series. Note also that the transformation of monthly data to a monthly series of annual values (for example) introduces a moving average process of order 11 in the transformed series, because contiguous monthly measures pertain to annual periods overlapping by 11 months. This moving-average effect can readily be modelled, directly or by autoregressive (or other) approximation.

The series, and the transformations applied to each for use as a forecast target, are the following:

- 1. Output growth: $y_{1,t} = 100(\ln(Y_t) - \ln(Y_{t-\ell}))$, where Y_t is quarterly real GDP at time t , and $\ell = 1$ quarters, yielding quarterly growth rates; for the US only, we also forecast $y_{1b,t}$ equal to monthly real industrial production, with $\ell = 1$, yielding monthly growth rates.
- 2. Inflation: $y_{2,t} = 100(\ln(P_t) - \ln(P_{t-\ell}))$, where P_t is the level of consumer prices at time t , and $\ell = 12$, for annual inflation; we also consider $\ell = 1$, for monthly inflation.
- 3. Current account balance as a proportion of GDP, $y_{3,t}$: no further transformation.
- 4. Balance on goods and services trade as a proportion of GDP, $y_{4,t}$: no further transformation.
- 5. Short-term ex-post real interest rates: $y_{5,t} = r_t^s - y_{2,t}$, where r_t^s is an

annualized short term interest rate.

- 6. Long-term ex-post real interest rates: $y_{6,t} = r_t^l - y_{2,t}$, where r_t^l is an annualized long term interest rate.
- 7. Growth in real personal disposable income: $y_{7,t} = 100(\ln(Y_t) - \ln(Y_{t-\ell}))$, where Y_t is monthly (US) or quarterly (Canada) real personal disposable income at time t , and $\ell = 1$.
- 8. Consolidated government surplus (deficit) as a percentage of GDP, $y_{8,t}$: no further transformation.

As discussed in Tkacz (2001), the time-series properties of short and long-term rates are sufficiently different as to warrant separate analysis. Furthermore, short-term rates are closely related to the policies followed by central bankers, while long-term rates are largely driven by non-policy factors, such as inflation expectations and market liquidity; this difference suggests possible differences in predictability, in the sense of Diebold and Kilian (2001), or forecast content.

The inflation series is the only one for which we take two transformations, and the comparison of these (see Figures 1a vs 1b and 1e vs. 1f) underlines the importance of the transformation for forecast skill, content, or predictability. When we take the difference at lag 12 for inflation, we produce a series with an MA(11) structure relative to the lag 1 difference; that is, the annually-differenced log price series is a different time series, and has a different time series structure, than the monthly difference in log price. The annual inflation rate will typically show more autocorrelation, more predictability, and more forecast content or skill. This is an illustration of the general feature that forecast content, skill, content horizon, predictability, etc. are features of a particular transformation of a variable, and that different transformations may show very different results. The choice depends on which quantity is of interest, and different choices are legitimate as long as weak stationarity is an adequate approximation (so that the unconditional mean has a well-defined meaning) over the period under consideration.

3.2 Implementation details

Implementation of these methods involves a number of parameter choices, including t_0 , the initial sample for estimation of models prior to pseudo-out-of-sample forecast comparison; p , the number of AR terms in AR or Diffusion+AR models; k , the number of factors for diffusion index forecasts. The aim is to optimize performance of each method in order to obtain a good estimate of the maximum obtainable horizon conditional on available sample size. We allow p to be no greater than 4 for quarterly data, 8 for monthly, and k to be no greater than 4. The lag length selected as optimal is retained throughout the pseudo-out-of-sample forecast period.

We take the initial sample for each empirical method as $t_0 = T/2$; as t_0 is larger, initial parameter estimates (and therefore forecast quality) is higher in the earlier

pseudo-out-of-sample forecasts, but the sample of these forecasts is smaller. The number of AR terms is chosen by the Schwarz information criterion, using an upper bound, and is used not only in the empirical methods but in defining the number of terms for the analytical AR computation. The number of principal components is chosen to optimize at an arbitrarily-chosen fixed horizon, and following results in Stock and Watson (2002b), is limited to an upper bound of four on the number of components.

3.3 Content horizon results

The results of the estimation of content are presented in Figures 1 and 2, for each of 19 (9 Canadian and 10 US) data series, and are summarized in the corresponding Tables 1 and 2. The point of interest to us, as the tables indicate, is not comparison of the methods, but rather the horizon achievable by the best method. We report both the analytical result in principle achievable from a pure AR process (computed via equations 2.1.2–2.1.4 above) as well as the best result obtained using the estimated MSE's from pseudo-out-of-sample sequences of empirical forecast observations, with content evaluated via equation 2.1.1. The maximum horizons considered for the two data frequencies are 36 months and 16 quarters respectively; horizons exceeding these values are reported as 36+ or 16+.

Confidence bands are not given in Figures 1 and 2, but an indication of the precision of the estimates is given by the bootstrap standard error of the forecast content for the results computed from the analytical expressions (2.1.2–2.1.4). For monthly series where substantial content remains at the maximum horizon (all three Canadian series, US 12-month real interest rates and inflation), the standard errors are in the region of 0.01 to 0.03 at horizon 1, rising to 0.15–0.20 at the maximum horizon; in the remaining monthly cases where content is near zero at the longest horizons, standard errors are similar at horizon 1 but decline to well under 0.01 at long horizons, reflecting the fact that variation around zero in the AR parameters has little effect on long-horizon content, so that uncertainty attributable to parameter estimation is small. The same patterns hold in quarterly data, but with larger standard errors reflecting the smaller sample sizes; typically 0.04–0.08 at horizon 1, rising to around 0.20 where content remains substantial at the maximum lag (all US series except real GDP growth, Canadian goods and services trade balance) or declining to around 0.01 or less where content is near zero (remaining quarterly series). Note that the bootstrap confidence bands are slightly asymmetrical around the estimate.

Table 1³
Forecast content horizons C_α , monthly data,
by analytical and best empirical methods

	analytical-AR			empirical		
	10%	5%	2%	10%	5%	2%
Data series						
Canada						
1 π_1	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
2 π_{12}	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
3 r_3	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
4 r_{12}	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
US						
1 π_1	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
2 π_{12}	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺	36 ⁺
3 rpdi	0	0	0	0	0	11
4 ip	1	1	1	0	1	1
5 r_3	9	13	17	4	28	30
6 r_{12}	36 ⁺	36 ⁺	36 ⁺	21	25	27

The figures indicate a number of general points, as well as results specific to the series of interest. In particular, we note that:

- . The best empirical method differs across time series. Where diffusion and AR methods are similar in performance, the equally-weighted combination tends to produce improvements.
- . The analytical results, representing potentially achievable results from pure persistence forecasts on the given sample size, tend to lie above the best empirical outcome, although this is not invariably the case. Note that the empirical

³Variables are presented in the same order as in the figures below. Variable definitions are: π_{12} , 12-month inflation; r_3 , three-month ex post real interest rate; r_{12} , twelve-month ex post real interest rate; rpdi, percentage change in real personal disposable income; ip, percentage change in the industrial production index.

results use a sequence of results on sample sizes smaller than the full sample, whereas the theoretical AR results take into account parameter uncertainty at the level pertaining to the full sample of data. This feature alone would tend to produce higher content in the theoretical AR results.

- . The results on δ -level content tend not to differ radically across empirical methods.
- . Data series such as growth in industrial production and growth in real GDP are difficult to forecast beyond the shortest horizon.
- . Inflation and real interest rate series are relatively persistent and have correspondingly high content horizons. Note that we treat the raw series as approximately stationary; studies in which these series are treated as I(1), so that differences are required for approximate stationarity, would show very short content horizons on the *differenced* series. Monthly inflation is much less persistent than the annual (12-month difference) inflation, and forecast content is correspondingly lower at all horizons. The maximum horizon at which measurable content remains is, however, also at least 36 months for the monthly inflation series.
- . Moderately high content horizons also tend to be observed in the trade balance and government surplus/ deficit (relative to GDP) measures.

Table 2⁴
Forecast content horizons C_α , quarterly data,
by analytical and best empirical methods

	analytical-AR			empirical		
	10%	5%	2%	10%	5%	2%
Data series						
Canada						
1 rgdp	1	1	1	1	1	2
2 ca	6	9	12	14	14	16 ⁺
3 gs	16 ⁺	16 ⁺	16 ⁺	15	16 ⁺	16 ⁺
4 rpdi	0	3	3	11	16 ⁺	16 ⁺
5 s/d	6	8	11	5	7	16 ⁺
US						
1 rgdp	1	1	1	0	1	2
2 gs	16 ⁺	16 ⁺	16 ⁺	15	16 ⁺	16 ⁺
3 ca	16 ⁺	16 ⁺	16 ⁺	16 ⁺	16 ⁺	16 ⁺
4 s/d	16 ⁺	16 ⁺	16 ⁺	16 ⁺	16 ⁺	16 ⁺

High forecast content and long content horizons tend to arise in persistent series, that is, series for which deviations from the mean are long-lasting. The apparent persistence of these deviations may however be exaggerated by a changing mean. This is related to the well-known phenomenon by which structural change may lead to apparent long memory (slow hyperbolic decay in the autocorrelation function) of a time series; see for example Teverosky and Taqqu (1997), Granger and Hyung (2004). To the extent that important structural changes are present in the time series examined here, then, the content horizons computed will tend to be generous. This problem may be particularly likely to have afflicted our inflation

⁴Variables are presented in the same order as in the figures below. Variable definitions are: rgdp, percentage change in real gross domestic product; ca, current account balance as a proportion of GDP; gs, goods and services trade balance as a proportion of GDP; rpdi, percentage change in real personal disposable income; s/d, surplus or deficit as a proportion of GDP.

results; if inflation has in fact shifted to a different mean over the sample period, then these horizons may exaggerate the true content horizons. Again, however, we note that in spite of this potential phenomenon, it is interesting that a number of the estimated horizons, particularly for income or output growth measures, appear to be quite short. These short horizons are of particular interest to us in the next section, where we compare with the horizons used in actual forecasting studies.

4. Maximum horizons in published studies

Having some knowledge of the maximum horizon at which forecasts have positive skill or content, it is interesting to consider the maximum horizons which are actually used in forecasting studies. To this end we have sampled a number of recent published studies indexed in popular electronic databases of articles. The set of variables that we consider in this section overlaps imperfectly with the set examined in Section 3; there are few published studies of the current account balance, goods and services trade balance and government surplus or deficit, and these are omitted from Table 3 below. We do include the exchange rate here, however; the change in an exchange rate (appropriately transformed), being an asset return, typically has a forecast content horizon close to zero (literally zero under the strong form of efficient markets hypothesis), but is nonetheless a popular variable of interest for forecasters, and a number of results are therefore included in the table.⁵

Table 3a/b records this small survey of the horizons at which these popular quantities of interest have been forecast, taken from approximately eighty published studies; the particular studies used in constructing the table are recorded in Appendix 2. We report first the maxima of the sets of horizons used in published studies, then in Table 3, the median of the longest horizons considered in each study. For example, if we were to observe five studies of a particular variable, which use the horizons (in months) (1,2,4), (1,2,4,8), (4,8,16,24), (1,2,6,12, 24,48) and (18,36), then Table 3a would record the maximum horizon (48 months), and Table 3b the median of the studies' maxima, 24 months (the individual maxima being 4,8,24,48,36).

An interesting feature does emerge from comparison of Table 3a with Tables 1 and 2: for a number of variables, the maximum horizon reported in published literature substantially exceeds the estimated content horizon. The exceptions lie in variables such as real interest rates, for which the content horizon is quite long. In general, there appears to be substantially more variability in actual content horizons across variables than there is in the maximum horizons reported. Table 3b suggests that for the variables with shorter content horizons (particularly GDP, industrial

⁵The conditional variance of exchange rates has a substantial content horizon, as Galbraith and Kışınbay (2005) note, but we do not consider second-moment forecasts in the present study.

production), even the median study typically examines a horizon that exceeds the content horizon. Again, the variability across variables forecast does not match well the variability in content horizons. Of course, the Table 3 values come from a set of available studies which provides only a few sample points for each cell of the Tables, and so should be taken as indicative rather than conclusive.

The former feature (that reported horizons often exceed the content horizon) is not in itself evidence of error in the particular studies; economic agents may need forecasts at very long horizons, regardless of content relative to the unconditional mean. It does suggest, however, that forecasts are being produced at horizons which are sufficiently long that only the unconditional mean (or the partial sum of unconditional mean growth rates, for example) serves as a reliable guide to the outcome. That is, some published forecasts are given at horizons for which the content, or forecast skill, is approximately zero. Of course, it is in principle possible that some studies use methods which we have not investigated and which allow for a substantially longer forecast content horizon than we have been able to establish. Again, the present study seeks only to begin to establish such benchmarks, and makes no claim that they are authoritative. Nonetheless, the qualitative similarity of the results above for different methods suggests that these horizons will not easily be exceeded by large margins by substituting some alternative statistical technique.

Table 3a
Maximum reported forecast horizons,
published studies recorded in Appendix 2⁶

Data series	Country or region		
	US	Euro	Other
Inflation	40Q	100M	92M
GDP	40Q	16Q	8Q
Exchange rate (v. US)	N/A	60M	60M
Ind. prod.	36M	12Q	12Q
Int. rate	40Q	–	40Q

⁶Horizons are given in quarters (Q) or months (M). Note that we do not specify the precise transformation used in the studies, which varies, implying that these values require interpretation. ‘Euro’ refers to studies of one or more countries within the Euro area; for exchange rates, these studies pre-date introduction of the single European currency. ‘N/A’, not applicable; ‘–’, no relevant studies identified.

Table 3b
 Median of longest reported forecast horizons in each study,
 published studies recorded in Appendix 2⁷

Data series	Country or region		
	US	Euro	Other
Inflation	24M	16Q	12Q
GDP	8Q	6Q	4Q
Exchange rate (v. US)	N/A	12M	12M
Ind. prod.	36M	12M	6Q
Int. rate	15Q	–	4Q

Although users of forecasts may well be interested in the values of macroeconomic quantities at points beyond the content horizon, nonetheless the optimal forecast of an approximately-stationary quantity at such a point is the unconditional mean, since conditioning information has by definition no value beyond the content horizon.⁸ As in meteorological forecasting, standard reporting procedures that reflect accumulating knowledge of these maximum horizons might well enhance transparency of the forecasting process.

5. Concluding remarks

Estimates of the content or skill of forecasts, and of the horizon at which these become approximately zero, are specific to particular forecasting methods, although this horizon may turn out to be similar for different methods. It is of course always possible that another method or further data may provide better results than existing techniques; the present study offers some estimates of these maximum horizons, but for this reason no such study can indicate the maximum that is achievable. These results should be seen instead as estimates of this content horizon for some standard, generally-successful methods, which provide reasonable

⁷The footnote to Table 3A also applies here.

⁸To return to the meteorological analogy, a weather forecaster asked for the temperature on a date one year from the present would normally give the historical mean temperature for that date, as being the best forecast that can be made; models run out of explanatory power for daily variation long before this time, so climatology (the set of unconditional properties) is the only source of information.

benchmarks for future studies in which forecasters attempt to extend the horizons, or examine new methods in comparison with the properties of existing techniques.

Although these results cannot be conclusive, they may also be of some value in guiding forecast reporting at longer horizons. Forecasts at horizons beyond the content horizon provide no information relative to unconditional properties of the series (that is, have no content or skill); while we cannot locate this horizon exactly, we can certainly find horizons beyond which content is very low. Reporting practices for forecasts beyond these horizons, if they are to be made, might well involve an acknowledgment of the limitations of information content of the forecasts and a reference to the unconditional properties of the series.

For a number of important macro-economic variables, the content horizon is quite substantial; in other cases, it is low. The differences across series in this horizon are large, whereas the differences in reported maximum horizons are less substantial. This information may be useful in guiding the horizons chosen not only for forecast research studies, but in routine forecast reporting to economic agents acting on forecasts.

Figure 1a
Forecast content functions, Canadian monthly data:
1-month inflation

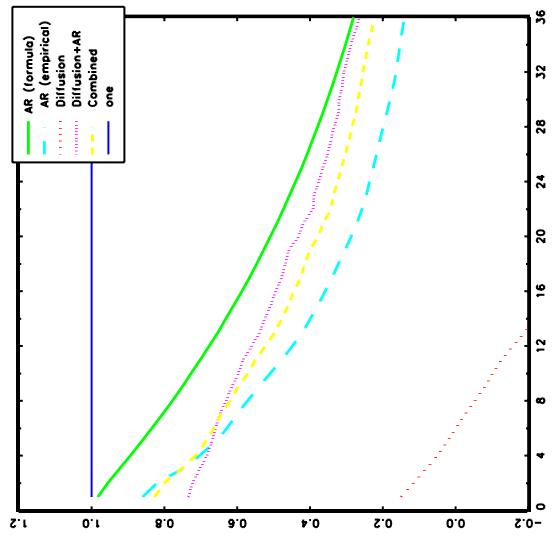


Figure 1b
Forecast content functions, Canadian monthly data:
12-month inflation

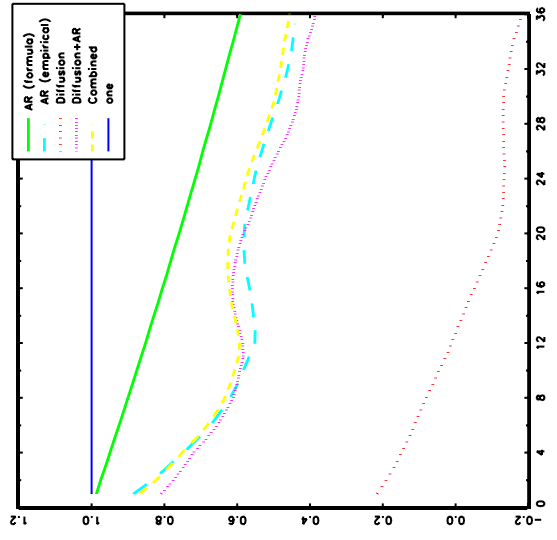


Figure 1c
Forecast content functions, Canadian monthly data:
3-month ex post real interest rate

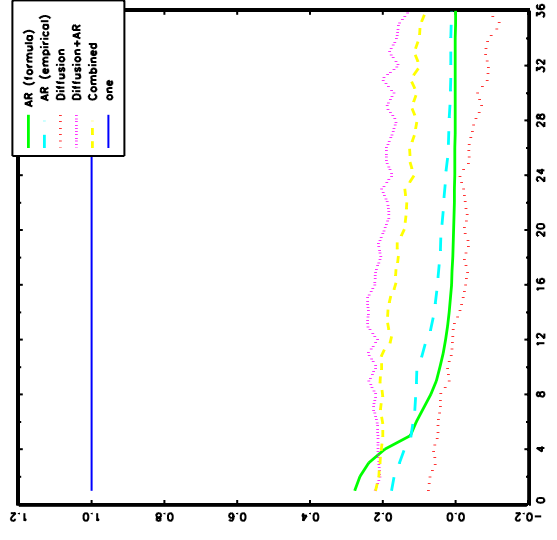


Figure 1d
Forecast content functions, Canadian monthly data:
12-month ex post real interest rate

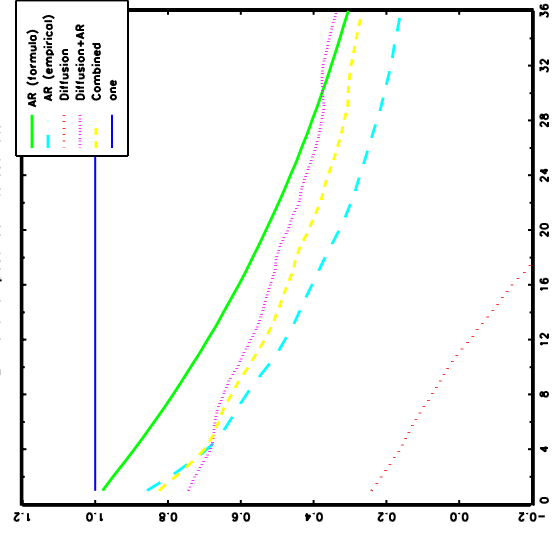


Figure 1e

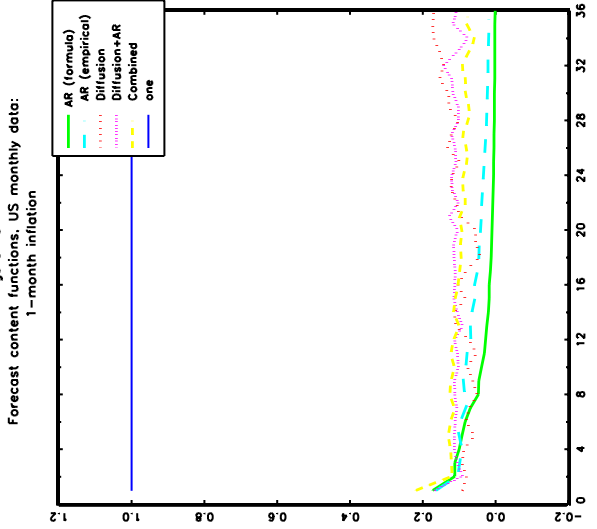


Figure 1f

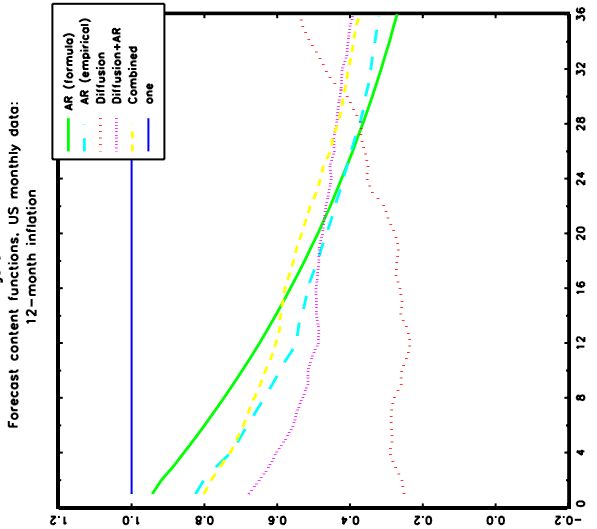


Figure 1g

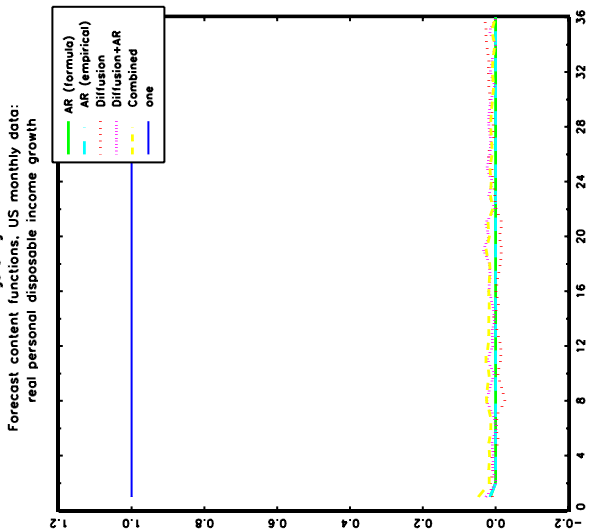


Figure 1h

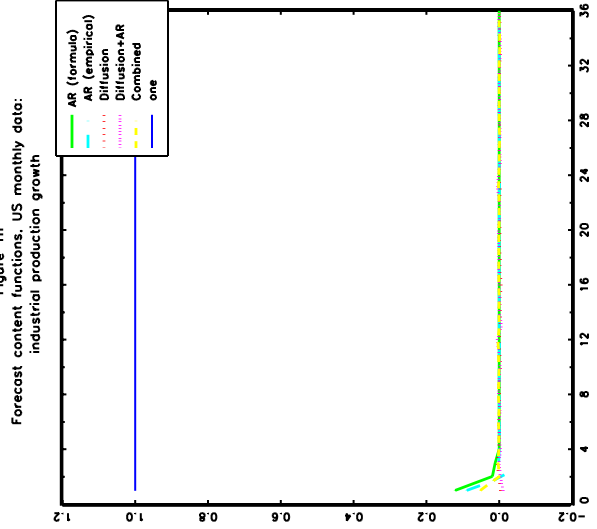


Figure 1i

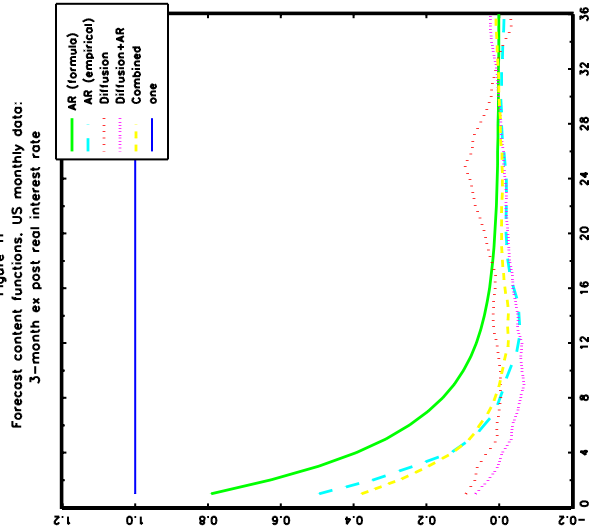


Figure 1j

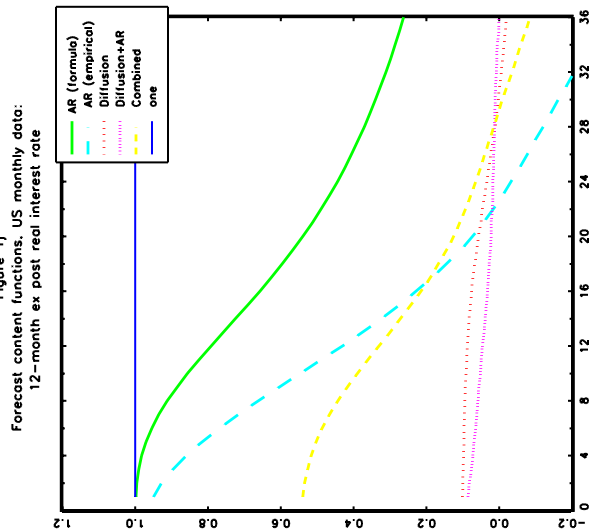


Figure 2a
Forecast content functions, Canadian quarterly data:
real GDP growth

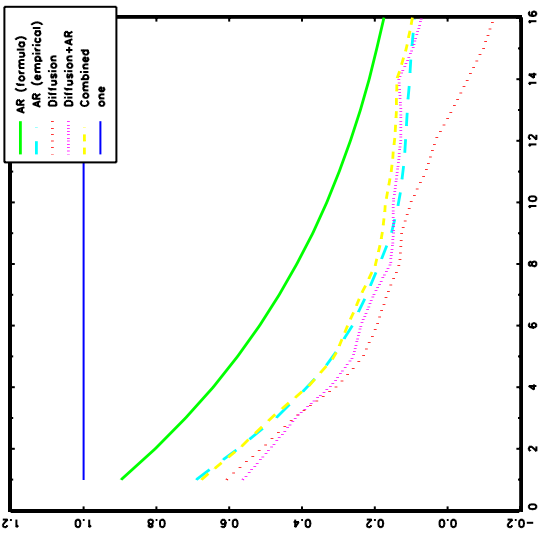


Figure 2b
Forecast content functions, Canadian quarterly data:
current account balance as proportion of GDP

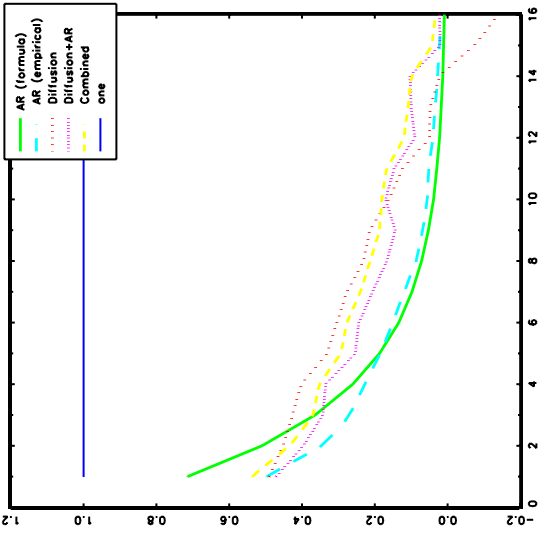


Figure 2c
Forecast content functions, Canadian quarterly data:
goods and services balance as proportion of GDP

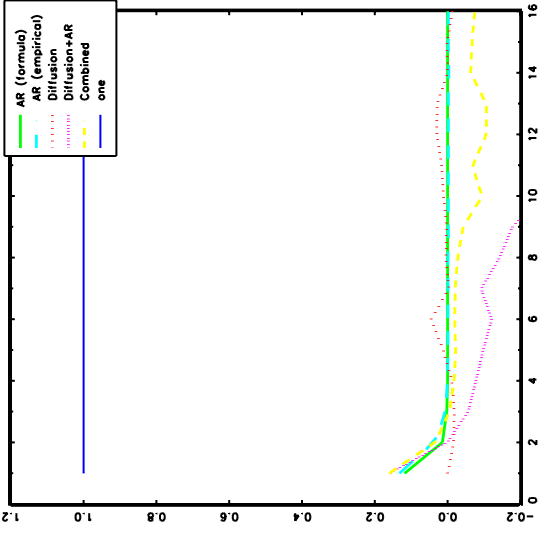


Figure 2d
Forecast content functions, Canadian quarterly data:
real personal disposable income

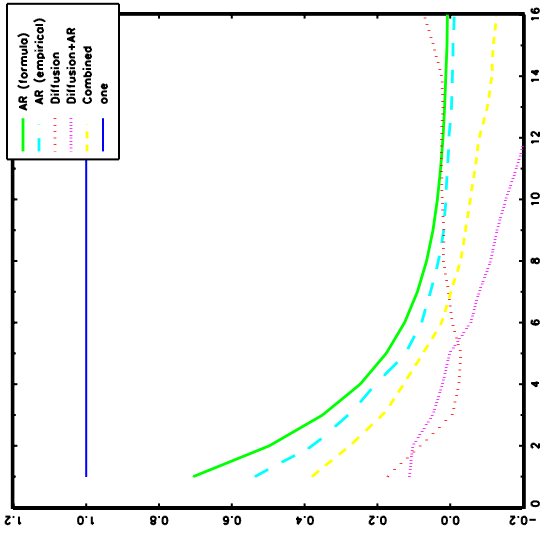


Figure 2e
Forecast content functions, Canadian quarterly data:
government surplus or deficit as proportion of GDP

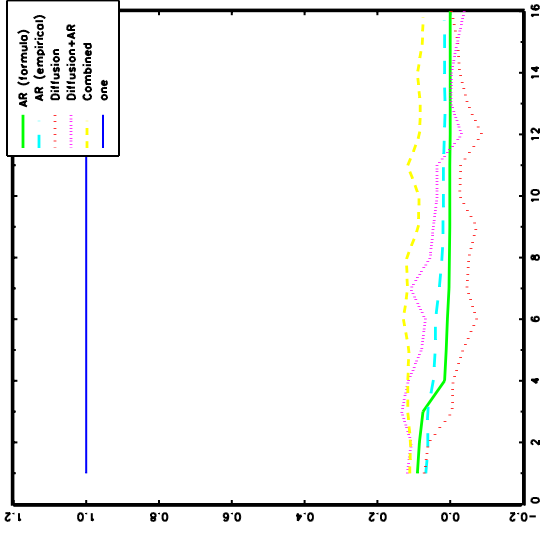


Figure 2h
Forecast content functions, US quarterly data:
current account balance as proportion of GDP

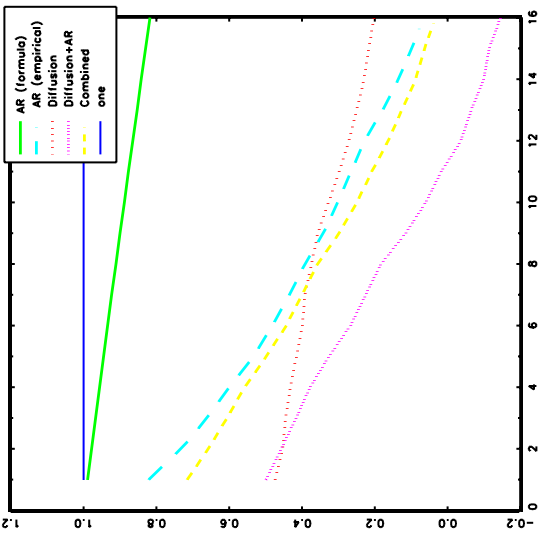


Figure 2g
Forecast content functions, US quarterly data:
goods and services balance as proportion of GDP

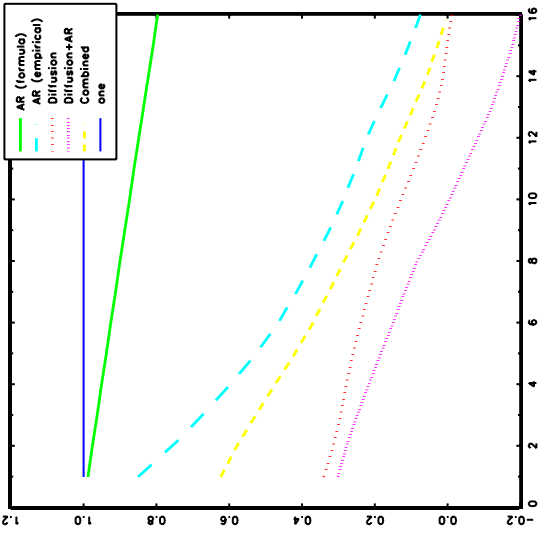


Figure 2f
Forecast content functions, US quarterly data:
real GDP growth

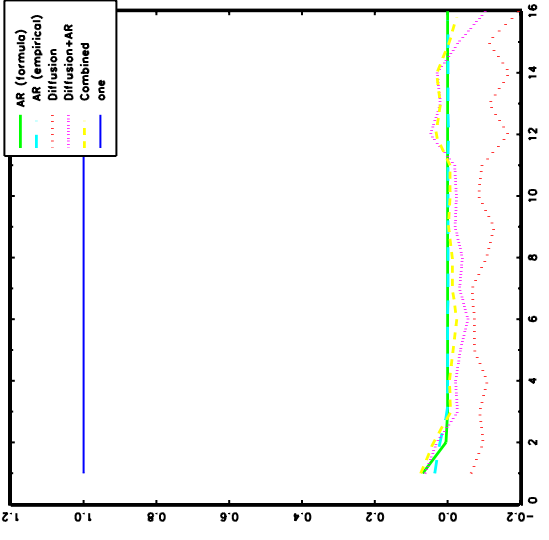
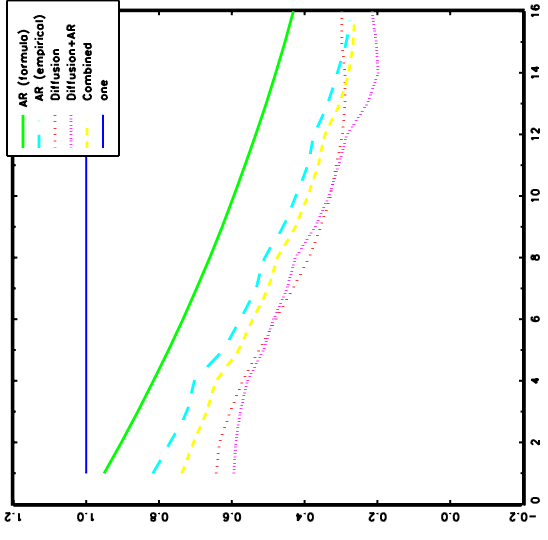


Figure 2i
Forecast content functions, US quarterly data:
government surplus or deficit as proportion of GDP



Data Appendix

NATIONAL ACCOUNTS (QUARTERLY)

1. GROSS DOMESTIC PRODUCT AT MARKET PRICES - VALUE (MIL\$,SA)
2. GROSS DOMESTIC PRODUCT AT MARKET PRICES - IMPLICIT PRICE INDEXES (97=100,SA)
3. GROSS NATIONAL PRODUCT AT MARKET PRICES - VALUE (MIL\$,SA)
4. GROSS NATIONAL PRODUCT AT MARKET PRICES - VOLUME (97=100,SA)
5. PERSONAL EXPENDITURE ON GOODS AND SERVICES (MIL\$,SA)
 6. DURABLE GOODS (MIL\$,SA)
 7. SEMI-DURABLE GOODS (MIL\$,SA)
 8. NON-DURABLE GOODS (MIL\$,SA)
 9. SERVICES (MIL\$,SA)
10. GOVERNMENT EXPENDITURE (MIL\$,SA)
11. RESIDENTIAL STRUCTURES (MIL\$,SA)
12. BUSINESS FIXED INVESTMENT (MIL\$,SA)
 13. NON-RESIDENTIAL STRUCTURES (MIL\$,SA)
 14. MACHINERY & EQUIPMENT (MIL\$,SA)
15. FINAL DOMESTIC DEMAND (MIL\$,SA)
 16. NET EXPORTS (MIL\$,SA)
 17. FINAL SALES (MIL\$,SA)
18. BUSINESS INVESTMENT IN INVENTORIES: NON-FARM (MIL\$,SA)
19. BUSINESS INVESTMENT IN INVENTORIES: FARM (MIL\$,SA)
20. DOMESTIC DEMAND (MIL\$,SA)
 21. EXPORTS OF GOODS & SERVICES (MIL\$,SA)
22. TOTAL DEMAND (MIL\$,SA)
23. DEDUCT: IMPORTS OF GOODS & SERVICES (MIL\$,SA)
24. LABOUR INCOME (MIL\$,SA)
25. CORPORATION PROFITS BEFORE TAXES (MIL\$,SA)
26. INVENTORY VALUATION ADJUSTMENT (MIL\$,SA)
27. NET INC OF NON-FARM UNINC BUSINESS, INCLUDING RENT (MIL\$,SA)
28. ACCRUED NET INC OF FARM OPERATORS FROM PRODUCTION (MIL\$,SA)
29. OTHER NET INCOME (MIL\$,SA)
30. TAXES LESS SUBSIDIES: ON FACTORS OF PRODUCTION (MIL\$,SA)
31. TAXES LESS SUBSIDIES: ON PRODUCTS (MIL\$,SA)
32. CAPITAL CONSUMPTION ALLOWANCES (MIL\$,SA)
33. NET LENDING (GOVERNMENT BALANCE) (MIL\$,SA)
 34. FEDERAL (MIL\$,SA)
 35. PROV. & MUNICIPALITIES (MIL\$,SA)
 36. C.P.P. & Q.P.P. (MIL\$,SA)
37. INCOME (PERSONAL) (MIL\$,SA)
38. CURRENT TRANSFERS TO GOVERNMENT (MIL\$,SA)
39. DISPOSABLE INCOME (MIL\$,SA)
40. WAGES, SALARIES AND SUPPLEMENTARY LABOUR INCOME (THOU\$,SA)

BUSINESS INVESTMENT (MONTHLY)

1. BUILDING PERMITS (INDUSTRIAL & COMMERCIAL) (MIL\$,SA)
2. COMMERCIAL VEHICLE SALES (THOU\$,SA)

HOUSING MARKET (QUARTERLY)

1. DWELLING STARTS - URBAN AREAS - TOTAL S.A.A.R. UNITS
2. DWELLING STARTS - URBAN AREAS - SINGLES S.A.A.R. UNITS
3. DWELLING STARTS - URBAN AREAS - MULTIPLES S.A.A.R. UNITS
4. DWELLING STARTS - URBAN AREAS - ATLANTIC PROVINCES S.A.A.R. UNITS
5. DWELLING STARTS - URBAN AREAS - QUEBEC S.A.A.R. UNITS
6. DWELLING STARTS - URBAN AREAS - ONTARIO S.A.A.R. UNITS
7. DWELLING STARTS - URBAN AREAS - PRAIRIE PROVINCES S.A.A.R. UNIT
8. DWELLINGS STARTS - URBAN AREAS - BRITISH COLUMBIA S.A.A.R. UNITS

BUILDING PERMITS AND NEWLY COMPLETED BUT UNOCCUPIED DWELLINGS (MONTHLY)

1. BUILDING PERMITS TOTAL UNITS ALL AREAS (SAAR)

2. BUILDING PERMITS SINGLE UNITS ALL AREAS (SAAR)
3. BUILDING PERMITS MULTIPLE UNITS ALL AREAS (SAAR)
4. HOUSES AND DUPLEXES - DWELLINGS COMP. BUT UNOC UNITS (SA)
5. ROW AND APARTMENTS - UNOC. DWELLINGS - TOTAL METROPOLITAN AREAS UNITS (SA)
6. ROW AND APARTMENTS - UNOC. DWELLINGS - MONTREAL DWELLING UNITS (SA)
7. ROW AND APARTMENTS - UNOC. DWELLINGS - TORONTO DWELLING UNITS (SA)
8. ROW AND APARTMENTS - UNOC. DWELLINGS - VANCOUVER DWELLING UNITS (SA)

BALANCE OF PAYMENTS (QUARTERLY)

1. TOTAL CURRENT ACCOUNT BALANCE (MIL\$,SA)
2. TOTAL CURRENT ACCOUNT BALANCE (AS % OF GDP)
3. GOODS AND SERVICES BALANCE (MIL\$,SA)
 4. GOODS BALANCE (MIL\$,SA)
 5. SERVICES BALANCE (MIL\$,SA)
6. INVESTMENT INCOME BALANCE (MIL\$,SA)
 7. DIRECT INVESTMENT INCOME BALANCE (MIL\$,SA)
 8. PORTFOLIO INVESTMENT INCOME BALANCE (MIL\$,SA)
 9. OTHER INVESTMENT INCOME BALANCE (MIL\$,SA)
10. TRANSFERS BALANCE (MIL\$,SA)
11. TOTAL CURRENT ACCOUNT RECEIPTS (MIL\$,SA)
 12. GOODS AND SERVICES RECEIPTS (MIL\$,SA)
 13. GOODS RECEIPTS (MIL\$,SA)
 14. SERVICES RECEIPTS (MIL\$,SA)
15. INVESTMENT INCOME RECEIPTS (MIL\$,SA)
 16. DIRECT INVESTMENT INCOME RECEIPTS (MIL\$,SA)
 17. PORTFOLIO INVESTMENT INCOME RECEIPTS (MIL\$,SA)
 18. OTHER INVESTMENT INCOME RECEIPTS (MIL\$,SA)
19. TRANSFERS RECEIPTS (MIL\$,SA)
20. TOTAL CURRENT ACCOUNT PAYMENTS (MIL\$,SA)
21. GOODS AND SERVICES PAYMENTS (MIL\$,SA)
 22. GOODS PAYMENTS (MIL\$,SA)
 23. SERVICES PAYMENTS (MIL\$,SA)
24. INVESTMENT INCOME PAYMENTS (MIL\$,SA)
 25. DIRECT INVESTMENT INCOME PAYMENTS (MIL\$,SA)
 26. PORTFOLIO INVESTMENT INCOME PAYMENTS (MIL\$,SA)
 27. OTHER INVESTMENT INCOME PAYMENTS (MIL\$,SA)
28. TRANSFERS PAYMENTS (MIL\$,SA)
29. CAPITAL ACCOUNT, NET FLOW (MIL\$,SA)
30. FINANCIAL ACCOUNT, NET FLOW (MIL\$,SA)
31. CANADIAN ASSETS, NET FLOW (MIL\$,SA)
32. CANADIAN DIRECT INVESTMENT ABROAD (MIL\$,SA)
33. CANADIAN PORTFOLIO INVESTMENT (MIL\$,SA)
 34. FOREIGN PORTFOLIO BONDS (MIL\$,SA)
 35. FOREIGN PORTFOLIO STOCKS (MIL\$,SA)
36. OTHER CANADIAN INVESTMENT (MIL\$,SA)
 37. LOANS (MIL\$,SA)
 38. DEPOSITS (MIL\$,SA)
 39. OFFICIAL INTERNATIONAL RESERVES (MIL\$,SA)
40. CANADIAN LIABILITIES, NET FLOW (MIL\$,SA)
41. FOREIGN DIRECT INVESTMENT IN CANADA (MIL\$,SA)
42. FOREIGN PORTFOLIO INVESTMENT (MIL\$,SA)
 43. CANADIAN PORTFOLIO BONDS (MIL\$,SA)
 44. CANADIAN PORTFOLIO STOCKS (MIL\$,SA)
 45. CANADIAN MONEY MARKET (MIL\$,SA)
46. OTHER FOREIGN INVESTMENT (MIL\$,SA)
 47. DEPOSITS (MIL\$,SA)
 48. OTHER LIABILITIES (MIL\$,SA)
49. TOTAL CAPITAL AND FINANCIAL ACCOUNTS, NET FLOW (MIL\$,SA)

PRICE INDEXES (MONTHLY)

1. C.P.I. TOTAL (92=100)
2. C.P.I. GOODS (92=100)
3. C.P.I. DURABLE GOODS (92=100)

4. C.P.I. AUTO AND TRUCK PURCHASES (92=100)
5. C.P.I. DURABLES EXCL. MOTOR VEHICLES (92=100)
6. C.P.I. SEMI-DURABLE GOODS (92=100)
7. C.P.I. NON-DURABLES (92=100)
8. C.P.I. NON-DURABLES EXCL. FOOD AND ENERGY (92=100)
9. C.P.I. GOODS AND SERVICES (92=100)
10. C.P.I. - FOOD (92=100)
 11. C.P.I. BAKERY & OTHER CEREAL PRODUCTS (92=100)
 12. C.P.I. DAIRY PRODUCTS (92=100)
13. C.P.I. ENERGY (92=100)
14. C.P.I. FUEL OIL AND OTHER FUEL (92=100)
15. C.P.I. NATURAL GAS (92=100)
16. C.P.I. ELECTRICITY (92=100)
17. C.P.I. GASOLINE (92=100)
18. C.P.I. ALL EXCL. FOOD (92=100)
19. C.P.I. ALL EXCL. FOOD AND ENERGY (92=100)
20. C.P.I. HOUSING (92=100)
21. C.P.I. GOODS EXCL. FOOD AND ENERGY (92=100)
22. C.P.I. GOODS EXCL. MOTOR VEHICLES (92=100)
23. C.P.I. SERVICES (92=100)
 24. C.P.I. SHELTER SERVICES (92=100)
 25. C.P.I. RENTALS (92=100)
26. INDUSTRY PRICE INDEX - ALL MANUFACTURING INDUSTRIES (97=100)
27. INDUSTRY PRICE INDEX - FOOD AND BEVERAGE MANUFACTURING (97=100)
28. INDUSTRY PRICE INDEX - TOTAL EXCL. FOOD & BEVERAGE MANUFACTURING (97=100)

GOVERNMENT REVENUE AND EXPENDITURE (QUARTERLY)

1. DIRECT TAXES - PERSONS (MIL\$,SA)
 2. FEDERAL (MIL\$,SA)
 3. PROVINCIAL (MIL\$,SA)
 4. C.P.P. & Q.P.P. (MIL\$,SA)
5. DIRECT TAXES - FROM CORPORATIONS & GOVT BUSINESS ENTERPRISES (MIL\$,SA)
 6. FEDERAL (MIL\$,SA)
 7. PROVINCIAL (MIL\$,SA)
8. INDIRECT TAXES (MIL\$,SA)
 9. FEDERAL (MIL\$,SA)
 10. PROVINCES & MUNICIPALITIES (MIL\$,SA)
11. OTHER REVENUES (MIL\$,SA)
 12. OTHER REVENUES - FEDERAL (MIL\$,SA)
 13. PROVINCES & MUNICIPALITIES (MIL\$,SA)
 14. C.P.P. & Q.P.P. (MIL\$,SA)
15. CURRENT TRANSFERS FROM GOVERNMENT (MIL\$,SA)
 16. FROM PROVINCIAL LEVEL (MIL\$,SA)
 17. FED. TO PROV. & MUNIC. (MIL\$,SA)
 18. PROV. TO MUNIC. (MIL\$,SA)
19. REVENUE BY LEVEL - FEDERAL (MIL\$,SA)
20. REVENUE BY LEVEL - PROVINCES & MUNICIPALITIES (MIL\$,SA)
21. REVENUE BY LEVEL - C.P.P. & Q.P.P. (MIL\$,SA)
22. GROSS CURRENT EXPENDITURE ON GOODS AND SERVICES (MIL\$,SA)
 23. FEDERAL - DEFENCE (MIL\$,SA)
 24. PROVINCES & MUNICIPALITIES (MIL\$,SA)
 25. C.P.P. & Q.P.P. (MIL\$,SA)
26. INTEREST ON THE PUBLIC DEBT (MIL\$,SA)
 27. INTEREST ON THE PUBLIC DEBT - FEDERAL (MIL\$,SA)
 28. PROVINCES & MUNICIPALITIES (MIL\$,SA)
29. OTHER EXPENDITURES (MIL\$,SA)
 30. OTHER EXPENDITURES - FEDERAL (MIL\$,SA)
 31. C.P.P. & Q.P.P. (MIL\$,SA)
 32. TOTAL (MIL\$,SA)
 33. TRANSFERS TO OTHER LEVELS (MIL\$,SA)
 34. TO GOVERNMENT (MIL\$,SA)
 35. TO LOCAL LEVEL (MIL\$,SA)
36. EXPENDITURE BY LEVEL - FEDERAL (MIL\$,SA)

37. C.P.P. & Q.P.P. (MIL\$,SA)
38. SURPLUS OR DEFICIT (NET LENDING) - WITHOUT Q.P.P. (MIL\$,SA)
39. FEDERAL (MIL\$,SA)
40. PROVINCES & MUNICIPALITIES (MIL\$,SA)
41. C.P.P. & Q.P.P. (MIL\$,SA)

MOTOR VEHICLE SALES (MONTHLY)

1. PASSENGER CAR SALES--NORTH AMERICAN MANUFACTURED (U,SA)
2. PASSENGER CAR SALES--OVERSEAS MANUFACTURED (U,SA)
3. TOTAL PASSENGER CAR SALES (U,SA)
4. TOTAL - NEW COMMERCIAL VEHICLE SALES (U,SA)
5. PASS. CARS - NORTH AMERICAN MFRD (U,SA)
6. PASSENGER OVERSEAS MANUFACTURED VEHICLE SALES (U,SA)
7. TOTAL COMMERCIAL VEHICLE SALES (U,SA)
8. TOTAL PASSENGER CAR SALES (U,SA)

INTEREST RATES (MONTHLY)

1. TREASURY BILL AUCTION - AVERAGE YIELDS: 3 MONTH (% PER ANN,NSA)
2. TREASURY BILL AUCTION - AVERAGE YIELDS: 6 MONTH (% PER ANN,NSA)
3. GOVERNMENT OF CANADA MARKETABLE BONDS, AVERAGE YIELD: 1-3 YEAR
4. GOVERNMENT OF CANADA MARKETABLE BONDS, AVERAGE YIELD: 3-5 YEAR (% PER ANN,NSA)
5. GOVERNMENT OF CANADA MARKETABLE BONDS, AVERAGE YIELD: 5-10 YEAR (% PER ANN,NSA)
6. GOVERNMENT OF CANADA MARKETABLE BONDS, AVERAGE YIELD: OVER 10 YEARS (% PER ANN,NSA)
7. PRIME CORPORATE PAPER RATE: 1 MONTH (% PER ANN,NSA)
8. PRIME CORPORATE PAPER RATE: 3 MONTH (% PER ANN,NSA)
9. BANKERS' ACCEPTANCES: 1 MONTH (% PER ANN,NSA)
10. CHARTERED BANK - 90 DAY DEPOSIT RECEIPTS (AVG. WK ENDING) (% PER ANN,NSA)
11. CHARTERED BANK (TYPICAL) - NON-CHEQUABLE SAVINGS DEPOSIT RATE (% PER ANN,NSA)
12. CHARTERED BANK ADMINISTERED INTEREST RATES: 5-YEAR PERSONAL FIXED TERM (% PER ANN,NSA)
13. CHARTERED BANK ADMINISTERED INTEREST RATES: PRIME BUSINESS (% PER ANN,NSA)
14. AVERAGE RESIDENTIAL MORTGAGE LENDING RATE - 5 YEAR (% PER ANN,NSA)
15. U.S. DOLLAR IN CANADA - 90 DAY DIFFERENTIAL (% PER ANN,NSA)

MONETARY AGGREGATES (MONTHLY)

1. CURR. OUTSIDE BKS (MIL\$,SA)
2. GROSS M1 - CURRENCY & GROSS DEMAND DEPOSITS, AOW (MIL\$,SA)
3. CDN. \$ DEPS.NON-PERS. NOTICE (MIL\$,NSA)
4. CDN. \$ DEPS.-PERS. NOTICE (MIL\$,NSA)
5. CDN. \$ DEPS.-PERS. SAV.-FIXED TERM (MIL\$,NSA)
6. M2-CURR. & ALL CHEQ. NOT. & PERS. TERM DEPS (MIL\$,SA)
7. GROSS M1,ALL NOTICE DEP. & CONTINUITY ADJUSTMENTS - M1++ (MIL\$,SA)
7. M2+,CSB'S & NON MONEY MARKET MUTUAL FUNDS - M2++ (MIL\$,SA)
9. TOTAL DEPOSITS AT TRUST AND MORTGAGE LOAN COMPANIES REPORTED BY CHARTERED BANKS (MIL\$,SA)
10. TOTAL DEPS. AT C.U. & C.P. (MIL\$,SA)

CREDIT AGGREGATES (MONTHLY)

1. HOUSEHOLD CREDIT (MIL\$,SA)
2. RESIDENTIAL MORTGAGE CREDIT (MIL\$,SA)
3. CONSUMER CREDIT (MIL\$,SA)
4. RES. MTG. CREDIT: O/S BAL. OF MAJOR PRIV. INSTT. LENDERS, TOTAL (MIL\$,SA)
5. TOTAL SHORT-TERM BUSINESS CREDIT (MIL\$,SA)
6. TOTAL BUSINESS CREDIT (MIL\$,SA)
7. TOTAL HOUSEHOLD & BUSINESS CREDIT (MIL\$,SA)

EXCHANGE RATES (BUSINESS)

1. U. S. DOLLAR (NOON) (CDN\$ PER US\$)
2. NOON 90 DAYS FORWARD CAN/US EXCHANGE RATE (CDN\$ PER US\$)

3. NOON CAN/JAPAN EXCHANGE RATE (CDN\$ PER YEN)
4. NOON CAN/SWITZERLAND EXCHANGE RATE (CDN\$ PER SWISS FRANC)
5. NOON CAN/UK EXCHANGE RATE (CDN\$ PER POUND)
6. CLOSING 90 DAYS FORWARD CAN/US EXCHANGE RATE (CDN\$ PER US\$)

STOCK MARKET (MONTHLY)

1. TORONTO & MONTREAL STOCK EXCHANGES-VALUE OF SHARES TRADED (MIL\$)
2. TORONTO & MONTREAL STOCK EXCHANGES-VOLUME OF SHARES TRADED (MIL\$)
3. TORONTO STOCK EXCHANGE - INDUSTRIALS, SHARES TRADED (MIL\$)
4. TORONTO STOCK EXCHANGE - INDUSTRIALS, VALUE OF SHARES TRADED (MIL\$)
5. TORONTO STOCK EXCHANGE - MINING AND OILS, SHARES TRADED (MIL\$)
6. TORONTO STOCK EXCHANGE - MINING AND OILS, VALUE OF SHARES TRADED (MIL\$)
7. TORONTO STOCK EXCHANGE - COMPOSITE (300)-CLOSE (75=1000)
8. TORONTO STOCK EXCHANGE - CLOSING QUOTATIONS AT MONTH-END - STOCK DIVIDEND YIELD (PERCENT)
9. TORONTO STOCK EXCHANGE - CLOSING QUOTATIONS AT MONTH END - PRICE EARNINGS RATIO (PERCENT)

U.S. DATA

NATIONAL ACCOUNTS

(QUARTERLY)

1. GROSS DOMESTIC PRODUCT (BIL\$,SA)
2. GROSS DOMESTIC PRODUCT: CHAIN-TYPE PRICE INDEX (2000=100,SA)
3. GROSS NATIONAL PRODUCT (BIL\$,SA)
4. GOVERNMENT CURR RECEIPTS & EXP - TOTAL EXPENDITURES (BIL\$,SA)
5. GOVERNMENT CURR RECEIPTS & EXP - INTEREST PAYMENTS (BIL\$,SA)
6. GOVERNMENT CONSUMPTION EXPENDITURES & GROSS INVESTMENT (BIL\$,SA)
 7. FEDERAL GOVT CONSUMPTION EXPENDITURES & GROSS INVESTMENT (BIL\$,SA)
 8. STATE & LOCAL CONSUMPTION EXPENDITURES & GROSS INVESTMENT (BIL\$,SA)
9. FEDERAL GOVERNMENT WAGE ACCURALS LESS DISBURSEMENTS (BIL\$,SA)
10. CORPORATE PROFITS BEFORE TAX EXCLUDING IVA (BIL\$,SA)
11. INVENTORY VALUATION ADJUSTMENT, CORPORATE (BIL\$,SA)
12. INDIRECT BUSINESS TAX & NONTAX LIABILITY (BIL\$,SA)

(MONTHLY)

13. NET RECEIPTS OF FEDERAL GOVERNMENT - TOTAL (BIL\$,NSA)
14. NET RECEIPTS OF FEDERAL GOVERNMENT - CUSTOMS (BIL\$,NSA)
15. PERSONAL CURRENT TAXES (BIL\$,SA)
16. CONTRIBUTIONS FOR GOVERNMENT SOCIAL INSURANCE (BIL\$,SA)
17. DISPOSABLE PERSONAL INCOME (BIL\$,SA)
18. DISPOSABLE PERSONAL INCOME PER CAPITA (BIL\$,SA)
19. DISPOSABLE PERSONAL INCOME, CHAINED (BIL 2000\$,SA)
20. PERSONAL DIVIDEND INCOME (BIL\$,SA)
21. PERSONAL INTEREST INCOME (BIL\$,SA)
22. COMPENSATIONS OF EMPLOYEES, RECEIVED (BIL\$,SA)
23. SUPPLEMENTS TO WAGES AND SALARIES (BIL\$,SA)
24. WAGE AND SALARY DISBURSEMENTS (BIL\$,SA)
25. PERSONAL CURRENT TRANSFER RECEIPTS (BIL\$,SA)

BALANCE OF PAYMENTS (QUARTERLY)

1. NET FOREIGN ASSETS IN US (BIL\$,SA)
2. FOREIGN ASSETS IN US, OFFICIAL - TOTAL (BIL\$,SA)
 3. US GOVERNMENT SECURITIES (BIL\$,SA)
 4. US TREASURY SECURITIES (BIL\$,SA)
 5. US LIABILITIES REPORTED BY BANKS (BIL\$,SA)
 6. OTHER NET FOREIGN ASSETS IN US (BIL\$,SA)
7. NET US ASSETS ABROAD (BIL\$,SA)
8. US ASSETS, OFFICIAL RESERVE (BIL\$,SA)
9. U.S. BALANCE ON CURRENT ACCOUNT (BIL\$,SA)
 10. U.S. BALANCE ON GOODS (BIL\$,SA)

11. U.S. BALANCE ON SERVICES (BIL\$,SA)
12. U.S. BALANCE ON INVESTMENT INCOME (BIL\$,SA)
13. U.S. BALANCE ON CURRENT ACCOUNT (% OF GDP)
14. NON-MERCHANDISE TRADE BALANCE (BIL\$,SA)
15. UNILATERAL TRANSFERS (EX MILITARY GRANTS), NET (BIL\$,SA)
 16. PRIVATE DEMITTANCES AND OTHER TRANSFERS
 17. US GOVERNMENT GRANTS
 18. GOVERNMENT PENSIONS AND OTHER TRANSFERS
19. EXPORTS OF GOODS & SERVICES (BIL\$,SAAR)
 20. EXPORTS - MERCHANDISE, ADJUSTED, EXCLUDING MILITARY (BIL\$,SA)
 21. EXPORTS - SERVICES (BIL\$,SA)
 22. EXPORTS - GOODS & SERVICES AND & INCOME RECEIPTS (BIL\$,SA)
 23. RECEIPTS OF INCOME & US ASSETS ABROAD (BIL\$,SA)
 24. INCOME FROM DIRECT INVESTMENT (BIL\$,SA)
25. IMPORTS OF GOODS & SERVICES (BIL\$,SAAR)
 26. IMPORTS - MERCHANDISE, ADJUSTED, EXCLUDING MILITARY (BIL\$,SA)

CONSUMPTION

(MONTHLY)

1. PERSONAL CONSUMPTION EXPENDITURES - TOTAL (BIL\$,SA)
 2. PERSONAL CONSUMPTION EXPENDITURES - DURABLE GOODS (BIL\$,SA)
 3. PERSONAL CONSUMPTION EXPENDITURES - NONDURABLE GOODS (BIL\$,SA)
 4. PERSONAL CONSUMPTION EXPENDITURES - SERVICES (BIL\$,SA)
- ##### (QUARTERLY)
5. CONSUMPTION OF FIXED CAPITAL (BIL\$,SA)
 6. CAPITAL CONSUMPTION AJUSTMENT (BIL\$,SA)

REAL OUTPUT

(MONTHLY)

1. INDUSTRIAL PROD INDEX - TOTAL INDEX (1997=100,NSA)
 2. INDUSTRIAL PROD INDEX - PRODUCTS, TOTAL (1997=100,NSA)
 3. INDUSTRIAL PROD INDEX - FINAL PRODUCTS TOTAL (1997=100,NSA)
 4. INDUSTRIAL PROD INDEX - CONSUMER GOODS (1997=100,NSA)
 5. INDUSTRIAL PROD INDEX - DURABLE CONSUMER GOODS (1997=100,NSA)
 6. INDUSTRIAL PROD INDEX - NONDURABLE CONSUMER GOODS (1997=100,NSA)
 7. INDUSTRIAL PROD INDEX - ENERGY, TOTAL (1997=100,NSA)
 8. INDUSTRIAL PROD INDEX - EQUIPMENT, TOTAL (1997=100,NSA)
 9. INDUSTRIAL PROD INDEX - MATERIALS (1997=100,NSA)
 10. INDUSTRIAL PROD INDEX - NONDURABLE GOODS MATERIALS (1997=100,NSA)
 11. INDUSTRIAL PROD INDEX - MANUFACTURING (1997=100,NSA)
 12. CAPACITY UTILIZATION - TOTAL (% OF CAPACITY,SA)
 13. CAPACITY UTILIZATION - MANUFACTURING (% OF CAPACITY,SA)
 14. CAPACITY UTILIZATION - MINING (% OF CAPACITY,SA)
 15. PURCHASING MANAGERS' INDEX (PERCENT,SA)
 16. PURCHASING MANAGERS' INDEX - EMPLOYMENT (PERCENT,SA)
 17. PURCHASING MANAGERS' INDEX - INVENTORIES (PERCENT,SA)
 18. PURCHASING MANAGERS' INDEX - NEW ORDERS (PERCENT,SA)
 19. PURCHASING MANAGERS' INDEX - PRODUCTION (PERCENT,SA)
 20. INDUSTRIAL CAPACITY - TOTAL (% OF 97 OUTPUT, SA)
 21. INDUSTRIAL CAPACITY - MANUFACTURING (% OF 97 OUTPUT, SA)
 22. INDUSTRIAL CAPACITY - MINING (% OF 97 OUTPUT,SA)
 23. MOTOR VEHICLE ASSEMBLIES - AUTO ASSEMBLIES (MIL U,SA)
- ##### (QUARTERLY)
24. OUTPUT INDEX - PRIVATE BUSINESS SECTOR (92=1.0,SA)
 25. OUTPUT INDEX - MANUFACTURING (92=1.0,SA)
 26. OUTPUT INDEX - NONFARM BUSINESS SECTOR (92=1.0,SA)

WHOLESALE, RETAIL & INVENTORIES (MONTHLY)

1. RETAIL UNIT SALES OF NEW PASSENGER CARS - TOTAL (MIL U,SA)
2. RETAIL UNIT SALES OF NEW PASSENGER CARS - DOMESTIC (MIL U,SA)

3. RETAIL UNIT SALES OF NEW PASSENGER CARS - IMPORTS (MIL U,SA)
4. RETAIL DOMESTIC UNIT SALES OF TRUCKS & BUSES - 0 THRU 10,000 LBS (THOUS U,SA)
5. AUTO SALES, BEA ESTIMATES OF UNIT DETAIL (THOUS U,SA)
6. FINAL SALES OF AUTOMOBILES - CONSUMER PERCENTAGE OF TOTAL (PERCENT,SA)
7. UNIT AUTO SALES - TOTAL (MIL U,SAAR)
8. UNIT TRUCK SALES - TOTAL (MIL U,SAAR)
9. SHIPMENTS - ALL MANUFACTURING INDUSTRIES (BIL\$,SA)
10. INVENTORIES - ALL MANUFACTURING INDUSTRIES (BIL\$,SA)
11. CHANGE IN BOOK VALUE, MANUFACTURING AND TRADE INVENTORIES (BIL\$,SA)
12. INVENTORY CHANGE - AUTOS (THOUS U,SA)
13. INVENTORY LEVEL - AUTOS (THOUS U,SA)
14. INVENTORY TO SALES RATIO - AUTOS (SAAR)

MONEY AND CREDIT QUANTITY AGGREGATES (MONTHLY)

1. MONEY SUPPLY - CURRENCY, DEMAND DEPOSITS, OTHER CHECKABLE DEP. (BIL\$,SA)
2. MONEY SUPPLY - MONDEY MARKET MUTUAL FUNDS (BIL\$,SA)
3. MONEY SUPPLY - M3 (BIL\$,SA)
4. MONETARY BASE, ADJ FOR RESERVE REQUIREMENT CHANGES (BIL\$,SA)
5. COMMERCIAL & INDUSTRIAL LOANS AT CB'S (BIL\$,SA)

HOUSING STARTS AND SALES

(MONTHLY)

1. HOUSING STARTS, PRIVATE INCLUDING FARM - TOTAL (MIL U,SA)
2. HOUSING PERMITS, PRIVATE (MIL U,SA)
3. HOUSING AUTHORIZED, 1 UNIT (MIL U,SA)
4. HOUSING AUTHORIZED, 2 TO 4 UNITS (MIL U,SA)
5. HOUSING AUTHORIZED, 5 OR MORE UNITS (MIL U,SA)
6. NEW ONE-FAMILY HOMES, MONTHS' SUPPLY AT CURRENT SALES RATE (PERCENT,SA)
7. NEW ONE-FAMILY HOMES FOR SALE AT END OF MONTH (MIL U,SA)
8. NEW ONE-FAMILY HOMES SOLD (MIL U,SA)
9. EXISTING SINGLE-FAMILY HOMES SOLD - TOTAL (MIL U,SA)
10. EXISTING SINGLE FAMILY HOMES SALES PRICES (MIL\$,NSA)
11. CONSTRUCTION CONTRACTS, FW DODGE - TOTAL (BIL\$,NSA)
12. CONSTRUCTION CONTRACTS, FW DODGE - RESIDENTIAL BUILDING (BIL\$,NSA)
13. CONSTRUCTION CONTRACTS, FW DODGE - NONRESIDENTIAL BUILDING (BIL\$,NSA)
14. CONSTRUCTION CONTRACTS, FW DODGE - PRIVATE OWNERSHIP (BIL\$,NSA)
15. CONSTRUCTION CONTRACTS, FW DODGE - PUBLIC OWNERSHIP (BIL\$,NSA)

(QUARTERLY)

16. VACANCY RATE, RENTAL HOUSING UNITS (PERCENT,NSA)
17. VACANCY RATE, HOMEOWNER HOUSING UNITS (PERCENT,NSA)

PRICE INDEXES (MONTHLY)

1. CPI (ALL URBAN) - ALL ITEMS (82-84=1.00,SA)
2. CPIU - FOOD & BEVERAGES (82-84=1.0,SA)
3. CPIU - ENERGY (82-84=1.0,SA)
4. CPIU - APPAREL & UPKEEP (82-84=1.0,SA)
5. CPIU - COMMODITIES (82-84=1.0,SA)
6. CPIU - DURABLES (82-84=1.0,SA)
7. CPIU - GAS & ELECTRICITY (82-84=1.0,SA)
8. CPIU - HOUSING (82-84=1.0,SA)
9. CPIU - MEDICAL CARE (82-84=1.0,SA)
10. CPIU - SERVICES (82-84=1.0,SA)
11. CPIU - TRANSPORTATION (82-84=1.0,SA)
12. CPIU - ALL ITEMS LESS FOOD (82-84=1.00,SA)
13. CPIU - ALL ITEMS LESS FOOD AND ENERGY (82-84=1.00,SA)
14. CPIU - ALL ITEMS LESS SHELTER (82-84=1.00,SA)
15. PERSONAL CONSUMPTION EXPENDITURES, PRICE INDEX (2000=100,SA)
 16. PCE, PRICE INDEX - GOODS (2000=100,SA)
 17. PCE, PRICE INDEX - DURABLE GOODS (2000=100,SA)
 18. PCE, PRICE INDEX - NONDURABLE GOODS (2000=100,SA)

19. PCE, PRICE INDEX - SERVICES (2000=100,SA)
20. PRODUCER PRICE INDEX - FINISHED GOODS (82=1.0,SA)
21. PRODUCER PRICE INDEX - FINISHED GOODS, EXCL. FOODS (82=1.0,SA)
22. PRODUCER PRICE INDEX - FINISHED CONSUMER GOODS (82=1.0,SA)
23. PRODUCER PRICE INDEX - CAPITAL EQUIPMENT (82=1.0,SA)
24. PRODUCER PRICE INDEX - INTERM MATERIALS, SUPPLIES AND COMPONENTS (82=1.0,SA)
25. PRODUCER PRICE INDEX - CRUDE MATERIALS (82=1.0,SA)
26. PRODUCER PRICE INDEX - CRUDE NONFOOD MATERIALS (82=1.0,SA)
27. INDEX OF SENSITIVE MATERIALS PRICES (BCI) (92=1.000,SA)
28. PURCHASING MANAGERS INDEX - PRICES (PERCENT,SA)

EMPLOYMENT AND HOURS

(MONTHLY)

1. INDEX OF HELP-WANTED ADVERTISING IN NEWSPAPERS (87=1.00,SA)
2. CIVILIAN LABOR FORCE - TOTAL (MIL,SA)
3. EMPLOYED - CIVILIAN TOTAL (MIL,SA)
4. UNEMPLOYMENT RATE - CIVILIAN (PERCENT,SA)
5. PARTICIPATION RATE - CIVILIAN LABOR FORCE, TOTAL (PERCENT,SA)
6. ALL EMPLOYEES: TOTAL NONFARM (THOUS,SA)
7. ALL EMPLOYEES: TOTAL PRIVATE (THOUS,SA)
8. AVERAGE WEEKLY HOURS, PRODUCTION WORKERS: TOTAL PRIVATE (HOURS,SA)
9. AVERAGE WEEKLY HOURS, PRODUCTION WORKERS: MANUFACTURING (HOURS,SA)
10. INDEX OF AGGREGATE WEEKLY HOURS: TOTAL PRIVATE (2002=100,SA)

(QUARTERLY)

11. OUTPUT PER WORKER (92=1.0 PER THOUS,SA)
12. OUTPUT PER HOUR OF ALL PERSONS - PRIVATE BUSINESS SECTOR (92=1.0,SA)
13. OUTPUT PER HOUR OF ALL PERSONS - MANUFACTURING (92=1.0,SA)
14. OUTPUT PER HOUR OF ALL PERSONS - NONFARM BUSINESS SECTOR (92=1.0,SA)
15. OUTPUT PER HOUR OF ALL PERSONS - NONFINANCIAL CORPORATIONS (92=1.0,SA)
16. COMPENSATION PER HOUR INDEX - NONFARM BUSINESS SECTOR (92=1.0,SA)
17. UNIT LABOR COSTS INDEX - NONFARM BUSINESS SECTOR (92=1.0,SA)
18. HOURS OF ALL PERSONS INDEX - MANUFACTURING (92=1.0,SA)
19. HOURS OF ALL PERSONS INDEX - PRIVATE BUSINESS SECTOR (92=1.0,SA)
20. HOURS OF ALL PERSONS INDEX - NONFARM BUSINESS SECTOR (92=1.0,SA)

AVERAGE HOURLY EARNINGS (MONTHLY)

1. AVG HR EARNINGS, PROD WORKERS: TOTAL PRIVATE (\$,SA)
2. AVG HR EARNINGS, PROD WORKERS: GOODS PRODUCING (\$,SA)
3. AVG HR EARNINGS, PROD WORKERS: CONSTRUCTION (\$,NSA)
4. AVG HR EARNINGS, PROD WORKERS: MANUFACTURING (\$,NSA)
5. AVG HR EARNINGS, PROD WORKERS: NATURAL RESOURCES AND MINING (\$,NSA)
6. AVG HR EARNINGS, PROD WORKERS: DURABLE GOODS (\$,NSA)
7. AVG HR EARNINGS, PROD WORKERS: NONDURABLE GOODS (\$,SA)
8. AVG HR EARNINGS, PROD WORKERS: PRIVATE SERVICE PROVIDING (\$,NSA)
9. AVG HR EARNINGS, PROD WORKERS: TRADE,TRANSPORTATION AND UTILITIES (\$,SA)
10. AVG HR EARNINGS, PROD WORKERS: FINANCIAL ACTIVITIES (\$,SA)

STOCK MARKET

(MONTHLY)

1. NYSE VALUE OF SHARES TRADED (MIL\$)
2. NYSE VOLUME OF SHARES TRADED (MIL\$)
3. NYSE CUSTOMERS' DEBIT BALANCES (MIL\$)
4. NYSE CUSTOMERS' FREE DEBT BALANCE (MIL\$)
5. S&P'S COMMON STOCK PRICE INDEX: COMPOSITE (41-43=10,NSA)

(QUARTERLY)

6. S&P'S PRICE-EARNINGS RATIO - INDUSTRIALS (NSA)
7. S&P'S PRICE-EARNINGS RATIO - COMPOSITE (NSA)
8. S&P'S PRICE-EARNINGS RATIO - UTILITIES (NSA)
9. S&P'S PRICE-EARNINGS RATIO - RAILROADS (NSA)

(WEEKLY)

10. S&P'S 500 COMPOSITE - PRICE-EARNINGS RATIO (NSA)

EXCHANGE RATES (MONTHLY)

1. EXCHANGE RATE IN NY: SWISS FRANC PER US \$
2. EXCHANGE RATE IN NY: CANADIAN \$ PER US \$
3. EXCHANGE RATE IN NY: JAPAN YEN PER US \$
4. EXCHANGE RATE IN NY: US CENTS PER BRITISH POUND

INTEREST RATES (MONTHLY)

1. PRIME RATE CHARGED BY BANKS (% PER ANNUM,NSA)
2. RATE ON 3-MONTH NEGOTIABLE CD'S, SECONDARY MARKET (% PER ANNUM,NSA)
3. EFFECTIVE RATE ON FEDERAL FUNDS (% PER ANNUM,NSA)
4. RATE ON US GOVERNMENT 3-MO T-BILLS, SECONDARY MARKET (% PER ANNUM,NSA)
5. MARKET YIELD ON US GOVERNMENT 6-MO BILLS (% PER ANNUM,NSA)
6. YIELD ON TREASURY SECURITIES AT CONST MATURITY OF 1 YEAR (% PER ANNUM,NSA)
7. YIELD ON TREASURY SECURITIES AT CONST MATURITY OF 3 YEARS (% PER ANNUM,NSA)
8. YIELD ON TREASURY SECURITIES AT CONST MATURITY OF 10 YEARS (% PER ANNUM,NSA)
9. YIELD ON MOODY'S AAA CORPORATE BONDS (% PER ANNUM)
10. YIELD ON MOODY'S BAA CORPORATE BONDS (% PER ANNUM)

MISCELLANEOUS (MONTHLY)

1. CONSUMER CONFIDENCE INDEX - PRESENT SITUATION (85=100,SA)
2. CONSUMER CONFIDENCE INDEX - EXPECTATIONS (85=100,SA)

Appendix 2: References for Table 3

- Anderson, R. G., D. L. Hoffman and R. H. Rasche (2002) A vector error-correction forecasting model of the US economy. *Journal of Macroeconomics* 24, 569-598.
- Bleaney, M. F. (1998) Exchange rate forecasts at long horizons: Are error-correction models superior? *Canadian Journal of Economics* 31, 852-864.
- Boero, G. and E. Marrocu (2004) The performance of SETAR Models: a regime conditional evaluation of point, interval and density forecasts. *International Journal of Forecasting* 20, 305-320.
- Boothe, P. and D. Glassman (1987) Comparing exchange rate forecasting models: accuracy versus profitability. *International Journal of Forecasting* 3, 65-79.
- Bos, C. S., Franses, P. H. and Ooms, M. (2002) Inflation, forecast intervals and long memory regression models. *International Journal of Forecasting* 18, 243-264.
- Byers, S. L. and K. B. Nowman (1998) Forecasting U.K. and U.S. interest rates using continuous time term structure models. *International Review of Financial Analysis* 7, 191-206.
- Camacho, M. (2004) Vector smooth transition regression models for US GDP and the composite index of leading indicators. *Journal of Forecasting* 23, 173-196.
- Canova, F. and M. Ciccarelli (2004) Forecasting and turning point predictions in a Bayesian panel VAR model. *Journal of Econometrics* 120, 327-359.
- Carruth, A. A., M. A. Hooker and A. J. Oswald (1998) Unemployment equilibria and input prices: theory and evidence from the United States. *Review of Economics and Statistics* 80, 621-628.
- Cheung, Y.-W. and M.D. Chinn (1997) Integration, cointegration and the forecast consistency of structural exchange rate models. NBER Working Paper 5943.
- Choi, J.-Y. and R. A. Ratti (2000) The predictive power of alternative indicators of monetary policy. *Journal of Macroeconomics* 22, 581-610
- Choi, W. G. (2002) The inverted Fisher hypothesis: inflation forecastability and asset substitution. IMF Staff Papers, 49.
- Chow, W. W. (2004) An outlier robust hierarchical Bayes model for forecasting: the case of Hong Kong. *Journal of Forecasting* 23, 99-114.
- Clarida, R. H., L. Sarno, M. P. Taylor and G. Valente (2001) The out-of-sample success of term structure models as exchange rate predictors: a step beyond. NBER Working Paper 8601.
- Clarida, R. H. and M. P. Taylor (1997) The term structure of forward exchange premiums and the forecastability of spot exchange rates: correcting the errors. *Review of Economics and Statistics* 79, 353-361.

- Clark, T.E. and M. W. McCracken (2001) Evaluating direct multi-step forecasts. Federal Reserve Bank of Kansas City Research Working Paper 01-14 (revised 2005).
- Clements, M. P. and D.F. Hendry (1995) Forecasting in cointegrated systems. *Journal of Applied Econometrics* 10, 127-146.
- Clements, M. P. and J. Smith (2001) Evaluating forecasts from SETAR models of exchange rates. *Journal of International Money and Finance* 20, 133-148
- Clements, M. P. and A. B. Galvão (2004) A comparison of tests of nonlinear cointegration with application to the predictability of US interest rates using the term structure. *International Journal of Forecasting* 20, 219-236.
- Croushore, D. and T. Stark (2001) A real-time data set for macroeconomists. *Journal of Econometrics* 105 111-130.
- Darné, O., V. Guiraud and M. Terraza (2004) Forecasts of the seasonal fractional integrated series. *Journal of Forecasting* 23, 1-17.
- Deaves, R. (1996) Forecasting Canadian Short-Term Interest Rates. *Canadian Journal of Economics* 29, 615-634.
- De Gooijer, J. G., B. K. Ray and H. Kräger (1998) Forecasting exchange rates using TSMARS. *Journal of International Money and Finance* 17, 513-534.
- DeJong, D. N., B. F. Ingram and C. H. Whiteman (2000) A Bayesian approach to dynamic macroeconomics. *Journal of Econometrics* 98, 203-223.
- Diebold, F. X. and C. Li (2003) Forecasting the term structure of government bond yields. NBER working paper 10048.
- Duy, T. A. and M. A. Thoma (1998) Modeling and forecasting cointegrated variables: Some practical experience. *Journal of Economics and Business* 50, 291-307.
- Eitrheim, O., T. A. Husebø and R. Nymoen (1999) Equilibrium-correction vs. differencing in macroeconomic forecasting. *Economic Modelling* 16, 515-544.
- Elliot, G. and A. Timmermann (2004) Optimal forecast combinations under general loss functions and forecast error distributions. *Journal of Econometrics* 122, 47-79.
- Engel, C. and J. D. Hamilton (1990) Long swings in the dollar: are they in the data and do markets know it? *American Economic Review* 80, 689-713.
- Evans, M. and P. Wachtel (1993) Inflation regimes and sources of inflation uncertainty. *Journal of Money, Credit and Banking* 25, 475-511.
- Fletcher, D. J. and O. D. Gulley (1996) Forecasting the real interest rate. *North American Journal of Economics and Finance* 7, 55-76.
- Forni, M., M. Hallin, M. Lippi and L. Reichlin (2003) Do financial variables help forecasting inflation and real activity in the euro area? *Journal of Monetary Economics* 50, 1243-1255.

- Franses, P. H. and M. Ooms (1997) A periodic long-memory model for quarterly UK inflation. *International Journal of Forecasting* 13, 117-126.
- Franses, P. H. and D. van Dijk (2005) The forecasting performance of various models for seasonality and nonlinearity for quarterly industrial production. *International Journal of Forecasting* 21, 87-102.
- Garcia-Ferrer, A. and P. Poncela (2002) Forecasting European GNP data through common factor models and other procedures. *Journal of Forecasting* 21, 225-244.
- Harvey, C. R. (1997) The relation between the term structure of interest rates and Canadian economic growth. *Canadian Journal of Economics* 30, 169-193.
- Hubrich, K. (2005) Forecasting euro area inflation: Does aggregating forecasts by HICP component improve forecast accuracy? *International Journal of Forecasting* 21, 119-136.
- Huh, C. (1996) Some evidence on the efficacy of the UK inflation targeting regime: an out-of-sample forecast approach. Board of Governors of the Federal Reserve System International Finance Discussion Papers 565.
- Hurvich, C. M. (2002) Multistep forecasting of long memory series using fractional exponential models. *International Journal of Forecasting* 18, 167-179.
- Jacobson, T. and S. Karlsson (2004) Finding good predictors for inflation: a Bayesian model averaging approach. *Journal of Forecasting* 23, 479-496.
- Joseph, N. L. (2001) Model specification and forecasting foreign exchange rates with Vector Autoregressions. *Journal of Forecasting* 20, 451-484.
- Kawasaki, Y. and P. H. Franses (2004) Do seasonal unit roots matter for forecasting monthly industrial production? *Journal of Forecasting* 23, 77-88.
- Kilian, L. and M. P. Taylor (2003) Why is it so difficult to beat the random walk forecast of exchange rates? *Journal of International Economics* 60, 85-107.
- Koop, G. and S. Potter (2003) Forecasting in large macroeconomic panels using Bayesian model averaging. Reserve Bank of New York Staff Reports, 163.
- Le Bihan, H. and F. Sédillot (2000) Do core inflation measures help forecast inflation? Out- of-sample evidence from French data. *Economics Letters* 69, 261-266.
- Lee, J. (1999) Alternative P^* models of inflation forecasts. *Economic Inquiry* 37, 312-325.
- Lindh, T. (2004) Medium-term forecasts of potential GDP and inflation using age structure information. *Journal of Forecasting* 23, 19-49.
- MacDonald, R. and I. W. Marsh (2004) Currency spillovers and tri-polarity: a simultaneous model of the US dollar, German mark and Japanese yen. *Journal of International Money and Finance* 23, 99-111.
- Man, K. S. (2003) Long memory time series and short term forecasts. *International Journal of Forecasting* 19, 477-491.

- Mark, N. C. (1995) Exchange rates and fundamentals: evidence on long-horizon predictability. *American Economic Review* 85, 201-218.
- Meade, N. (2002) A comparison of the accuracy of short term foreign exchange forecasting methods. *International Journal of Forecasting* 18, 67-83.
- Meade, N. and M. R. Maier (2003) Evidence of long memory in short-term interest rates. *Journal of Forecasting* 22, 553-568.
- McCrae, M., Y. Lin, D. Pavlik and C.M. Gulati (2002) Can cointegration-based forecasting outperform univariate models? An application to Asian exchange rates. *Journal of Forecasting* 21, 355-380.
- Moshiri, S. and L. Brown (2004) Unemployment variation over the business cycles: a comparison of forecasting models. *Journal of Forecasting* 23, 497-511.
- Najand, M. and C. Bond (2000) Structural models of exchange rate determination. *Journal of Multinational Financial Management* 10, 15-27.
- Peña, D. and P. Poncela (2004) Forecasting with nonstationary dynamic factor models. *Journal of Econometrics* 119, 291-321.
- Qi, M. and Y. Wu (2003) Nonlinear prediction of exchange rates with monetary fundamentals. *Journal of Empirical Finance* 10, 623-640.
- Rapach, D. E. and M. E. Wohar (2002) Testing the monetary model of exchange rate determination: new evidence from a century of data. *Journal of International Economics* 58, 359-385.
- Richards, G. R. (2004) A fractal forecasting model for financial time series. *Journal of Forecasting* 23, 587-602.
- Robertson, D. (1992) Term structure forecasts of inflation. *Economic Journal* 102, 1083-1093.
- Sarantis, N. (1999) Modeling non-linearities in real effective exchange rates. *Journal of International Money and Finance* 18, 27-45.
- Sarno, L. (2003) Nonlinear exchange rate models: a selective overview. IMF Working Paper No. 03/111.
- Sarno, L. and G. Valente (2004) Comparing the accuracy of density forecasts from competing models. *Journal of Forecasting* 23, 541-557.
- Sekine, T. Modeling and forecasting inflation in Japan. IMF Working Paper No. 01/82.
- Schunk, D. L. (2001) The relative forecasting performance of the Divisia and simple sum monetary aggregates. *Journal of Money, Credit and Banking* 33, 272-283.
- Siddique, A. and R. J. Sweeney (1998) Forecasting real exchange rates. *Journal of International Money and Finance* 17, 63-70.

- Stock, J. H. and M. W. Watson (1999) Forecasting inflation. *Journal of Monetary Economics* 44, 293-335.
- Stock, J. H. and M. W. Watson (2004) Combination forecasts of output growth in a seven-country data set. *Journal of Forecasting* 23, 405-430.
- Stockton, D. J. and J. E. Glassman (1987) An evaluation of the forecast performance of alternative models of inflation. *Review of Economics and Statistics* 69, 108-117.
- Tambakis, D. N. and A. Van Royen (2002) Conditional predictability of daily exchange rates. *Journal of Forecasting* 21, 301-315.
- Tsay, R. S. and C-S Wu (2003) Forecasting with leading indicators revisited. *Journal of Forecasting* 22, 603-617.
- Villani, M. (2001) Bayesian prediction with cointegrated vector autoregressions. *International Journal of Forecasting* 17, 585-605.
- Wen, Y. and B. Zeng (1999) A simple nonlinear filter for economic time series analysis. *Economics Letters* 64, 151-160.

References

- Brisson, M., B. Campbell and J.W. Galbraith (2003) Forecasting some Low- Predictability Time Series Using Diffusion Indices. *Journal of Forecasting* 22, 515-531.
- Diebold, F.X. and L. Kilian (2001) Measuring predictability: theory and macroeconomic applications. *Journal of Applied Econometrics* 16, 657-669.
- Galbraith, J.W. (2003) Content horizons for univariate time series forecasts. *International Journal of Forecasting* 19, 43-55.
- Galbraith, J.W. and T. Kışınbay (2005) Content horizons for conditional variance forecasts. *International Journal of Forecasting* 21, 249-260.
- Ghelli, A. (2004). Forecast verification: probabilistic aspects. From *Use and Interpretation of ECMWF products*, European Centre for Medium Range Weather Forecasting, Meteorological Training Course Lecture Programme.
- Granger, C.W.J. (1996) Can we improve the perceived quality of economic forecasts? *Journal of Applied Econometrics* 11, 455-473.
- Granger, C.W.J. and N. Hyung (2004) Occasional structural breaks and long memory with an application to the S&P 500 absolute stock returns. *Journal of Empirical Finance* 11, 399-421.
- Li, F. and G. Tkacz (2004) Combining forecasts with nonparametric kernel regressions. *Studies in Nonlinear Dynamics and Econometrics* 8, article 2.
- Murphy, A.H. and R.L. Winkler (1987) A general framework for forecast verification. *Monthly Weather Review* 115, 1330-1338.
- Öller, L.-E. (1985). How far can changes in business activity be forecast? *International Journal of Forecasting* 1, 135-141.
- Stock, J.H. and M.W. Watson (1999a) A comparison of linear and nonlinear univariate models for forecasting macroeconomic time series. In Engle, R.F. and H. White eds., *Cointegration, Causality and Forecasting*. Oxford University Press, Oxford, New York.
- Stock, J.H. and M.W. Watson (1999b) Forecasting inflation. *Journal of Monetary Economics* 44, 293-335.
- Stock, J.H. and M.W. Watson (2002a) Macroeconomic forecasting using diffusion indexes. *Journal of Business and Economic Statistics* 20, 147-162.
- Stock, J.H. and M.W. Watson (2002b) Forecasting using principal components from a large number of predictors. *Journal of the American Statistical Association* 97, 1167-1179.
- Stock, J.H. and M.W. Watson (2004) Combination forecasts of output growth in a seven-country data set. *Journal of Forecasting* 23,405-430.
- Teversky, V. and M. Taqqu (1997) Testing for long range dependence in the presence of shifting means or a slowly-declining trend, using a variance-type estimator. *Journal of Time Series Analysis* 18, 279-304.

Tkacz, G. (2001) Estimating the fractional order of integration of interest rates using a wavelet OLS estimator. *Studies in Nonlinear Dynamics and Econometrics* 5, 19-32.