Internet Appendix for

"Macroeconomic News in Asset Pricing and Reality"

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This appendix reports details, additional empirical analysis, and derivations for "Macroeconomic News in Asset Pricing and Reality." Section I describes the construction of some of the data. It also reports additional information about Greenbook forecasts. Section II presents results of regressions that show robustness of the conclusions in the main text. It also discusses how to interpret some of the regressions. Sections III and IV derive results necessary for solving the dynamic model in the main text. Section III calculates the covariance matrix of the state vector and Section IV calculates the covariance matrix of the observables. Section V derives formulas for inferring unobserved Brownians from the observables. Finally, Section VI presents additional empirical estimates of the dynamic model.

I. Construction and Properties of the Data

This section describes how the ex ante real yield is constructed. It also reports evidence of the (un)forecastability of Greenbook forecast revisions. Finally, it describes the construction of forecast revisions from the Survey of Professional Forecasters.

A. Calculation of the Ex Ante One-Year Real Yield

The one-year ex ante real yield is the nominal one-year yield less a measure of expected inflation. I use Greenbook forecasts of inflation for the GDP deflator.

I need some auxiliary assumptions to back out an ex ante real yield. The correct measure of expected inflation is the expectation of the log change in the price level from the date of the Greenbook forecast to the same date next year. However, Greenbook forecasts of expected inflation are forecasts of the percentage change in average price level in quarter $j-1$ to the average price level in quarter j. To infer point-to-point expected inflation I assume that Greenbook forecasts are for price levels from one quarter's midpoint to the next quarter's midpoint. I also assume that expected inflation over each midpoint-to-midpoint is constant. In other words, for Greenbook forecast i, expected inflation for any arbitrary day in the future is a step function in time, where steps occur at quarter midpoints.

Following the definition of real output growth forecasts in the main text, denote the log of forecasted inflation at Greenbook forecast i for horizon j as

$$\pi_i^{(j)} \equiv 100 \log E_i^G \left(\left(\frac{DEFLATOR_{q_i+j}}{DEFLATOR_{q_j+j-1}} \right)^4 \right).$$

For Greenbook forecast i, define the fraction of the quarter remaining as f_i. For example, a Greenbook forecast made in the first week of a quarter has a fraction f_i close to one, while a Greenbook forecast made in the last week of a quarter has a fraction f_i close to zero. Then expected one-year inflation at i is measured by

$$EXP\_INFL_i = \begin{cases} \frac{1}{4}((f_i - 0.5)\pi_i^{(0)} + \sum_{j=1}^{3} \pi_i^{(j)} + (1.5 - f_i)\pi_i^{(4)}), & f_i > 0.5; \\ \frac{1}{4}((f_i + 0.5)\pi_i^{(1)} + \sum_{j=2}^{4} \pi_i^{(j)} + (0.5 - f_i)\pi_i^{(5)}), & f_i \leq 0.5. \end{cases}$$

There are a few observations for which $f_i < 0.5$ and the five-quarter-ahead forecast is missing. In these cases the five-quarter-ahead expectation is proxied by the four-quarter-ahead expectation. The first Greenbook forecasts in 1976 and 1977 are missing four-quarter-ahead inflation expectations. For these two observations, expected one-year inflation is set to missing.

B. Properties of Greenbook Forecast Revisions

The main text examines forecast accuracy by projecting future realizations of output growth on lagged forecasts. Here I examine properties of forecast revisions. Forecast revisions should be unforecastable with lagged forecast revisions. I test this restriction by regressing forecast revisions of Greenbook i on forecast revisions of the previous Greenbook. I summarize the term structure of lagged forecast revisions with the nowcast and the three-quarter-ahead revision. (I use the three-quarter horizon rather than the four-quarter horizon because the latter is missing 17 observations.) The regression is

$$\epsilon_i^{(j)} = b_0 + b_1 \epsilon_{i-1}^{(0)} + b_2 \epsilon_{i-1}^{(3)} + e_i^{(j)}, \qquad j = 0, \ldots, 4.$$

Results are in Table IAI. Of the five reported regressions, two have point estimates for the lagged nowcast revision are statistically different from zero at the 5% level. None of the point estimates on the lagged three-quarter-ahead revision are statistically significant. The R^2s are no greater than 4%.

C. Survey of Professional Forecasters Data

The Survey of Professional Forecasters (SPF) data are available from the Philadelphia Federal Reserve website. I use their Excel file `SPFmicrodata.xlsx`. Respondents to the SPF in the middle of quarter t predict levels of nominal GDP and the GDP price index for quarters $t+i$, $i = -1, \ldots, 4$. I define a forecaster's prediction of real GDP for quarter $t+i$ as the ratio of her prediction of nominal GDP to her prediction of the price level.

I transform these forecaster-specific forecasts of real GDP and the price level into logs, then calculate "consensus" forecasts of log real GDP and log price level. These consensus forecasts are mean forecasts excluding any individual forecasts that are more than two standard deviations from the full-sample mean. Denote these consensus forecasts for horizon j as of quarter t by

$$\begin{aligned}(\log RGDP)_{t,j} &\equiv \text{consensus forecast of } j \text{ ahead log real GDP;} \\ (\log P)_{t,j} &\equiv \text{consensus forecast of } j \text{ ahead log price index.}\end{aligned}$$

Consensus forecasts of j-ahead growth rates as of quarter t are defined as

$$g_{t,j} \equiv 100 \left(\log RGDP\right)_{t,j} - 100 \left(\log RGDP\right)_{t,j-1}.$$

Note that the forecast of the lagged growth rate ($j = -1$) requires quarter-t forecasts of log real GDP and the log price level for quarter $t-2$. The SPF does not ask forecasters to predict two-quarter-earlier values, since NIPA has already released its estimates for that quarter. I therefore use the reported NIPA values from the Philadelphia Federal Reserve's real-time NIPA dataset. Consensus forecast output growth revisions are

$$\epsilon_t^{(j)} \equiv g_{t,j} - g_{t-1,j+1}.$$

The SPF forecast innovations are available each quarter from 1969Q1 through 2019Q4. (I exclude the pandemic.) Table IAII reports mean outer products of these forecast innovations. The sample is split at the same point used in the main text, year-end 1996. As with Greenbook data, the longer-horizon forecast revisions in the early sample negatively covary with revisions in lagged output growth and the nowcast revisions. All covariances are positive in the later sample.

To match the timing of SPF data, I construct mid-quarter observations of excess stock returns and changes in bond yields. Mid-quarter to mid-quarter stock returns are constructed with the CRSP daily value-weighted index. I then subtract the contemporaneous return to a one-quarter Treasury bill to produce excess stock returns. Nominal bond yields are from Gurkaynak, Sack and Wright (2007). For SPF data I use the seven-year zero-coupon bond yield instead of the ten-year coupon yield. Some observations of yields with maturities greater than seven years are missing for the SPF sample, which goes back further in time than the Greenbook sample.

Mid-quarter ex ante real one-year yields are defined as mid-quarter nominal one-year yields less expected annual inflation. Mid-quarter expected annual inflation for quarter t is the consensus forecast of the log price level at quarter $t+4$ divided by the consensus forecast of the log price level at quarter t. There are five observations in the database missing a consensus forecast of the four-quarter-ahead price level. These missing observations are replaced with the consensus forecast of the three-quarter-ahead log price level plus the consensus forecast of the change in the log price level from $t+2$ to $t+3$. In other words, for these missing five observations, I assume a constant expected inflation rate from quarter $t+2$ to quarter $t+4$.

II. Additional Discussion About Regressions

A. Time Averaging Effects on Regression Coefficients

Table III in the main text reports regressions of j-quarter-ahead real output growth on contemporaneous changes in bond yields. The discussion here explains why time-averaging converts a purely contemporaneous relation into a predictive relation of yields changes for one-quarter-ahead output growth and a smaller relation between yield changes and one lagged quarter output growth.

Consider a martingale increase in instantaneous output at some random time between two Greenbook forecast dates $i-1$ and i. The latter forecast is in quarter q_i. For about half of the observations, the earlier forecast date $i-1$ is in the same quarter. In this case, the martingale increase in instantaneous output will not affect average output in quarter q_{i-1}. It will raise average output in quarter q_i, and raise average output in quarter q_{i+1} by more than it raises average output in quarter q_i. Therefore contemporaneous output growth (i.e., growth from quarter q_{i-1} to q_i) and one-quarter-ahead output growth (i.e., output growth from quarter q_i to quarter q_{i+1}) will both increase.

For the other half of the observations, the first of the two Greenbook forecast dates $i-1$ will be in the previous quarter (i.e., $q_{i-1} \neq q_i$). For these observations the random time of the martingale increase might be during q_{i-i}. If so, it will raise average output in quarter q_{i-1} and raise average output in quarter q_i by more than it raises average output in quarter t. Therefore lagged output growth (e.g., growth from quarter q_{i-2} to q_{i-1}) and contemporaneous output growth (from quarter q_i to quarter q_{i+1}) will both increase.

B. Alternative Regression Specifications

The main text describes regressions of excess stock returns and changes in bond yields on output forecast revisions. For example, for the one-year nominal yield, the regression is

$$\Delta n_{1y,i} = b_0 + b_1 \epsilon_i^{(0)} + b_2 \epsilon_i^{(3)} + e_{1yr,i}.$$

To maximize the number of observations, I use the three-quarter-ahead forecast revisions on the right side rather than the four-quarter-ahead revisions. Table IV in the main text contains the results. Table IAIII reports results of regressions that replace $\epsilon_t^{(3)}$ in these regressions with $\epsilon_t^{(4)}$. Other than fewer observations, there are no material differences with the results in Table IV.

Table IAIV reports regression estimates using SPF forecast revisions (and the associated excess stock returns and changes in bond yields). The sample is longer than the sample for Table IV in the main text but has fewer observations. The only material differences are associated with standard errors for the stock return regressions. They are much larger with SPF data. For example, looking only at the subsample results, in Table IAIV we cannot reject statistically the hypothesis of no relation between stock returns and three-quarter-ahead forecast innovations. Only the full-sample results are statistically significant at the 5% level.

Finally, I replace innovations of Greenbook output growth forecasts with innovations of Greenbook forecasts of growth in real personal consumption expenditures. Construction of these forecast innovations follows exactly the construction of output growth forecast innovations. These data are available beginning in the middle of 1978. Results are in Table IAV. The only material differences between these results and those in the main text's Table IV are with stock return regressions. Stock returns are less closely associated with consumption growth forecast innovations than with output growth forecast innovations.

C. Results for Treasury Inflation-Protected Securities

Daily ten-year yields on Treasury Inflation-Protected Securities (TIPS) are from Gurkaynak, Sack, and Wright (2010). I construct changes in the ten-year TIPS yield following the construction of ten-year nominal Treasury yields. The first Greenbook date for which a TIPS yield is observed is January 28 1999. The first Greenbook date for which a change is observed is March 24 1999.

I exclude the two Greenbook observations in the fourth quarter of 2008. Campbell, Shiller, and Viceira (2009) document that the failure of Lehman Brothers in September 2008 created substantial distortions in the TIPS market. Kashyap, Berner, and Goodhart (2011) explain why fire sales of TIPS collateral associated with the failure drove TIPS prices down. Wright (2009) shows that quoted Treasury and TIPS bond prices in the aftermath of the failure implied arbitrage opportunities. Distortions in the TIPS market persisted throughout 2008, thus the probability distribution from which the 2008Q4 observations are drawn differs substantially from the distribution from which the other observations are drawn.

Table IAVI is the TIPS version of Table III in the main text. It reports projections of Greenbook forecast revisions on changes in ten-year bond yields. For comparison, the table reports results for both the ten-year TIPS yield and the ten-year nominal Treasury yield. As with Panel C in Table III (the late sample, 1996 through 2015), the estimated coefficients for the nowcast revision are positive and statistically significant, while the coefficients for horizons equal to and greater than two are statistically indistinguishable from zero.

Table IAVII is the TIPS version of Table IV in the text. It reports projections of changes in ten-year yields on the nowcast revision and the three-quarter-ahead revision. As with Panel C in Table IV (the late sample, 1996 through 2015), the estimated coefficients for the nowcast revision are positive and statistically significant at the 1% level, while the estimated coefficients on the three-quarter-ahead revision are negative and statistically indistinguishable from zero.

III. The Covariance Matrix of the State Vector

This section describes how to calculate the covariance matrix of the state vector for the model in Section III of the main text. It first derives the covariance matrix of the macroeconomic state vector. It then augments this covariance matrix to include stock returns and changes in bond yields.

A. Covariance of the Macroeconomic State Vector

Stack instantaneous log output, the instantaneous drift, and cumulative log output in the macroeconomic vector

$$X_{m,t} \equiv \begin{pmatrix} y_t & x_t & Y_t \end{pmatrix}'. \tag{IA1}$$

The state vector's dynamics are in the Ornstein-Uhlenbeck class,

$$dX_{m,t} = K_m X_{m,t} dt + \Omega_m dB_{m,t}, \tag{IA2}$$

$$K_m = \begin{pmatrix} 0 & 1 & 0 \\ 0 & -\rho & 0 \\ 1 & 0 & 0 \end{pmatrix}, \qquad \Omega_m = \begin{pmatrix} \sigma_y & 0 \\ 0 & \sigma_x \\ 0 & 0 \end{pmatrix}. \tag{IA3}$$

The covariance matrix of the state at a future date conditioned on the current state is

$$\mathrm{Cov}\left(X_{m,t+s} | X_{m,t}\right) = \int_0^s e^{K_m u} \Omega_m Z \Omega_m' e^{K_m u'} du, \tag{IA4}$$

$$Z = \begin{pmatrix} 1 & \sigma_{xy} \\ \sigma_{xy} & 1 \end{pmatrix}.$$

Because of the homoskedastic setting, this conditional covariance depends on the time interval but not on the state. To solve (IA4), write the matrix K_m in Jordan normal form,

$$K_m = V_m J_m V_m^{-1},$$

$$V_m = \begin{pmatrix} 0 & \rho^{-1} & -\rho^{-1} \\ 0 & 0 & 1 \\ \rho^{-1} & -\rho^{-2} & \rho^{-2} \end{pmatrix}, \qquad J_m = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & -\rho \end{pmatrix}.$$

The conditional covariance (IA4) is therefore

$$C_{Xm}(s) \equiv \mathrm{Cov}\left(X_{m,t+s} | X_{m,t}\right) = V_m \left(\int_0^s e^{J_m u} \mathcal{M}_m e^{J_m u'} du \right) V_m', \tag{IA5}$$

defining

$$\mathcal{M}_m \equiv V_m^{-1} \Omega_m Z \Omega_m' V_m^{-1\prime}.$$

The subscript on the covariance matrix indicates that it is the covariance matrix for the macroeconomic state vector.

Recognize that

$$e^{J_m u} = \begin{pmatrix} 1 & u & 0 \\ 0 & 1 & 0 \\ 0 & 0 & e^{-\rho u} \end{pmatrix} \tag{IA6}$$

and plug it into (IA5). Then multiply together the terms to be integrated,

$$e^{J_m u}\mathcal{M}_m e^{J_m u'} =$$
$$\begin{pmatrix} \mathcal{M}_{m(1,1)} + 2u\mathcal{M}_{m(2,1)} + u^2\mathcal{M}_{m(2,2)} & \mathcal{M}_{m(1,2)} + u\mathcal{M}_{m(2,2)} & e^{-\rho u}\mathcal{M}_{m(1,3)} + ue^{-\rho u}\mathcal{M}_{m(2,3)} \\ \mathcal{M}_{m(2,1)} + u\mathcal{M}_{m(2,2)} & \mathcal{M}_{m(2,2)} & e^{-\rho u}\mathcal{M}_{m(2,3)} \\ e^{-\rho u}\mathcal{M}_{m(3,1)} + ue^{-\rho u}\mathcal{M}_{m(3,2)} & e^{-\rho u}\mathcal{M}_{m(3,2)} & e^{-2\rho u}\mathcal{M}_{m(3,3)} \end{pmatrix}.$$

Denote closed form solutions for some integrals with

$$\begin{aligned} A_1(s) \equiv \int_0^s e^{-\rho u} du =& \rho^{-1}\left(1 - e^{-\rho s}\right), \\ A_2(s) \equiv \int_0^s e^{-2\rho u} du =& (1/2)\rho^{-1}\left(1 - e^{-2\rho s}\right), \\ A_3(s) \equiv \int_0^s ue^{-\rho u} du =& \rho^{-1}\left(\rho^{-1} - e^{-\rho s}(s + \rho^{-1})\right). \end{aligned}$$

For convenience, I include another closed-form integral in this list, although it is not used yet. The integral of the matrix (IA6) is

$$A_4(s) \equiv \int_0^s e^{J_m u} du = \begin{pmatrix} s & \frac{s^2}{2} & 0 \\ 0 & s & 0 \\ 0 & 0 & A_1(s) \end{pmatrix}.$$

Using this notation, and given the matrix $\mathcal{M}_m$, the integral in (IA5) is

$$\int_0^s e^{J_m u}\mathcal{M}_m e^{J_m u'} du =$$
$$\begin{pmatrix} \mathcal{M}_{m(1,1)}s + \mathcal{M}_{m(2,1)}s^2 + \frac{1}{3}\mathcal{M}_{m(2,2)}s^3 & \mathcal{M}_{m(1,2)}s + \frac{1}{2}\mathcal{M}_{m(2,2)}s^2 & \mathcal{M}_{m(1,3)}A_1(s) + \mathcal{M}_{m(2,3)}A_3(s) \\ \mathcal{M}_{m(2,1)}s + \frac{1}{2}\mathcal{M}_{m(2,2)}s^2 & \mathcal{M}_{m(2,2)}s & \mathcal{M}_{m(2,3)}A_1(s) \\ \mathcal{M}_{m(3,1)}A_1(s) + \mathcal{M}_{m(3,2)}A_3(s) & \mathcal{M}_{m(3,2)}A_1(s) & \mathcal{M}_{m(3,3)}A_2(s) \end{pmatrix}. \tag{IA7}$$

Plug (IA7) into (IA5) to solve for the conditional covariance of the macroeconomic state vector.

B. Covariance Matrix of the Entire State Vector

Now add asset information. Recall the macroeconomic vector (IA1) is not observed until $t + L$. Define an augmented state vector observed at $t + L$ as

$$X_t = \begin{pmatrix} X'_{m,t} & s_{t+L} & r_{1yr,t+L} & n_{1yr,t+L} & n_{10yr,t+L} \end{pmatrix}'. \tag{IA8}$$

There are four additional elements in this augmented state vector. For the purposes of a future derivation, set the number of additional elements to

$$n \equiv \text{number of non-output elements in the state vector.} \tag{IA9}$$

Using (IA2) and (IA3), the dynamics of the augmented state vector are also Ornstein-Uhlenbeck,

$$dX_t = KX_t dt + \Omega dB_{m,t} + \Sigma dB_{nm,t+L}, \tag{IA10}$$

$$K \equiv \begin{pmatrix} K_m & 0_{3\times n} \\ 0_{n\times 3} & 0_{n\times n} \end{pmatrix}, \qquad \Omega = \begin{pmatrix} \Omega_m \\ \Omega_a \end{pmatrix}, \qquad \Sigma = \begin{pmatrix} 0_{3\times n} \\ \Sigma_a \end{pmatrix}. \tag{IA11}$$

The conditional covariance of this expanded state vector is

$$\text{Cov}\left(X_{t+L+s}|X_{t+L}\right) = \int_0^s e^{Ku}\Omega Z\Omega' e^{Ku'}du + s\Sigma\Sigma'.$$

Again, use the Jordan normal form,

$$K = VJV^{-1},$$

$$V = \begin{pmatrix} V_m & 0_{3\times n} \\ 0_{n\times 3} & I_{n\times n} \end{pmatrix}, \qquad J = \begin{pmatrix} J_m & 0_{3\times n} \\ 0_{n\times 3} & 0_{n\times n} \end{pmatrix}.$$

The matrix exponential of Ju is

$$e^{Ju} = \begin{pmatrix} e^{J_m u} & 0_{3\times n} \\ 0_{n\times 3} & I_{n\times n} \end{pmatrix}.$$

The conditional covariance is

$$C_X(s) \equiv \text{Cov}\left(X_{t+L+s}|X_{t+L}\right) = V\left(\int_0^s e^{Ju}\mathcal{M}e^{Ju'}du\right)V' + s\Sigma\Sigma', \tag{IA12}$$

where

$$\mathcal{M} \equiv V^{-1}\Omega Z\Omega' V^{-1\prime}.$$

The subscript on the covariance matrix indicates that it is the covariance matrix for the entire state vector.

Straightforward matrix multiplication produces additional ingredients.

$$V^{-1} = \begin{pmatrix} V_m^{-1} & 0_{3\times n} \\ 0_{n\times 3} & I_{n\times n} \end{pmatrix}, \qquad \mathcal{M} = \begin{pmatrix} \mathcal{M}_m & V_m^{-1}\Omega_m Z\Omega_a' \\ \Omega_a Z\Omega_m' \left(V_m^{-1}\right)' & \Omega_a Z\Omega_a' \end{pmatrix}.$$

The term to be integrated is

$$e^{Ju}\mathcal{M}e^{Ju} = \begin{pmatrix} e^{J_m u}\mathcal{M}_m e^{J_m u'} & e^{J_m u}V_m^{-1}\Omega_m Z\Omega_a' \\ \Omega_a Z\Omega_m' \left(V_m^{-1}\right)' e^{J_m u'} & \Omega_a Z\Omega_a' \end{pmatrix}.$$

Integrating,

$$\int_0^s e^{Ju}\mathcal{M}e^{Ju}du = \begin{pmatrix} \int_0^s e^{J_m u}\mathcal{M}_m e^{J_m u'}du & A_4(s)V_m^{-1}\Omega_m Z\Omega_a' \\ \Omega_a Z\Omega_m' \left(V_m^{-1}\right)' A_4(s)' & \Omega_a Z\Omega_a' s \end{pmatrix}.$$

Plugging into (IA12),

$$C_X(s) = \begin{pmatrix} C_{Xm}(s) & V_m A_4(s) V_m^{-1} \Omega_m Z \Omega_a' \\ \Omega_a Z \Omega_m' \left(V_m^{-1}\right)' A_4(s)' V_m' & \Omega_a Z \Omega_a' s \end{pmatrix} + s\Sigma\Sigma'. \tag{IA13}$$

Equation (IA13) is the covariance matrix of innovations in the state vector over a length of time s.

IV. The Covariance Matrix of Observables

This section determines the loadings of the observables—forecast innovations, stock returns, and changes in bond yields—on the state-vector innovations. Then the section calculates the covariance matrix of the observables using the covariance matrix of the state vector calculated in this document's Section III.

A. Quarterly Output as a Function of the State: Intuition

Recall that Y_t denotes cumulative log output, where time is measured in quarters. Quarter-end times are integers. To simplify notation, I refer to the index number of a quarter and the ending time of a quarter using the same variable τ. Quarter τ (an index, $\tau \in \mathbb{N}$) begins at integer time $\tau - 1$ on the real line and ends at integer time τ on the real line. The change in log output from index quarter $\tau + j - 1$ to index quarter $\tau + j$ is given by first-differencing equation (22) in the main text,

$$\Delta Y^Q_{\tau+j} = Y_{\tau+j} - 2Y_{\tau+j-1} + Y_{\tau-j-2}. \tag{IA14}$$

Consider two successive Greenbook forecast dates t_1 and t_2 (on the real line). We want the covariance matrix of innovations in forecasts of log output from index quarter $\tau + j - 1$ to index quarter $\tau + j$. The timeline of the forecasts and the quarter-end dates varies with j. As it varies, so does the functional form of the forecast innovations. The simplest case is illustrated in Figure A1.

Figure A1 illustrates timing of forecasts of the change in log output from quarter $\tau + 1$ to quarter $\tau + 2$. From (IA14), this requires forecasts of three separate future values of cumulative log output. Since cumulative log output is an element of the state vector, the forecast made at t_2 of log output growth is a linear combination of the state vector observed at t_2. The easiest way to think of the forecast revision from t_1 to t_2 is this linear combination times (realized state vector at t_2) less (forecast at t_1 of the state vector at t_2). The uncertainty in this forecast revision is therefore a linear combination of the uncertainty in the state vector from t_1 to t_2.

A more complicated case is illustrated in Figure A2. Again, we consider forecasts at t_1 and t_2 of the change in log output from quarter $\tau + 1$ to quarter $\tau + 2$. As of t_1, Y_τ is already known, since $Y_{\tau+L}$ is earlier than t_1. Between t_1 and t_2, $Y_{\tau+1}$ is observed at $\tau + 1 + L$. Thus as of t_2, $Y_{\tau+2}$ is the only component of the quarterly change in log output that is unknown. The innovation in the observed state vector from t_1 to $\tau+1+L$ affects both $Y_{\tau+1}$ and the forecast at t_2 of $Y_{\tau+2}$. The innovation of the observed state vector from $\tau+1+L$ to t_2 affects only the forecast at t_2 of $Y_{\tau+2}$. Because these two state-vector innovations have different effects on the total innovation in the forecast of the quarterly change in log output, they cannot be added together.

For many pairs of Greenbook forecast dates t_1 and t_2, the timeline of some of the forecasts of quarterly output growth will look like Figure A1 and the timeline of others will be variants of Figure A2, where one (and only one) of the three values Y_τ, $Y_{\tau+1}$, and $Y_{\tau+2}$ is revealed between the forecast dates. We need to construct covariances between innovations for forecasts characterized by Figure A1 with innovations for forecasts characterized by Figure A2. This requires splitting up the single state-vector innovation described with Figure A1 into two pieces that are contemporaneous with the two pieces in Figure A2.

In a nutshell, because a quarter-end value of cumulative log output can be revealed between two Greenbook forecast dates, formulas for forecast innovations and associated covariance matrices are complicated. Many cases must be considered. Derivations follow.

B. Expected Quarterly Output Growth

Write innovations in forecasted quarterly growth as a linear function of innovations in the state vector. Therefore the covariance matrix of forecast innovations, stock returns, and changes in bond yields can be expressed as a function of the state-vector covariance matrix (IA13).

Agents at a non-integer date t in index quarter τ forecast (IA14). The time until the next quarter-end is, using the floor function,

$$d(t) = 1 + \lfloor t \rfloor - t.$$

For example, at $t = 3.2$, the quarter ends at $t + d(t) = 4$ and the time until the next quarter-end is $d(t) = 0.8$. Using this definition and the identity $\tau \equiv t + d(t)$, the forecast is

$$E_t\left(\Delta Y^Q_{t+d(t)+j}\right) = E_t\left(Y_{t+d(t)+j}\right) - 2E_t\left(Y_{t+d(t)+j-1}\right) + E_t\left(Y_{t+d(t)-j-2}\right).$$

When agents observe the state vector with a lag L, this conditional expectation is

$$\begin{aligned} E_t\left(\Delta Y^Q_{t+d(t)+j}\right) =& e_3' E\left(X_{t+d(t)+j}|X_{t-L}\right) - 2e_3' E\left(X_{t+d(t)+j-1}|X_{t-L}\right) \\ &+ e_3' E\left(X_{t+d(t)+j-2}|X_{t-L}\right) \end{aligned} \tag{IA15}$$

where e_3 is a conformable vector with one in element 3 and zeros elsewhere. Although the right side of (IA15) has three expectations of random variables, this document's Section

IV.A explains that one or more may be known at t. A function for the known number of values, given $L \geq 0$, is

$$\mathcal{N}(j,t) = \begin{cases} 3, & L \leq -d(t) - j; \\ 2, & -d(t) - j < L \leq 1 - j - d(t); \\ 1, & 1 - d(t) - j < L \leq 2 - j - d(t); \\ 0, & 2 - j - d(t) < L. \end{cases} \tag{IA16}$$

The expectations in (IA15) that are not realizations are calculated using the Ornstein-Uhlenbeck conditional expectation formula

$$E\left(X_{t+s} | X_t\right) = e^{Ks} X_t.$$

To express the expectations in (IA15), first define the matrix-valued function

$$\Theta(j,t) \equiv \begin{cases} 0_{(3+n)\times(3+n)}, & \mathcal{N}(j,t) = 3; \\ \exp(K(j + d(t) + L)), & \mathcal{N}(j,t) = 2; \\ \exp(K(j + d(t) + L)) - 2\exp(K(j - 1 + d(t) + L)), & \mathcal{N}(j,t) = 1; \\ \exp(K(j + d(t) + L)) - 2\exp(K(j - 1 + d(t) + L)) & \\ \quad + \exp(K(j - 2 + d(t) + L)), & \mathcal{N}(j,t) = 0. \end{cases}$$

Then (IA15) is

$$E_t\left(\Delta Y^Q_{t+d(t)+j}\right) = \begin{cases} e_3'\Big(X_{t+d(t)+j} - 2X_{t+d(t)+j-1} + X_{t+d(t)+j-2}\Big), & \mathcal{N}(j,t) = 3; \\ e_3'\Big(\Theta(j,t)X_{t-L} - 2X_{t+d(t)+j-1} + X_{t+d(t)+j-2}\Big), & \mathcal{N}(j,t) = 2; \\ e_3'\Big(\Theta(j,t)X_{t-L} + X_{t+d(t)+j-2}\Big), & \mathcal{N}(j,t) = 1; \\ e_3'\Theta(j,t)X_{t-L}, & \mathcal{N}(j,t) = 0. \end{cases} \tag{IA17}$$

The next subsection derives formulas for discrete-time innovations in (IA17).

C. Forecast Revisions of Quarterly Output Growth

Consider two successive forecasts made at t_1 and t_2. The forecasts are made at most a quarter apart, a fact that implies only one quarter-ending value of cumulative log output can be revealed between the forecast dates. Formally, the forecast dates satisfy

$$\text{Maintained Assumption:} \qquad t_1 < t_2 \leq t_1 + 1. \tag{IA18}$$

The forecast dates are otherwise arbitrary. From (IA18), the forecasts are either made in the same calendar quarter or in successive quarters. An indicator variable equals one if the dates are in the same calendar quarter, and zero otherwise.

$$\mathcal{I}_{same}(t_1, t_2) = \begin{cases} 1, & \lfloor t_1 \rfloor = \lfloor t_2 \rfloor; \\ 0, & \lfloor t_1 \rfloor < \lfloor t_2 \rfloor. \end{cases}$$

The forecast innovation for some fixed quarter-end date is the forecast at t_2 less the forecast at t_1. Since the forecasts might be made in different quarters, we need unambiguous notation to refer to the horizon of the forecast. The main text, and this appendix, refer to the forecast horizon as of the later date t_2. The forecast horizon at t_1 is either j or $j+1$, depending on whether the forecast dates are in the same quarter. The forecast revision is

$$\epsilon_{t_2}^{(j)} \equiv \begin{cases} E_{t_2}\left(\Delta Y^Q_{t_2+j+d(t_2)}\right) - E_{t_1}\left(\Delta Y^Q_{t_1+j+d(t_1)}\right), & \mathcal{I}_{same}(t_1, t_2) = 1; \\ E_{t_2}\left(\Delta Y^Q_{t_2+j+d(t_2)}\right) - E_{t_1}\left(\Delta Y^Q_{t_1+j+1+d(t_1)}\right), & \mathcal{I}_{same}(t_1, t_2) = 0. \end{cases} \tag{IA19}$$

The left side notation of (IA19) specifies only the latter date. The earlier date is the date of the immediately preceding forecast.

As discussed in this document's Section IV.A, formulas for the forecast revision (IA19) are complicated by the possible dependence of the revision on two discrete-time innovations in the state vector. One is the innovation in expected future states owing to the change in the state from its value at $t_1 - L$, observed at t_1, to its value at $t_2 - L$, observed at t_2. The other is the possible realization of a quarter-end state that is unknown at t_1 and known at t_2.

Define an indicator variable that equals one if a quarter-end value is observed between two dates and zero otherwise. At most one quarter-end value will be revealed because the forecast dates are not more than one quarter apart. The indicator variable is the difference between the number of known quarter-end values at the second date less the number of known quarter-end values at the first date. Using the function (IA16), the variable is

$$QEND(t_1, t_2) = \mathcal{N}(0, t_2) - \mathcal{N}(1 - \mathcal{I}_{same}(t_1, t_2), t_1).$$

Recall that $t+d(t)$ is the ending time of the current quarter from the perspective of agents at t. As of time t, the next quarter-end value revealed is the quarter-end at $t + d(t) - p(t)$, an integer. The function $p(t)$ is

$$p(t) = \lfloor t \rfloor - \lfloor t - L \rfloor.$$

If $p(t) = 0$, then agents at t know all of the quarter-end values for quarter-ends prior to t. If, however, $p(t) = 1$, agents at t don't know the previous quarter-end value; the information lag is too long. In principle, $p(t) = 2$ is possible. The first interval for which we track innovations in the state vector is from $t_1 - L$ to $t_1 + d(t_1) - p(t_1)$. The second interval is from the ending date of the first interval to $t_2 - L$.

The total forecast innovation depends on the expectation of the state vector at $t_2 - L$ given its realization at the end of the first interval. This expectation is

$$E(X_{t_2-L}|X_{t_1+d(t_1)-p(t_1)}) = \Gamma(t_1,t_2)X_{t_1+d(t_1)-p(t_1)},$$
$$\Gamma(t_1,t_2) \equiv \exp(K(t_2 - L - (t_1 + d(t_1) - p(t_1)))).$$

Define the function

$$\Theta^*(j,t_1,t_2) = \begin{cases} I, & \mathcal{N}(j,t_2) = 3; \\ \Theta(j,t_2)\Gamma(t_1,t_2) - 2I, & \mathcal{N}(j,t_2) = 2; \\ \Theta(j,t_2)\Gamma(t_1,t_2) + I, & \mathcal{N}(j,t_2) = 1; \\ \Theta(j,t_2)\Gamma(t_1,t_2), & \mathcal{N}(j,t_2) = 0. \end{cases}$$

Using these functions, the forecast innovation is

$$\epsilon_{t_2}^{(j)} = \begin{cases} e_3'\Theta(j,t_2)\tilde{X}_{t_1-L,t_2-L}, & QEND(t_1,t_2) = 0; \\ e_3'\Theta^*(j,t_1,t_2)\tilde{X}_{t_1-L,t_1+d(t_1)-p(t_1)} & \\ \qquad +e_3'\Theta(j,t_2)\tilde{X}_{t_1+d(t_1)-p(t_1),t_2-L}, & QEND(t_1,t_2) = 1. \end{cases} \tag{IA20}$$

D. Innovation Vector for Greenbook Meeting i

The main text writes the vector of innovations for Greenbook meeting i, which occurs at time t_i, as

$$\epsilon_{t_i} \equiv \left(\begin{array}{cccccccc} \epsilon_{t_i}^{(j_{i,min})} & \ldots & \epsilon_{t_i}^{(j_{i,max})} & \epsilon_{t_i}^{(xr)} & \epsilon_{t_i}^{(r1)} & \epsilon_{t_i}^{(n1)} & \epsilon_{t_i}^{(n10)} \end{array} \right)'.$$

From (IA20) and the definition of the state vector (IA8), this vector of innovations is

$$\epsilon_{t_i} = \begin{pmatrix} e_3'\Theta(j_{i,min},t_i) \\ \vdots \\ e_3'\Theta(j_{i,max},t_i) \\ e_4' \\ \vdots \\ e_7' \end{pmatrix} \tilde{X}_{t_{i-1}-L,t_i-L}, \qquad QEND(t_{i-1},t_i) = 0; \tag{IA21}$$

$$\epsilon_{t_i} = \begin{pmatrix} e_3'\Theta^*(j_{i,min}, t_{i-1}, t_i) \\ \vdots \\ e_3'\Theta^*(j_{i,max}, t_{i-1}, t_i) \\ e_4' \\ \vdots \\ e_7' \end{pmatrix} \tilde{X}_{t_{i-1}-L, t_{i-1}+d(t_{i-1})-p(t_{i-1})}$$
$$+ \begin{pmatrix} e_3'\Theta(j_{i,min}, t_i) \\ \vdots \\ e_3'\Theta(j_{i,max}, t_i) \\ e_4' \\ \vdots \\ e_7' \end{pmatrix} \tilde{X}_{t_{i-1}+d(t_{i-1})-p(t_{i-1}), t_i - L}, \qquad QEND(t_{i-1}, t_i) = 1. \tag{IA22}$$

The final four rows in the matrices of (IA21) and (IA22) pick out the final four innovations in the state vector. In other words, they pick out the stock return and the changes in bond yields.

E. The Covariance Matrix of Innovations

Denote the matrices in (IA21) and (IA22) by

$$P(t_i) \equiv \begin{pmatrix} e_3'\Theta(j_{i,min}, t_i) \\ \vdots \\ e_3'\Theta(j_{i,max}, t_i) \\ e_4' \\ \vdots \\ e_7' \end{pmatrix}, \qquad P^*(t_i) \equiv \begin{pmatrix} e_3'\Theta^*(j_{i,min}, t_{i-1}, t_i) \\ \vdots \\ e_3'\Theta^*(j_{i,max}, t_{i-1}, t_i) \\ e_4' \\ \vdots \\ e_7' \end{pmatrix}, \tag{IA23}$$

where the dependence of the matrices on the forecast horizons is implicit. The covariance matrix of innovations at Greenbook meeting date t_i depends on whether a quarter-end value is revealed between meeting date t_{i-1} and t_i. Since this event is nonstochastic (given the model's parameters), the covariance matrix is

$$C(t_i) = \begin{cases} P(t_i)C_X(t_i - t_{i-1})P(t_i)', & QEND(t_{i-1}, t_i) = 0; \\ P^*(t_i)C_X(d(t_{i-1}) - p(t_{i-1}) + L)P^*(t_i)', & \\ +P(t_i)C_X(t_i - L - t_{i-1} - d(t_{i-1}) + p(t_{i-1}))P(t_i)', & QEND(t_{i-1}, t_i) = 1. \end{cases}$$

This is the covariance matrix defined in equation (26) of the main text.

V. Inferring Brownian Increments from Observables

Section IV.D of the main text describes regressions of unobserved, discrete increments to the two macroeconomic Brownians on observed innovations. The specifications are

$$B_{1,t_i} - B_{1,t_{i-1}} = \chi_1' \hat{\epsilon}_i + e_{1,\tau_2}, \tag{IA24}$$

$$B_{2,t_i} - B_{2,t_{i-1}} = \chi_2' \hat{\epsilon}_i + e_{2,\tau_2}. \tag{IA25}$$

This section describes how the regression coefficient vectors are calculated. In a nutshell, add the unobserved Brownians to the state vector and calculate the covariance matrix of the expanded state vector. The coefficient vectors are functions of this covariance matrix.

Define an expanded state vector as

$$X_t^\dagger = \begin{pmatrix} X_t' & B_{1t} & B_{2t} \end{pmatrix}'.$$

This is a length-nine vector. Setting n in (IA9) equal to six, the vector has Ornstein-Uhlenbeck dynamics of the usual form (IA10). The formula for the matrix $K^\dagger$ is unchanged from that in (IA11) (given the new n), while

$$\Omega^\dagger = \begin{pmatrix} \Omega_m \\ \Omega_a \\ I_{2\times 2} \end{pmatrix}, \qquad \Sigma^\dagger = \begin{pmatrix} \Sigma & 0_{7\times 2} \\ 0_{2\times 7} & 0_{2\times 2} \end{pmatrix}.$$

Using these matrices, follow the steps of this document's Section III.B to produce the conditional covariance matrix of the expanded state vector, an expanded version of (IA13). Denote it by

$$C_X^\dagger(s) = \mathrm{Cov}(X_{t+s}^\dagger | X_t^\dagger).$$

Next, modify the matrices (IA23) by adding two rows at the bottom for the Brownians,

$$P^\dagger(t_i) \equiv \begin{pmatrix} e_3'\Theta(j_{i,min}, t_i) \\ \vdots \\ e_3'\Theta(j_{i,max}, t_i) \\ e_4' \\ \vdots \\ e_7' \\ e_8' \\ e_9' \end{pmatrix}, \qquad P^{*\dagger}(t_i) \equiv \begin{pmatrix} e_3'\Theta^*(j_{i,min}, t_{i-1}, t_i) \\ \vdots \\ e_3'\Theta^*(j_{i,max}, t_{i-1}, t_i) \\ e_4' \\ \vdots \\ e_7' \\ e_8' \\ e_9' \end{pmatrix}.$$

The covariance matrix of observables and the two Brownians is then

$$C^\dagger(t_i) = \begin{cases} P(t_i)^\dagger C_X^\dagger(t_i - t_{i-1}) P^\dagger(t_i)', & QEND(t_{i-1}, t_i) = 0; \\ P^{*\dagger}(t_i) C_X^\dagger(d(t_{i-1}) - p(t_{i-1}) + L) P^{*\dagger}(t_i)', & \\ +P^\dagger(t_i) C_X^\dagger(t_i - L - t_{i-1} - d(t_{i-1}) + p(t_{i-1})) P^\dagger(t_i)', & QEND(t_{i-1}, t_i) = 1. \end{cases}$$

The final modifications are to the total covariance matrix in the appendix of the main text. Replace this covariance matrix with

$$C^{\dagger}_{total}(\tau_i, j_{i,min}, j_{i,max}; \psi) \equiv E(\hat{\epsilon}_i \hat{\epsilon}_i') = C^{\dagger}(\tau_i, j_{i,min}, j_{i,max}; \psi) + C^{\dagger}_{err}(\psi),$$

$$C^{\dagger}_{err}(\psi) = \begin{pmatrix} \mathrm{diag}(\sigma^2_{i,err}) & 0_{N_i \times n} \\ 0_{n \times N_i} & 0_{n \times n} \end{pmatrix}.$$

The vectors in (IA24) and (IA25) are

$$\chi_1 = \left(C^{\dagger}_{total}\right)^{-1}_{[1:7,1:7]} C^{\dagger}_{total[1:7,8]},$$

$$\chi_2 = \left(C^{\dagger}_{total}\right)^{-1}_{[1:7,1:7]} C^{\dagger}_{total[1:7,9]}.$$

VI. Full Sample Results for the Dynamic Model

The main text reports estimates of the model's parameters for the two periods 1975 through 1996 and 1997 through 2015. Table IAVIII reports estimates for the full sample 1975 through 2015. The results are, not surprisingly, a weighted average of the two subsample results, with the weight on the early period substantially greater than the weight on the second.

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Table IAI
Forecastability of Greenbook Forecast Revisions

The forecast revision of j-ahead output as of Greenbook i is the forecast in Greenbook i less the forecast for the same calendar quarter in Greenbook $i-1$. Forecast revisions for Greenbook i are regressed on the nowcast revision and three-quarter-ahead revision for Greenbook $i-1$. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Most of the regressions use 348 observations from January 1975 through December 2015. The regression for $j = 4$ uses 331 observations. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Horizon of Realization (j)	Lagged Nowcast Revision	Lagged 3 Quarter Ahead Forecast Revision	R^2
0	0.119**	−0.228	0.04
	(0.069)	(0.221)	
1	0.033	0.059	0.00
	(0.049)	(0.128)	
2	−0.067*	0.090	0.02
	(0.039)	(0.087)	
3	−0.074**	0.084	0.04
	(0.030)	(0.086)	
4	−0.036*	0.065	0.02
	(0.021)	(0.063)	

Table IAII
Second Moments of SPF Forecast Revisions of Output Growth

The forecast revision of j-ahead output growth in mid-quarter t is the consensus forecast from the Survey of Professional Forecasters (SPF) for t less the consensus forecast for the same calendar quarter from the SPF for quarter $t-1$. The table reports sample mean outer products of these revisions. Revisions are expressed in annualized percentage points.

Horizon	Horizon (quarters ahead)				
(quarters ahead)	-1	0	1	2	3
A. 1969 through 1996, 112 Observations					
−1	4.32				
0	0.64	1.98			
1	0.05	0.76	1.17		
2	−0.59	0.10	0.47	0.82	
3	−0.52	−0.06	0.05	0.31	0.63
B. 1997 through 2019, 92 Observations					
−1	1.82				
0	0.40	0.83			
1	0.28	0.46	0.35		
2	0.07	0.18	0.14	0.11	
3	0.10	0.11	0.10	0.06	0.12

Table IAIII
Projections of Aggregate Stock Returns and Changes in Bond Yields on Forecast Revisions of Output Growth (4-q-ahead version)

Excess aggregate stock returns and changes in bond yields between FOMC forecast dates are regressed on contemporaneous revisions in Greenbook forecasts of current quarterly real output growth (the nowcast) and four-quarter-ahead real output growth. Stock returns are expressed in percent. All variables are expressed in annualized percentage points. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Dependent Variable	Nowcast	Four Quarters Ahead	R^2
A. 1975 through 2015, 331 Observations			
Excess Stock Return	0.511	4.329***	0.09
	(0.331)	(1.175)	
Δ 1 Yr Real Yield	0.215***	−0.228**	0.18
	(0.052)	(0.095)	
Δ 1 Yr Nominal Yield	0.236***	−0.308***	0.24
	(0.054)	(0.087)	
Δ 10 Yr Nominal Yield	0.134***	−0.159***	0.16
	(0.027)	(0.060)	
B. 1975 through 1996, 179 Observations			
Excess Stock Return	−0.255	1.003	0.01
	(0.282)	(1.370)	
Δ 1 Yr Real Yield	0.239***	−0.270*	0.20
	(0.073)	(0.149)	
Δ 1 Yr Nominal Yield	0.246***	−0.423***	0.20
	(0.075)	(0.140)	
Δ 10 Yr Nominal Yield	0.134***	−0.203**	0.20
	(0.036)	(0.083)	
C. 1997 through 2015, 152 Observations			
Excess Stock Return	1.554**	8.360***	0.34
	(0.691)	(1.479)	
Δ 1 Yr Real Yield	0.120***	−0.085	0.14
	(0.026)	(0.086)	
Δ 1 Yr Nominal Yield	0.157***	−0.066	0.20
	(0.033)	(0.065)	
Δ 10 Yr Nominal Yield	0.115***	−0.078	0.09
	(0.038)	(0.096)	

Table IAIV
Projections of Aggregate Stock Returns and Changes in Bond Yields on Forecast Revisions of Output Growth (SPF version)

Excess aggregate stock returns and changes in bond yields between Survey of Professional Forecasters (SPF) forecast dates are regressed on contemporaneous revisions in SPF forecasts of current quarterly real output growth (the nowcast) and three-quarter-ahead real output growth. Stock returns are expressed in percent. All variables are expressed in annualized percentage points. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Dependent Variable	Nowcast	Three Quarters Ahead	R^2
A. 1969 through 2019, 199 Observations			
Excess Stock Return	1.972***	2.580**	0.12
	(0.682)	(1.128)	
Δ 1 Yr Real Yield	0.357***	−0.126	0.25
	(0.069)	(0.130)	
Δ 1 Yr Nominal Yield	0.406***	−0.250**	0.33
	(0.066)	(0.116)	
Δ 7 Yr Nominal Yield	0.201***	−0.160**	0.19
	(0.036)	(0.072)	
B. 1969 through 1996, 107 Observations			
Excess Stock Return	1.077	1.762	0.05
	(0.719)	(1.073)	
Δ 1 Yr Real Yield	0.416***	−0.120	0.27
	(0.088)	(0.153)	
Δ 1 Yr Nominal Yield	0.444***	−0.268*	0.34
	(0.088)	(0.139)	
Δ 7 Yr Nominal Yield	0.192***	−0.183**	0.19
	(0.047)	(0.083)	
C. 1997 through 2019, 92 Observations			
Excess Stock Return	3.688***	5.121	0.30
	(1.107)	(3.462)	
Δ 1 Yr Real Yield	0.195***	0.061	0.25
	(0.062)	(0.091)	
Δ 1 Yr Nominal Yield	0.279***	0.024	0.40
	(0.050)	(0.102)	
Δ 7 Yr Nominal Yield	0.204***	−0.014	0.20
	(0.053)	(0.123)	

Table IAV
Projections of Aggregate Stock Returns and Changes in Bond Yields on Forecast Revisions of Real Personal Consumption Expenditures

Excess aggregate stock returns and changes in bond yields between FOMC forecast dates are regressed on contemporaneous revisions in Greenbook forecasts of current quarterly real PCE growth (the nowcast) and three-quarter-ahead real PCE growth. Stock returns are expressed in percent. All variables are expressed in annualized percentage points. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Dependent Variable	Nowcast	Three Quarters Ahead	R^2
A. July 1978 through 2015, 306 Observations			
Excess Stock Return	−0.052	1.666*	0.13
	(0.311)	(0.882)	
Δ 1 Yr Real Yield	0.196***	−0.026	0.12
	(0.051)	(0.072)	
Δ 1 Yr Nominal Yield	0.196***	−0.057	0.13
	(0.052)	(0.080)	
Δ 10 Yr Nominal Yield	0.124***	−0.046	0.11
	(0.024)	(0.034)	
B. July 1978 through 1996, 154 Observations			
Excess Stock Return	−0.363	1.236	0.02
	(0.364)	(1.201)	
Δ 1 Yr Real Yield	0.238***	−0.075	0.15
	(0.067)	(0.165)	
Δ 1 Yr Nominal Yield	0.224***	−0.202	0.15
	(0.068)	(0.165)	
Δ 10 Yr Nominal Yield	0.128***	−0.109	0.13
	(0.032)	(0.081)	
C. 1997 through 2015, 152 Observations			
Excess Stock Return	0.712	1.599	0.05
	(0.606)	(1.281)	
Δ 1 Yr Real Yield	0.071**	0.048	0.08
	(0.030)	(0.037)	
Δ 1 Yr Nominal Yield	0.088***	0.062*	0.12
	(0.032)	(0.036)	
Δ 10 Yr Nominal Yield	0.098***	−0.003	0.07
	(0.030)	(0.027)	

Table IAVI
Projections of Greenbook Forecast Revisions of Output Growth on Changes in Ten-Year Bond Yields

Revisions in Greenbook forecasts of j-quarter-ahead real output growth are regressed on contemporaneous changes in ten-year nominal and TIPS yields. These are all bivariate regressions. The sample is from March 1999 through December 2015 and excludes the two Greenbook forecasts in the fourth quarter of 2008. There are 133 observations. All variables are expressed in annualized percentage points. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Explanatory	Horizon (quarters ahead)					
Variable	-1	0	1	2	3	4
Δ 10 Yr Nominal Yield	0.463**	0.676***	0.286**	0.084	0.033	0.057
	(0.197)	(0.211)	(0.141)	(0.120)	(0.110)	(0.103)
Δ 10 Yr TIPS Yield	0.390	0.638***	0.253	-0.124	-0.136	-0.154
	(0.306)	(0.242)	(0.183)	(0.154)	(0.155)	(0.119)

Table IAVII
Projections of Changes in Ten-Year Nominal and TIPS Yields on Forecast Revisions of Output Growth

Changes in bond yields between FOMC forecast dates are regressed on contemporaneous revisions in Greenbook forecasts of current quarterly real output growth (the nowcast) and three-quarter-ahead real output growth. The sample is from March 1999 through December 2015 and excludes the two Greenbook forecasts in the fourth quarter of 2008. There are 133 observations. All variables are expressed in annualized percentage points. The table reports parameter estimates. Asymptotic White standard errors are in parentheses. Asterisks denote statistical significance at two-sided p values of 10%, 5%, and 1%.

Dependent Variable	Nowcast	Three Quarters Ahead	R^2
Δ 10 Yr Nominal Yield	0.127***	−0.028	0.09
	(0.031)	(0.062)	
Δ 10 Yr TIPS Yield	0.079***	−0.076	0.06
	(0.022)	(0.056)	

Table IAVIII
Model Parameter Estimates, 1975 through 2015

The model and estimation method are described in Section III. Asymptotic standard errors are in parentheses. In Panel B, asterisks represent asymptotic two-sided p-values versus zero of 10%, 5% and 1%.

Panel A. Output Growth Dynamics

					Std Dev of Measurement Error (Horizon)					
σ_y	σ_x	σ_{xy}	ρ	L	-1	0	1	2	3	4
0.50	0.19	-0.42	0.11	0.23	0.23	0.15	0.16	0.09	0.06	0.07
(0.03)	(0.02)	(0.07)	(0.03)	(0.03)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)

Panel B. Loadings of Stock Returns and Bond Yields on Macro Innovations

Innovation	Stock Return	One Year Real Yield	One Year Nominal Yield	Ten Year Nominal Yield
Immediate	1.80^{***}	0.42^{***}	0.47^{***}	0.24^{***}
Output	(0.56)	(0.07)	(0.06)	(0.04)
Growth	4.27^{***}	0.05	-0.01	-0.02
Rate	(0.56)	(0.07)	(0.08)	(0.05)

Panel C. Cholesky Factorization of Non-Output Components of Stock Returns and Bond Yields

	Stock Return	One Year Real Yield	One Year Nominal Yield	Ten Year Nominal Yield
Stock Return	7.10			
	(0.22)			
One Year	-0.17	0.84		
Real Yield	(0.06)	(0.03)		
One Year	-0.15	0.73	0.31	
Nominal Yield	(0.06)	(0.03)	(0.01)	
Ten Year	-0.10	0.30	0.13	0.42
Nominal Yield	(0.03)	(0.03)	(0.03)	(0.02)

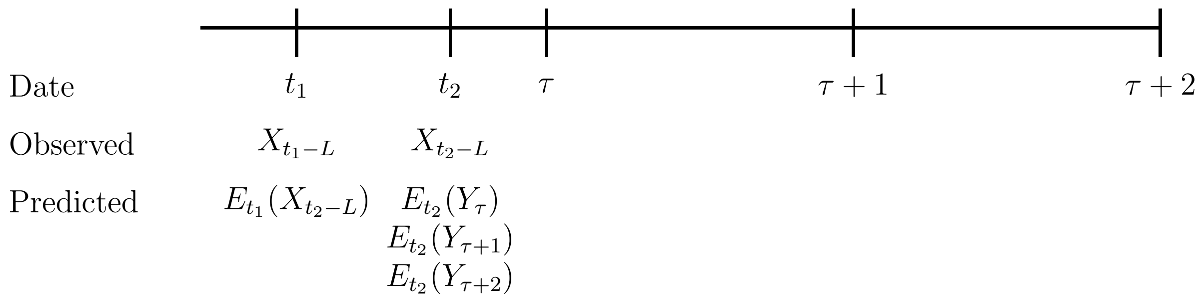

Figure IA1. Time line of forecast innovations: Simplest case. Greenbook forecasts of output growth from quarter $\tau+1$ to $\tau+2$ are made at dates t_1 and t_2. No quarter-end values of output are revealed between these dates.

Date	τ	$\tau + L$	t_1	$\tau + 1$	$\tau + 1 + L$	t_2	$\tau + 2$
Observed		Y_τ	$X_{t_1 - L}$		$Y_{\tau+1}$	$X_{t_2 - L}$	
Predicted			$E_{t_1}(Y_{\tau+1})$ $E_{t_1}(X_{t_2 - L})$			$E_{t_2}(Y_{\tau+2})$	

Figure IA2. Time line of forecast innovations: More complicated case. Greenbook forecasts of output growth from quarter $\tau + 1$ to $\tau + 2$ are made at dates t_1 and t_2. The figure is not to scale. A quarter-end value is revealed between the two forecast dates.