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Abstract

This paper utilizes Greenbook forecasts of consumption and income to predict expected asset returns through a present-value model of consumption. The study finds that, despite the valuable information contained in Greenbook forecasts, the expected asset returns obtained from this approach do not provide meaningful insights into future asset returns. This contrasts with previous literature suggesting predictability using the present-value model.

Keywords: Consumption, Asset Returns, Present-Value Model, Greenbook Forecasts

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1 Introduction

In recent years, significant attention has been given to the connection between the macroeconomy and financial markets. One prominent model utilized to establish this link is the present-value model of consumption. This model utilizes the idea that the present discounted value of consumption equals the present discounted value of lifetime wealth. An implication of this relationship is that an equilibrium relationship between consumption and wealth provides us with information about agents' expectations of future movements in consumption and wealth. The literature has considered different versions of the present-value model. One of the shortcomings of the conventional present-value model of consumption is that it proxies human wealth with current labor income. Whelan (2008) presented a framework where the assumption about unobservable human wealth is not required. According to that framework, the present-value model can be expressed as follows:

$$x_t - a_t \approx E_t \sum_{j=1}^{\infty} \rho^j (r^a_{t+j} - \Delta x_{t+j}) \tag{1}$$

In this equation, x_t represents the logarithm of consumption minus labor income, a_t represents the logarithm of observable household assets, r^a_t represents the return on these assets, andρ is a known constant slightly less than one. The model suggests that the logarithmic ratio of excess consumption (consumption exceeding labor income) to observable assets can be expressed as an expected discounted sum of future returns on household assets minus future growth rates of excess consumption. Therefore, an unexpected increase in excess consumption today implies either news of higher future returns or a downward revision in expected future growth rates of excess consumption. Previous studies, including Whelan (2008) and Lettau and Ludvigson (2001), have adopted the approach of using the excess consumption-assets ratio and the consumption-wealth ratio as indicators for future asset returns and future excess consumption growth rates[1]. Lettau and Ludvigson (2001) specif-

[1] Other papers that use present value models in finance include Conrad and Kaul (1988), Brandt and Kang (2004), Bidarkota and Dupoyet (2007), Rytchkov (2008), Pastor and Stambaugh (2009),Binsbergen and Koijen (2010), Kishor and Kumari (2013) among others.

ically employ the estimated residuals from a cointegrating regression of consumption, labor income, and wealth (cay) as a proxy for expected asset returns. These studies have provided evidence suggesting that households adjust their consumption spending in anticipation of changes in the return on household assets. This has the implication that asset returns can be predicted based on the consumption decision of the households.

In this paper, we present an alternative approach to estimating expected asset growth, departing from the method used by Whelan (2008) and Lettau and Ludvigson (2001,2005). We utilize Greenbook[2] (GB) forecasts of excess consumption growth (Δx_{t+j}) on the right hand side of the present value model and estimate expected asset growth as a residual. GB forecasts are prepared by the Fed Board Staff and are presented to the Federal Open Market Committee (FOMC) prior to each of their meetings In particular, our approach yields the following formula for expected asset growth:

$$E_t \sum_{j=1}^{\infty} \rho^j r^a_{t+j} \approx x_t - a_t + E_t \sum_{j=1}^{\infty} \rho^j \Delta x_{t+j} \tag{2}$$

This approach offers several advantages. The existing approach in the literature estimates the present discounted value of asset returns and excess consumption growth jointly and attributes most of the variations in this combined series to movements in expected asset return. Our approach of using the GB forecasts of expected excess consumption growth clearly separates these two unobserved variables and estimates expected asset growth as a residual from the above equation. Another key advantage is that our approach bypasses the issue of model uncertainty. Currently, there is no consensus on whether the VAR or State Space approach is superior for estimating expected excess consumption growth or asset return. By incorporating GB forecasts, we mitigate this uncertainty. Additionally, our approach addresses the challenge of estimation uncertainty. While it is true that similar limitations may exist with GB forecasts, we can evaluate their usefulness by testing their predictive power. As shown in this paper, these forecasts exhibit strong predictive capabilities for future excess

[2] In June 2010, the Greenbook was merged with another document called the Bluebook to form the Tealbook. GB forecasts are now referred to as Tealbook forecasts.

consumption growth. Leveraging sophisticated models, GB forecasts effectively aggregate information about future movements in excess consumption growth. Numerous studies in the forecasting literature have highlighted the value of these forecasts in providing insights into macroeconomic variables.[3] By adopting this alternative approach and leveraging Greenbook forecasts, our research contributes to enhancing the understanding and prediction of asset growth with a present value model.[4]

Our findings indicate that when GB forecasts are used as a proxy for expected excess consumption growth in the present value model, the expected asset returns obtained as residuals do not possess informative content about future movements in asset returns. This contrasts with previous literature that has demonstrated the predictive usefulness of present-value models for future returns. To explore the possibility that GB forecasts may include measurement errors in household expectations of expected excess consumption growth, we also estimate a model assuming classical measurement error in GB forecasts. Under this framework, the residual from the present value model represents the expected asset return and an error term. However, the results from this analysis are remarkably similar to those obtained without considering measurement error.

The paper is structured as follows:Section 2 describes the data; Section 3 introduces GB forecasts into the present-value model of consumption and discusses the empirical results; and Section 4 concludes.

2 Data Description

We use data at quarterly frequency and our sample runs from 1978 through 2017. Data on household assets come from the Federal Reserve Board's Flow of Funds, with durable

[3] Some notable references include Romer and Romer (2002), Sims (2002), Faust et al. (2004), Kishor (2010), Bhatt et al. (2020) among others.

[4] One can argue that the superiority of the Greenbook forecasts in predicted future income could be due to access to information that is not readily available to public. Such information asymmetry between household and the staff at the Federal Reserve Board can have implication for the expectation formation. However, there is evidence that the superiority of the GB forecasts is not due to this asymmetry in the information set between the households and the staff at the Federal Reserve Board. In Section 2 we provide a more detailed exposition of this issue.

goods expenses subtracted to measure consumption. The study adopts Whelan (2008) and Lettau and Ludvigson (2001) methodologies for calculating after tax labor income, The data is deflated using the personal consumption expenditure price index

To proxy expected consumption growth and income growth, we rely on the GB forecasts. These forecasts, which predict the growth of consumption and real disposable income, are presented to the Federal Open Market Committee (FOMC) prior to each of their meetings. Considering that there are typically eight regular FOMC meetings in a calendar year, we can acquire a fresh set of forecasts approximately every 1.5 months. It's important to note that these forecasts become publicly available with a delay of five years.[5] Therefore, our sample is limited to data spanning the years 1978 to 2017. The information regarding Greenbooks (GBs) can be obtained from the Federal Reserve Bank of Philadelphia.[6]

To obtain quarterly forecasts, we use predictions made at the end of each quarter during our sample period. For each quarter, there are two sets of forecasts: one from the first half and another from the second half of the quarter. These forecasts cover the current quarter and extend into several future quarters. Typically, forecasts are available up to four quarters ahead. We specifically utilize 1-4 quarter ahead forecasts for consumption and real disposable income growth.

Table 1 illustrates the effectiveness of Greenbook (GB) forecasts in predicting consumption and income growth across various forecast horizons, demonstrating the GB forecasts' predictive capability for future trends in both consumption and income growth. The findings are derived from a regression analysis of observed consumption growth and income growth against forecasts at differing horizons. As anticipated, the R-squared values are highest for current quarter forecasts and decrease for longer horizons. Nonetheless, the coefficients for the forecasts remain significant at all conventional levels across various horizons. These regression outcomes indicate that GB forecasts are forward-looking and not adversely affected by model and estimation uncertainties. Figure 1 compares the observed levels of excess

[5] For example, the GB forecast of 2019 will only be made available in 2024.

[6] See https://www.philadelphiafed.org/research-and-data/real-time-center/greenbook-data/pdf-data-set

consumption with forecasts for different horizons. The level forecasts are imputed from the growth forecasts with the past observed level of consumption and after tax labor income.

3 Model Specification

3.1 A Present-Value Model of Consumption

This section is based on the present-value model proposed by Whelan (2008) and incorporates the latent variable approach introduced by Binsbergen and Koijen (2010). These models use Campbell and Shiller (1988) as a baseline where they demonstrated that the logarithm of the consumption-aggregate wealth ratio provides valuable insights into expected returns on wealth and anticipated consumption growth rates. Whelan (2008) examines a budget constraint that depicts the dynamics of total observable assets. The constraint can be expressed as follows:

$$A_{t+1} = R^a_{t+1}(A_t + Y_t - C_t) \tag{3}$$

where A_t is total household assets, R^a_{t+1} is the gross return on assets, Y_t is labor income and C_t is consumption. Dividing across by A_t and taking logs we get:

$$\Delta a_{t+1} = r^a_{t+1} + \log\left(1 - \frac{C_t - Y_t}{A_t}\right) \tag{4}$$

Define, excess consumption as $X_t = C_t - Y_t$[7]

Equation (4) can be rewritten as:

$$\Delta a_{t+1} = r^a_{t+1} + \log(1 - \exp(x_t - a_t)) \tag{5}$$

where $\log(1 - \exp(x_t - a_t))$ is a non-linear function. Solving the above equations and rearranging, yields the following expression[8]:

[7] In this study, the US data series utilized adheres to a standard labor income definition. It was observed that consumption consistently surpasses labor income, resulting in a positive value for x_t. This positive value can be interpreted as being influenced by the inclusion of income from assets, in addition to post-tax labor income y_t, which is used to finance consumption.

[8] Readers are referred to Whelan (2008) for details on the derivation of the above equation.

$$x_t - a_t \approx \rho(r^a_{t+1} + \kappa - \Delta x_{t+1}) + \rho(x_{t+1} - a_{t+1}) \tag{6}$$

where $\rho = 1 - \exp(\overline{x} - \overline{a})$. Solving forward via repeated substitution and imposing the condition that $\lim_{j\to\infty} \rho^{-j}(x_{t+j} - a_{t+j}) = 0$ and taking conditional expectation at time t, we obtain

$$x_t - a_t \approx \frac{\rho\kappa}{1-\rho} + E_t \sum_{j=1}^{\infty} \rho^j (r^a_{t+j} - \Delta x_{t+j}) \tag{7}$$

We can write the present discounted value of the expected asset returns as $E_t \sum_{j=1}^{\infty} \rho^j (r^a_{t+j}) \approx x_t - a_t + E_t \sum_{j=1}^{\infty} \rho^j \Delta x_{t+j}$. We proxy the expected excess consumption growth with the the forecasts calculated from Greenbook. The discount factor $\rho = 1 - \exp(\overline{x} - \overline{a})$. In our data, this is estimated to be 0.971. In our framework, we have the forecasts of excess consumption growth up to 4 quarters. Expected consumption growth beyond 4-quarters is approximated by 4-quarter ahead forecasts. In particular, we obtain expected asset growth with the following formula

$$E_t \sum_{j=1}^{\infty} \rho^j (r^a_{t+j}) \approx x_t - a_t + \rho E_r \Delta x^{GB}_{t+1} + \rho^2 E_r \Delta x^{GB}_{t+2} + \rho^3 E_r \Delta x^{GB}_{t+3} + \rho^4 E_r \Delta x^{GB}_{t+4} + \frac{\rho^4}{1-\rho} E_r \Delta x^{GB}_{t+4} \tag{8}$$

The estimated expected asset returns for this exercise, shown in Figure 2, are plotted alongside observed asset returns. Table 2 presents the cross-correlation between these estimated returns and realized returns at various horizons. Notably, the contemporaneous correlation is 0.27, impressive considering the noisiness in quarterly asset returns. The correlation with excess consumption-asset ratio is lower, at 0.08. However, when examining the correlation with future realized returns, the expected measure underperforms, becoming insignificant after two quarters. Yet, the correlation with the excess consumption-asset ratio remains significant up to six quarters. We also explore the correlation between expected returns and the discounted sum of realized returns over the next four quarters, $\sum_{j=1}^{4} \rho^j (r^a_{t+j})$,with these results also detailed in Table 2, alongside those for the excess consumption-asset ratio. These findings align with earlier quarterly return results.

A key insight from the present value model of consumption is that the excess consumption-asset ratio reflects household expectations about future excess consumption growth and future asset returns. To test if the current ratio indeed predicts future asset movements and consumption growth, we performed a Granger causality test. This tested whether past expected returns predict future realized returns after accounting for realized return lags. As reported in Table 3, we found no evidence that past expected returns Granger cause future realized returns. Contrarily, past realized returns seem to predict expected returns, challenging the efficacy of present value models in predicting asset returns. Additionally, we found no support for the hypothesis that past movements in the excess consumption-asset ratio Granger cause future realized returns. However, there is strong evidence that this ratio predicts forecasts of excess consumption growth at various horizons, as detailed in Table 3.

Table 4 reports our in-sample predictive regression results. As anticipated, past realized returns, explaining only 5% of future returns, are not significant predictors. Moreover, past expected returns, accounting for just 1.1% of future returns, also show limited predictive power. Including both lagged realized and expected returns as regressors does not improve the R-squared, which remains at 5%, and the individual coefficients continue to be insignificant.

3.2 Greenbook Forecasts as Imperfect Proxies for Household's Expected Return

It is reasonable to consider that the expected asset returns of households may differ from those forecasted by Federal Reserve staff members. One reason could be that Fed staff have access to a superior information set. However, Faust et al. (2004) suggest that any advantage in the Federal Reserve Board's information set, not publicly shared, is likely minor and subtle. They note that the information from Federal Reserve policy surprises about the economy's state does not consistently enhance the forecasts based on their statistical releases. This indicates that the superiority of Greenbook (GB) forecasts may not be due to asymmetric information alone, but rather due to the staff's enhanced ability to aggregate available information.

Recognizing the minimal differences in the information set, in this study, we hypothesize that the expected asset returns, estimated as the residual from the present value relationship, could be prone to measurement errors. Suppose $E_t \sum_{j=1}^{\infty} \rho^j \Delta x_{t+j} = \sum_{j=1}^{\infty} \rho^j \Delta x_{t+j}^{GB} + u_t, u_t\tilde{}iidN(0, \sigma_u^2)$. We assume that household's expected excess consumption growth equals GB forecasts plus a serially uncorrelated measurement error. This implies that

$$x_t - a_t + \sum_{j=1}^{\infty} \rho^j \Delta x_{t+j}^{GB} = E_t \sum_{j=1}^{\infty} \rho^j (r_{t+j}^a) + u_t. \tag{9}$$

The above equation has two unobservables on the right hand side. To identify these two unobservables, we assume that expected presented discounted value of asset returns follow an AR(1) process. In particular, the model has the following structure

$$E_t \sum_{j=1}^{\infty} \rho^j (r_{t+j}^a) = r_{a,t}^e = \alpha + \beta r_{a,t-1}^e + \varepsilon_t, \varepsilon_t\tilde{}iidN(0, \sigma_\varepsilon^2) \tag{10}$$

We assume that measurement error u_t, and the shock to expected asset returns, ε_t are uncorrelated, i.e., $\text{cov}(u_t, \varepsilon_t) = 0$. The above two equations can be cast into a state space form and estimated using maximum likelihood via the Kalman filter. The estimated expected asset returns are reported in Figure 3. The figure plots the estimated asset returns from this exercise with the one from the model that does not assume any measurement error. It is clear that the filtering of expected asset return does not change the results obtained from the previous section. The correlation between expected return from the GB forecasts (baseline) and the one obtained with the measurement error model is 0.99. Expected return obtained from the measurement error model is slightly less volatile as expected. However, all other properties like Granger causality and cross lag correlation remains similar.

4 Conclusions

This paper utilizes the data provided by the Greenbook forecasts of consumption and income to derive expected asset returns using a present-value model of consumption. The rationale behind this approach is the recognition that Greenbook forecasts possess significant information regarding future changes in consumption and income, and they are not subject to the limitations of conventional modeling choices faced by researchers. By employing this methodology, the paper calculates expected asset returns as a residual value from the present value model of consumption. Utilizing observable excess consumption-asset ratios and approximating expected excess consumption growth with Greenbook forecasts enabled the extraction of expected asset growth in the United States from 1978 to 2017. The findings indicate that the expected asset returns obtained through this approach do not provide valuable insights into future asset returns, contradicting some existing literature that suggests asset returns can be predicted using a present-value model of consumption.

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Table 1: Predictive Ability Test for Greenbook Forecasts

Forecast horizon	Intercept	Lag	R^2
Panel A: Consumption Growth GB Forecast Predictive Power			
0-period	-0.28	0.87	0.51
	(0.38)	(0.00)	
1-period	0.18	0.68	0.23
	(0.66)	(0.00)	
2-period	0.22	0.63	0.14
	(0.70)	(0.00)	
3-period	0.59	0.49	0.07
	(0.37)	(0.02)	
4-period	0.57	0.50	0.05
	(0.32)	(0.01)	
Panel B: Real Disposable Income Growth GB Forecast Predictive Power			
0-period	-0.31	0.73	0.51
	(0.18)	(0.00)	
1-period	-0.12	0.65	0.36
	(0.65)	(0.00)	
2-period	0.29	0.54	0.14
	(0.41)	(0.00)	
3-period	0.67	0.38	0.05
	(0.14)	(0.00)	
4-period	0.66	0.37	0.04
	(0.19)	(0.02)	

[a] P-values are shown in parentheses. The dependent variables are real consumption and disposable income growth.

Table 2: Cross lag correlation with realized asset returns

Lags	r_t^e	x_t-a_t
Panel A: Cross lag correlation with quarterly return		
0	0.27	0.08
1	0.16	0.20
2	0.08	0.19
3	0.08	0.16
4	-0.03	0.19
6	-0.02	0.15
9	-0.05	0.10
12	-0.06	0.03
Panel B: Cross lag correlation with one-year ahead return		
0	0.14	0.31
1	0.11	0.26
2	0.16	0.25
3	0.11	0.24
4	0.11	0.23
6	0.06	0.17
9	0.03	0.07
12	-0.01	-0.01

[a] The table shows correlation between expected asset return (r_t^e) and excess consumption asset ratio ($x_t - a_t$) with realized asset returns at different horizons.

Table 3: Granger Causality Test Results

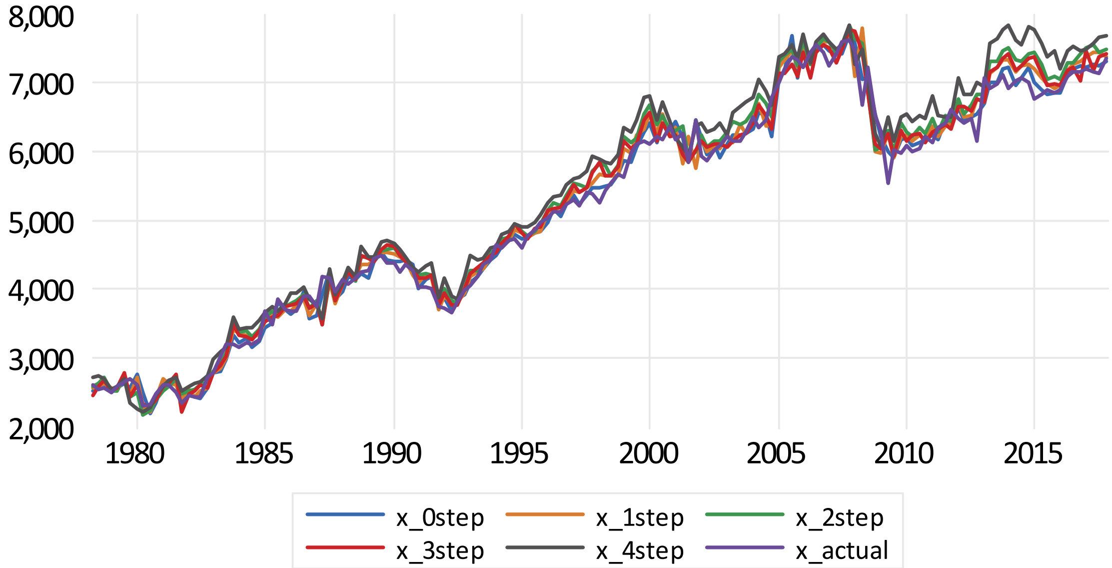
H_0	p-value
r_t^e Granger causes r_t	0.37
r_t Granger causes r_t^e	0.00
r_t^e Granger causes r_{t_4}	0.28
r_{t_4} Granger causes r_t^e	0.00
$r_t^{e,m}$ Granger causes r_t	0.67
r_t Granger causes $r_t^{e,m}$	0.00

[a] r_t^e is expected asset return from the baseline GB forecast model. r_t is realized asset r_{t_4} represents one year ahead return. $r_t^{e,m}$ is expected return from measurement error model.

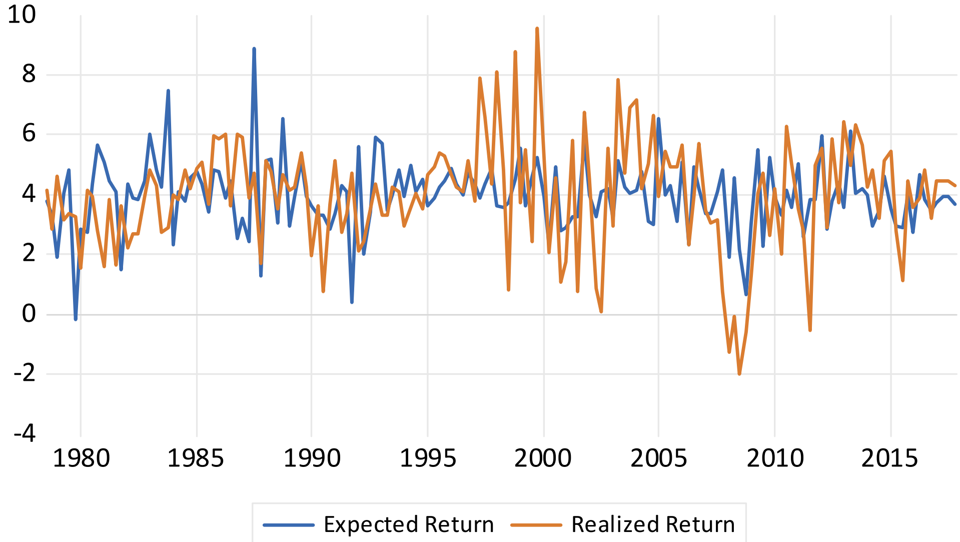
Table 4: Predictive Ability Test for Expected Asset Return

Predictive Regression for Realized Asset Returns (r_t)			
Explanatory Variable	Model 1	Model 2	Model 3
Lagged r_t	0.24		0.22
	(0.11)		(0.15)
Lagged r_t^e		0.20	0.11
		(0.14)	(0.41)
R-squared	0.05	0.01	0.05

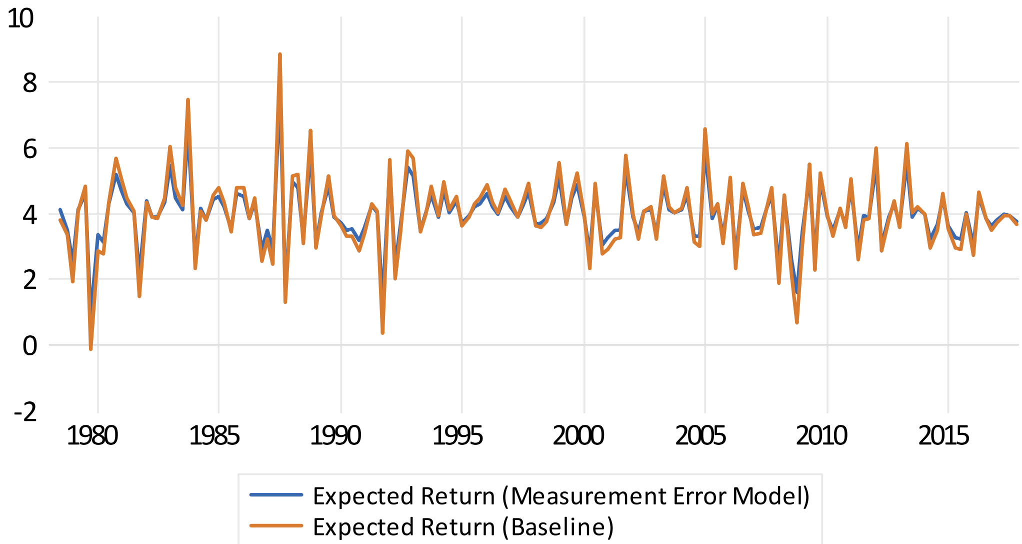
[a] P-values are shown in parentheses. The dependent variable is realized asset return (r_t). r_t^e is expected return from our baseline model.



Actual Excess consumption and Greenbook forecasts at different horizons



Expected return from a present-value model with Greenbook forecasts



Comparison with a measurement error model