A Tale of Fear and Euphoria in the Stock Market

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Abstract

We propose a consumption-based model to explain the unstable (sometimes positive and sometimes negative) relations between stock market variance with stock market risk premia and prices. In the model, market risk premia depend positively (negatively) on "fear" ("euphoria") variance. Market prices, which decrease with discount rates, correlate negatively (positively) with fear (euphoria) variance. As the sum of fear and euphoria variances, the market variance may correlate positively or negatively with expected returns and prices, depending on the relative importance of the two variances. Our empirical findings support the model's key assumptions and many novel implications.

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I. Introduction

Modern asset pricing models stipulate that when perceived uncertainty is high, investors require a high equity premium or discount rate, leading to a low stock market valuation multiple. In contrast with these implications, the existing literature has documented unstable, i.e., sometimes positive and sometimes negative, relations between stock market variance with stock market risk premia and prices. In this paper, we explain these seemingly puzzling empirical findings using a variant of the Bansal and Yaron (2004) long-run risk model.

Stock market prices decrease with *fear* and increase with *euphoria*. These dominant forces in the financial market, as keenly acknowledged by former Fed chair Alan Greenspan, are represented by two types of aggregate uncertainty in our model. Specifically, we consider two main drivers of business cycles: neutral or disembodied technology (DT) shocks and investment-specific technology (IST) shocks (e.g., Fisher (2006)).[1] These shocks have distinct asset pricing implications due to their different effects on consumption.

DT shocks account for the conventional view of stock market variance-return or price relations. The variance of DT shocks, which correlates positively with equity premia and negatively with scaled market prices, is a *fear* gauge. The economic mechanism of these relations is the same as that of the Bansal and Yaron (2004) model. A positive DT shock increases both current and future (1) consumption and (2) aggregate corporate cash flows. These assumptions

[1]DT shocks, e.g., sharp spikes in crude oil prices, affect the production of all goods homogeneously. IST shocks influence only investment goods, e.g., equipment used to produce computer chips. Note that we use the terminology "technology shocks" rather loosely here. The U.S. economy may be shaped by many other driving forces, such as monetary policy (e.g., Ramey (2016)), which are also a source of DT or IST shocks in our model. For example, Papanikolaou (2011) suggests that IST shocks might originate from credit market frictions.

imply that (1) DT shocks have a positive risk price and (2) the equity market loads positively on DT shocks.

IST shocks are a novel addition to the long-run risk model. Their variance is a *euphoria* measure as it correlates negatively (positively) with equity premia (scaled market prices) under two assumptions. First, IST shocks have a negative (positive) effect on current (future) consumption, and their risk price is negative when the adverse effect on current consumption is relatively large in magnitude. Second, the equity market loads positively on IST shocks as they increase current and future aggregate corporate cash flows.

Fear and euphoria have opposing effects on equity premia and scaled market prices. As the sum of DT and IST variances, stock market variance may correlate positively or negatively with equity premia and scaled market prices in small samples, depending on the relative importance of fear and euphoria. We illustrate these novel theoretical results through the lens of the negative correlation condition (NCC), $cov_{t-1}(M_t(1+R_{m,t}),(1+R_{m,t})) \leq 0$, where M_t is the pricing kernel and $R_{m,t}$ is the market return. NCC, which holds in standard asset pricing models, allows Martin (2017) to derive a lower equity premium bound that increases with options-implied market variance. By contrast, $cov_{t-1}(M_t(1+R_{m,t}),(1+R_{m,t}))$ is not always negative in our model as it depends negatively (positively) on DT (IST) variance.

Using the Papanikolaou (2011) measure of IST shocks, we document compelling evidence for our model's key assumptions that sheds important new light on long-run risks. While IST shocks decrease (increase) current consumption (corporate profits), they correlate positively with survey and Fed forecasts of long-run economic activity and corporate profits. There is also mounting empirical support for our model's main theoretical implications. In multiple regressions, scaled market prices correlate negatively with DT variance and positively with IST variance and long-run future consumption growth, with R^2 of up to 65%. In addition, equity premia depend positively (negatively) on DT (IST) variance. Moreover, loadings on DT and IST variances are significantly priced in cross-sectional stock returns, and their explanatory power is similar to that of loadings on DT and IST shocks.

Our model predicts a close relation between the price or value-weighted average stock variance and IST variance. Intuitively, stocks with more loadings on euphoria variance have lower risk premia and, hence, higher market prices, ceteris paribus. The model-implied euphoria variance correlates closely with its IST shocks-based counterpart and provides similar or stronger empirical support for our model's main implications. In addition, shocks to IST variance have a negative risk price. Our model thus helps explain the seemingly conflicting findings. Average stock variance correlates positively with scaled market prices (Pastor and Veronesi (2009)), while its innovations are negatively priced in the cross-section of stock returns (Herskovic, Kelly, Lustig, and Van Nieuwerburgh (2016)).

The remainder of the paper is organized as follows. We review the related literature in Section II and report empirical support for our model's main assumptions in Section III. We discuss the model in Section IV and use simulation to illustrate its key results in Section V. We examine the model's main theoretical implications in Section VI and offer some concluding remarks in Section VII.

II. Related Literature

The IST risk price, λ_{IST}, can be theoretically positive or negative, depending on households' preferences and the production function. Papanikolaou (2011) first analyzes the asset pricing implications of IST shocks using a two-sector general equilibrium model. λ_{IST} is negative because IST shocks reduce current consumption, and households prefer late resolution of uncertainty. The equity premium is positive because market returns load negatively on IST shocks ($\beta_{IST} < 0$).[2] Garlappi and Song (2017) point out that λ_{IST} can be positive when allowing for varying capital utilization rates. They also show that future cash flows and market returns load positively on IST shocks ($\beta_{IST} > 0$) when firms have market power. To generate a sizable equity premium, λ_{IST} needs to be positive.

Existing empirical studies also disagree on the sign of λ_{IST}. Kogan and Papanikolaou (2013) and Kogan and Papanikolaou (2014) find $\lambda_{IST} < 0$ because stocks with larger IST loadings have lower expected returns. In addition, the value premium, which loads negatively on IST shocks, is positive in many international markets (Fama and French (1998)). By contrast, Garlappi and Song (2016) document a weak or positive λ_{IST} using the portfolios sorted by the market cap, the book-to-market equity ratio, and momentum. The result may reflect omitted variable bias. Guo and Pai (2020) show that the momentum profit, which is not accounted for by IST shocks, reflects loadings on other economic risks in aggregate consumption.[3]

[2]Positive IST shocks increase interest rates (future cash flows) and, hence, lower (raise) the present value of future cash flows. The interest rate effect dominates the cash flow effect because Papanikolaou (2011) assumes a relatively low elasticity of intertemporal substitution.

[3]Bansal, Dittmar, and Lundblad (2005) show that loadings of cash flows on aggregate consumption positively predict returns on the portfolios formed by the market cap, the book-to-market equity ratio, and momentum. Similarly, using the same testing portfolios and real-time personal consumption expenditure data from the Bureau of Economic Analysis, Guo and Pai (2020) find that loadings of portfolio returns on aggregate consumption are positively priced. The results imply a negative IST risk price because aggregate consumption correlates negatively with IST shocks. Garlappi and Song (2020) find that the investment-market equity ratio, a proxy for IST loadings,

In our model, the market portfolio loads positively on IST shocks ($\beta_{IST} > 0$), which have a negative risk price ($\lambda_{IST} < 0$). Our evidence supports both implications. From 1963Q1 to 2016Q4, IST shocks have a 44% correlation with the excess market return and are negatively and significantly priced in the cross-section of portfolio returns. In addition, IST (DT) variance contributes negatively (positively) to equity market risk premia. This new feature accounts for large fluctuations in the price-dividend ratio that challenge standard long-run risk models. As in Bansal, Kiku, and Yaron (2012) and Segal (2019), the volatility risks generate a sizable equity premium in our model.

Merton (1973) first argues for a positive stock market variance-return relation, which also holds in standard dynamic rational-expectations asset pricing models. The empirical evidence for the conjecture is, however, elusive, and Lochstoer and Muir (2022), Nagel and Xu (2022), and Yang (2022) attribute the weak relation to investors' cognitive biases.

Guo and Whitelaw (2006), Guo and Savickas (2008), and Guo, Savickas, Wang, and Yang (2009) uncover a positive partial stock market variance-return relation when using scaled market prices, average stock variance and value premium variance, respectively, as a proxy for hedging risk factors. Our model offers a unified explanation for these findings.

Adrian, Crump, and Vogt (2019) document a nonlinear relation between conditional equity premia and market variance. Kilic and Shaliastovich (2019) find that bad (good) variance risk premium correlates positively (negatively) with future market returns. Fear and euphoria variances have significant predictive power even when we control for these effects.

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correlates positively with the cross-section of expected stock returns. The evidence also supports the argument for a negative IST risk price. If the IST risk price is negative, stocks with a large loading on IST shocks have a high market price and, hence, a low investment-market equity ratio.

The conventional wisdom is that stock market prices decrease with variance (e.g., Lettau, Ludvigson, and Wachter (2008)). The variance-price relation, however, is often non-monotonic in models with learning (e.g., Pastor and Veronesi (2009), Ju and Miao (2012), and Ghaderi, Kilic, and Seo (2022)). Specifically, Pastor and Veronesi (2009) argue that uncertainty about information technology produces big spikes in both market prices and variance during the dot-com bubble.

Guo (2004) argues that stock market variance is a U-shaped function of scaled market prices. In his limited stock market participation model, shareholders' liquidity condition is the primary driver of financial market dynamics. While positive (negative) liquidity shocks increase (decrease) market prices, both types of shocks increase market variance.

Segal, Shaliastovich, and Yaron (2015) argue that good (bad) variance, which is the uncertainty of positive (negative) economic news, correlates positively (negatively) with stock market prices. In their model, both variances contribute positively to the conditional equity premium, and their direct impacts on stock market prices are negative. The good variance-price relation is positive because good variance correlates positively with future economic growth. We argue that euphoria variance correlates positively with scaled market prices because of its negative relation with equity premia.

III. Empirical Motivations

We provide empirical evidence to motivate the assumptions adopted in the model presented in the next section. A positive IST shock decreases current consumption and increases future consumption. In addition, DT shocks have positive effects on both current and future consumption. Moreover, IST shocks correlate positively with current and future dividends, as do

DT shocks. We examine these assumptions using (1) the Papanikolaou (2011) IST measure and (2) our model's implication that market returns are a proxy for the DT shock when we control for their correlation with the IST shock.

Panel A of Table I shows that aggregate consumption growth correlates negatively with IST shocks and positively with market returns in the multiple ordinary least squares (OLS) regression. However, the relation is negligible for IST shocks in the simple regression. These results reflect omitted variable bias. Consistent with our model's implications, IST shocks and excess market returns are positively correlated but have opposing effects on consumption growth.[4] Our model and empirical findings offer a potential explanation for the weak and unstable wealth effect documented by Ludvigson and Steindel (1999).

We use median SPF (Survey of Professional Forecasters) forecasts to measure expected economic growth. Table I shows that IST shocks correlate positively and significantly with 2-year consumption (Panel B), 10-year GDP (Panel C), and 10-year productivity (Panel D) forecasts. Panels E and F report similar results for the FOMC Tealbook (formerly Greenbook) PCE and GDP forecasts over the next seven quarters, respectively. These novel findings indicate that IST

[4]Aggregate consumption is measured using real-time real personal consumption expenditures (PCE) on nondurable goods and services. As shown in the online Appendix, our model quantitatively explains the findings reported in Panel A of Table I, including the omitted variable problem. In reality, market returns might have many other determinants that also affect consumption. To address this issue, we follow Garlappi and Song (2016) to use the percentage change in the total factor productivity, ΔTFP, as a measure of DT shocks and find that stock market returns correlate positively and significantly with both IST shocks and ΔTFP in the multiple regression. Moreover, results reported in Panel A remain qualitatively similar when we use ΔTFP as an instrumental variable for excess market returns, suggesting that DT shocks are an essential driver of both market returns and aggregate consumption growth. For brevity, these results are provided in the online Appendix.

shocks are a crucial driver of long-run growth. DT shocks correlate positively with economic activity forecasts in simple regressions, while the relation is noticeably weaker, especially in multiple regressions.

Table I shows that both IST and DT shocks correlate positively with three standard corporate cash flow measures: free cash flows (Panel G), net equity payouts (Panel H), and earnings (Panel I).[5]. In addition, both shocks have strong positive effects on SPF forecasts of aggregate corporate profits over the next two years (Panel J). The online Appendix shows similar results for analysts' long-run earnings forecasts. These findings also align with the argument that IST and DT shocks are crucial drivers of long-run economic growth, through which technology shocks affect future dividends in standard long-run risk models.

Figures 1 and 1 report estimated impulse responses (solid lines) of consumption to DT and IST shocks, respectively. A positive DT shock increases current and future consumption, while IST shocks correlate negatively (positively) with current (future) consumption. These results are consistent with those reported in Table I.

In the long-run risk model, stock market variance originates from aggregate uncertainty. We estimate the conditional variance of real PCE (nondurable goods and services) growth using the GARCH (1,1) model from 1985Q1 to 2018Q4. Figure 2 shows that, like stock market

[5]Firms use only retained earnings to finance their investments in standard production-based asset pricing models. The assumption implies countercyclical dividends, the difference between earnings and investments (Kaltenbrunner and Lochstoer (2010)). Debt financing is widely used in practice. Davydiuk, Richard, Shaliastovich, and Yaron (2021) emphasize that at the aggregate level, investments of public companies can be financed by labor income and savings in addition to retained earnings. The empirical counterpart of "dividends" in these models are cash flows available for debt and equity investors.

variance (thick dashed line), consumption variance (thin dashed line) correlates positively with the price-earnings ratio (solid line) during the dot-com bubble, while the relation is negative during the subprime mortgage crisis.

IV. Model

This section presents a model to explain the unstable stock market variance-return or price relations. For brevity, we focus on the model's (1) main assumptions motivated by the empirical evidence reported in the preceding section and (2) main theoretical implications. We provide the detailed derivations in the online Appendix.

A. Preference and Aggregate Consumption Dynamics

Households have the recursive utility function $U_t = \left[(1-\delta)C_t^{\frac{1-\gamma}{\theta}} + \delta\big(\mathbb{E}_t[U_{t+1}^{1-\gamma}]\big)^{\frac{1}{\theta}}\right]^{\frac{\theta}{1-\gamma}}$, where $0 < \delta < 1$ is the time discount factor, $\gamma > 0$ is the relative risk aversion coefficient, $\psi > 0$ is the elasticity of intertemporal substitution, and $\theta = \frac{1-\gamma}{1-\frac{1}{\psi}}$. We use uppercase letters for original variables and lowercase letters for their natural logarithms unless otherwise indicated. Aggregate consumption dynamics are as follows:

$$
\begin{aligned}
\Delta c_{t+1} &= \mu_c + x_t + \sigma_{g,t}\eta_{t+1} - \psi_x \sigma_{x,t} e_{t+1}, \\
x_{t+1} &= \rho x_t + \varphi_\eta \sigma_{g,t}\eta_{t+1} + \varphi_e \sigma_{x,t} e_{t+1}, \\
\sigma_{g,t+1}^2 &= \sigma_g^2 + v_g(\sigma_{g,t}^2 - \sigma_g^2) + \sigma_1 z_{1,t+1}, \\
\sigma_{x,t+1}^2 &= \sigma_x^2 + v_x(\sigma_{x,t}^2 - \sigma_x^2) + \sigma_2 z_{1,t+1} + \sigma_3 z_{2,t+1}.
\end{aligned} \tag{1}
$$

Δc_{t+1} is the log consumption growth rate with the unconditional mean μ_c. x_t is the expected log consumption growth rate, which has a zero mean and follows an autoregressive process of order one or AR(1) process.

The DT shock, η_{t+1}, has positive effects on both (1) current and (2) future ($\varphi_\eta > 0$) consumption. The IST shock, e_{t+1}, decreases current ($\psi_x > 0$) but increases future ($\varphi_e > 0$) consumption. These assumptions are consistent with results reported in Table I.[6] $\sigma^2_{g,t}$ and $\sigma^2_{x,t}$ are the conditional variances of DT and IST shocks, respectively. $\sigma^2_{g,t}$ and $\sigma^2_{x,t}$ follow AR(1) processes with the unconditional means σ^2_g and σ^2_x and with homoscedastic shocks $z_{1,t+1}$ and $z_{2,t+1}$, respectively. The term $\sigma_2 z_{1,t+1}$ determines the correlation between $\sigma^2_{g,t}$ and $\sigma^2_{x,t}$. The shocks, η_{t+1}, e_{t+1}, $z_{1,t+1}$, and $z_{2,t+1}$ have i.i.d. standard normal distributions. Our model is equivalent to the Bansal and Yaron (2004) model when we remove IST shocks.

B. Pricing Kernel

Using the Campbell and Shiller (1988) log-linear approximation, we can write the log return on the claim to aggregate consumption as $r_{a,t+1} = k_0 + k_1 z_{t+1} - z_t + \Delta c_{t+1}$, where $z_t = \ln(P_t/C_t)$ is the log price-consumption ratio, $\bar{z} = \mathbb{E}[z_t],\ k_0 = \ln(e^{\bar{z}} + 1) - \frac{\bar{z}e^{\bar{z}}}{e^{\bar{z}}+1}$, and $k_1 = \frac{e^{\bar{z}}}{e^{\bar{z}}+1} < 1$. The log price-consumption ratio is a linear function of state variables: $z_t = A_0 + A_1\sigma^2_{g,t} + A_2\sigma^2_{x,t} + A_3 x_t$, where $A_1 = \frac{(1-\gamma+\theta k_1 A_3 \varphi_\eta)^2}{2\theta(1-k_1 v_g)}$, $A_2 = \frac{[(\gamma-1)\psi_x+\theta k_1 A_3\varphi_e]^2}{2\theta(1-k_1 v_x)}$, and

[6]The evidence for $\varphi_\eta > 0$ is somewhat weak, possibly because of the small sample. Kaltenbrunner and Lochstoer (2010) and Croce (2014) show that DT shocks can endogenously generate persistent consumption growth, and we find that DT shocks correlate strongly with long-run corporate profit forecasts. That said, we show below that $\varphi_\eta > 0$ is not a necessary assumption for our model's main theoretical implications.

$A_3 = \frac{1-\frac{1}{\psi}}{1-k_1\rho}$. The shock to the log pricing kernel is

$$\begin{aligned} m_{t+1} - \mathbb{E}_t[m_{t+1}] &= -\lambda_{DT}\sigma_{g,t}\eta_{t+1} - \lambda_{IST}\sigma_{x,t}e_{t+1} \\ &\quad + k_1(\theta-1)(A_1\sigma_1 + A_2\sigma_2)z_{1,t+1} + k_1(\theta-1)A_2\sigma_3 z_{2,t+1}. \end{aligned} \tag{2}$$

$\lambda_{DT} = \gamma - k_1\varphi_\eta\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}$ is the risk price of the DT shock, η_{t+1}, and has two parts. The first part, γ, is positive because DT shocks increase current consumption. We follow Bansal and Yaron (2004) to assume that households prefer early resolution of uncertainty or $\gamma > \frac{1}{\psi}$. The second part, $-k_1\varphi_\eta\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}$, which reflects the positive effect of DT shocks on future consumption, is also positive. $\lambda_{IST} = -\gamma\psi_x - k_1\varphi_e\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}$ is the risk price of the IST shock, e_{t+1}, and has ambiguous sign. $-\gamma\psi_x$ is negative because IST shocks decrease current consumption. When households prefer early resolution of uncertainty, $-k_1\varphi_e\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}$ is positive because IST shocks increase future consumption. The IST risk price is negative in our calibration because $-\gamma\psi_x$ dominates $-k_1\varphi_e\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}$ in magnitude. The risk price is negative for uncertainty innovations, $z_{1,t+1}$ and $z_{2,t+1}$, under the standard assumption $\gamma > 1$.

C. Stock Market Returns

Results reported in Table I imply the following process for the aggregate dividend:

$$\Delta d_{t+1} = \mu_d + \phi x_t + \pi_\eta\sigma_{g,t}\eta_{t+1} + \pi_e\sigma_{x,t}e_{t+1}. \tag{3}$$

The log dividend growth rate depends positively on both DT ($\pi_\eta > 0$) and IST ($\pi_e > 0$) shocks, which also correlate positively with future dividends via their positive effects on x_t. We follow Bansal and Yaron (2004) to assume a constant leverage ratio $\phi > 1$.

The log-linearized stock market return is $r_{m,t+1} = k_{0,m} + k_{1,m} z_{m,t+1} - z_{m,t} + \Delta d_{t+1}$, where $z_{m,t} = \ln(P_{m,t}/D_t)$ is the log price-dividend ratio, $\bar{z}_m = \mathbb{E}[z_{m,t}]$, $k_{0,m} = \ln(e^{\bar{z}_m} + 1) - \frac{\bar{z}_m e^{\bar{z}_m}}{e^{\bar{z}_m}+1}$, and $k_{1,m} = \frac{e^{\bar{z}_m}}{e^{\bar{z}_m}+1} < 1$. The log price-dividend ratio is a linear function of state variables:

(4)
$$z_{m,t} = A_{0,m} + A_{1,m}\sigma_{g,t}^2 + A_{2,m}\sigma_{x,t}^2 + A_{3,m}x_t,$$

where $A_{1,m} = \frac{1}{1-k_{1,m}v_g}[(\theta-1)(k_1 v_g - 1)A_1 + \frac{1}{2}(\beta_{DT} - \lambda_{DT})^2]$, $A_{2,m} = \frac{1}{1-k_{1,m}v_x}\left[(\theta-1)(k_1 v_x - 1)A_2 + \frac{1}{2}(\beta_{IST} - \lambda_{IST})^2\right]$, and $A_{3,m} = \frac{\phi - \frac{1}{\psi}}{1-k_{1,m}\rho}$. Note that $\beta_{DT} = \pi_\eta + k_{1,m}A_{3,m}\varphi_\eta$ and $\beta_{IST} = \pi_e + k_{1,m}A_{3,m}\varphi_e$ are loadings of the market portfolio on DT and IST shocks, respectively.

The conditional equity premium is a linear function of DT and IST variances

(5)
$$\mathbb{E}_t[r_{m,t+1} - r_t^f] + \frac{1}{2}\sigma_{m,t}^2 = c_0 + \lambda_{DT}\beta_{DT}\sigma_{g,t}^2 + \lambda_{IST}\beta_{IST}\sigma_{x,t}^2,$$

where r_t^f is the log risk-free rate, $\frac{1}{2}\sigma_{m,t}^2$ is the Jensen's inequality adjustment term, $\sigma_{m,t}^2$ is market variance, c_0 is a generic constant term. Both β_{DT} and β_{IST} are positive because DT and IST shocks have positive effects on current and future aggregate cash flows, and we follow Bansal and Yaron (2004) to assume that $A_{3,m} > 0$ or $\phi > \frac{1}{\psi}$. Therefore, the conditional equity premium depends positively on DT variance and negatively on IST variance. As mentioned in footnote 6, this key theoretical implication holds even when φ_η is zero.

There is a mechanical inverse relation between stock prices and discount rates. The coefficients of DT and IST variances in equation (4) of the price-dividend ratio decrease with their counterparts in equation (5) of the conditional equity premium. In our calibration, an increase in DT (IST) variance increases (decreases) the conditional equity premium and, therefore, lowers (raises) stock market prices.[7] To highlight their distinct effects on stock market prices, we dub $\sigma^2_{g,t}$ fear variance and $\sigma^2_{x,t}$ euphoria variance.

Conditional market variance is a linear function of fear and euphoria variances

$$\sigma^2_{m,t} = c_0 + \beta^2_{DT}\sigma^2_{g,t} + \beta^2_{IST}\sigma^2_{x,t}. \tag{6}$$

Existing empirical studies focus on the relationship between expected stock market variance and returns. In addition, market variance and IST variance are more reliably available in data than DT variance. For these reasons, we use equation (6) to substitute DT variance out by market variance in main theoretical implications.

Using equations (4) and (6), we rewrite the log stock market price-dividend ratio as

$$z_{m,t} = c_0 + \frac{A_{1,m}}{\beta^2_{DT}}\sigma^2_{m,t} + (A_{2,m} - \frac{A_{1,m}\beta^2_{IST}}{\beta^2_{DT}})\sigma^2_{x,t} + A_{3,m}x_t. \tag{7}$$

[7] The coefficients in equation (4) are not linear functions of their counterparts in equation (5) because the discount rate equals the sum of the equity premium and the risk-free rate. Because the risk-free rate is relatively smooth in both data and our model, the equity premium is the dominant determinant of the discount rate and, hence, the price-dividend ratio.

The coefficient of market variance has the same (negative) sign as the coefficient of fear variance in equation (4). Similarly, the coefficient of euphoria variance has the same (positive) sign as that in equation (4) because $A_{1,m} < 0$. Thus, market variance is a proxy for fear variance when we control for its correlation with euphoria variance.

The conditional equity premium is also a linear function of market and euphoria variances

$$(8) \qquad \mathbb{E}_t[r_{m,t+1} - r_t^f] + \frac{1}{2}\sigma_{m,t}^2 = c_0 + \frac{\lambda_{DT}}{\beta_{DT}}\sigma_{m,t}^2 + (\lambda_{IST}\beta_{IST} - \frac{\lambda_{DT}\beta_{IST}^2}{\beta_{DT}})\sigma_{x,t}^2.$$

The coefficient of market variance has the same (positive) sign as the coefficient of fear variance in equation (5). Similarly, the coefficient of euphoria variance is negative if the coefficient of euphoria variance in equation (5) is negative.

D. Individual Stock Returns

The log dividend growth rate of stock p is

$$(9) \qquad \Delta d_{p,t+1} = \mu_d + \phi_p x_t + \pi_{\eta,p}\sigma_{g,t}\eta_{t+1} + \pi_{e,p}\sigma_{x,t}e_{t+1} + \pi_p z_{p,t+1},$$

where $z_{p,t+1}$ is an i.i.d. standard normal homoscedastic idiosyncratic shock. The conditional risk premium of stock p is a linear function of market (or fear) and euphoria variances:

$$(10) \qquad \mathbb{E}[r_{p,t+1} - r_t^f] = c_0 + \alpha_p E[\sigma_{m,t}^2] + \beta_p E[\sigma_{x,t}^2],$$

where the coefficients α_p and β_p depend on loadings of stock p's cash flows on DT and IST shocks, respectively.

E. The Risk-Free Rate

Using the Euler equation $\mathbb{E}_t[M_{t+1}R_t^f] = 1$ and equation (6), we have the risk-free rate

$$r_t^f = c_0 + \frac{1}{\psi}x_t + c\frac{1}{\beta_{DT}^2}\sigma_{m,t}^2 + [d - c\frac{\beta_{IST}^2}{\beta_{DT}^2}]\sigma_{x,t}^2, \tag{11}$$

where $c = -[(\theta-1)(k_1 v_g - 1)A_1 + \frac{1}{2}\lambda_{DT}^2]$, and $d = -[(\theta-1)(k_1 v_x - 1)A_2 + \frac{1}{2}\lambda_{IST}^2]$. The risk-free rate depends on both market (or fear) and euphoria variances because of the precautionary saving effect. It also increases with the expected consumption growth, x_t.

F. Negative Correlation Condition

In our model, NCC depends on both fear and euphoria variances:

$$\begin{aligned} & cov_t(M_{t+1}(1+R_{m,t+1}),(1+R_{m,t+1})) = \\ & \mathbb{E}_t(1+R_{m,t+1})[\exp\left(a_0 + a_1\sigma_{g,t}^2 + a_2\sigma_{x,t}^2)\right) - 1], \end{aligned} \tag{12}$$

where a_0 is a constant term, $a_1 = \beta_{DT}^2 - \lambda_{DT}\beta_{DT}$, and $a_2 = \beta_{IST}^2 - \lambda_{IST}\beta_{IST}$. Because $\mathbb{E}_t(1+R_{m,t+1})$ is positive, the sign of $cov_t(M_{t+1}(1+R_{m,t+1}),(1+R_{m,t+1}))$ is the same as that of $[\exp\left(a_0 + a_1\sigma_{g,t}^2 + a_2\sigma_{x,t}^2)\right) - 1]$. NCC holds in standard long-run risk models, in which $a_0 < 0$, $a_1 < 0$, and $a_2 = 0$. In our model, a_2 is positive because $\lambda_{IST} < 0$ and $\beta_{IST} > 0$. In addition, a_1 is negative, as in standard long-run risk models. Thus, NCC may be violated when IST variance dominates DT variance or the market valuation multiple is high.

G. Model's Main Novel Implications

By including IST shocks as an additional driver of economic dynamics, our model has several novel implications compared with standard long-run risk models.

First, the stock market variance-price relation is unstable because in equation (4), the price-dividend ratio depends negatively (positively) on fear (euphoria) variance. In addition, equation (7) shows that the *partial* market variance-price relation is negative in multiple regressions when we control for euphoria variance, which correlates positively with the price-dividend ratio. Moreover, the opposing effects of fear and euphoria variances on stock prices enable our model to match the observed large variation in the price-dividend ratio.

Second, as we illustrate in equation (5), the market variance-return relation is positive (negative) when fear (euphoria) variance is the dominant component of aggregate uncertainty. In addition, equation (8) shows that the *partial* market variance-return relation is positive in multiple regressions when we control for euphoria variance, which correlates negatively with the conditional equity premium.

Third, equation (10) shows that loadings on the market (α_p) and euphoria (β_p) variances help explain the cross-section of expected excess stock returns. In addition, their explanatory power is similar to loadings on DT and IST shocks, which are related to α_p and β_p, respectively. We use this theoretical implication to validate cross-sectional risk factors.

Fourth, if a stock has larger loadings on IST shocks, its variance comprises more IST variance. Because the IST risk price is negative, the stock has a lower risk premium and, hence, a higher price. A price- or value-weighted average stock variance is a proxy for euphoria variance. We use this theoretical implication to validate the empirical IST measure.

Last, $cov_{t-1}(M_t(1+R_{m,t}),(1+R_{m,t}))$ can sometimes be positive because it increases with euphoria variance. In the next section, we illustrate these implications using model simulation.

V. Model Simulation

A. Calibration

Table II presents parameter values used to calibrate the model at the monthly frequency. With two exceptions, parameter values for DT shocks are identical to those adopted in Bansal et al. (2012): $\mu_c = \mu_d = 0.0015$; $\rho = 0.975$; $v_g = 0.999$; $\sigma_1 = 0.0000028$; $\phi = 2.5$; and $\pi_\eta = 2.6$.[8] The parameters $\varphi_\eta = 0.05$ and $\sigma_g = 0.005$ are similar to 0.038 and 0.0072, respectively, in Bansal et al. (2012). A smaller σ_g offsets the increase in short-run consumption volatility associated with newly added IST shocks and reduces the equity premium. A larger φ_η increases the long-run effects of DT shocks on consumption and, hence, the equity premium.

We set $\psi_x = 0.0389$ and $\sigma_x = 0.005$ to ensure that IST shocks do not drastically increase consumption volatility. A one standard deviation increase in IST shocks reduces current consumption by $0.0389 * 0.005 * \sqrt{12} = 0.07\%$ per year. Figure 3 in Papanikolaou (2011)

[8]Shocks to current and future consumption are distinct in Bansal et al. (2012). We loosely refer to them as DT shocks, which positively affect current and future consumption in our model.

(reproduced in Figure 3) shows that a one standard deviation increase in IST shocks lowers current consumption by 0.15%*2=0.30% a year, with the lower bound of about 0.07%.

A positive IST shock also leads to a permanent increase in future consumption. The net benefit of the shock is the present value of the associated consumption changes, which decreases with the discount rate. The estimated annual impulse responses (solid line) reported in Figure 1 have a zero present value when the annual discount rate is about 9.67%. This break-even discount rate implies $\varphi_e = 0.001256$ in our model.[9]

The dashed line in Figure 1 shows the annual model impulse responses, scaled to have the same long-run value as its empirical counterpart (solid line). Similarly, Figure 3 shows that the quarterly model impulse responses also closely match the lower bound reported by Papanikolaou (2011), which we reproduce in Figure 3. Using the codes and data obtained from Dimitris Papanikolaou at Northwestern University, we find that the impulse responses of consumption are negative in the first 40 quarters. Our model thus reasonably matches the estimated effect of IST shocks on consumption.

The parameter $\pi_e = 3.5$ implies that a one standard deviation increase in IST shocks increases current dividends by $\mathbb{E}[\pi_e \sigma_{x,t}] = 3.5 * 0.005 * \sqrt{12} = 6.06\%$ per year. The calibration is consistent with the empirical evidence in Table I. The estimated coefficient of IST shocks in the aggregate earnings (free cash flow) growth regression is 0.368 (0.367), and the standard deviation of IST shocks is 0.196. These estimates indicate that a one standard deviation increase in IST

[9]We assume that consumption is 100 before an IST shock and construct the consumption path using the impulse responses. We choose the parameter value for φ_e so that the present value of the difference between the consumption paths with and without the IST shock equals zero at the break-even discount rate.

shocks raises annual earnings (free cash flows) by 7.21% (7.19%), respectively. The results are quantitatively similar for the net equity payout growth.

The parameters $v_x = 0.9995$ and $\sigma_3 = 0.000005$ are larger than their respective DT counterparts. These parameter values enable us to use large volatility risks to offset the negative effect of IST variance on the equity premium in our model. Using the DT parameter values for IST shocks generates smaller equity premiums, although it does not affect our main results qualitatively. Segal (2019) also relies on large volatility risks to match the observed equity premium.

DT shocks positively affect aggregate consumption and dividends and induce a strong positive correlation between the two variables. To match the correlation implied by their model with its data counterpart, Bansal et al. (2012) assume that dividends have a large idiosyncratic risk. Because IST shocks have opposing effects on aggregate consumption and dividends, we do not need the idiosyncratic risk in our model.

We set $\gamma = 3.7$ and $\psi = 1.02$, compared with $\gamma = 10$ and $\psi = 1.5$ in Bansal et al. (2012). Our parameter values align with the mounting evidence of limited stock market participation. For top shareholders, the γ estimate is as low as 3.99 in Malloy, Moskowitz, and Vissing-Jørgensen (2009) and the average of ψ estimates is 0.90 in Vissing-Jørgensen (2002). A smaller ψ helps explain the observed standard deviation of the risk-free rate, which challenges standard long-run risk models. A smaller ψ also implies a higher risk-free rate; we set $\delta = 0.9998$ instead of 0.9989 adopted in Bansal et al. (2012) to offset this effect. These parameter values imply a negative IST risk price in our model.

Last, we assume that fear and euphoria variances are uncorrelated by setting the parameter $\sigma_2 = 0$. The specification is similar to the zero correlation between bad and good variances or environment fundamentals adopted in the calibration of Segal et al. (2015) and Bekaert and Engstrom (2017). The online Appendix shows that allowing for a moderate correlation between the two variances does not qualitatively change our main results.

B. Aggregate Quantities and Asset Prices

Table III shows the summary statistics of key variables. The column titled "Data Estimate" reproduces the Bansal et al. (2012) estimation from actual data spanning the 1930 to 2008 period with 79 annual observations. We also use the Papanikolaou (2011) IST measure to calculate the correlation of market returns with IST shocks, $Corr(R, e)$. We generate 1,948 monthly observations for each simulation, discard the first 1,000 observations, and convert the remaining 948 observations into 79 annual observations.

For comparison with actual data, we sum up monthly consumption in a year and then use annual consumption to calculate annual consumption growth. As Working (1960) points out, this measure of annual consumption growth has a positive time-aggregation bias of up to 0.25 in its first-order autocorrelation. Annual dividend growth is constructed similarly. We conduct 10,000 simulations and report the distribution of the summary statistics in columns under the title "Model". The column "Pop" reports the summary statistics from the simulation of 100,000 annual observations.

The price-dividend ratio and the risk-free rate in the Bansal et al. (2012) model are far too smooth compared with their empirical counterparts. By contrast, Table III shows that key statistics of all selected variables are within the 95% interval of simulated data. The price-dividend ratio is more volatile in our model compared with Bansal et al. (2012), as it correlates positively with euphoria variance and has a fat right tail, as during the dot-com bubble. Our model has a more volatile risk-free rate than the Bansal et al. (2012) model because of lower ψ and more volatile expected economic growth influenced by both DT and IST shocks. It is worth noting that the median correlation of IST shocks with market returns in simulated data (0.56) closely matches its empirical counterpart (0.44).

The observed volatility of aggregate consumption (2.16%) is within the 90% interval of simulated data. The median volatility of 3.06% in our model is somewhat higher than 2.47% in the Bansal et al. (2012) model, although both are lower than that of shareholders' consumption reported in Vissing-Jørgensen (2002) and Malloy et al. (2009). Our calibration is consistent with the evidence that marginal investors are less risk-averse and bear more systematic risks than average households.

Over the period 1967 to 2016, the summary statistics of earnings, free cash flows, and net equity payouts are similar to those of dividends, with one exception. Consistent with the evidence documented by Davydiuk et al. (2021), we find that the growth rates of the alternative cash flow measures are more volatile than those of dividends. Noting that the total payout has more unpriced idiosyncratic risk than dividends, Davydiuk et al. (2021) use a long-run risk model to show that the two cash flow measures have the same asset pricing implications. Similarly, our main results remain intact when we follow Bansal et al. (2012) and Davydiuk et al. (2021) to add an idiosyncratic shock to the dividend growth in equation (3) to match the volatility of alternative cash flow measures. With this caveat, we focus on the calibration parameters in Table II for theoretical illustration.

C. Stock Market Variance-Price Relation

This subsection illustrates the relation between stock market variance and the log price-dividend ratio. For comparison with empirical findings based on the quarterly sample from 1963Q1 to 2016Q4, we use 216 quarterly observations in each simulated sample. Specifically, we generate a monthly sample of 1,648 observations, discard the first 1,000 observations, and convert the remainder into 216 quarterly observations. We generate 10,000 simulated samples and report their distributions in Table IV. The column "Pop" reports the results of 100,000 simulated quarterly observations.

Panel A of Table IV reports OLS estimation results of regressing the log price-dividend ratio on a constant and market variance. Because standard asset pricing models stipulate a negative variance-price relation, we sort the coefficient of market variance and its t-value from high to low. The R^2 is sorted from low to high. The simple variance-price relation is unstable in our model. It is either positive or insignificant in over 30% of simulated samples, and the median R^2 is only 20%. Similarly, Figure 4 shows that conditional stock market variance is a V-shaped function of the price-dividend ratio.

The unstable stock market variance-price relation reflects that, as we illustrate in Panel B of Table IV, the price-dividend ratio increases with euphoria variance in our model. Moreover, equation (7) shows that the price-dividend ratio is a linear function of market variance, euphoria variance, and expected economic growth. The coefficient of market variance is negative in multiple regressions. When we control for its correlation with IST variance, market variance is a proxy for DT variance.

To illustrate this point, in Panel C of Table IV, we report the OLS estimation results of regressing the price-dividend ratio on both market and euphoria variances. The coefficient of market (euphoria) variance is always negative (positive). Shiller (1981) shows that expected dividend growth accounts for a relatively small fraction of variation in stock market prices. Consistent with this evidence, the median R^2 is around 90%, indicating that market and euphoria variances are the two main drivers of stock market fluctuations.

D. Stock Market Variance-Return Relation

We follow existing studies to use the realized excess market return as a proxy for the conditional equity premium. Panel A of Table V shows that the stock market variance-return relation is unstable in simple regressions. The coefficient of market variance, VMKT, is negative in over 30% of simulated samples. The result reflects that, as we show in Panel B, euphoria variance (VE), a component of market variance, correlates negatively with future excess market returns. We illustrate this point using two figures. First, as mentioned above, conditional market variance is a V-shaped function of the price-dividend ratio (Figure 4). Second, consistent with the present-value relation, the conditional equity premium decreases monotonically with the price-dividend ratio (Figure 4). Therefore, the variance-return relation can be positive, negative, or insignificant in small samples, depending on the relative importance of fear and euphoria in the stock market.

When we include both variances in the forecast regression in Panel C of Table V, the coefficient of the market (euphoria) variance is positive (negative) in most simulated samples. In addition, the coefficients, t-values, and R^2 in Panel C are larger in magnitude than their simple regression counterparts in Panels A and B. The difference between simple and multiple regressions reflects omitted variable bias. In simulated data, the median correlation of market variance with euphoria variance is 65%, although they have opposing effects on future market returns. As a result, in the simple regressions, the estimated coefficient of the market (euphoria) variance is biased downward (upward) toward zero.

As we show in the online Appendix, the price-dividend ratio negatively predicts excess market returns in our model because of its strong correlations with market and euphoria variances (Table IV). Moreover, consistent with the evidence documented by Guo and Whitelaw (2006), market variance correlates positively with future market returns when the price-dividend ratio is also included in forecast regressions. The scaled market price is a proxy for euphoria variance when we control for its correlation with market variance in multiple forecast regressions.

E. Value-Weighted Average Stock Variance

To illustrate implications for the cross-section of stock returns, we construct 125 portfolios with different loadings on systematic risks using equation (9). Specifically, ϕ_p, $\pi_{\eta,p}$, and $\pi_{e,p}$ take one of five possible values [1.7, 2.1, 2.5, 3.0, 3.3], [1.8, 2.2, 2.6, 3.0, 3.4], and [2.7, 3.1, 3.5, 3.9, 4.3], respectively. The average values of ϕ_p, $\pi_{\eta,p}$, and $\pi_{e,p}$ equal respectively those of the market portfolio. The idiosyncratic volatility, π_p, is 0.003 for all portfolios.

Stocks with larger $\pi_{e,p}$ or more loadings on IST shocks have higher price-dividend ratios, ceteris paribus. In addition, their variance contains relatively more euphoria components. Thus, the value-weighted average stock variance (VWASV) has a stronger correlation with euphoria variance than with fear variance. Our simple setup does not have a formal specification for the cross-sectional distribution of market capitalization. We use the squared price-dividend ratio as the weight in simulated data as an approximation.

The correlation between VWASV and euphoria variance is 84%, compared with only 52% with fear variance. By contrast, the equal-weighted average stock variance has almost identical correlations with euphoria and fear variances. Panels D of Tables IV and V show that the explanatory power of VWASV for the log price-dividend ratio and the equity premium, respectively, is very similar to that of euphoria variance.

F. The Cross-Section of Stock Returns

We run the Fama and MacBeth (1973) regression using the 125 portfolios above. In Panel A of Table VI, we use DT and IST shocks as the risk factors and estimate the factor loadings using the full sample. The estimated DT (IST) risk price in most simulated samples is positive (negative). The median R^2 is 93%, indicating that DT and IST shocks account for the most variation in cross-sectional stock returns in our model.

The pricing of DT and IST shocks can be estimated using an alternative specification. In equation (10), loadings on market and euphoria variances, which depend respectively on exposures to DT and IST shocks, explain cross-sectional portfolio returns. To examine this implication, in the first stage of the Fama and MacBeth (1973) regression, for each portfolio, we run a time-series forecast regression of its excess returns on lagged market and euphoria variances using the full sample. In the second stage, we run the cross-sectional regression of portfolio returns on their market variance loadings, $\hat{\alpha_p}$, and euphoria variance loadings, $\hat{\beta}_p$. $\hat{\alpha_p}$ ($\hat{\beta}_p$) is positive (negative) for portfolios with positive exposures to DT (IST) shocks. The estimated risk prices of loadings $\hat{\alpha_p}$ and $\hat{\beta}_p$ are positive because they equal the unconditional means of market and euphoria variances, respectively.

Panel B of Table VI shows that the estimated risk prices are positive for both market (VMKT) and euphoria (VE) variances in most simulated samples. The median R^2 of 78% is comparable to that obtained using the conventional specification reported in Panel A. The results are similar when we use VWASV as a proxy for euphoria variance (Panel C).

G. Negative Correlation Condition

$cov_t(M_{t+1}(1 + R_{m,t+1}), (1 + R_{m,t+1}))$ is always negative in standard long-run risk models as they include only fear variance. By contrast, as we show using simulated data, it can also be positive in our model when euphoria variance is the dominant component of aggregate uncertainty (Figure 5) or the price-dividend is high (Figure 5). This implication is consistent with the evidence that NCC does not always hold (Bakshi, Crosby, Gao, and Zhou (2021)), especially during the dot-com bubble (Gao and Martin (2021)).

H. Alternative IST Shock Calibration

Justiniano, Primiceri, and Tambalotti (2010) analyze a dynamic stochastic general equilibrium (DSGE) model in which IST shocks are transitory, and households have habit preference. Treating IST shocks as a latent variable, they estimate the model using the Bayesian method. Similar to the results reported in Figure 1, Justiniano et al. (2010) show in Figure 3 that consumption decreases initially and increases eventually following a positive IST shock.

However, their estimated initial consumption decline is much smaller and, as shown in the online Appendix, implies a much higher break-even discount rate of 35.75%.

Because we are mainly interested in asset pricing implications, the direct IST measure proposed by Papanikolaou (2011) offers more relevant empirical guidance for our model calibration than does the latent estimation of a DSGE model that includes many types of economic shocks and identification assumptions. In addition, we empirically validate our model's main assumptions and implications using the equity return-based IST measure.

As a robustness check, we use the 35.75% break-even discount rate to calibrate IST shocks by increasing φ_e from 0.001256 in the benchmark model to 0.0022. The IST risk price is negative and relatively large for $\gamma = 2.5$ and $\psi = 0.7$. The online Appendix shows that our main theoretical results for the alternative calibration are qualitatively similar. Market variance is a V-shaped function of the price-dividend ratio, while the conditional equity premium decreases monotonically with the price-dividend ratio. Empirical statistics of the key variables reported in Table III are also within the 95% interval of simulated data with one exception. The 2.5 percentile of consumption volatility (2.31%) in simulated data is slightly higher than 2.16% in actual data. Nevertheless, it is much lower than shareholders' consumption volatility reported in Vissing-Jørgensen (2002) and Malloy et al. (2009).

VI. Empirical Tests of Main Theoretical Implications

A. Forecasting Excess Stock Market Returns

Table VII reports the OLS estimation results of forecasting one-quarter-ahead excess stock market returns. VMKT is market variance. Vβ_{IMC} is the variance of the Papanikolaou (2011) IST measure—the return difference between high and low IMC (the equity return spread between investment and consumption goods producers) beta stocks. VMKT (Vβ_{IMC}) correlates positively (negatively) with future excess market returns in simple regressions (Panel A). As conjectured, VMKT and Vβ_{IMC} have stronger predictive power together than individually (panel B). They also predict out-of-sample market returns (Panel C). As a robustness check, we follow Kogan and Papanikolaou (2013) and Kogan and Papanikolaou (2014) to construct alternative equity return-based IST measures and find similar results for the average of ten standardized IST-based euphoria variance measures, AVEV. The online Appendix shows that the results are similar for each of these ten euphoria variance measures. For brevity, we focus mainly on Vβ_{IMC} in the remainder of the paper.

B. Stock Market Variance and Prices

In our model, the log price-dividend ratio depends negatively and positively on market and euphoria variances, respectively. It also correlates positively with future consumption growth (FCG), which we measure using consumption growth over the following 40 quarters in empirical analyses. Panel A of Table VIII shows a weak stock market variance-price relation. Except for the price-payout ratio, the relation becomes significantly negative when we add Vβ_{IMC} and FCG to the regressions (Panel B). In addition, scale market prices correlate positively and significantly with Vβ_{IMC} and FCG, and the adjusted R^2 ranges from 44% to 62%.

C. Implied Cost of Capital

Pastor, Sinha, and Swaminathan (2008) uncover a positive market variance-return relation using the implied cost of capital (ICC) as a proxy for conditional equity premia. Panel A of Table IX confirms that the relation is significantly positive for their ICC measure, PSS and the one used in Li, Ng, and Swaminathan (2013), LNS, while it is weak for the others. When we add $V\beta_{IMC}$ to the regressions in Panel B, all ICC measures correlate positively with market variance, and the relation is significant at the 10% or lower level except the one proposed by Easton (2004). In addition, all ICC measures correlate negatively with β_{IMC}, and the adjusted R^2 is noticeably higher than its counterpart reported in Panel A. Our findings indicate that market and euphoria variances are crucial determinants of equity market risk premia.

D. Explaining Cross-Sectional Portfolio Returns

We use the Fama and MacBeth (1973) regression to examine whether DT and IST shocks are priced in the cross-section of returns on 175 value-weighted portfolios.[10] The measure of IST shocks is the same as in Table I, the spread between high and low IMC beta stocks. We use the excess market return orthogonalized by the IST shock as a proxy for the DT shock. Panel A of Table X shows that the estimated risk price is significantly negative (positive) for IST (DT)

[10]We first sort stocks equally into five groups by the market cap, and then within each size group, we sort stocks equally into quintiles by each of seven proxies that Kogan and Papanikolaou (2013) and Kogan and Papanikolaou (2014) use to measure IST loadings. The online Appendix reports similar results for alternative testing portfolios.

shocks, and the cross-sectional R^2 is 40%. Loadings on market and euphoria variances are also significantly priced with the cross-sectional R^2 of 47% (Panel B).[11]

E. Risk-Free Rate and Variances

Hartzmark (2016) documents a strong negative effect of aggregate uncertainty on the risk-free rate. In Table XI, we shed light on this intriguing evidence by investigating the novel implication stipulated in equation (11) that the risk-free rate depends on both market and euphoria variances. While the relation with the risk-free rate is weak for both VMKT and Vβ_{IMC} in simple regressions (Panel A), they together have significant explanatory power at the 10% or lower level (Panel B).

F. Average Stock Variance as a Euphoria Measure

We examine the model's main implications using three average stock variances weighted by the market value (VWASV), the squared market-book equity ratio (MB2ASV), and the squared price-earnings ratio (PE2ASV), respectively.[12] The results are similar for the model-based euphoria variance measures, owning to their strong correlations with Vβ_{IMC}. VWASV, MB2ASV, or PE2ASV correlates negatively and significantly with future excess stock market returns when together with market variance (Table VII). In addition, VWASV correlates

[11] Because market and euphoria variances are persistent and have measurement errors, we include two lags for both variances in the first-stage regression. The loadings used in the second stage are the sum of the coefficients of the two lags. The results are qualitatively similar when we include only one lag for both variances in the estimation.

[12] We do not use the squared price-dividend ratio as weights because many firms, especially high tech firms, pay no dividends.

positively with scaled market prices (Table VIII), correlates negatively with the implied cost of capital (Table IX), is positively priced in the cross-section of expected stock returns (Table X), and correlates significantly with the risk-free rate (Table XI). The results are similar for MB2ASV and PE2ASV (untabulated).

VWASV appears to be a better empirical measure of euphoria variance than Vβ_{IMC}. Untabulated results show that VWASV always drives out IST-based euphoria variances in forecast regressions of excess market returns. Similarly, Tables 7 to 11 indicate that VWASV often provides stronger support for our model's main implications. In addition, we show below that VWASV has a stronger correlation with aggregate uncertainty than Vβ_{IMC}.

G. Aggregate Uncertainty and Fear and Euphoria Variances

Aggregate uncertainty depends positively on both fear and euphoria variances in our model. We examine this implication using one-tailed tests. As expected, Table XII shows that log market (L_VMKT) and euphoria (L_Vβ_{IMC} or L_VWASV) variances correlate positively and significantly with concurrent and future log standardized PCE (nondurable goods and services) variance in simple regressions. Moreover, for multiple regressions, both L_VMKT and L_VWASV have significant explanatory power except the eight-quarter horizon; similarly, coefficients of both L_VMKT and L_Vβ_{IMC} are positive albeit significant only for L_VMKT.

VII. Conclusion

We argue that stock market variance has two distinct components: fear and euphoria. The conditional equity premium depends positively on fear variance and negatively on euphoria variance. Scaled market prices, which decrease with discount rates, correlate negatively (positively) with fear (euphoria) variance. Because it is the sum of fear and euphoria variances, the market variance may correlate positively or negatively with expected market returns and prices, depending on the relative importance of the two variances. Consistent with our model's implication, we show that fear and euphoria variances and expected long-run economic growth account for up to 65% of the variation in scaled market prices.

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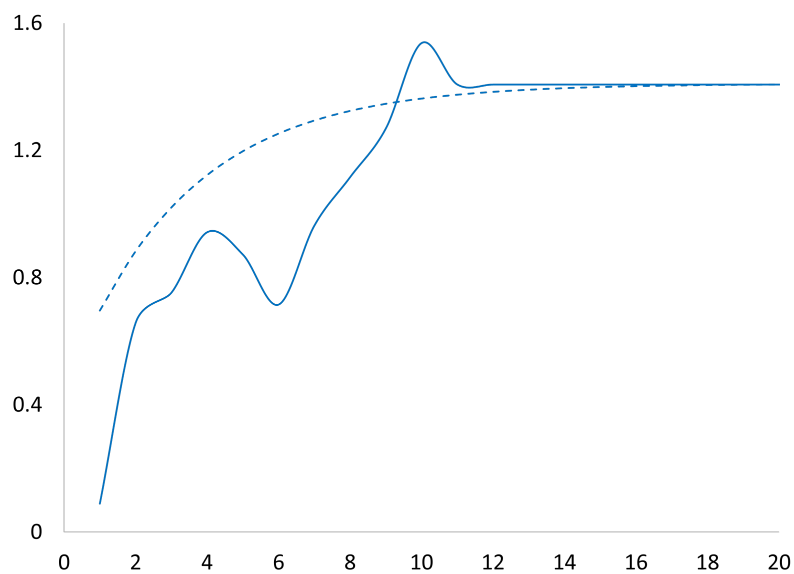
FIGURE 1

Impulse Responses of Consumption to DT and IST Shocks

The figure plots impulse responses of annual consumption to one standard deviation increase in IST and DT shocks. The vertical axis denotes percentage changes in consumption. The horizontal axis denotes the number of years following the shock. Solid and dashed lines are for actual and simulated data from the benchmark model, respectively. We use the Papanikolaou (2011) IST measure in the empirical estimation. We use the excess market return orthogonalized by the IST shock as a proxy for the DT shock. We scale the model impulse responses so that their long-run value is identical to the estimated impulse responses.

(a) DT Shock



(b) IST Shock

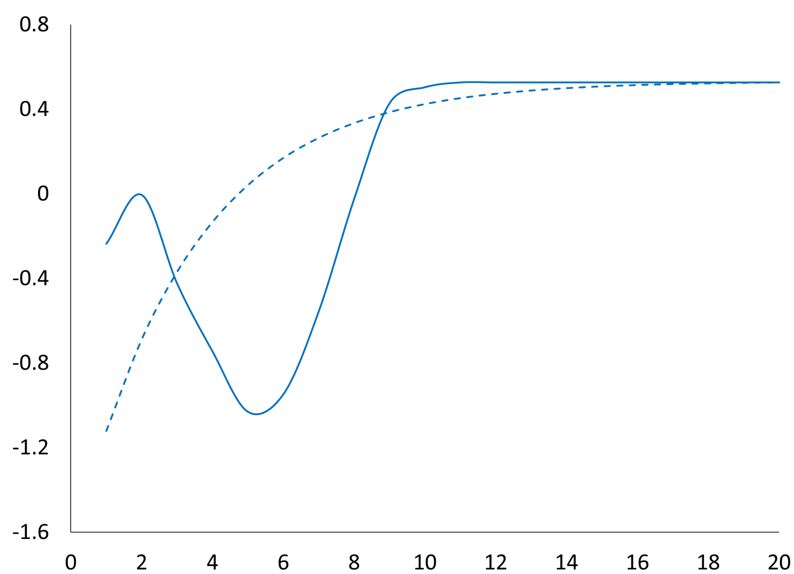


FIGURE 2

Variances and Stock Market Price

The figure plots the standardized stock market variance (thick dashed line, left vertical axis), the standardized consumption variance (thin dashed link, left vertical axis), and the price-earnings ratio (solid line, right vertical axis)

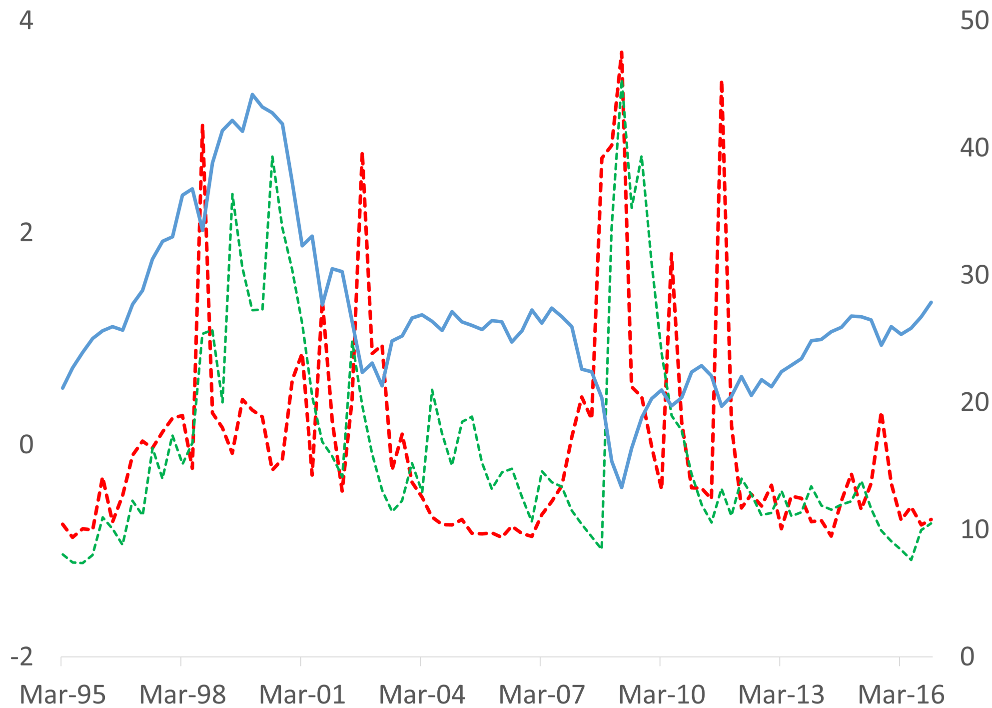
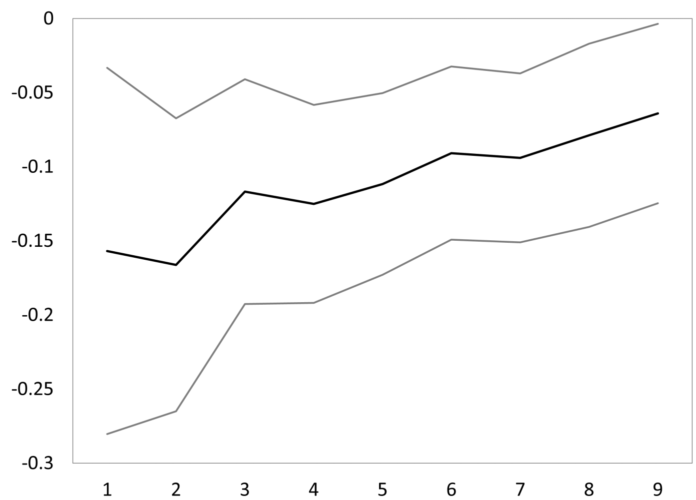


FIGURE 3

Impulse Responses of Consumption to DT and IST Shocks

(a) Papanikolaou (2011) Empirical Finding



(b) Calibration in Our Model

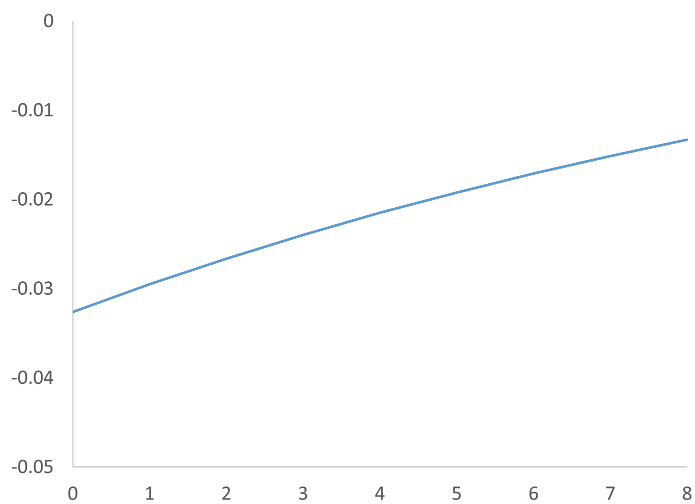
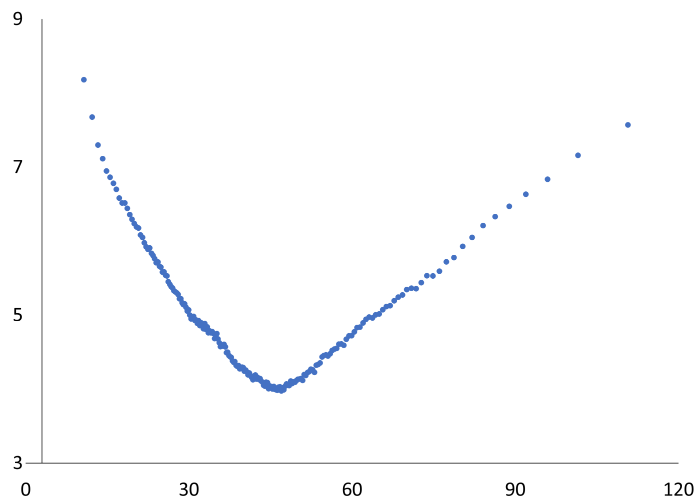


FIGURE 4

Impulse Responses of Consumption to DT and IST Shocks

The figure plots the relations between the price-dividend ratio (horizontal axis) with conditional market variance and conditional equity premia (in percentage points, vertical axis) in simulated data.

(a) Conditional Market Variance



(b) Conditional Equity Premium

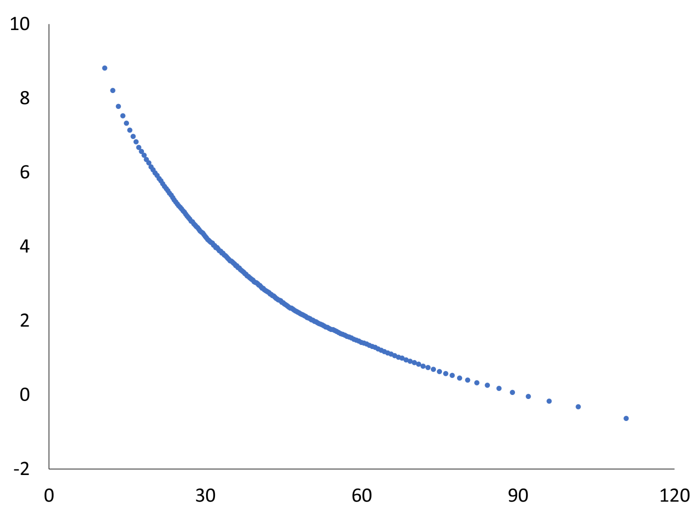
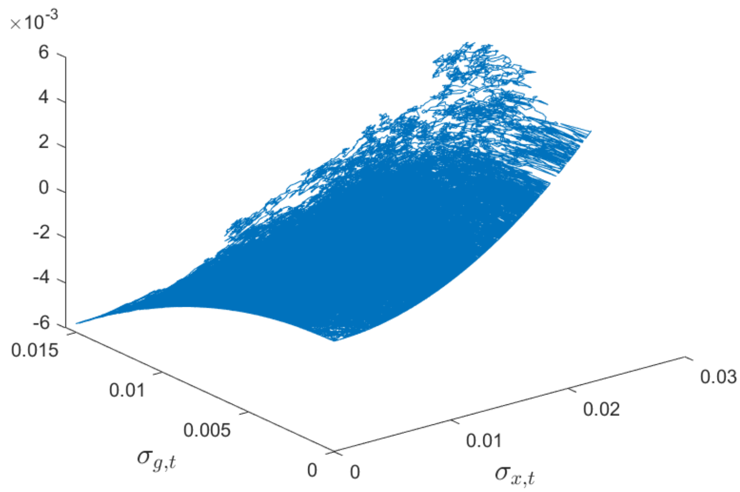


FIGURE 5

Negative Correlation Condition in Simulated Data

(a) NCC and Fear and Euphoria Variances



(b) NCC and Price-Dividend Ratio

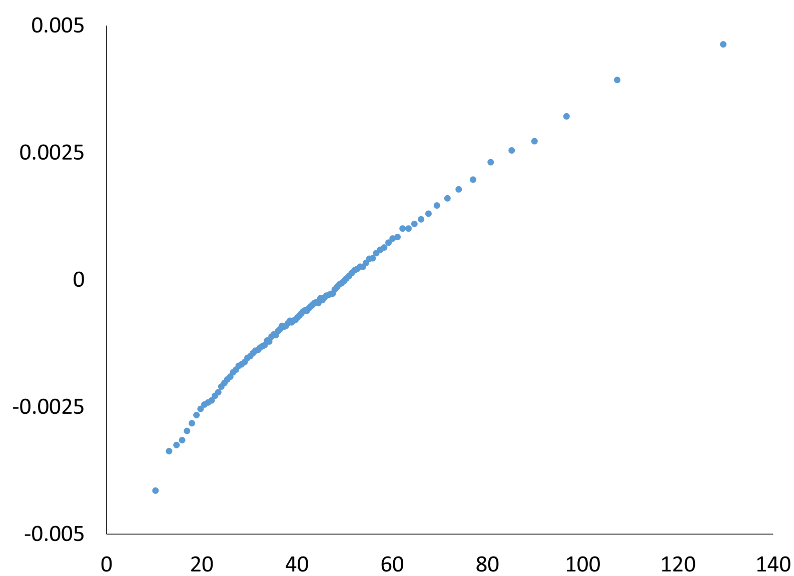


TABLE I

Consumption, Cash Flows, and IST shocks

The table reports the OLS estimation results of regressing the annual growth rate of aggregate consumption or corporate cash flows on its lag (DV_LAG), IST shocks (IST), and excess stock market returns (ERET). We also use SPF and Tealbook forecasts to measure long-run economic or corporate cash flow growth. We follow Papanikolaou (2011) to construct IST shocks. In parentheses, we report t-statistics constructed using Newey-West standard errors with two lags. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

DV_LAG	IST	ERET	R^2	DV_LAG	IST	ERET	R^2
Panel A: Consumption				Panel B: SPF 2-Year PCE			
0.408***	0.001		0.130	0.636***	0.018***		0.459
(3.360)	(0.184)			(8.025)	(3.015)		
0.590***		0.032***	0.338	0.613***		0.022**	0.445
(4.597)		(2.787)		(6.902)		(2.114)	
0.605***	-0.014**	0.039***	0.367	0.644***	0.013**	0.015	0.500
(5.075)	(-1.983)	(3.527)		(8.601)	(2.097)	(1.295)	
Panel C: SPF 10-Year GDP				Panel D: SPF 10-Year Productivity			
0.924***	0.359**		0.714	0.949***	0.494***		0.800
(10.437)	(2.752)			(12.286)	(2.922)		
0.867***		0.152	0.658	0.879***		0.200	0.714
(10.188)		(0.855)		(10.226)		(1.505)	
0.911***	0.410***	-0.132	0.718	0.930***	0.566***	-0.190	0.806
(10.453)	(3.026)	(-0.661)		(12.045)	(3.171)	(-1.230)	
Panel E: Tealbook 7-Quarter PCE				Panel F: Tealbook 7-Quarter GDP			
0.618***	0.077**		0.469	0.594***	0.153***		0.475
(5.444)	(2.438)			(5.374)	(2.803)		
0.593***		0.085*	0.452	0.523***		0.075	0.287
(4.586)		(1.741)		(3.568)		(1.108)	
0.609***	0.057*	0.051	0.485	0.594***	0.159***	-0.016	0.476
(5.273)	(1.650)	(0.945)		(5.402)	(3.457)	(-0.248)	

DV_LAG	IST	ERET	R^2	DV_LAG	IST	ERET	R^2
Panel G: Free Cash Flows				Panel H: Net Equity Payouts			
0.209	0.419**		0.116	-0.361***	1.035***		0.312
(1.314)	(2.199)			(-3.046)	(2.808)		
0.112		0.343	0.020	-0.358***		1.260***	0.356
(0.768)		(1.596)		(-2.917)		(4.381)	
0.215	0.367*	0.147	0.101	-0.343***	0.648**	0.939***	0.401
(1.477)	(1.797)	(0.594)		(-3.039)	(2.027)	(4.882)	
Panel I: Earnings				Panel J: SPF 2-Year Corporate Profits			
0.178	0.513**		0.114	0.061	0.080***		0.633
(1.612)	(2.395)			(0.616)	(3.796)		
0.068		0.505	0.094	-0.023		0.076**	0.427
(0.707)		(1.465)		(-0.229)		(2.330)	
0.146	0.368**	0.319	0.136	0.060	0.063***	0.041**	0.724
(1.256)	(2.335)	(0.982)		(0.705)	(3.607)	(1.989)	

TABLE II

Configuration of Model Parameters

The table reports the parameter values used in the benchmark model.

Preferences	δ	γ	ψ			
	0.9998	3.7	1.02			
Consumption	μ_c	ρ	φ_η	φ_e	ψ_x	σ_g
	0.0015	0.975	0.05	0.001256	0.0389	0.005
	σ_x	v_g	v_x	σ_1	σ_2	σ_3
	0.005	0.999	0.9995	0.0000028	0	0.000005
Dividends	μ_d	ϕ	π_e	π_η	π_p	
	0.0015	2.5	3.5	2.6	0.003	

TABLE III

Consumption, Dividend, and Asset Returns

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p - d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; $AC1$ to $AC5$ are the first to fifth-order autocorrelation coefficients; and $Corr$ is the correlation coefficient. The column under the name "Data Estimate" reproduces annual estimates from the 1930 to 2008 period reported in Bansal et al. (2012) and Beeler and Campbell (2012). $Corr(R, e)$ is the correlation between the market return and IST shocks estimated using the sample spanning the 1964 to 2016 period. The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.81	0.10	0.41	3.20	3.58	1.79
$\sigma(\Delta c)$	2.16	3.06	1.65	1.80	4.97	5.41	3.49
$AC1(\Delta c)$	0.45	0.59	0.35	0.39	0.74	0.76	0.63
$AC2(\Delta c)$	0.16	0.34	0.01	0.07	0.57	0.61	0.40
$AC3(\Delta c)$	-0.10	0.22	-0.11	-0.05	0.48	0.52	0.29
$AC4(\Delta c)$	-0.24	0.14	-0.19	-0.13	0.42	0.47	0.21
$AC5(\Delta c)$	-0.02	0.08	-0.23	-0.19	0.36	0.41	0.16
$E[\Delta d]$	1.15	1.82	-3.54	-2.60	6.14	7.23	1.79
$\sigma(\Delta d)$	11.05	12.96	7.92	8.57	18.93	20.07	14.64
$AC1(\Delta d)$	0.21	0.37	0.12	0.16	0.58	0.62	0.39
$Corr(\Delta c, \Delta d)$	0.55	0.61	0.20	0.26	0.86	0.89	0.59
$E[R]$	7.66	7.02	1.71	2.52	12.93	14.41	7.36
$\sigma(R)$	20.28	22.93	15.41	16.40	32.41	34.72	25.06
$AC1(R)$	0.02	0.02	-0.21	-0.17	0.22	0.26	0.04
$Corr(R, e)$	0.44	0.56	0.21	0.27	0.79	0.82	0.57
$E[p - d]$	3.36	3.67	2.93	3.06	4.12	4.21	3.67
$\sigma(p - d)$	0.45	0.24	0.13	0.15	0.43	0.47	0.45
$AC1(p - d)$	0.87	0.87	0.69	0.73	0.95	0.95	0.97
$E[R^f]$	0.57	1.49	-0.06	0.23	2.34	2.51	1.39
$\sigma(R^f)$	2.86	1.70	0.90	0.98	2.84	3.11	2.01
$AC1(R^f)$	0.65	0.80	0.64	0.67	0.88	0.89	0.83

TABLE IV

Price-Dividend Ratio and Variances in Simulated Data

The table reports the OLS estimation results of regressing the stock market price-dividend ratio on contemporaneous variances for simulated data. We generate 10,000 simulated samples and report their distributions. The column "Pop" reports the results of 100,000 simulated quarterly observations. VMKT is stock market variance, VE is euphoria variance, and VWASV is value-weighted average stock variance. t-values are reported in parentheses. The coefficient and the t-value of stock market variance are sorted from the highest to the lowest. All other statistics are sorted from the lowest to the highest. The column "Scaler" indicates the actual values of the statistics reported in a row are the reported values time the scaler in that row. For example, the scaler for R^2 is 0.01, indicating that it is reported in percentage.

	Median	10%	30%	70%	90%	Pop	Scaler
Panel A: Stock Market Variance							
VMKT	-33.395	23.629	-10.713	-56.034	-86.493	-13.164	1
	(-3.388)	(2.327)	(-1.045)	(-6.041)	(-10.562)	(-64.871)	1
R^2	20.078	0.849	7.576	38.115	62.972	2.549	0.01
Panel B: Euphoria Variance							
VE	8.291	-1.740	4.473	12.026	18.027	8.119	100
	(4.253)	(-0.779)	(2.046)	(6.904)	(11.631)	(291.074)	1
R^2	23.687	1.110	9.159	42.473	66.545	30.289	0.01
Panel C: Stock Market Variance and Euphoria Variance							
VMKT	-0.959	-0.777	-0.888	-1.031	-1.147	-0.962	100
	(-17.094)	(-9.428)	(-13.748)	(-21.115)	(-28.777)	(-1408.273)	1
VE	2.050	1.674	1.908	2.189	2.410	2.055	1000
	(17.861)	(9.082)	(13.714)	(22.898)	(31.888)	(1863.096)	1
R^2	88.663	70.780	83.264	92.331	95.549	95.277	0.01
Panel D: Stock Market Variance and Value-Weighted Average Stock Variance							
VMKT	-5.004	-3.423	-4.245	-5.902	-10.784	-3.574	100
	(-31.005)	(-18.234)	(-24.922)	(-38.164)	(-51.113)	(-248.037)	1
VWASV	4.858	3.233	4.100	5.778	7.134	3.371	100
	(29.548)	(17.322)	(23.869)	(36.427)	(48.609)	(225.714)	1
R^2	96.227	91.458	94.726	97.319	98.341	91.896	0.01

TABLE V

Excess Stock market Returns and Variances in Simulated Data

The table reports the OLS estimation results of regressing one-quarter-ahead excess stock market returns on stock variances for simulated data. We generate 10,000 simulated samples and report their distributions. The column "Pop" reports the results of 100,000 simulated quarterly observations. VMKT is stock market variance, VE is euphoria variance, and VWASV is value-weighted average stock variance. t-values are reported in parentheses. R^2 is reported in percentage.

	Median	10%	30%	70%	90%	Pop
Panel A: Stock Market Variance						
VMKT	1.034	-2.700	-0.429	2.679	5.479	0.309
	(0.372)	(-0.943)	(-0.153)	(0.956)	(1.767)	(13.145)
R^2	0.242	0.007	0.075	0.586	1.462	0.022
Panel B: Euphoria Variance						
VE	-21.839	55.863	8.586	-56.420	-115.111	-5.797
	(-0.378)	(0.957)	(0.153)	(-0.940)	(-1.721)	(-13.751)
R^2	0.249	0.007	0.077	0.577	1.415	0.025
Panel C: Stock Market Variance and Euphoria Variance						
VMKT	3.510	-1.733	1.291	6.139	10.701	1.136
	(0.877)	(-0.450)	(0.337)	(1.422)	(2.251)	(34.129)
VE	-73.714	37.192	-25.855	-127.518	-223.135	-20.478
	(-0.875)	(0.458)	(-0.313)	(-1.428)	(-2.232)	(-34.217)
R^2	0.965	0.144	0.513	1.641	2.953	0.169
Panel D: Stock Market Variance and Value-Weighted Average Stock Variance						
VMKT	19.284	-4.249	8.451	32.320	58.405	4.275
	(1.044)	(-0.255)	(0.509)	(1.592)	(2.398)	(11.865)
VWASV	-18.612	5.316	-7.882	-31.816	-58.148	-3.878
	(-1.004)	(0.339)	(-0.457)	(-1.546)	(-2.364)	(-11.278)
R^2	1.052	0.179	0.562	1.790	3.243	0.212

TABLE VI

Cross-Section of Expected Excess Returns in Simulated Data

The table reports the Fama and MacBeth (1973) regression results for simulated data. In the first stage, we run a time-series forecasting regression of returns on conditional stock market variance and euphoria variance for each portfolio. In the second stage, we run the cross-sectional regression of portfolio returns on their loadings on the stock market variance and the euphoria variance. The table reports the estimated risk prices of loadings on variances. t-values are reported in parentheses. VMKT is stock market variance, VE is euphoria variance, and VWASV is value-weighted average stock variance. The column "Scaler" indicates the actual values of the statistics reported in a row are the reported values time the scaler in that row. For example, the scaler for R^2 is 0.01, indicating that it is reported in percentage. We generate 10,000 simulated samples and report their distributions. The column "Pop" reports the results of 100,000 simulated quarterly observations.

	Median	10%	30%	70%	90%	Pop	Scaler
Panel A: DT and IST Shocks							
λ_0	0.007	0.005	0.006	0.008	0.009	0.008	1
	(4.677)	(3.514)	(4.154)	(5.295)	(6.299)	(109.814)	1
λ_{DT}	0.148	-0.016	0.079	0.216	0.320	0.140	1
	(1.132)	(-0.121)	(0.608)	(1.641)	(2.400)	(22.599)	1
λ_{IST}	-0.145	0.045	-0.066	-0.233	-0.382	-0.156	1
	(-0.893)	(0.288)	(-0.415)	(-1.385)	(-2.117)	(-21.058)	1
R^2	92.586	71.137	87.518	95.365	97.537	96.911	0.01
Panel B: Market Variance and Euphoria Variance							
λ_0	0.501	0.024	0.332	0.696	1.081	0.033	0.01
	(1.869)	(0.068)	(1.115)	(2.678)	(3.927)	(2.132)	1
λ_{VMKT}	1.185	-1.639	0.287	2.209	4.474	15.422	0.001
	(0.872)	(-0.861)	(0.211)	(1.492)	(2.324)	(30.461)	1
λ_{VE}	0.040	-0.092	-0.001	0.086	0.183	0.481	0.001
	(0.663)	(-1.035)	(-0.017)	(1.278)	(2.111)	(17.635)	1
R^2	77.815	30.602	62.239	87.000	93.305	99.389	0.01
Panel C: Market Variance and Value-Weighted Average Stock Variance							
λ_0	0.492	0.005	0.320	0.677	1.049	0.080	0.01
	(1.843)	(0.015)	(1.085)	(2.666)	(3.927)	(3.908)	1
λ_{VMKT}	4.744	-6.650	1.248	8.920	17.469	58.374	0.001
	(0.887)	(-0.882)	(0.216)	(1.512)	(2.354)	(30.441)	1
λ_{VWASV}	1.146	-1.163	0.274	2.157	4.245	14.302	0.001
	(0.879)	(-0.889)	(0.195)	(1.489)	(2.341)	(30.106)	1
R^2	77.873	30.854	62.229	87.008	93.391	99.625	0.01

TABLE VII

Forecasting Excess Stock Market Returns Using Variances

The table reports the OLS estimation results of forecasting one-quarter-ahead excess stock market returns using variances. VMKT is stock market variance. Vβ_{IMC} is the realized variance of the Papanikolaou (2011) IST measure. AVEV is the average of ten standardized IST-based euphoria variance measures. VWASV, MB2WAV, and PE2WAV are average stock variances weighted by the market value, the squared market-book equity ratio, and the squared price-earnings ratio, respectively. The sample spans the 1963Q1 to 2016Q4 period. Panel A reports the simple regression results. Panel B reports the multiple regression results with stock market variance and a euphoria variance measure as the forecasting variables. Panel C reports the out-of-sample forecast results. We use the 1963Q1 to 1989Q4 period for initial in-sample estimation and make the out-of-sample forecast recursively for the 1990Q1 to 2016Q4 period using an expanding sample. MSER is the mean squared forecasting error ratio of the forecasting model to a benchmark model in which the conditional equity premium equals the average equity premium in historical data. ENC_NEW is the encompassing test proposed by Clark and McCracken (2001). t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A		Panel B			Panel C		
Variable	All Variances	R^2	Euphoria Variance	Market Variance	R^2	MSER	ENC_NEW Statistics	5% BSCV
VMKT	2.799**	3.707						
	(2.054)							
Vβ_{IMC}	-4.414*	1.280	-9.446***	4.557***	9.650	0.931	12.380	2.379
	(-1.662)		(-2.725)	(4.904)				
AVEV	-0.898	0.347	-2.715***	4.765***	8.679	0.913	13.586	2.370
	(-1.481)		(-4.339)	(4.453)				
VWASV	-0.065	-0.440	-2.096***	8.979***	13.473	0.825	21.880	2.330
	(-0.168)		(-4.063)	(6.849)				
MB2WAV	-0.197**	1.439	-0.389***	4.365***	9.361	0.947	23.418	2.449
	(-2.587)		(-5.398)	(3.191)				
PE2WAV	-0.241*	1.165	-0.656***	5.441***	11.660	0.863	24.439	2.448
	(-1.910)		(-5.924)	(5.041)				

TABLE VIII

Scaled Stock Market Prices and Variances

The table reports the OLS estimation results of regressing scaled stock market prices on the contemporaneous stock market and euphoria variances. We also control for a linear trend in the regression. PD is the price-dividend ratio. PPO is the price-payout ratio. PE is the price-earnings ratio. VMKT is stock market variance. Vβ_{IMC} is the realized variance of the Papanikolaou (2011) IST measure. VWASV is the value-weighted average stock variance. FCG is the consumption growth over the following 40 quarters. The sample spans the 1963Q1 to 2016Q4 period. t-value is reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	PD	PPO	PE
Panel A: Stock Market Variance			
VMKT	-1.477	5.026	-5.505
	(-0.253)	(1.093)	(-0.844)
FCG	0.046*	0.026**	0.087***
	(1.919)	(2.394)	(3.408)
R^2	52.554	23.858	35.857
Panel B: Stock Market Variance and β_{IMC} Portfolio variance			
Vβ_{IMC}	0.792***	0.744***	0.696***
	(5.619)	(4.678)	(6.639)
VMKT	-12.096*	-4.960	-14.840*
	(-1.871)	(-1.371)	(-1.951)
FCG	0.047*	0.028***	0.088***
	(1.886)	(3.053)	(3.237)
R^2	61.863	52.124	43.563
Panel C: Stock Market Variance and Value-Weighted Average Stock Variance			
VWASV	0.102***	0.132***	0.080***
	(4.204)	(4.060)	(3.239)
VMKT	-30.374***	-32.318***	-27.986***
	(-3.745)	(-4.071)	(-3.076)
FCG	0.044*	0.025**	0.086***
	(1.662)	(2.523)	(3.076)
R^2	59.543	64.545	40.275

TABLE IX

Implied Cost of Capital and Stock Market Variance

The table reports the OLS estimation results of regressing the implied cost of capital on the contemporaneous stock market and euphoria variances. PSS, GLS, Easton, OJ, and GG are the implied cost of capital measures constructed following Pastor et al. (2008), Gebhardt, Lee, and Swaminathan (2001), Easton (2004), Ohlson and Juettner-Nauroth (2005), and Gordon and Gordon (1997), respectively. AICC is the average of these five ICC measures. LNS is the ICC measure used in Li et al. (2013). LNS is available over the 1981Q1 to 2011Q4 period, GLS and AICC are available over the 1982Q1 to 2016Q4 period, and the other ICC measures are available over the 1981Q1 to 2016Q4 period. VMKT is stock market variance. Vβ_{IMC} is the realized variance of the Papanikolaou (2011) IST measure constructed using the portfolios formed on IMC betas. VWASV is the value-weighted average stock variance. t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	PSS	GLS	Easton	OJ	GG	AICC	LNS
Panel A: Stock Market Variance							
VMKT	0.161*	0.137	0.075	0.110	0.145	0.125	0.225**
	(1.787)	(1.593)	(0.820)	(1.393)	(1.510)	(1.428)	(2.217)
R^2	5.060	3.149	0.283	1.815	3.239	2.529	4.694
Panel B: Stock Market Variance and β_{IMC} Portfolio Variance							
Vβ_{IMC}	-0.258	-0.395	-0.261	-0.323*	-0.355	-0.318	-0.488
	(-1.097)	(-1.594)	(-1.052)	(-1.650)	(-1.346)	(-1.346)	(-1.596)
VMKT	0.215**	0.219**	0.129	0.177*	0.219**	0.191*	0.332**
	(2.172)	(2.178)	(1.240)	(1.886)	(2.090)	(1.908)	(2.571)
R^2	6.825	7.722	1.543	4.721	6.432	5.279	7.856
Panel C: Stock Market Variance and Value-Weighted Average Stock Variance							
VWASV	-0.116***	-0.146***	-0.122***	-0.109***	-14.935***	-0.129***	-0.122*
	(-3.415)	(-4.332)	(-3.058)	(-3.129)	(-4.566)	(-3.707)	(-1.923)
VMKT	0.522***	0.596***	0.455***	0.451***	0.612***	0.529***	0.599***
	(3.885)	(4.398)	(3.090)	(3.408)	(4.472)	(3.872)	(2.812)
R^2	19.683	25.114	12.911	13.989	24.022	19.490	12.446

TABLE X

The Cross-Section of Portfolio Returns

The table reports the Fama and MacBeth (1973) cross-sectional regression results using 175 value-weighted portfolios. We first sort stocks equally into five portfolios by market capitalization. Then, within each size portfolio, we sort stocks equally into five portfolios by each of the seven characteristics: the investment-capital ratio, Tobin's Q, the price-earnings ratio, idiosyncratic volatility, IMC beta, the book-to-market equity ratio, and market beta. We use IST and DT shocks as risk factors in Panel A. The IST shock is the return difference between high and low IMC beta stocks. The DT shock is residual from the regression of the excess market return on a constant and the IST shock. We use euphoria and market variances as risk factors in Panel B. We consider two euphoria variance measures. Vβ_{IMC} is the variance of IST shocks, and VWASV is the value-weighted average stock variance. The data span the 1963Q1 to 2016Q4 period. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: IST and DT Shocks				
	λ_0	λ_{IST}	λ_{DT}	R^2
	-0.018	-0.040*	0.047***	39.994
	(-1.267)	(-1.696)	(3.337)	
Panel B: Euphoria and Market Variances				
	λ_0	λ_{VE}	λ_{VMKT}	R^2
Vβ_{IMC}	0.026***	0.003**	0.004**	47.490
	(3.217)	(2.512)	(2.025)	
VWASV	0.030***	0.020***	0.003**	72.697
	(5.210)	(3.435)	(2.372)	

TABLE XI

The Risk-Free Rate and Stock Variances

The table reports the OLS estimation results of regressing the risk-free rate on contemporaneous stock market and euphoria variances. VMKT is stock market variance. Vβ_{IMC} is the realized variance of the Papanikolaou (2011) IST measure. VWASV is the value-weighted average stock variance. The sample spans the 1963Q1 to 2016Q4 period. t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A		Panel B		
	Variance	R^2	Euphoria Variance	Market Variance	R^2
VMKT	-0.068 (-1.201)	0.683			
Vβ_{IMC}	0.135 (1.018)	0.004	0.256* (1.860)	-0.121* (-1.695)	3.204
VWASV	0.010 (0.477)	-0.259	0.071*** (3.087)	-0.288*** (-2.923)	7.625

TABLE XII

Forecasting Consumption Variance

The table reports the OLS estimation results of forecasting standardized log consumption variance from 1985Q1 to 2016Q4. L_VMKT is the log stock market variance. L_Vβ_{IMC} is the log variance of the hedging portfolio formed by the IMC β. L_VWASV is the log value-weighted average stock variance. We use the Newey-West standard errors to construct t-values reported in parentheses. We use 1, 4, 6, and 8 lags for one, four, six, and eight-quarter forecast horizons. ***, **, and * denote one-sided significance at the 1%, 5%, and 10% levels, respectively.

Panel A: One Quarter				Panel B: Four Quarters			
L_VMKT	L_Vβ_{IMC}	L_VWASV	R^2	L_VMKT	L_Vβ_{IMC}	L_VWASV	R^2
0.469***			0.193	2.020***			0.260
(3.640)				(3.224)			
	0.247**		0.073		0.992**		0.076
	(1.901)				(1.667)		
		0.628***	0.204			2.634***	0.263
		(3.902)				(3.231)	
0.338*	0.213		0.214	1.942***	0.174		0.261
(1.318)	(0.577)			(3.315)	(0.370)		
0.230*		0.389**	0.219	1.092**		1.503**	0.289
(1.463)		(1.982)		(1.778)		(1.844)	
Panel C: Six Quarters				**Panel D: Eight Quarters**			
L_VMKT	L_Vβ_{IMC}	L_VWASV	R^2	L_VMKT	L_Vβ_{IMC}	L_VWASV	R^2
3.011***			0.290	3.642***			0.276
(3.435)				(3.476)			
	1.494**		0.081		1.578*		0.058
	(1.714)				(1.470)		
		3.814***	0.278			4.254***	0.225
		(3.153)				(2.852)	
2.895***	0.259		0.292	3.631***	0.025		0.276
(3.631)	(0.386)			(3.749)	(0.029)		
1.821**		1.931*	0.315	2.822***		1.332	0.284
(2.061)		(1.570)		(2.345)		(0.845)	

A Tale of Fear and Euphoria in the Stock Market - Online Appendix

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We provide details of model deviations in Section A, additional calibration results in Section B, data descriptions in Section C, and supplemental empirical results in Section D.

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A. Model Derivations

A. Consumption Dynamics

Aggregate consumption dynamics are as follows

$$\begin{aligned}
\Delta c_{t+1} &= \mu_c + x_t + \sigma_{g,t}\eta_{t+1} - \psi_x \sigma_{x,t} e_{t+1}, \\
x_{t+1} &= \rho x_t + \varphi_\eta \sigma_{g,t}\eta_{t+1} + \varphi_e \sigma_{x,t} e_{t+1}, \\
\sigma^2_{g,t+1} &= \sigma^2_g + v_g(\sigma^2_{g,t} - \sigma^2_g) + \sigma_1 z_{1,t+1}, \\
\sigma^2_{x,t+1} &= \sigma^2_x + v_x(\sigma^2_{x,t} - \sigma^2_x) + \sigma_2 z_{1,t+1} + \sigma_3 z_{2,t+1}.
\end{aligned}$$

The shocks $\eta_{t+1}, e_{t+1}, z_{1,t+1}, z_{2,t+1}$ are i.i.d. standard normal.

Using the log-linear approximation of Campbell and Shiller (1988), we can write the log return on the claim to aggregate consumption as

$$\begin{aligned}
r_{a,t+1} &= \ln \frac{P_{t+1} + C_{t+1}}{P_t} = \ln \frac{P_{t+1} + C_{t+1}}{C_{t+1}} - \ln \frac{P_t}{C_t} + \ln \frac{C_{t+1}}{C_t} \\
&= k_0 + k_1 z_{t+1} - z_t + \Delta c_{t+1}, \qquad (1)
\end{aligned}$$

where $z_t = \ln \frac{P_t}{C_t}$, $\bar{z} = \mathbb{E}[z_t]$, $k_1 = \dfrac{e^{\bar{z}}}{e^{\bar{z}} + 1} < 1$, $k_0 = \ln(e^{\bar{z}} + 1) - \dfrac{\bar{z}e^{\bar{z}}}{e^{\bar{z}} + 1}$. From Epstein and Zin (1989), the log pricing kernel is

$$(2) \qquad m_{t+1} = \ln M_{t+1} = \theta \ln \delta - \frac{\theta}{\psi}\Delta c_{t+1} + (\theta - 1) r_{a,t+1}.$$

The Euler equation for return on any asset i is $\mathbb{E}_t[M_{t+1}R_{i,t+1}] = 1$, which can be rewritten as

$$(3) \qquad \mathbb{E}_t\big[\exp\big(\theta \ln \delta - \frac{\theta}{\psi}\Delta c_{t+1} + (\theta - 1) r_{a,t+1} + r_{i,t+1}\big)\big] = 1.$$

Equation (3) holds for the return on the claim to aggregate consumption $r_{a,t+1}$

$$\mathbb{E}_t\big[\exp\big(\theta\ln\delta - \frac{\theta}{\psi}\Delta c_{t+1} + \theta r_{a,t+1}\big)\big] = 1. \tag{4}$$

The log price-consumption ratio is a linear function of state variables:

$$z_t = A_0 + A_1\sigma_{g,t}^2 + A_2\sigma_{x,t}^2 + A_3 x_t, \tag{5}$$

where A_0, A_1, A_2, A_3 are constants to be determined below. Combining equation (1) and equation (5), we have

$$\begin{aligned} r_{a,t+1} &= c_1 + (k_1 v_g - 1)A_1\sigma_{g,t}^2 + (k_1 v_x - 1)A_2\sigma_{x,t}^2 + (k_1 A_1\sigma_1 + k_1 A_2\sigma_2)z_{1,t+1} \\ &\quad + k_1 A_2\sigma_3 z_{2,t+1} + (k_1 A_3\rho - A_3 + 1)x_t + (k_1 A_3\varphi_e - \psi_x)\sigma_{x,t}e_{t+1} \\ &\quad + (k_1 A_3\varphi_\eta + 1)\sigma_{g,t}\eta_{t+1}, \end{aligned}$$

where $c_1 = k_0 + (k_1 - 1)A_0 + k_1 A_1\sigma_g^2(1 - v_g) + k_1 A_2\sigma_x^2(1 - v_x) + \mu_c$. Note that

$$\begin{aligned} &\theta\ln\delta - \frac{\theta}{\psi}\Delta c_{t+1} + \theta r_{a,t+1} \\ = \; &\theta\ln\delta + \theta c_1 - \frac{\theta}{\psi}\mu_c + [A_3\theta(\rho k_1 - 1) + 1 - \gamma]x_t + \theta(k_1 v_g - 1)A_1\sigma_{g,t}^2 + \theta(k_1 v_x - 1)A_2\sigma_{x,t}^2 \\ &+ \theta k_1(A_1\sigma_1 + A_2\sigma_2)z_{1,t+1} + \theta k_1 A_2\sigma_3 z_{2,t+1} \\ &+ [\theta k_1 A_3\varphi_e + (\gamma - 1)\psi_x]\sigma_{x,t}e_{t+1} + (1 - \gamma + \theta k_1 A_3\varphi_\eta)\sigma_{g,t}\eta_{t+1}. \end{aligned}$$

Using equation (4) and the fact that $\ln(\mathbb{E}[X]) = \mathbb{E}[\ln(X)] - \frac{1}{2}\mathrm{Var}[\ln(X)]$ for log normal distributed variable X, we have

$$
\begin{aligned}
&A_3\theta(\rho k_1 - 1) + 1 - \gamma = 0,\\
&\theta(k_1 v_g - 1)A_1 + \frac{1}{2}(1-\gamma+\theta k_1 A_3\varphi_\eta)^2 = 0,\\
&\theta(k_1 v_x - 1)A_2 + \frac{1}{2}[\theta k_1 A_3 \varphi_e + (\gamma-1)\psi_x]^2 = 0,\\
&\theta\ln\delta + \theta c_1 - \frac{\theta}{\psi}\mu_c + \frac{1}{2}\theta^2 k_1^2(A_1\sigma_1 + A_2\sigma_2)^2 + \frac{1}{2}\theta^2 k_1^2 A_2^2\sigma_3^2 = 0,
\end{aligned}
$$

from which we get

$$
\begin{aligned}
A_3 &= \frac{1-\frac{1}{\psi}}{1-k_1\rho},\\
A_1 &= \frac{(1-\gamma+\theta k_1 A_3\varphi_\eta)^2}{2\theta(1-k_1 v_g)},\\
A_2 &= \frac{[\theta k_1 A_3\varphi_e + (\gamma-1)\psi_x]^2}{2\theta(1-k_1 v_x)},\\
A_0 &= \frac{1}{1-k_1}\Big[\ln\delta + k_0 + (1-\frac{1}{\psi})\mu_c + \frac{1}{2}\theta k_1^2(A_1\sigma_1 + A_2\sigma_2)^2 + \frac{1}{2}\theta k_1^2 A_2^2\sigma_3^2\\
&\qquad + k_1 A_1\sigma_g^2(1-v_g) + k_1 A_2\sigma_x^2(1-v_x)\Big].
\end{aligned}
$$

B. Pricing kernel

The log pricing kernel is

$$
\begin{aligned}
m_{t+1} &= \theta\ln\delta - \frac{\theta}{\psi}\Delta c_{t+1} + (\theta-1)r_{a,t+1}\\
&= c_2 + [A_3(\theta-1)(\rho k_1 - 1) - \gamma]x_t + (\theta-1)(k_1 v_g - 1)A_1\sigma_{g,t}^2\\
&\quad +(\theta-1)(k_1 v_x - 1)A_2\sigma_{x,t}^2\\
&\quad +k_1(\theta-1)(A_1\sigma_1 + A_2\sigma_2)z_{1,t+1} + (\theta-1)k_1 A_2\sigma_3 z_{2,t+1}\\
&\quad +[(\theta-1)k_1 A_3\varphi_e + \gamma\psi_x]\sigma_{x,t}e_{t+1} - [\gamma - (\theta-1)k_1 A_3\varphi_\eta]\sigma_{g,t}\eta_{t+1},
\end{aligned} \tag{6}
$$

where $c_2 = \theta \ln \delta - \frac{\theta}{\psi}\mu_c + (\theta - 1)c_1$. The shock to the pricing kernel is

$$\begin{aligned} & m_{t+1} - \mathbb{E}_t[m_{t+1}] \\ = \; & k_1(\theta-1)(A_1\sigma_1 + A_2\sigma_2)z_{1,t+1} + (\theta-1)k_1A_2\sigma_3 z_{2,t+1} \\ & +[(\theta-1)k_1A_3\varphi_e + \gamma\psi_x]\sigma_{x,t}e_{t+1} - [\gamma - (\theta-1)k_1A_3\varphi_\eta]\sigma_{g,t}\eta_{t+1}. \end{aligned}$$

Substituting $A_3 = \frac{1-\frac{1}{\psi}}{1-k_1\rho}$ into equation (6), we have

$$\begin{aligned} m_{t+1} - \mathbb{E}_t[m_{t+1}] &= k_1(\theta-1)(A_1\sigma_1 + A_2\sigma_2)z_{1,t+1} + k_1(\theta-1)A_2\sigma_3 z_{2,t+1} \\ &\quad +[\gamma\psi_x + k_1\varphi_e\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}]\sigma_{x,t}e_{t+1} - [\gamma - k_1\varphi_\eta\frac{\frac{1}{\psi}-\gamma}{1-k_1\rho}]\sigma_{g,t}\eta_{t+1}. \end{aligned} \tag{7}$$

C. Equity premium, Conditional Stock Market Variance, and Risk-Free Rate

Using the log linear approximation for the stock market return, we have

$$\begin{aligned} r_{m,t+1} &= \ln\frac{P_{m,t+1}+D_{t+1}}{P_{m,t}} = \ln\frac{P_{m,t+1}+D_{t+1}}{D_{t+1}} - \ln\frac{P_{m,t}}{D_t} + \ln\frac{D_{t+1}}{D_t} \\ &= k_{0,m} + k_{1,m}z_{m,t+1} - z_{m,t} + \Delta d_{t+1}, \end{aligned} \tag{8}$$

where $z_{m,t} = \ln\frac{P_{m,t}}{D_t}$, $\bar{z}_m = \mathbb{E}[z_{m,t}]$, $k_{1,m} = \dfrac{e^{\bar{z}_m}}{e^{\bar{z}_m}+1} < 1$, and $k_{0,m} = \ln(e^{\bar{z}_m}+1) - \dfrac{\bar{z}_m e^{\bar{z}_m}}{e^{\bar{z}_m}+1}$. The market portfolio's dividend growth process is

$$\Delta d_{t+1} = \mu_d + \phi x_t + \pi_\eta\sigma_{g,t}\eta_{t+1} + \pi_e\sigma_{x,t}e_{t+1}.$$

Suppose that the log stock market price-dividend ratio is a linear function of state variables

$$z_{m,t} = A_{0,m} + A_{1,m}\sigma_{g,t}^2 + A_{2,m}\sigma_{x,t}^2 + A_{3,m}x_t, \tag{9}$$

where $A_{0,m}, A_{1,m}, A_{2,m}, A_{3,m}$ are constants to be determined below. Combining equations (8) and

(9), we have

$$\begin{aligned} r_{m,t+1} &= k_{0,m} + k_{1,m} z_{m,t+1} - z_{m,t} + \Delta d_{t+1} \\ &= c_3 + (k_{1,m} v_g - 1) A_{1,m} \sigma_{g,t}^2 + (k_{1,m} v_x - 1) A_{2,m} \sigma_{x,t}^2 + (k_{1,m} A_{3,m} \rho - A_{3,m} + \phi) x_t \\ &\quad + (k_{1,m} A_{1,m} \sigma_1 + k_{1,m} A_{2,m} \sigma_2) z_{1,t+1} + k_{1,m} A_{2,m} \sigma_3 z_{2,t+1} \\ &\quad + (k_{1,m} A_{3,m} \varphi_e + \pi_e) \sigma_{x,t} e_{t+1} + (\pi_\eta + k_{1,m} A_{3,m} \varphi_\eta) \sigma_{g,t} \eta_{t+1}, \end{aligned} \tag{10}$$

where $c_3 = k_{0,m} + (k_{1,m} - 1) A_{0,m} + k_{1,m} A_{1,m} \sigma_g^2 (1 - v_g) + k_{1,m} A_{2,m} \sigma_x^2 (1 - v_x) + \mu_d$.

Combining equations (6) and (10), we have

$$\begin{aligned} & m_{t+1} + r_{m,t+1} \\ = \; & \theta \ln \delta - \frac{\theta}{\psi} \Delta c_{t+1} + (\theta - 1) r_{a,t+1} + r_{m,t+1} \\ = \; & c_2 + c_3 + [A_3 (\theta - 1)(\rho k_1 - 1) - \gamma + k_{1,m} A_{3,m} \rho - A_{3,m} + \phi] x_t \\ & + [(\theta - 1)(k_1 v_g - 1) A_1 + (k_{1,m} v_g - 1) A_{1,m}] \sigma_{g,t}^2 \\ & + [(\theta - 1)(k_1 v_x - 1) A_2 + (k_{1,m} v_x - 1) A_{2,m}] \sigma_{x,t}^2 \\ & + [k_1 (\theta - 1)(A_1 \sigma_1 + A_2 \sigma_2) + k_{1,m} (A_{1,m} \sigma_1 + A_{2,m} \sigma_2)] z_{1,t+1} \\ & + [(\theta - 1) k_1 A_2 + k_{1,m} A_{2,m}] \sigma_3 z_{2,t+1} \\ & + [(\theta - 1) k_1 A_3 \varphi_e + \gamma \psi_x + k_{1,m} A_{3,m} \varphi_e + \pi_e] \sigma_{x,t} e_{t+1} \\ & + [\pi_\eta - \gamma + k_{1,m} A_{3,m} \varphi_\eta + (\theta - 1) k_1 A_3 \varphi_\eta] \sigma_{g,t} \eta_{t+1}. \end{aligned}$$

Using the Euler equation $\mathbb{E}_t[M_{t+1} R_{m,t+1}] = 1$ and the fact that $\ln(\mathbb{E}[X]) = \mathbb{E}[\ln(X)] -$

$\frac{1}{2}\text{Var}[\ln(X)]$ for log normal distributed variable X, we have

$$\begin{aligned}
A_3(\theta-1)(\rho k_1-1)-\gamma+k_{1,m}A_{3,m}\rho-A_{3,m}+\phi &= 0,\\
(\theta-1)(k_1 v_g-1)A_1+(k_{1,m}v_g-1)A_{1,m}+\frac{1}{2}[\pi_\eta-\gamma+k_{1,m}A_{3,m}\varphi_\eta+(\theta-1)k_1A_3\varphi_\eta]^2 &= 0,\\
(\theta-1)(k_1 v_x-1)A_2+(k_{1,m}v_x-1)A_{2,m}+\frac{1}{2}((\theta-1)k_1A_3\varphi_e+\gamma\psi_x+k_{1,m}A_{3,m}\varphi_e+\pi_e)^2 &= 0,\\
c_2+c_3+\frac{1}{2}[k_1(\theta-1)(A_1\sigma_1+A_2\sigma_2)+k_{1,m}(A_{1,m}\sigma_1+A_{2,m}\sigma_2)]^2 & \\
+\frac{1}{2}[(\theta-1)k_1A_2+k_{1,m}A_{2,m}]^2\sigma_3^2 &= 0,
\end{aligned}$$

from which we have

$$\begin{aligned}
A_{0,m} &= \frac{1}{1-k_{1,m}}\Big[c_2+k_{0,m}+k_{1,m}A_{1,m}\sigma_g^2(1-v_g)+k_{1,m}A_{2,m}\sigma_x^2(1-v_x)+\mu_d+\\
&\qquad +\frac{1}{2}[k_1(\theta-1)(A_1\sigma_1+A_2\sigma_2)+k_{1,m}(A_{1,m}\sigma_1+A_{2,m}\sigma_2)]^2\\
&\qquad +\frac{1}{2}[(\theta-1)k_1A_2+k_{1,m}A_{2,m}]^2\sigma_3^2\Big],\\
A_{1,m} &= \frac{(\theta-1)(k_1v_g-1)A_1+\frac{1}{2}[\pi_\eta-\gamma+k_{1,m}A_{3,m}\varphi_\eta+(\theta-1)k_1A_3\varphi_\eta]^2}{1-k_{1,m}v_g},\\
A_{2,m} &= \frac{1}{1-k_{1,m}v_x}\Big[(\theta-1)(k_1v_x-1)A_2+\frac{1}{2}((\theta-1)k_1A_3\varphi_e+\gamma\psi_x+k_{1,m}A_{3,m}\varphi_e+\pi_e)^2\Big],\\
A_{3,m} &= \frac{\phi-\frac{1}{\psi}}{1-k_{1,m}\rho}.
\end{aligned}$$

From equation (10), we can derive the conditional stock market variance

$$\sigma_{m,t}^2=c_4+(k_{1,m}A_{3,m}\varphi_e+\pi_e)^2\sigma_{x,t}^2+(\pi_\eta+k_{1,m}A_{3,m}\varphi_\eta)^2\sigma_{g,t}^2, \tag{11}$$

where $c_4=k_{1,m}^2(A_{1,m}\sigma_1+A_{2,m}\sigma_2)^2+k_{1,m}^2A_{2,m}^2\sigma_3^2$. Using equation (11), we can substitute $\sigma_{g,t}^2$ out from equation (9) by $\sigma_{m,t}^2$:

$$\begin{aligned}
z_{m,t} &= A_{0,m}+A_{1,m}\sigma_{g,t}^2+A_{2,m}\sigma_{x,t}^2+A_{3,m}x_t\\
&= A_{0,m}-\frac{A_{1,m}}{(\pi_\eta+k_{1,m}A_{3,m}\varphi_\eta)^2}c_4+a\sigma_{m,t}^2+b\sigma_{x,t}^2+A_{3,m}x_t,
\end{aligned} \tag{12}$$

where $a = \frac{A_{1,m}}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}$ and $b = A_{2,m} - \frac{A_{1,m}}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}(k_{1,m}A_{3,m}\varphi_e + \pi_e)^2$.

Using equations (6) and (10), we have

$$\begin{aligned} Cov_t[m_{t+1}, r_{m,t+1}] &= c_5 - [\gamma - (\theta-1)k_1A_3\varphi_\eta](\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)\sigma_{g,t}^2 \\ &\quad + [(\theta-1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,m}A_{3,m}\varphi_e + \pi_e)\sigma_{x,t}^2, \end{aligned}$$

where $c_5 = k_1k_{1,m}(\theta-1)(A_1\sigma_1 + A_2\sigma_2)(A_{1,m}\sigma_1 + A_{2,m}\sigma_2) + (\theta-1)k_1k_{1,m}A_{2,m}A_2\sigma_3^2$. By the Euler equations $\mathbb{E}_t[M_{t+1}R_{m,t+1}] = 1$ and $\mathbb{E}_t[M_{t+1}R_t^f] = 1$ we have

$$\begin{aligned} \mathbb{E}_t[r_{m,t+1} - r_t^f] &= -\frac{1}{2}\sigma_{m,t}^2 - Cov_t[m_{t+1}, r_{m,t+1}] \\ &= -c_5 - \frac{1}{2}\sigma_{m,t}^2 + [\gamma - (\theta-1)k_1A_3\varphi_\eta](\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)\sigma_{g,t}^2 \\ &\quad - [(\theta-1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,m}A_{3,m}\varphi_e + \pi_e)\sigma_{x,t}^2. \end{aligned} \tag{13}$$

From (11) and (13) we have

$$\mathbb{E}_t[r_{m,t+1} - r_t^f] = c_6 + \alpha\sigma_{m,t}^2 + \beta\sigma_{x,t}^2,$$

where

$$\begin{aligned} c_6 &= -c_5 - \frac{\gamma - (\theta-1)k_1A_3\varphi_\eta}{\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta}c_4, \\ \alpha &= -\frac{1}{2} + \frac{\gamma - (\theta-1)k_1A_3\varphi_\eta}{\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta}, \\ \beta &= -[(\theta-1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,m}A_{3,m}\varphi_e + \pi_e) - \frac{\gamma - (\theta-1)k_1A_3\varphi_\eta}{\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta}(k_{1,m}A_{3,m}\varphi_e + \pi_e)^2. \end{aligned}$$

By the Euler equation $\mathbb{E}_t[M_{t+1}R_t^f] = 1$ we have

$$\begin{aligned} r_t^f &= -\mathbb{E}_t[m_{t+1}] - \frac{1}{2}\mathrm{Var}_t[m_{t+1}] \\ &= c_7 - [A_3(\theta-1)(\rho k_1 - 1) - \gamma]x_t + c\sigma_{g,t}^2 + d\sigma_{x,t}^2 \\ &= c_7 - \frac{cc_4}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2} + \frac{1}{\psi}x_t + \frac{c}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}\sigma_{m,t}^2 \\ &\quad + [d - \frac{c}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}(k_{1,m}A_{3,m}\varphi_e + \pi_e)^2]\sigma_{x,t}^2, \end{aligned}$$

where

$$\begin{aligned} c_7 &= -c_2 - \frac{1}{2}k_1^2(\theta-1)^2[(A_1\sigma_1 + A_2\sigma_2)^2 + A_2^2\sigma_3^2], \\ c &= -[(\theta-1)(k_1 v_g - 1)A_1 + \frac{1}{2}[\gamma - (\theta-1)k_1A_3\varphi_\eta]^2], \\ d &= -[(\theta-1)(k_1 v_x - 1)A_2 + \frac{1}{2}((\theta-1)k_1A_3\varphi_e + \gamma\psi_x)^2]. \end{aligned}$$

D. Stock Portfolio Returns

Using the log linear approximation for the return on portfolio p, we have

$$r_{p,t+1} = \ln\frac{P_{p,t+1} + D_{p,t+1}}{P_{p,t}} = k_{0,p} + k_{1,p}z_{p,t+1} - z_{p,t} + \Delta d_{p,t+1}, \tag{14}$$

where $z_{p,t} = \ln\frac{P_{p,t}}{D_{p,t}}$, $\bar{z}_p = \mathbb{E}[z_{p,t}]$, $k_{1,p} = \dfrac{e^{\bar{z}_p}}{e^{\bar{z}_p} + 1} < 1$, and $k_{0,p} = \ln(e^{\bar{z}_p} + 1) - \dfrac{\bar{z}_p e^{\bar{z}_p}}{e^{\bar{z}_p} + 1}$.

The portfolio's dividend growth process is

$$\Delta d_{p,t+1} = \mu_d + \phi_p x_t + \pi_{\eta,p}\sigma_{g,t}\eta_{t+1} + \pi_{e,p}\sigma_{x,t}e_{t+1} + \pi_p z_{p,t+1}.$$

We suppose that the log price-dividend ratio has the following form

$$z_{p,t} = A_{0,p} + A_{1,p}\sigma_{g,t}^2 + A_{2,p}\sigma_{x,t}^2 + A_{3,p}x_t, \tag{15}$$

where $A_{0,p}, A_{1,p}, A_{2,p}, A_{3,p}$ are constants to be determined below.

Combining equations (14) and (15), we have

$$\begin{aligned} r_{p,t+1} &= c_{3,p} + (k_{1,p}v_g - 1)A_{1,p}\sigma^2_{g,t} + (k_{1,p}v_x - 1)A_{2,p}\sigma^2_{x,t} \\ &+ (k_{1,p}A_{3,p}\rho - A_{3,p} + \phi_p)x_t + k_{1,p}(A_{1,p}\sigma_1 + A_{2,p}\sigma_2)z_{1,t+1} \\ &+ k_{1,p}A_{2,p}\sigma_3 z_{2,t+1} + \pi_p z_{p,t+1} + (k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})\sigma_{x,t}e_{t+1} \\ &+ (\pi_{\eta,p} + k_{1,p}A_{3,p}\varphi_\eta)\sigma_{g,t}\eta_{t+1}, \end{aligned} \tag{16}$$

where $c_{3,p} = k_{0,p} + (k_{1,p} - 1)A_{0,p} + k_{1,p}A_{1,p}\sigma^2_g(1 - v_g) + k_{1,p}A_{2,p}\sigma^2_x(1 - v_x) + \mu_d$. The conditional variance of the portfolio return is

$$\sigma^2_{p,t} = c_{4,p} + (k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})^2\sigma^2_{x,t} + (\pi_{\eta,p} + k_{1,p}A_{3,p}\varphi_\eta)^2\sigma^2_{g,t},$$

where $c_{4,p} = k^2_{1,p}(A_{1,p}\sigma_1 + A_{2,p}\sigma_2)^2 + k^2_{1,p}A^2_{2,p}\sigma^2_3 + \pi^2_p$.

The covariance of the portfolio return with the log pricing kernel is

$$\begin{aligned} Cov_t[m_{t+1}, r_{p,t+1}] &= c_{5,p} - [\gamma - (\theta - 1)k_1A_3\varphi_\eta](\pi_{\eta,p} + k_{1,p}A_{3,p}\varphi_\eta)\sigma^2_{g,t} \\ &+ [(\theta - 1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})\sigma^2_{x,t}, \end{aligned}$$

where $c_{5,p} = k_1k_{1,p}(\theta - 1)(A_1\sigma_1 + A_2\sigma_2)(A_{1,p}\sigma_1 + A_{2,p}\sigma_2) + (\theta - 1)k_1k_{1,p}A_{2,p}A_2\sigma^2_3$.

By the Euler equations $\mathbb{E}_t[M_{t+1}R_{p,t+1}] = 1$ and $\mathbb{E}_t[M_{t+1}R^f_t] = 1$ we have

$$\begin{aligned} \mathbb{E}_t[r_{p,t+1} - r^f_t] &= -\frac{1}{2}\sigma^2_{p,t} - Cov_t[m_{t+1}, r_{p,t+1}] \\ &= -c_{5,p} - \frac{1}{2}c_{4,p} - \frac{1}{2}(k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})^2\sigma^2_{x,t} \\ &+ \Big[[\gamma - (\theta - 1)k_1A_3\varphi_\eta](\pi_{\eta,p} + k_{1,p}A_{3,p}\varphi_\eta) - \frac{1}{2}(k_{1,p}A_{3,p}\varphi_\eta + \pi_{\eta,p})^2\Big]\sigma^2_{g,t} \\ &- [(\theta - 1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})\sigma^2_{x,t}. \end{aligned} \tag{17}$$

Substituting equation (11) into equation (17), we have

$$\mathbb{E}_t[r_{p,t+1} - r_t^f] = c_{6,p} + \alpha_p \sigma_{m,t}^2 + \beta_p \sigma_{x,t}^2,$$

where

$$\begin{aligned}
c_{6,p} &= -c_{5,p} - \frac{1}{2}c_{4,p} - \frac{a_p}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}c_4, \\
\alpha_p &= \frac{a_p}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}, \\
\beta_p &= -[(\theta-1)k_1A_3\varphi_e + \gamma\psi_x](k_{1,p}A_{3,p}\varphi_e + \pi_{e,p}) - \frac{a_p}{(\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2}(k_{1,m}A_{3,m}\varphi_e + \pi_e)^2 \\
&\quad -\frac{1}{2}(k_{1,p}A_{3,p}\varphi_e + \pi_{e,p})^2.
\end{aligned}$$

Combining equations (6) and (16), we have

$$\begin{aligned}
m_{t+1} + r_{p,t+1} &= \theta \ln \delta - \frac{\theta}{\psi}\Delta c_{t+1} + (\theta-1)r_{a,t+1} + r_{p,t+1} \\
&= c_2 + c_{3,p} + [A_3(\theta-1)(\rho k_1 - 1) - \gamma + k_{1,p}A_{3,p}\rho - A_{3,p} + \phi_p]x_t \\
&\quad +[(\theta-1)(k_1 v_g - 1)A_1 + (k_{1,p}v_g - 1)A_{1,p}]\sigma_{g,t}^2 \\
&\quad +[(\theta-1)(k_1 v_x - 1)A_2 + (k_{1,p}v_x - 1)A_{2,p}]\sigma_{x,t}^2 \\
&\quad +[k_1(\theta-1)(A_1\sigma_1 + A_2\sigma_2) + k_{1,p}(A_{1,p}\sigma_1 + A_{2,p}\sigma_2)]z_{1,t+1} \\
&\quad +[(\theta-1)k_1A_2 + k_{1,p}A_{2,p}]\sigma_3 z_{2,t+1} \\
&\quad +[(\theta-1)k_1A_3\varphi_e + \gamma\psi_x + k_{1,p}A_{3,p}\varphi_e + \pi_{e,p}]\sigma_{x,t}e_{t+1} \\
&\quad +[\pi_{\eta,p} - \gamma + (\theta-1)k_1A_3\varphi_\eta + k_{1,p}A_{3,p}\varphi_\eta]\sigma_{g,t}\eta_{t+1} + \pi_p z_{p,t+1}.
\end{aligned}$$

Using the Euler equation $\mathbb{E}_t[M_{t+1}R_{p,t+1}] = 1$ and the fact that $\ln(\mathbb{E}[X]) = \mathbb{E}[\ln(X)] -$

$\frac{1}{2}\text{Var}[\ln(X)]$ for log normal distributed variable X, we have

$$\begin{aligned}
A_3(\theta-1)(\rho k_1-1)-\gamma+k_{1,p}A_{3,p}\rho-A_{3,p}+\phi_p &= 0,\\
(\theta-1)(k_1v_g-1)A_1+(k_{1,p}v_g-1)A_{1,p}+\frac{1}{2}[\pi_{\eta,p}-\gamma+(\theta-1)k_1A_3\varphi_\eta+k_{1,p}A_{3,p}\varphi_\eta]^2 &= 0,\\
(\theta-1)(k_1v_x-1)A_2+(k_{1,p}v_x-1)A_{2,p} &\\
+\frac{1}{2}((\theta-1)k_1A_3\varphi_e+\gamma\psi_x+k_{1,p}A_{3,p}\varphi_e+\pi_{e,p})^2 &= 0,\\
c_2+c_{3,p}+\frac{1}{2}[k_1(\theta-1)(A_1\sigma_1+A_2\sigma_2)+k_{1,p}(A_{1,p}\sigma_1+A_{2,p}\sigma_2)]^2 &\\
+\frac{1}{2}[(\theta-1)k_1A_2+k_{1,p}A_{2,p}]^2\sigma_3^2+\frac{1}{2}\pi_p^2 &= 0,
\end{aligned}$$

from which we get

$$\begin{aligned}
A_{0,p} &= \frac{1}{1-k_{1,p}}\Big[c_2+k_{0,p}+k_{1,p}A_{1,p}\sigma_g^2(1-v_g)+k_{1,p}A_{2,p}\sigma_x^2(1-v_x)+\mu_d+\\
&\qquad +\frac{1}{2}[k_1(\theta-1)(A_1\sigma_1+A_2\sigma_2)+k_{1,p}(A_{1,p}\sigma_1+A_{2,p}\sigma_2)]^2\\
&\qquad +\frac{1}{2}[(\theta-1)k_1A_2+k_{1,p}A_{2,p}]^2\sigma_3^2+\frac{1}{2}\pi_p^2\Big],\\
A_{1,p} &= \frac{(\theta-1)(k_1v_g-1)A_1+\frac{1}{2}[\pi_{\eta,p}-\gamma+(\theta-1)k_1A_3\varphi_\eta+k_{1,p}A_{3,p}\varphi_\eta]^2}{1-k_{1,p}v_g},\\
A_{2,p} &= \frac{1}{1-k_{1,p}v_x}\big[(\theta-1)(k_1v_x-1)A_2+\frac{1}{2}((\theta-1)k_1A_3\varphi_e+\gamma\psi_x+k_{1,p}A_{3,p}\varphi_e+\pi_{e,p})^2\big],\\
A_{3,p} &= \frac{\phi_p-\frac{1}{\psi}}{1-k_{1,p}\rho}.
\end{aligned}$$

E. Negative Correlation Condition

$$\begin{aligned}
& cov_t(M_{t+1}R_{m,t+1},R_{m,t+1})\\
=\ & \mathbb{E}_t[M_{t+1}R_{m,t+1}^2]-\mathbb{E}_t[M_{t+1}R_{m,t+1}]\mathbb{E}_t[R_{m,t+1}]\\
=\ & \mathbb{E}_t[M_{t+1}R_{m,t+1}^2]-\mathbb{E}_t[R_{m,t+1}]=\mathbb{E}_t[\exp(m_{t+1}+2r_{m,t+1})]-\mathbb{E}_t[\exp(r_{m,t+1})]\\
=\ & \exp\big(\mathbb{E}_t[m_{t+1}]+2\mathbb{E}_t[r_{m,t+1}]+2Var_t[r_{m,t+1}]+\frac{1}{2}Var_t[m_{t+1}]+2cov_t(m_{t+1},r_{m,t+1})\big)\\
& -\exp\big(\mathbb{E}_t[r_{m,t+1}]+\frac{1}{2}Var_t[r_{m,t+1}]\big). \qquad (18)
\end{aligned}$$

The assumption that M_{t+1} and $R_{m,t+1}$ are jointly log-normal distributed is used in equation (18). The no-arbitrage condition $\mathbb{E}_t[M_{t+1}R_{m,t+1}] = 1$ implies

$$\exp\left(\mathbb{E}_t[m_{t+1}] + \mathbb{E}_t[r_{m,t+1}] + \frac{1}{2}Var_t[r_{m,t+1}] + \frac{1}{2}Var_t[m_{t+1}] + cov_t(m_{t+1}, r_{m,t+1})\right) = 1.$$

Substituting the log-linearized no-arbitrage condition into equation (18), we have

$$\begin{aligned}
& cov_t(M_{t+1}R_{m,t+1}, R_{m,t+1}) \\
= \; & \exp\left(\mathbb{E}_t[r_{m,t+1}] + 1.5Var_t[r_{m,t+1}] + cov_t(m_{t+1}, r_{m,t+1})\right) - \exp\left(\mathbb{E}_t[r_{m,t+1}] + \frac{1}{2}Var_t[r_{m,t+1}]\right) \\
= \; & \exp\left(\mathbb{E}_t[r_{m,t+1}] + \frac{1}{2}Var_t[r_{m,t+1}]\right)[\exp\left(Var_t[r_{m,t+1}] + cov_t(m_{t+1}, r_{m,t+1})\right) - 1]. \qquad (19)
\end{aligned}$$

Note that

$$\begin{aligned}
Var_t[r_{m,t+1}] &= c_4 + (\pi_e + k_{1,m}A_{3,m}\varphi_e)^2\sigma_{x,t}^2 + (\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2\sigma_{g,t}^2, \\
Cov_t[m_{t+1}, r_{m,t+1}] &= c_5 + [\gamma\psi_x + k_1\varphi_e\frac{\frac{1}{\psi} - \gamma}{1 - k_1\rho}](\pi_e + k_{1,m}A_{3,m}\varphi_e)\sigma_{x,t}^2 \\
&\quad -[\gamma - k_1\varphi_\eta\frac{\frac{1}{\psi} - \gamma}{1 - k_1\rho}](\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)\sigma_{g,t}^2.
\end{aligned}$$

Therefore,

$$Var_t[r_{m,t+1}] + Cov_t[m_{t+1}, r_{m,t+1}] = a_0 + a_1\sigma_{x,t}^2 + a_2\sigma_{g,t}^2,$$

where

$$\begin{aligned}
a_0 &= c_4 + c_5, \\
a_1 &= (\pi_e + k_{1,m}A_{3,m}\varphi_e)^2 + [\gamma\psi_x + k_1\varphi_e\frac{\frac{1}{\psi} - \gamma}{1 - k_1\rho}](\pi_e + k_{1,m}A_{3,m}\varphi_e) > 0, \\
a_2 &= (\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta)^2 - [\gamma - k_1\varphi_\eta\frac{\frac{1}{\psi} - \gamma}{1 - k_1\rho}](\pi_\eta + k_{1,m}A_{3,m}\varphi_\eta) < 0.
\end{aligned}$$

B. Additional Simulation Results

A. Long-Horizon Forecast Regressions

In Table A1, we report the OLS estimation results of forecasting long-horizon excess stock market returns using quarterly predictor variables. In Panel A, we use price-dividend ratio (PD) as the predictor variable. For example, we use quarter t PD to forecast excess stock market returns over the period from quarter $t+1$ to quarter $t+4$ for the 1-year forecast horizon. In parentheses, we report the Newey-West t-value; the number of lags equals the number of quarters in the forecast horizon. We find that consistent with the actual data, PD correlates negatively with future excess stock market returns and R^2 increases monotonically with forecast horizons from 1 year to 5 years.

Panels B and C of Table A1 report long-horizon forecast regression results using stock market variance (VMKT) and euphoria variance (VE) as the predictor variables, respectively. We use both market and euphoria variances as the predictor variables in Panel D. The two variances jointly have stronger market return predictive power than they do individually. R^2 in Panel D is higher than its counterpart in Panel A. This is because the market return predictive power of the price-dividend ratio reflects its correlations with stock market variance and euphoria variance.

B. Alternative IST Calibration

Justiniano, Primiceri, and Tambalotti (2010) estimate impulse responses of consumption to IST shocks and report the findings in their Figure 3 for only the first 16 quarters. IST shocks are transitory in their model. We assume that consumption peaks at the 16th quarter and then reverse to the steady state value gradually with a symmetric path. The break-even discount rate is 35.75%, which is used to choose the parameter values for IST shocks reported in Table A2.

Figure 1 plots the Justiniano et al. (2010) estimated (solid line) and model (dashed line) impulse responses of consumption to one standard deviation increase in the IST shock. For comparison, we scale the model impulse responses so that the impact effect is the same as that of the Justiniano et al. (2010) estimated impulse responses.

The risk price is negative for IST shocks under the alternative calibration. Figure 2 shows that stock market variance is a V-shaped function of the price-dividend ratio. Figure 2 shows that the conditional equity premium decreases monotonically with the price-dividend ratio. Table A3 shows that key statistics of consumption, dividends, market returns, the price-dividend ratio, and the risk-free rate are within the 95% interval of simulated samples. The only exception is that the consumption volatility (2.16%) is slightly higher than the 97.5 percentile of simulated samples (2.31%).

We assume that the correlation between good and bad variances is zero. As a robustness check, we calibrate the model allowing for nonzero σ_2 and the other model parameters have the same value as those used in the benchmark calibration. We assume a positive correlation in Figure 3, ranging from 0.2 to 0.8. For comparison, we also include the benchmark case of zero correlation. Our main theoretical implication of a V-shaped stock market variance-price relation holds when DT and IST variances are positively correlated. Figure 3 shows similar results for negative correlations. In addition, Tables A4 to A7 show that our model's other asset pricing implications remain qualitatively similar for both positive and negative correlations between DT and IST variances.

C. DT Shocks, IST Shocks, and Consumption Growth

Panel A of Table A8 shows that in the multiple regression, consumption growth correlates negatively with IST shocks and positively with excess stock market returns in simulated data from the benchmark calibration. Interestingly, the effect of IST shocks on consumption growth is weak in the simple regression. These theoretical results quantitatively match their empirical counterparts reported in Panel C. Excess market returns are a proxy for DT shocks when together with IST shocks in our model. Consistent with this prediction, Panel B shows that excess market returns correlate positively and significantly with both IST shocks and ΔTFP, a proxy for DT shocks. Moreover, results reported in Panel A remain qualitatively similar when we use ΔTFP as an instrumental variable for excess market returns in Panel D.

C. Data Appendix

A. Main Variables

We use quarterly data spanning the 1963Q1 to 2016Q4 period unless otherwise indicated. Daily and monthly stock return data are from the Center of Research in Security Prices (CRSP), annual accounting data are from Compustat, and analysts earnings forecast data are from I/B/E/S. We obtain the Fama-French 5 factor portfolio return data from Kenneth French at Dartmouth College, the aggregate earnings-price ratio data from Robert Shiller at Yale University, and industry classification data from Dimitris Papanikolaou at Northwestern University. We follow Boudoukh, Michaely, Richardson, and Roberts (2007) to construct the dividend-price ratio and the net (equity) payout-price ratio using CRSP dividend payments and assuming zero-reinvestment.[1]

As a robustness check, we follow Pastor, Sinha, and Swaminathan (2008) to use the implied cost of capital (ICC) as a proxy for the conditional equity premium. For robustness, we consider five commonly used ICC measures proposed by Pastor et al. (2008), Gebhardt, Lee, and Swaminathan (2001), Easton (2004), Ohlson and Juettner-Nauroth (2005), and Gordon and Gordon (1997). We also obtain the Li, Ng, and Swaminathan (2013) ICC measure from David Ng at Cornell University. I/B/E/S publishes monthly consensus forecasts on the third Thursday of each month. We impose a minimum reporting lag of three months to make sure that earnings forecasts are made based on publicly available accounting information.

Papanikolaou (2011) shows that the spread in equity returns between investment-goods pro-

[1]We employ two methods to calculate corporate dividend payments: (1) the CRSP stock market indices with and without the dividend distribution and (2) the CRSP dividend payments (CRSP item DIVAMT). The corporate net payout is the difference between dividend payments and equity issuance that we compute using the monthly change in the number of shares outstanding. We use several dividend reinvestment assumptions, including no reinvestment, the risk-free rate, and the market rate at the end of each month. Results are similar for all alternative methods. For brevity, we use CRSP dividend payments data and assume zero-reinvestment to construct the dividend-price ratio and the net payout-price ratio.

ducers and consumption-goods producers (IMC) correlates closely with the IST shock measure constructed using the relative price of new equipment. We follow Papanikolaou (2011) to measure IST shocks using the return difference between high and low IMC beta stocks. Because the equity return-based IST proxy is available at a higher (daily) frequency, we can measure IST variance more precisely using realized variance.

Kogan and Papanikolaou (2013,0) argue that stocks with higher investment-capital ratios, Tobin's Q, price-earnings ratios, market-to-book equity ratios, market betas, and idiosyncratic volatilities are more sensitive to IST shocks. The high-minus-low spreads in returns on portfolios sorted by these characteristics are also proxies for IST shocks. Kogan and Papanikolaou (2013) find strong commonality among the IST proxies. We use the average and first principle component of the eight IST proxies as two additional IST measures.

To construct the daily IMC spread, we use industry classification data to sort stocks into two portfolios, investment-goods producers and consumption-goods producers. We calculate the daily value-weighted portfolio returns, and IMC is the difference in returns between the two portfolios. To construct daily high-minus-low portfolio spreads, we first sort stocks into two portfolios using the median NYSE market cap as the breaking point. Within each size portfolio, we sort stocks equally into three portfolios by each of the aforementioned seven characteristics. If the characteristic uses accounting data that have release delays, we form the portfolios at the end of June of year $t + 1$ and hold the portfolios for a year. Otherwise, we form the portfolios at the end of December of year t and hold the portfolios for a year.[2] We construct daily portfolio returns using the value weight. We then construct a high-minus-low hedging portfolio for each characteristic. For example, we construct the return differences between high and low Tobin's Q portfolios for both small and big stocks and use their simple average as a proxy for IST shocks.

We construct quarterly realized variance of each IST measure using the formula:

$$RV_t = \sum_{i=1}^{N_t} r_{i,t}^2 + 2 \sum_{i=1}^{N_t} r_{i,t} r_{i+1,t}, \tag{20}$$

[2]Results are similar for monthly rebalanced portfolios or independently sorted portfolios.

where $r_{i,t}$ is the ith day excess return, N_t is the number of daily returns in quarter t, and the second term is the correction of serial correlation in daily returns. For the first principle component of the eight IST proxies, we do not include the second term because it generates negative realized variance in some quarters.

Consistent with the conjecture that euphoria variance is a systematic risk, we document a strong commonality among the ten IST-based euphoria variance measures. To highlight this point, we also use the average and first principle component of the ten standardized IST-based euphoria variance measures as additional proxies for euphoria variance.

To construct VWASV, we first calculate quarterly realized variance of individual stocks and then aggregate them using the value weight. Because options-implied variance is a better measure of conditional variance than is realized variance, we use options-implied variance to construct VWASV after 1996. Consistent with the model implication, we document a strong relation between VWASV and IST-based euphoria variance measures. The correlation of VWASV with the 12 IST-based euphoria variance measures ranges from 59% to 79% over the 1963Q1 to 2016Q4 period, with an average of 69%.

Similar to simulated data, we also use the squared market-book (MB) equity ratio and price-earnings (PE) ratio as the weights to construct two alternative average stock variance measures, MB2ASV and PE2ASV, respectively. The price-dividend ratio is not used because many high-tech stocks pay no dividends. We assume that idiosyncratic volatility is constant across stocks in simulation. Campbell, Lettau, Malkiel, and Xu (2001) and many others, however, show that small stocks have much higher idiosyncratic volatility than big stocks. To address this issue, we construct BM2ASV and PE2ASV using the 500 largest stocks. We also winsorize the MB and PE ratios at the 5 and 95 percentiles to mitigate measurement errors. The correlations of BM2ASV and PE2ASV with VWASV (the average IST-based euphoria variance) are 0.67 and 0.80 (0.72 and 0.82), respectively.

Last, we use the realized market variance as a proxy for the conditional market variance up to 1985 and use options-implied market variance obtained from CBOE afterward.

B. SPF and Tealbook Forecasts

We assume in the model that both IST and DT shocks correlate positively with expected consumption and dividend growth. We investigate these assumptions using SPF (Survey of Professional Forecasters) and Tealbook forecasts as measures of expected consumption and profits growth. We obtained both forecasts from Philadelphia Fed.[3]

Croushore and Stark (2019) provide a comprehensive overview of SPF studies and conclude that "no forecasting model has consistently outperformed the SPF (page 7)" with an important caveat. Romer and Romer (2000) find that the Tealbook forecasts outperform the SPF forecasts, while Capistrán (2008) shows that SPF contains additional information not incorporated in the Tealbook.

The Bureau of Economic Analysis (BEA) usually releases quarter q National Income and Products Accounts (NIPA) data in the first month of the following quarter $q + 1$. The SPF survey questions are sent to forecasters in quarter $q + 1$ immediately after the previous quarter q NIPA data become available; and the forecasters usually have only one week to submit their forecasts. We use Table 3 from Croushore and Stark (2019) (reproduced in Figure 4) to illustrate the structure of the SPF forecasts. In the example, NGDP is the nominal gross domestic product. NGDP1 is the historical NGDP of the previous quarter. NGDP2-NGDP6 are the NGDP forecasts over the following 1-5 quarters, respectively. NGDPA and NGDPB are the forecasts for the current and following year NGDP, respectively.

We construct the forecasts of the real PCE (SPF variable RCONSUM) growth rates over the next 1 to 5 quarters and two years using the first-quarter survey of each year, which provides the longest-term (2-year-ahead) PCE growth forecast, $\frac{RCONSUMB}{RCONSUM1} - 1$. Our annual sample spans the 1982 to 2016 period. We regress the SPF forecast of the PCE growth rate over the next i period on

[3]The SPF forecasts are available from https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/survey-of-professional-forecasters. The Tealbook forecasts are available from https://www.philadelphiafed.org/surveys-and-data/real-time-data-research/greenbook.

its own lag and the concurrent IST and DT shocks:

$$\Delta PCE_{t+1}^{F,i} = a^i + b^i \Delta PCE_t^{F,i} + c^i IST_{t+1} + d^i ERET_{t+1}, \tag{21}$$

where we use the excess market return, ERET, as a proxy for the DT shock.

We use the SPF variable CPROF to construct the 2-year-ahead corporate profit growth forecast. Because the measure of CPROF is inconsistent before 2006Q1, we use the sample spanning the 2006 to 2016 period.[4] Starting from 1992, the first-quarter SPF includes the 10-year-ahead GDP and productivity growth forecasts, which are a proxy for x_t in long-run risk models.

In the first FOMC meeting every year, staff economists at the Fed provide their forecasts of PCE and GDP growth rates over the each of following seven quarters in the Tealbook. We construct the growth rates over the next seven quarters over the 1988 to 2016 period.

C. Daily and Monthly IST Factors

Accounting data are from Compustat Annual Fundamental files. Stock prices, stock returns, and shares outstanding of common stocks traded on NYSE, AMEX, and Nasdaq are from CRSP. Daily excess stock market returns and daily risk-free rates are from Ken French at Dartmouth College. We exclude Utility firms (SIC 4900-4949), financial firms (SIC 6000-6799), and firms

[4]The SPF Document indicates in page 23: "Prior to the survey of 2006Q1, it is corporate profits after tax excluding IVA and CCAdj. The historical values of this particular measure are subject to large discrete jumps when there is a change in tax law affecting depreciation provisions. The time series of projections for this series in the Survey of Professional Forecasters may or may not capture the jumps in historical values, depending on whether the forecasters anticipated the corresponding changes in tax law. Beginning with the survey of 2006:Q1, we switched to the after-tax measure that includes IVA and CCAdj." The document is available at `https://www.philadelphiafed.org/-/media/frbp/assets/surveys-and-data/survey-of-professional-forecasters/spf-documentation.pdf?la=en&hash=F2D73A2CE0C3EA90E71A363719588D25`.

that have negative or missing book values of equities. We follow Hou, Xue, and Zhang (2015) to construct book values of equities using Compustat annual data files. It equals (a) stockholders' book equities, plus (b) balance sheet deferred taxes and investment tax credit, and minus (c) book values of preferred stocks. We use the Compustat item *SEQ* as a measure of stockholders' book equities. If *SEQ* is not available, we use the sum of the book value of common equities *CEQ* and the par value of preferred stocks *PSTK*. If the sum of *CEQ* and *PSTK* is not available, we use the difference between the book value of total assets *AT* and the book value of total liabilities *LT*. Balance sheet deferred taxes and investment tax credit are measured by *TXDITC*. The book value of preferred stocks is redemption value *PSTKRV*, liquidation value *PSTKL*, or par value *PSTK* of preferred stocks, depending on the availability.

Papanikolaou (2011) argues that HML is closely related to IST shocks, and we obtain daily and monthly HML from Kenneth French at Dartmouth College. Following Papanikolaou (2011), we construct the daily investment-minus-consumption factor, IMC, as the difference in daily returns between the value-weighted portfolio of investment-goods producers and the value-weighted portfolio of consumption-goods producers. We thank Dimitris Papanikolaou at Kellogg School of Management of Northwestern University for providing the classification of investment-goods producers and consumption-goods producers used in Papanikolaou (2011).

Following Kogan and Papanikolaou (2013), we construct six additional proxies of IST shocks using portfolios formed by Tobin's Q, the investment-capital ratio (IK) the price-earnings ratio (PE), loadings on excess stock market returns (β_{MKT}), idiosyncratic volatility (IMCIV), and loadings on IMC (β_{IMC}). As in Kogan and Papanikolaou (2013), we exclude investment-goods producers from our sample. For portfolios that require accounting data, i.e., Tobin's Q, IK, and PE, we rank stocks using year t annual accounting data, and rebalance portfolios at the end of June, year $t + 1$. For portfolios that require only stock return data, i.e., β_{MKT}, IMCIV, and β_{IMC}, we rank stocks using data available at the end of year t, and rebalance portfolios at the end of year t. We construct daily and monthly IST shock proxies using double sorts. We first sort stocks into two groups using the median NYSE market capitalization as the breakpoint. Within each size portfolio, we sort stocks into three portfolios by a firm characteristic, e.g., IK, using the NYSE $30th$ and $70th$ IK percentiles as the breakpoints. We construct the daily or monthly value-weighted portfolio returns and calculate the return difference between low and high IK, for example, portfolios. The IK factor is the average of the long-short portfolio returns of small and big stocks. We construct the other factors in the same way. Table A9 provides more details of IST factors.

We also construct five-by-five portfolios using each of the aforementioned six firm characteristics. We first sort all stocks into five size portfolios using the NYSE $20th$, $40th$, $60th$, and $80th$ market capitalization percentiles as the breakpoints. Within each size portfolio, we sort stocks into five portfolios by a firm characteristic, e.g., IK, using the NYSE $20th$, $40th$, $60th$, and $80th$ IK percentiles as breakpoints. We calculate monthly both equal-weighted and value-weighted returns for each portfolio. Monthly equal-weighed and value-weighted returns on the five-by-five portfolios formed on BM are obtained from Kenneth French at Dartmouth College.

D. Implied Cost of Capital

We construct five ICC measures. Analyst consensus (mean) earnings forecast data are from the I/B/E/S unadjusted summary file. Accounting data are from Compustat. The end-of-month stock price and shares outstanding data are from CRSP. The 10-year treasury yield and GDP growth rate are from the Federal Reserve Bank of St. Louis. We use WRDS's iclink to link I/B/E/S data and CRSP data and then merge them with Compustat data using the CRSP/Compustat Merged linking table. We impose the following data requirements. First, firms must have common stocks traded on NYSE, AMEX, or NASDAQ. Second, a stock must have a valid SIC code that can be used to classify the stock into one of Fama-French 48 industries. The requirement allows us to construct the median payout ratio for each industry-size group. We use the historical SIC code from Compustat (Compustat item *SICH*). If *SICH* is unavailable, we use the SIC code from CRSP (CRSP item **SICCD**). Third, stocks must have valid CRSP price (CRSP item **PRC**) and shares outstanding (CRSP item **SHROUT**) that are used to calculate market capitalization. Fourth, we exclude observations with negative or missing I/B/E/S earnings forecast for the current fiscal year FE_{t+1}

(I/B/E/S FPI=1). Fifth, I/B/E/S publishes monthly consensus forecasts on the third Thursday of each month. To ensure that earnings forecasts are made based on publicly available accounting information, we impose a minimum reporting lag of three months. Last, because of the low coverage in I/B/E/S data files in early years, our sample begins from January 1981.

E. Pastor, Sinha, and Swaminathan (2008) Measure

Pastor et al. (2008) define ICC as:

$$\mathrm{P}_t = \sum_{k=1}^{15} \frac{\mathrm{FE}_{t+k}(1 - \mathrm{b}_{t+k})}{(1 + \mathrm{r}_e)^k} + \frac{\mathrm{FE}_{t+16}}{\mathrm{r}_e(1 + \mathrm{r}_e)^{15}},$$

where r_e is the implied cost of capital, b_{t+k} is the expected year $t + k$ plowback rate, FE_{t+k} is the analyst forecast of the $t + k$ year earnings per share, and P_t is the current month price per share. We calculate the implied cost of capital from the finite-horizon free cash flow valuation model using a three-stage procedure.

Stage 1: Earnings growth rate

We define earnings growth rate as

$$\mathrm{g}_{t+i} = \mathrm{g}_{t+i-1} \times \exp\left[\frac{\log(\frac{\mathrm{g}}{\mathrm{g}_{LT}})}{T - 1}\right], \quad \text{for i = 4 to 16.}$$

We use I/B/E/S (FPI=0) item LTG as a measure of analyst long-term growth rate forecasts, g_{LT}. If LTG is missing, we use $(\mathrm{FE}_{t+2}/\mathrm{FE}_{t+1}) - 1$ instead. If consensus forecast for year t+2 is also missing, we use $(\mathrm{FE}_{t+1}/\mathrm{FE}_{t+0}) - 1$ as an alternative measure. If the analyst long-term growth rate forecast measure has a value below 2% (above 100%), we replace it with 2% (100%). We then measure earnings growth rate between year $t + 4$ and year $t + 16$ by assuming that firm earnings growth rates mean-revert to the steady-state growth rate by year $t + 17$. We assume that the steady-state growth rate, g, equals the long-run nominal GDP growth rate, which is the expanding rolling average of the sum of annual real GDP growth rate and implicit price deflator growth rate. Our GDP data begins in 1930. The real GDP growth rate and implicit price deflator data are from the Federal Reserve Bank of St. Louis.

Stage 2: Expected Earnings Per Share

We calculate the expected earnings per share using the formula:

$$\text{FE}_{t+i} = \text{FE}_{t+i-1} \times (1 + g_{t+k}) \text{ , for i = 4 to 16.}$$

We obtain FE_{t+2} from I/B/E/S. If it is missing, we assume that it equals $\text{FE}_{t+1} \times (1 + g_{LT})$. After obtaining FE_{t+2}, we remove firms with missing or negative FE_{t+1} and FE_{t+2}. The forecast of three-year-ahead earnings is FE_{t+3}=$\text{FE}_{t+2} \times (1 + g_{LT})$. We then use FE_{t+3} and the corresponding growth rate obtained from stage 1 to measure FE_{t+i} recursively.

Stage 3: Plowback rate

The plowback rate forecast for year $t + 1$ and $t + 2$ can be constructed using the most recent accounting data. We construct the forecast in the years after $t + 2$ recursively using the formula:

$$b_{t+k} = b_{t+k-1} - \frac{b_{t+2} - b}{14} = b_{t+k-1} - \frac{b_{t+2} - \frac{g}{r_e}}{14}, \text{ for k = 3 to 15.}$$

Plowback rate (PB_t) equals one minus net payout ratio NP_t. We measure NP_t in three ways. First, we define $\text{NP}_t = \dfrac{\text{D}_t + \text{REP}_t - \text{NE}_t}{\text{NI}_t}$, where D_t is the common dividend (Compustat item *DVC*), REP_t is the share repurchase (Compustat item *PRSTKC*), NE_t is the net equity issuance (Compustat item *SSTK*), and NI_t is net income (Compustat item *IB*). Second, if IB is missing or has a negative value, we use the one-year ahead consensus earnings forecast made at the end of previous calendar year, FE_{t-1}, to measure NI_t or $\text{NP}_t = \dfrac{\text{D}_t + \text{REP}_t - \text{NE}_t}{\text{FE}_{t-1}}$. Last, if NP_t is still unavailable or if the NP_t from the first two steps has a value above 1 or below -0.5, we use the median NP_t of the corresponding industry-size portfolio instead. To compute the median NP_t, we first sort firms into Fama-French 48 industries. Within each industry, we use firm market capitalization at the end of previous calendar year to sort firms equally into three portfolios. If the resulting NP_t from each industry-size portfolio has a value above 1 or below -0.5, we replace it with 1 or -0.5, respectively. Hence, the minimum (maximum) plowback rate is 0 (1.5). If a firm still does not have valid plowback rate after these procedures, we remove it from the sample.

We estimate the plowback rates for year $t+3$ to year $t+16$ recursively by assuming that the plowback rate mean-reverts linearly to a steady-state value at year t+17. The steady-state plowback rate is $b = g/r_e$, where the steady state growth rate g is obtained from stage 1 and r_e is the implied cost of capital that we are interested in. Therefore, the expanded free cash flow valuation model is

$$\begin{aligned} P_t &= \frac{\text{FE}_{t+1}(1-\text{PB}_t)}{(1+r_e)^1} + \frac{\text{FE}_{t+2}(1-\text{PB}_t)}{(1+r_e)^2} \\ &\quad + \sum_{k=3}^{15} \frac{\text{FE}_{t+k}\left(1-\left(b_{t+k-1} - \dfrac{\text{PB}_t - \frac{g}{r_e}}{14}\right)\right)}{(1+r_e)^k} + \frac{\text{FE}_{t+16}}{r_e(1+r_e)^{15}}, \end{aligned}$$

and we can solve for r_e numerically.

F. Gebhardt et al. (2001) Measure

Gebhardt et al. (2001) use the following equation to solve for ICC:

$$\text{P}_t = \text{B}_t + \sum_{k=1}^{11} \frac{(\text{FROE}_{t+k} - r_e)B_{t+k-1}}{(1+r_e)^k} + \frac{(\text{FROE}_{t+12} - r_e)B_{t+11}}{r_e(1+r_e)^{11}}.$$

P_t is the stock price from CRSP monthly files. We use shares outstanding data from I/B/E/S to calculate the book equity value per share, B_t. If the shares outstanding value from I/B/E/S is missing, we construct an interpolated value using CRSP data: $d*\mathbf{SHROUT}_{m-1}+(1-d)*\mathbf{SHROUT}_m$, where d is the ratio of the number of days between previous month-end and current I/B/E/S statistical period to the total number of trading days in month m, and **SHROUT** is the number of monthly-end shares outstanding from CRSP. r_e is the implied cost of capital. FROE is the expected return on equity (ROE).

For years $t+1$ to $t+2$, $\text{FROE}_{t+k} = \frac{\text{FE}_{t+k}}{\text{B}_{t+k-1}}$. We obtain FE_{t+1} and FE_{t+2} from I/B/E/S. For year $t+3$, we use the analyst long-term earnings growth rate forecast (LTG) from I/B/E/S (FPI=0) to calculate $\text{FE}_{t+3} = \text{FE}_{t+2} \times (1 + \text{LTG})$. If LTG is missing, we replace it with $(\text{FE}_{t+2}/\text{FE}_{t+1}) - 1$. If consensus forecasts in year $t+2$ is also missing, we use $(\text{FE}_{t+1}/\text{FE}_{t+0}) - 1$. We require non-negative and non-missing I/B/E/S consensus earnings forecasts. After year $t+3$, we estimate FROE by assuming that it linearly mean-reverts to the industry median ROE by year $t+11$. $\text{ROE}_t = \frac{\text{E}_t}{\text{B}_t}$, where E_t is the actual EPS obtained from I/B/E/S unadjusted summary files. As in Gebhardt et al. (2001), we exclude firms with negative EPS when estimating the industry median ROE because profitable firms provide more accurate estimation over the industry's long-term equilibrium rate of return on equity than do unprofitable firms. We require a minimum of five years and a maximum of ten years rolling window to compute the industry median ROE, ROE_{int}. Hence, $\text{FROE}_{t+3+j} = \text{FROE}_{t+3} \times (1 + g_{int})^j$ where $g_{int} = (\frac{\text{ROE}_{int}}{\text{FROE}_{t+3}})^{\frac{1}{9}} - 1$.

The book equity value per share is obtained from clean surplus accounting $\text{B}_{t+j} = \text{B}_{t+j-1} + \text{FE}_{t+j} - \text{D}_{t+j}$, for j = 1 to 11. B_t is the book equity value per share measured as the ratio of most recent book equity value to the number of shares outstanding. FE_{t+k} is the year t forecast of EPS in year $t+k$. D_{t+k} is the year t forecast of dividend per shares in year $t+k$; it is the product of the most recent dividend payout ratio with FE_{t+k}. We use Compustat data to construct the dividend payout ratio as $\frac{DVC}{IB}$. For firms with negative or missing *IB*, we use $\frac{DVC}{(0.06*AT)}$ as an alternative dividend payout ratio. Note that the historical average return on assets is 0.06 in the US data. We require firms to have a valid payout ratio. For firms with a payout ratio below zero or above one, we replace it with zero or one, respectively.

Following Gebhardt et al. (2001), we impose following data requirements. First, firms must have non-missing book value of equity. The definition of book equity is the same as the one used to construct IST factors in the preceding subsection. We remove firms with a negative book value of equity. Second, firms must have non-missing net income (*IB*). For firms with negative *IB*, we replace it with $0.06 \times AT$ if possible. Third, firms must have non-missing dividends (*DVC*) and long-term debt (*DLTT*). Last, we exclude firms with missing or negative earnings forecasts for the following fiscal year (I/B/E/S FPI=2).

G. Easton (2004) Measure

Easton (2004) uses the following equation to estimate the implied cost of capital:

$$\mathrm{P}_t = \frac{\mathrm{FE}_{t+2} + r_e \times \mathrm{D}_{t+1} - \mathrm{FE}_{t+1}}{r_e^2}.$$

P_t is the stock price. r_e is the implied cost of capital. FE_{t+1} and FE_{t+2} are consensus analyst earnings forecasts for the current and next fiscal years. D_{t+1} is the expected dividend per share, and is calculated as the product of FE_{t+1} with the most recent payout ratio. The definition and criteria of the payout ratio is the same as that used in Gebhardt et al. (2001). We require firms with non-missing book value of equity, net income (*IB*), and dividends (*DVC*). Firms with a negative book value of equity are excluded. We also exclude firms with missing or negative earnings forecasts for the next fiscal year (I/B/E/S FPI=2).

H. Ohlson and Juettner-Nauroth (2005) Measure

Ohlson and Juettner-Nauroth (2005) construct the implied cost of capital using the following equation:

$$r_e = A + \sqrt{A^2 + \frac{\mathrm{FE}_{t+1}}{\mathrm{P}_t} \times (g - (\gamma - 1))}.$$

r_e is the implied cost of capital. $A = 0.5\Big[(\gamma - 1) + \frac{\mathrm{D}_{t+1}}{\mathrm{P}_t}\Big]$. D_{t+1} is the expected dividend per share, and is calculated as the product of FE_{t+1} with the most recent payout ratio. FE_{t+1} and FE_{t+2} are consensus analyst earnings forecasts for the current and next fiscal years. P_t is the stock price. $\gamma - 1$ is set to 10-year Treasury yield minus 3%. $g = 0.5\Big[\Big(\frac{\mathrm{FE}_{t+2} - \mathrm{FE}_{t+1}}{\mathrm{FE}_{t+1}}\Big) + \mathrm{LTG}_t\Big]$. As in Gode and Mohanram (2003), we use the average of near-term and long-term growth rates to estimate g. The definition and criteria of the payout ratio is the same as that used in Gebhardt et al. (2001). We require firms with non-missing book value of equity, net income (*IB*), and dividends (*DVC*). Firms with negative book value of equity are excluded. We also exclude firms with missing or negative earnings forecasts for the next fiscal year (I/B/E/S FPI=2).

I. Gordon and Gordon (1997) Measure

The Gordon and Gordon (1997) measure is a special case of the finite-horizon Gordon growth model. They use the following equation to calculate the implied cost of capital:

$$\mathrm{P}_t = \frac{\mathrm{FE}_{t+1}}{r_e}.$$

r_e is the implied cost of capital. FE_{t+1} is consensus analysts earnings forecasts for the current fiscal year. Firms with missing or negative earnings forecasts for the next fiscal year (I/B/E/S FPI=2) are excluded.

D. Supplemental Empirical Results

A. IST Shocks, Consumption, and Cash Flows

In Table A11, we report the OLS estimation results of regressing the change in long-run analyst earnings growth forecast on its own lag (DV_LAG), IST shocks (IST), lagged IST shocks (IST_LAG), excess stock market returns (ERET), and lagged excess stock market returns (ERET_LAG). We construct long-run analyst earnings growth forecast using I/B/E/S long-term earnings growth forecast data and include only firms with the December fiscal year end.

We construct daily stock return difference between investment-goods producers and consumption-goods producers, IMC, and then form portfolios on IMC betas. We use the return difference between high IMC-beta stocks and low IMC-beta stocks as a proxy for IST shocks. The annual sample spans the 1983 to 2015 period. In parentheses we report t-statistics constructed using Newey-West standard errors with two lags. We find that both IST and IST_LAG correlate positively and significantly with the change in long-run analyst earnings growth forecast even when controlling for ERET and ERET_LAG.

B. Summary Statistics

Table A12 provides summary statistics of main variables used in the empirical analysis. Panel A reports log price ratios. PD is the price-dividend ratio. PPO is the price-payout ratio. PE is the price-earnings ratio. Panel B reports the implied cost of capital measures. PSS, GLS, Easton, OJ, GG are ICC measures proposed by Pastor et al. (2008), Gebhardt et al. (2001), Easton (2004), Ohlson and Juettner-Nauroth (2005), and Gordon and Gordon (1997), respectively. AICC is the average of these five ICC measures. LNS is the ICC measure used in Li et al. (2013). Panel C reports empirical measures of euphoria variance and stock market variance. We have eight proxies for IST shocks. VIMC is quarterly realized variance of IMC. VIK, VTobinQ, VPE, VIMCIV, Vβ_{IMC}, VIMC, Vβ_{MKT}, and VHML are quarterly realized variances of hedging portfolios formed by characteristics IK, Tobin's Q, PE ratio, IMC idiosyncratic volatilities, IMC beta, Market Beta, and book-to-market equity ratio, respectively. We also calculate first principle component and the average of the eight IST measures, and VFPC and VAVE are their realized variances, respectively. FPCV and AVEV are the first principle component and the average of these (standardized) IST-based euphoria variance measures. VWASV is the value-weighted average stock variance. EWASV is the equity-weighted average stock variance. TYVIX is the options-implied bond variance. VMKT is stock market variance. Panel D reports asset returns. IK, TobinQ, PE, IMCIV, β_{IMC}, β_{MKT}, and HML are quarterly returns on hedging portfolios formed by characteristics IK, Tobin's Q, PE ratio, IMC idiosyncratic volatilities, IMC beta, Market Beta, and book-to-market equity ratio, respectively. AVE is the average of returns on the seven hedging portfolio returns. CMA, RMW, and SMB are the conservative-minus-aggressive, robust-minus-weak, and small-minus-big factors, respectively. ERET is the excess stock market return, and RF is the real risk-free rate.

C. Forecasting Excess Stock Market Returns Using Variances

Panel A of Table A13 reports the univariate regression results of forecasting one-quarter-ahead excess stock market returns with stock market variance and various measures of euphoria variance. Over the 1963Q1 to 2016Q4 period, stock market variance, VMKT, correlates positively and significantly with future excess stock market returns at the 5% level. By contrast, the correlation is negative for the IST-based euphoria variance measures except for Vβ_{MKT}, although it is statistically insignificant in most cases. The correlation is negative albeit statistically insignificant for the value-weighted average stock variance (VWASV) and bond variance (TYVIX).

In Panel B of Table A13, we include both stock market variance and a euphoria variance measure as forecasting variables. Consistent with our model's prediction, we find that the two variances have much stronger forecasting power for excess stock market returns in bivariate regressions than in univariate regressions. The coefficient on VMKT is always significantly positive, and the coefficient on euphoria variance is always significantly negative. More importantly, the coefficients and t-values are substantially larger in magnitude than their univariate counterparts reported in Panel A for both stock market variance and euphoria variance. In addition, the R^2 is much higher in bivariate regressions than in corresponding univariate regressions. The difference reflects the omitted variables problem. The coefficient of correlation between VMKT and euphoria variance measures is positive, ranging between 30% to 70%, while VMKT and euphoria variance have opposite effects on conditional equity premium. If we omit euphoria variance (VMKT) in the forecast regression, the coefficient on VMKT (euphoria variance) is downward (upward) biased toward zero.[5]

For comparison, we include the equal-weighted average stock variance, EWASV, as a predictor in Table A13. Its predictive power for excess stock market returns is much weaker than that of

[5]The multicollinearity problem cannot explain our findings because it inflates standard errors and does not increases R^2. As a further robustness check, we orthogonalize market variance by euphoria variance and vice versa, and find that the orthogonalized market variance or euphoria variance has significant predictive power for excess market returns (untabulated).

VWASV. Specifically, the effect of EWASV on the conditional equity premium is statistically insignificant at the 10% level in both univariate and bivariate regressions. By contrast, VWASV is statistically significant at the 1% level in the bivariate regression. These results are consistent with the model's prediction that VWASV has closer correlation with euphoria variance than does EWASV.

As a robustness check, we also investigate the out-of-sample predictive power of stock market variance and euphoria variance in Panel C of Table A13. For TYVIX, we use the 2003Q1 to 2009Q4 period for the initial in-sample estimation and make the out-of-sample forecast for the 2010Q1 to 2016Q4 period using an expanding sample. For the other euphoria variance measures, we use the 1963Q1 to 1989Q4 period for initial in-sample estimation and make the out-of-sample forecast for the 1990Q1 to 2016Q4 period using an expanding sample. We use two standard measures to gauge the out-of-sample performance. MSER is the mean squared forecasting errors ratio of the forecasting model to a benchmark model in which conditional equity premium equals average equity premium in historical data. ENC_NEW is the encompassing test proposed by Clark and McCracken (2001). 8 out of 12 IST-based euphoria variance measures have smaller mean squared forecasting errors than does the benchmark model. The encompassing test shows that the out-of-sample predictive power is statistically significant at the 5% level for all IST-based euphoria variance measures. Results are similar for VWASV and TYVIX.

As expected, VWASV has market return predictive power similar to that of IST-based euphoria variance measures. For example, it drives out IST-based euphoria variance measures except for VHML in the multivariate regressions of forecasting excess stock market returns. In addition, the predictive power of TYVIX is similar to that of VWASV: TYVIX becomes statistically insignificant when we control for VWASV in the forecasting regression. These results are not reported here but are available upon request. Because IST-based euphoria variance measures have similar predictive for excess stock market returns, for brevity, in the remainder of the appendix we use their first principle component, FPCV, and their average, AVEV as IST-based proxies for euphoria variance. Because TYVIX is available only for a short sample period, we use VWASV as the alternative euphoria variance measure in the remainder of the appendix.

D. Forecasting Excess Stock Market Returns Using ICC and Scaled Stock Market Prices

If ICC is a measure of the conditional equity premium, it may forecast excess stock market returns. Consistent with this conjecture, Li et al. (2013) show that their ICC measure does have significant predictive power for excess stock market returns. We replicate their main finding in Panel A of Table A14 that LNS correlates positively and significantly with the one-quarter-ahead excess stock market return at the 5% level. The other ICC measures also correlate positively with future excess stock market returns; however, the relation is statistically insignificant at the 5% level.

To investigate whether the forecasting power of ICC for excess stock market returns reflects its correlation with stock market variance and euphoria variance, we decompose ICC into two components by regressing it on stock market variance and euphoria variance. We use FPCV as the euphoria variance measure in Panel A of Table A14. The fitted component of ICC measures correlates positively and significantly with future stock market returns, while the residual component has negligible predictive power. Results are similar when we use AVEV and VWASV as euphoria variance measures in Panels B and C, respectively.

In our model, the price-dividend ratio correlates with stock market variance and euphoria variance because these variances are the determinants of conditional equity premium. To investigate this implication, we decompose the scaled stock market price into two components by regressing it on stock market variance and euphoria variance. In Panel A of Table A14, we use FPCV as the proxy for euphoria variance. For all three stock market price measures, the fitted component correlates negatively and significantly with one-quarter-ahead excess stock market returns at the 1% level, while the predictive power is negligible for the residual component. Panels B and C show that results are similar when we use AVEV and VWASV, respectively, as proxies for euphoria variance.

E. Forecasting Anomalies

In our model, stocks that are more sensitive to IST shocks have more negative loadings on euphoria variance and thus lower expected returns. Similarly, stocks that are more sensitive to DT shocks have more positive loadings on fear variance and thus higher expected returns. To investigate this implication, we form portfolios on the investment-capital ratio, Tobin's Q, the price-earnings ratio, idiosyncratic volatility, IMC beta, and market beta. We construct hedging portfolios that have a long (short) position in stocks that are least (most) sensitive to IST shocks. For example, we buy stocks with a low investment-capital ratio, sell stocks with a high investment-capital ratio, and take the return spread as the return on the zero-cost hedging portfolio formed by the investment-capital ratio. Because extant studies, e.g., Kogan and Papanikolaou (2013,0), have shown that these hedging portfolios have significant loadings on IST shocks, we expect that these long-short portfolios have positive loadings on euphoria variance.

In addition, Kogan and Papanikolaou (2013,0) argue that the strong comovement among portfolios formed on the investment-capital ratio, Tobin's Q, the price-earnings ratio, idiosyncratic volatility, IMC beta, market beta, and the book-to-market equity ratio reflects their strong sensitivity to IST shocks. To investigate this conjecture, we calculate the average of returns on the long-short portfolios formed on these characteristics, AVE, as a measure of the commonality.

We also consider the four hedging risk factors in the Fama and French (2015) five-factor model, HML, CMA, RMW, and SMB. HML longs (shorts) stocks with high (low) book-to-market equity ratios; CMA longs (shorts) stocks with low (high) total asset growth; RMW longs (shorts) stocks with high (low) profitability; and SMB longs (shorts) stocks with small (big) market capitalization.

In Table A15, we report the OLS regression results of forecasting long-short portfolio returns using stock market variance and euphoria variance. We use FPCV as a proxy for euphoria variance in Panel A. As expected, the coefficient on euphoria variance is positive in all cases; and it is statistically significant at least at the 10% in most cases. The coefficient on stock market variance is negative in all cases except for SMB, and is statistically significant at least at the 10% level except for CMA and SMB. Again, we find similar results using AVEV and VWASV as proxies for euphoria variance in Panels B and C, respectively. To summarize, stocks with different sensitivity to DT and IST shocks have different loadings on stock market variance and euphoria variance, and these differences in their loadings are related to their different expected excess returns.

F. Cross-Section of Expected Stock Returns

In Panel A of Table A16, we report the Fama and MacBeth (1973) regression results for the 32 triple-sorted portfolios formed on market capitalization, operation profit, and total asset growth. The risk price is significantly positive at the 1% level for loadings on euphoria variance and at the 10% level for loadings on stock market variance. Panel D reports that results are qualitatively similar for the 32 triple-sorted portfolios formed on market capitalization, book-to-market equity ratios, and total asset growth.

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FIGURE 1

Justiniano et al. (2010) Impulse Responses

Solid line is the impulse responses of consumption to IST shocks estimated by Justiniano et al. (2010). Dashed line is the model impulse responses. For comparison, scaled the model impulse responses that the impact effect is the same as that of the estimated impulse responses.

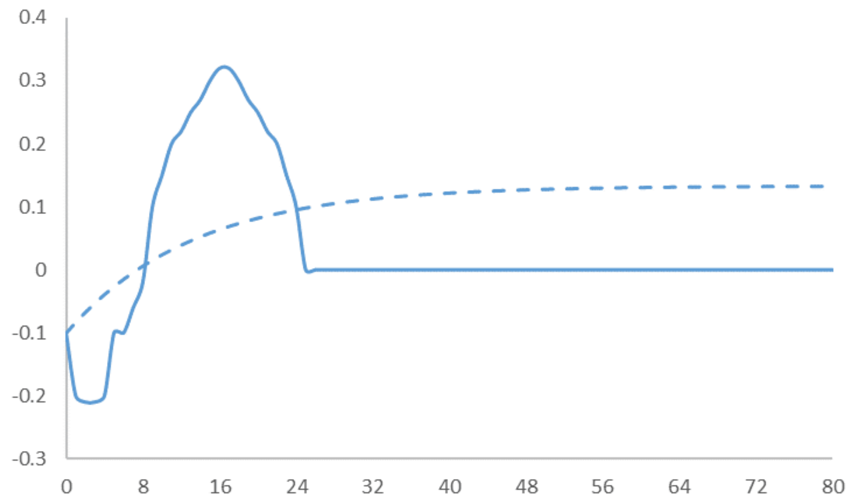
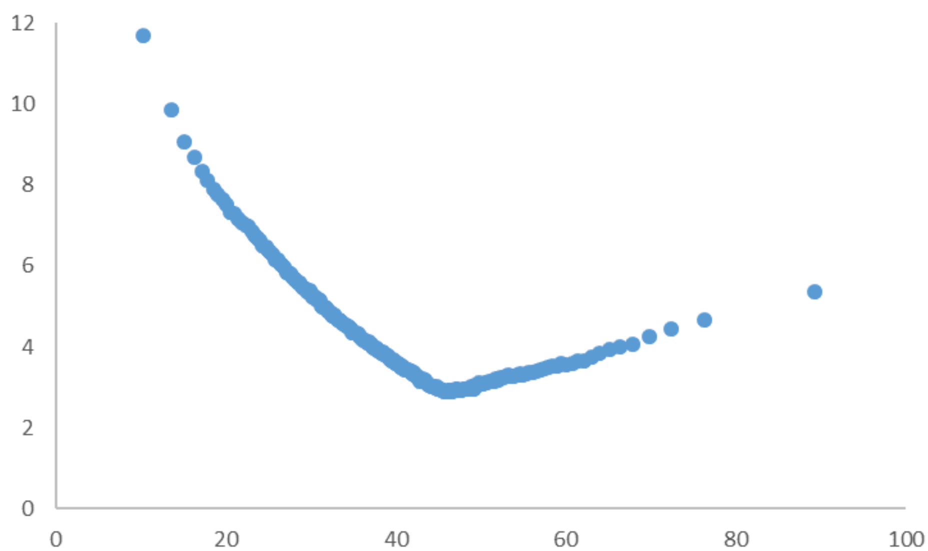


FIGURE 2

Market Variance and Equity Premium

The figure plots the relation between the price-dividend ratio (horizontal axis) and the conditional market variance or the conditional equity premium (in percentage, vertical axis) in simulated data

(a) Conditional Market Variance



(b) Conditional Equity Premium

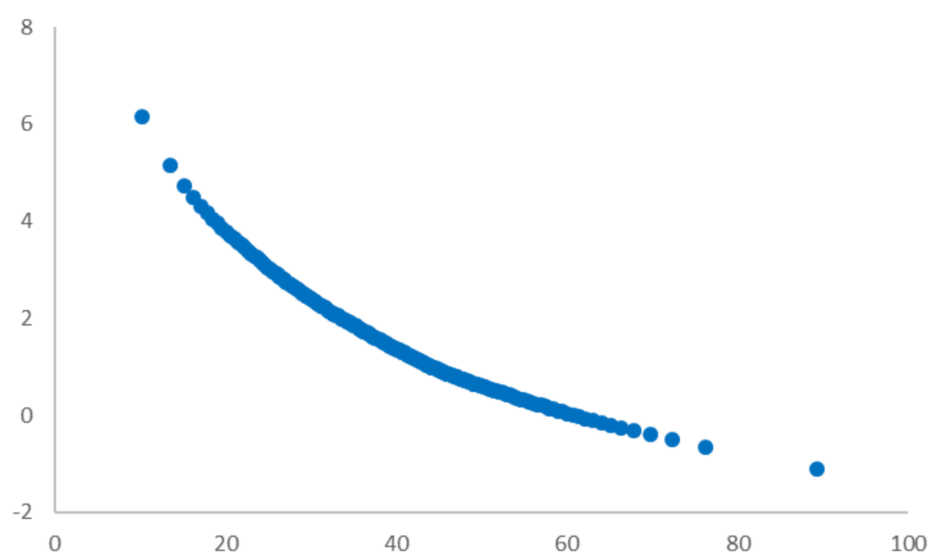
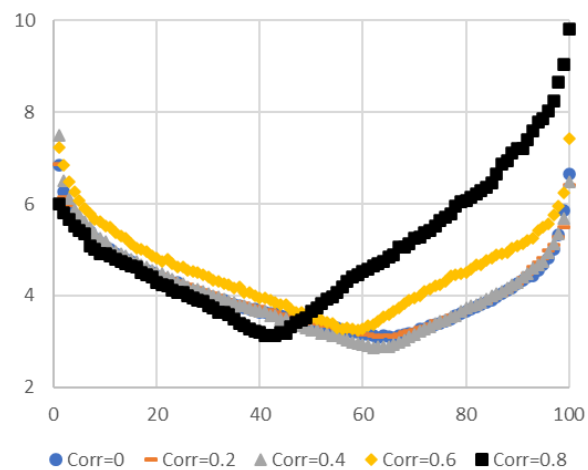


FIGURE 3

Stock Market Variance-Price Relation in Our Model for Nonzero correlation

This figure shows stock Market Variance-Price Relation in Our Model for Nonzero correlation between DT and IST Variances. The vertical axis denotes stock market variance in percentage point. The horizon axis denotes the range of the price dividend ratio from lowest (1) to highest(100).

(a) Positive Correlation



(b) Negative Correlation

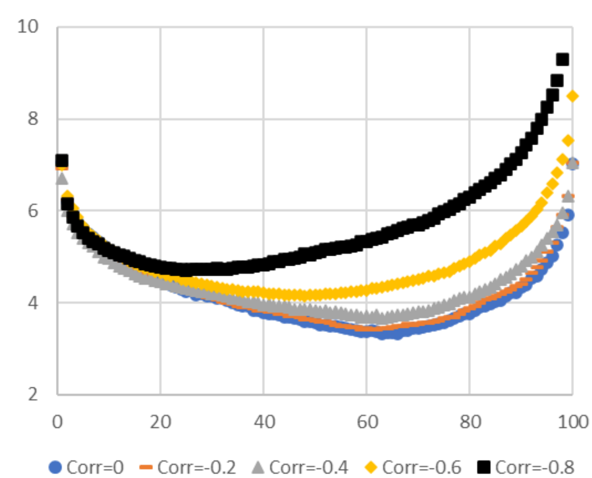


FIGURE 4

SPF Variable Description

Table 3. Example: Forecast Horizons for Nominal GDP at Three Survey Dates

Survey Date (Year, Quarter)		Quarterly Historical Value	Quarterly Projections: Quarter Forecast					Annual-Average Projections: Year Forecast	
(1) Year	(2) Quarter	(3) NGDP1	(4) NGDP2	(5) NGDP3	(6) NGDP4	(7) NGDP5	(8) NGDP6	(9) NGDPA	(10) NGDPB
2005	3	2005:Q2	2005:Q3	2005:Q4	2006:Q1	2006:Q2	2006:Q3	2005	2006
2005	4	2005:Q3	2005:Q4	2006:Q1	2006:Q2	2006:Q3	2006:Q4	2005	2006
2006	1	2005:Q4	2006:Q1	2006:Q2	2006:Q3	2006:Q4	2007:Q1	2006	2007

Table notes. The table shows how we organize the survey's median (or mean) responses for three survey dates: 2005:Q3, 2005:Q4, and 2006:Q1. The entries in columns (1)–(2) show the year and quarter when we conducted the survey. The entry in column (3) shows the observation date for the last known historical quarter at the time we sent the questionnaire to the panelists. The entries in columns (4)–(8) show the quarterly observation dates forecast. The entries in columns (9)–(10) show the annual observation dates forecast: Notice how the annual-average forecast horizons are fixed within a calendar year and change in each first-quarter survey. Moody's now views the historical values for the Aaa and Baa corporate bond yields (BOND and BAABOND) as proprietary. Accordingly, the Philadelphia Fed is not permitted to release these historical values to the public.

TABLE A1

Forecasting Excess Stock Market Returns over Long Horizons

The table reports the OLS estimation results of regressing long-horizon excess stock market returns on quarterly predictor variables for simulated data. We use overlapping quarterly returns. Parentheses report the Newey-West t-value; the number of lags equals to the number of quarters in the forecast horizon. We generate 10,000 simulated samples and report their distributions. The column "Pop" reports the results obtained from 100,000 simulated quarterly observations. PD is the price-dividend ratio. VMKT is stock market variance. VE is euphoria variance. R^2 is reported in percentage.

	1 year			3 years			5 years		
	Median	70%	Pop	Median	70%	Pop	Median	70%	Pop
Panel A: Price-Dividend Ratio									
PD	-0.059	-0.086	-0.040	-0.175	-0.248	-0.118	-0.279	-0.399	-0.913
	(-1.341)	(-1.866)	(-71.916)	(-1.504)	(-2.133)	(-73.884)	(-1.621)	(-2.325)	(-73.430)
R^2	0.851	1.580	0.665	2.425	4.558	1.916	3.888	7.252	3.062
Panel B: Stock Market Variance									
VMKT	0.559	1.127	0.313	1.614	3.271	0.908	2.629	5.328	1.467
	(0.606)	(1.183)	(26.898)	(0.663)	(1.311)	(27.130)	(0.704)	(1.408)	(26.490)
R^2	0.318	0.752	0.001	0.931	2.156	0.252	1.527	3.540	0.395
Panel C: Euphoria Variance									
VE	-9.608	-20.397	-6.296	-28.079	-59.647	-18.634	-46.064	-99.256	-30.659
	(-0.521)	(-1.086)	(-30.496)	(-0.587)	(-1.229)	(-31.505)	(-0.630)	(-1.316)	(-31.389)
R^2	0.290	0.669	0.117	0.846	1.967	0.342	1.425	3.195	0.557
Panel D: Stock Market Variance and Euphoria Variance									
VMKT	1.713	2.510	1.149	4.920	7.257	3.363	7.953	11.698	5.480
	(1.267)	(1.846)	(69.637)	(1.426)	(2.106)	(71.791)	(1.536)	(2.286)	(71.636)
VE	-31.188	-48.903	-20.700	-94.147	-140.834	-60.804	-150.880	-227.018	-99.364
	(-1.205)	(-1.767)	(-70.337)	(-1.367)	(-2.025)	(-72.397)	(-1.468)	(-2.209)	(-71.980)
R^2	1.383	2.255	0.714	3.987	6.410	2.052	6.379	10.093	3.281

TABLE A2

Alternative Configuration of Model Parameters

The table reports the parameter values used in the model. We calibrate the IST shock using the impulse responses estimated by Justiniano et al. (2010).

Preferences	δ	γ	ψ			
	0.9997	2.5	0.7			
Consumption	μ_c	ρ	φ_η	φ_e	ψ_x	σ_g
	0.0015	0.975	0.1	0.0022	0.0389	0.002
	σ_x	v_g	v_x	σ_1	σ_2	σ_3
	0.002	0.999	0.9995	0.000003	0	0.000004
Dividends	μ_d	ϕ	π_e	π_η		
	0.0015	2.2	3	3.5		

TABLE A3

Consumption, Dividend, and Asset Returns

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p - d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; ACi is the ith-order autocorrelation coefficient; $VR6$ is the variance ratio of six-year growth rate to six times one-year growth rate; and $Corr$ is the correlation coefficient. The column under the name "Data" reproduces annual estimates from the 1930 to 2008 period reported in Bansal, Kiku, and Yaron (2012) and Beeler and Campbell (2012). The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years. We use the parameter values reported in Table A2 to generate simulated data.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.82	-0.91	-0.42	4.03	4.62	1.78
$\sigma(\Delta c)$	2.16	4.28	2.31	2.51	7.20	7.93	4.97
$AC1(\Delta c)$	0.45	0.72	0.53	0.56	0.84	0.85	0.76
$E[\Delta d]$	1.15	1.80	-5.35	-4.03	7.55	8.98	1.76
$\sigma(\Delta d)$	11.05	13.99	8.57	9.23	20.87	22.63	15.69
$AC1(\Delta d)$	0.21	0.51	0.24	0.29	0.70	0.73	0.55
$Corr(\Delta c, \Delta d)$	0.55	0.83	0.49	0.56	0.95	0.96	0.82
$E[R]$	7.66	7.16	0.37	1.39	14.69	16.82	7.53
$\sigma(R)$	20.28	22.77	14.82	15.79	34.86	37.80	25.26
$AC1(R)$	0.02	0.11	-0.14	-0.10	0.34	0.38	0.15
$Corr(R, e)$	0.44	0.42	0.10	0.14	0.69	0.73	0.42
$E[p - d]$	3.36	3.65	3.07	3.19	3.94	4.00	3.64
$\sigma(p - d)$	0.45	0.20	0.11	0.12	0.34	0.38	0.34
$AC1(p - d)$	0.87	0.86	0.66	0.70	0.94	0.95	0.96
$E[R^f]$	0.57	3.33	0.15	0.73	5.96	6.63	3.30
$\sigma(R^f)$	2.86	4.77	2.55	2.79	8.11	8.97	5.59
$AC1(R^f)$	0.65	0.79	0.63	0.66	0.88	0.89	0.82

TABLE A4

Consumption, Dividend, and Asset Returns: $Corr(\sigma_g^2, \sigma_x^2) = 0.8$

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p - d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; $AC1$ to $AC5$ are the first to fifth-order autocorrelation coefficients; and $Corr$ is the correlation coefficient. The column under the name "Data Estimate" reproduces annual estimates from the 1930 to 2008 period reported in Bansal et al. (2012) and Beeler and Campbell (2012). $Corr(R, e)$ is the correlation between the market return and IST shocks estimated using the sample spanning the 1964 to 2016 period. The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.81	0.09	0.41	3.20	3.58	1.79
$\sigma(\Delta c)$	2.16	3.06	1.65	1.80	4.97	5.41	3.49
$AC1(\Delta c)$	0.45	0.59	0.36	0.39	0.74	0.76	0.63
$AC2(\Delta c)$	0.16	0.34	0.01	0.06	0.57	0.61	0.40
$AC3(\Delta c)$	-0.10	0.22	-0.11	-0.05	0.48	0.52	0.29
$AC4(\Delta c)$	-0.24	0.14	-0.19	-0.13	0.42	0.46	0.21
$AC5(\Delta c)$	-0.02	0.08	-0.23	-0.19	0.36	0.41	0.16
$E[\Delta d]$	1.15	1.79	-4.23	-2.95	6.66	7.76	1.75
$\sigma(\Delta d)$	11.05	14.93	8.08	8.79	23.83	25.63	17.23
$AC1(\Delta d)$	0.21	0.33	0.09	0.13	0.53	0.56	0.35
$Corr(\Delta c, \Delta d)$	0.55	0.51	0.20	0.26	0.71	0.74	0.48
$E[R]$	7.66	5.46	-0.10	0.70	12.59	14.38	5.94
$\sigma(R)$	20.28	24.06	14.42	15.40	38.85	42.46	27.75
$AC1(R)$	0.02	0.02	-0.22	-0.18	0.22	0.26	0.04
$Corr(R, e)$	0.44	0.65	0.41	0.45	0.79	0.81	0.65
$E[p - d]$	3.36	4.63	4.05	4.17	5.23	5.39	4.76
$\sigma(p - d)$	0.45	0.23	0.12	0.13	0.41	0.46	0.49
$AC1(p - d)$	0.87	0.87	0.68	0.71	0.95	0.96	0.98
$E[R^f]$	0.57	1.49	-0.05	0.24	2.35	2.51	1.39
$\sigma(R^f)$	2.86	1.70	0.90	0.98	2.85	3.11	2.02
$AC1(R^f)$	0.65	0.80	0.64	0.67	0.88	0.89	0.83

TABLE A5

Consumption, Dividend, and Asset Returns: $Corr(\sigma_g^2, \sigma_x^2) = -0.8$

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p - d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; $AC1$ to $AC5$ are the first to fifth-order autocorrelation coefficients; and $Corr$ is the correlation coefficient. The column under the name "Data Estimate" reproduces annual estimates from the 1930 to 2008 period reported in Bansal et al. (2012) and Beeler and Campbell (2012). $Corr(R, e)$ is the correlation between the market return and IST shocks estimated using the sample spanning the 1964 to 2016 period. The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.81	0.10	0.41	3.20	3.58	1.79
$\sigma(\Delta c)$	2.16	3.06	1.66	1.80	4.97	5.40	3.49
$AC1(\Delta c)$	0.45	0.59	0.35	0.39	0.74	0.76	0.63
$AC2(\Delta c)$	0.16	0.34	0.01	0.06	0.57	0.61	0.40
$AC3(\Delta c)$	-0.10	0.22	-0.11	-0.05	0.48	0.52	0.29
$AC4(\Delta c)$	-0.24	0.14	-0.19	-0.13	0.41	0.46	0.21
$AC5(\Delta c)$	-0.02	0.08	-0.24	-0.19	0.36	0.41	0.16
$E[\Delta d]$	1.15	1.84	-3.99	-3.07	6.60	7.66	1.81
$\sigma(\Delta d)$	11.05	15.17	10.41	11.07	21.61	23.21	17.12
$AC1(\Delta d)$	0.21	0.34	0.09	0.13	0.56	0.60	0.35
$Corr(\Delta c, \Delta d)$	0.55	0.61	0.20	0.26	0.86	0.89	0.59
$E[R]$	7.66	8.11	1.92	2.88	14.12	15.50	8.35
$\sigma(R)$	20.28	27.36	20.29	21.27	35.71	37.69	29.22
$AC1(R)$	0.02	0.02	-0.21	-0.18	0.21	0.25	0.03
$Corr(R, e)$	0.44	0.61	0.22	0.28	0.84	0.86	0.62
$E[p - d]$	3.36	3.56	2.77	2.90	4.27	4.41	3.62
$\sigma(p - d)$	0.45	0.31	0.18	0.19	0.53	0.59	0.57
$AC1(p - d)$	0.87	0.88	0.70	0.74	0.95	0.96	0.97
$E[R^f]$	0.57	1.49	-0.06	0.24	2.34	2.51	1.39
$\sigma(R^f)$	2.86	1.70	0.90	0.98	2.84	3.11	2.02
$AC1(R^f)$	0.65	0.80	0.64	0.67	0.88	0.89	0.83

TABLE A6

Consumption, Dividend, and Asset Returns: $Corr(\sigma_g^2, \sigma_x^2) = 0.6$

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p-d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; $AC1$ to $AC5$ are the first to fifth-order autocorrelation coefficients; and $Corr$ is the correlation coefficient. The column under the name "Data Estimate" reproduces annual estimates from the 1930 to 2008 period reported in Bansal et al. (2012) and Beeler and Campbell (2012). $Corr(R, e)$ is the correlation between the market return and IST shocks estimated using the sample spanning the 1964 to 2016 period. The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.81	0.10	0.41	3.20	3.58	1.79
$\sigma(\Delta c)$	2.16	3.06	1.65	1.80	4.97	5.41	3.49
$AC1(\Delta c)$	0.45	0.59	0.35	0.39	0.74	0.76	0.63
$AC2(\Delta c)$	0.16	0.34	0.01	0.06	0.57	0.61	0.40
$AC3(\Delta c)$	-0.10	0.22	-0.11	-0.05	0.48	0.52	0.29
$AC4(\Delta c)$	-0.24	0.14	-0.18	-0.13	0.42	0.47	0.21
$AC5(\Delta c)$	-0.02	0.08	-0.24	-0.19	0.36	0.41	0.16
$E[\Delta d]$	1.15	1.80	-3.88	-2.73	6.36	7.34	1.76
$\sigma(\Delta d)$	11.05	13.53	7.61	8.33	21.20	22.86	15.68
$AC1(\Delta d)$	0.21	0.35	0.11	0.14	0.55	0.59	0.37
$Corr(\Delta c, \Delta d)$	0.55	0.57	0.23	0.29	0.78	0.81	0.54
$E[R]$	7.66	6.27	0.99	1.78	12.69	14.28	6.68
$\sigma(R)$	20.28	22.75	14.05	14.97	35.31	38.26	25.75
$AC1(R)$	0.02	0.02	-0.21	-0.18	0.22	0.26	0.04
$Corr(R, e)$	0.44	0.61	0.32	0.37	0.79	0.81	0.61
$E[p-d]$	3.36	3.97	3.34	3.46	4.39	4.49	4.01
$\sigma(p-d)$	0.45	0.22	0.12	0.13	0.38	0.42	0.41
$AC1(p-d)$	0.87	0.87	0.68	0.72	0.94	0.95	0.97
$E[R^f]$	0.57	1.49	-0.06	0.24	2.34	2.51	1.39
$\sigma(R^f)$	2.86	1.70	0.90	0.98	2.84	3.11	2.02
$AC1(R^f)$	0.65	0.80	0.64	0.67	0.88	0.89	0.83

TABLE A7

Consumption, Dividend, and Asset Returns: $Corr(\sigma_g^2, \sigma_x^2) = -0.6$

The table reports summary statistics of the consumption growth rate, Δc; the dividend growth rate, Δd; the stock market return, R; the log price-dividend ratio, $p-d$; and the risk-free rate, R^f. E is the mean; σ is the standard deviation; $AC1$ to $AC5$ are the first to fifth-order autocorrelation coefficients; and $Corr$ is the correlation coefficient. The column under the name "Data Estimate" reproduces annual estimates from the 1930 to 2008 period reported in Bansal et al. (2012) and Beeler and Campbell (2012). $Corr(R, e)$ is the correlation between the market return and IST shocks estimated using the sample spanning the 1964 to 2016 period. The column under the name "Model" reports the distribution of annual estimates from 10,000 simulated samples of 79 years each. "Pop" reports annual estimates from a long simulated sample of 100,000 years.

	Data	Model					
Moment	Estimate	Median	2.5%	5%	95%	97.5%	Pop
$E[\Delta c]$	1.93	1.81	0.10	0.41	3.20	3.58	1.79
$\sigma(\Delta c)$	2.16	3.06	1.66	1.80	4.97	5.40	3.49
$AC1(\Delta c)$	0.45	0.59	0.35	0.39	0.74	0.76	0.63
$AC2(\Delta c)$	0.16	0.34	0.01	0.07	0.57	0.61	0.40
$AC3(\Delta c)$	-0.10	0.22	-0.11	-0.05	0.48	0.52	0.29
$AC4(\Delta c)$	-0.24	0.14	-0.19	-0.13	0.42	0.46	0.21
$AC5(\Delta c)$	-0.02	0.08	-0.24	-0.19	0.36	0.41	0.16
$E[\Delta d]$	1.15	1.84	-3.67	-2.78	6.35	7.31	1.80
$\sigma(\Delta d)$	11.05	13.95	9.26	9.88	19.51	20.71	15.57
$AC1(\Delta d)$	0.21	0.36	0.11	0.15	0.58	0.61	0.37
$Corr(\Delta c, \Delta d)$	0.55	0.57	0.11	0.17	0.87	0.90	0.55
$E[R]$	7.66	7.68	1.92	2.81	13.50	14.88	7.94
$\sigma(R)$	20.28	25.08	18.12	19.13	32.98	34.85	26.81
$AC1(R)$	0.02	0.01	-0.21	-0.17	0.21	0.25	0.04
$Corr(R, e)$	0.44	0.57	0.20	0.25	0.82	0.85	0.57
1 $E[p-d]$	3.36	3.57	2.80	2.93	4.15	4.27	3.59
$\sigma(p-d)$	0.45	0.28	0.16	0.17	0.48	0.53	0.52
$AC1(p-d)$	0.87	0.88	0.70	0.74	0.95	0.96	0.97
$E[R^f]$	0.57	1.49	-0.06	0.24	2.34	2.51	1.39
$\sigma(R^f)$	2.86	1.70	0.89	0.99	2.84	3.11	2.01
$AC1(R^f)$	0.65	0.80	0.64	0.67	0.88	0.89	0.83

TABLE A8

Consumption, IST shocks, and Excess Market Returns

The table reports the OLS estimation results of regressing the growth rate of aggregate consumption on IST shocks and excess market returns (ERET) using simulated (Panel A) and actual data (Panels C and D). We use the excess market return as a proxy for DT shocks in Panels A and D and use the TFP growth rate (ΔTFP) as an instrumental variable for the excess market return in Panel D. We examine the relation between the excess market return with IST shocks and ΔTFP in Panel D. We construct daily stock return difference between investment-goods producers and consumption-goods producers, IMC, and then form 5 by 5 monthly portfolios on the market cap and the IMC beta estimated using daily returns in a month. We use the average return difference between high and low IMC-beta stocks of the top three market cap quintiles as a proxy for IST shocks. We use real-time real personal consumption expenditures on nondurable goods and services from the Bureau of Economic Analysis to construct aggregate consumption growth. ΔTFP is constructed using quarterly utilization-adjusted TFP data obtained from the San Francisco Fed. The annual sample spans the 1967 to 2016 period. In parentheses we report t-statistics constructed using Newey-West standard errors with two lags. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

DV_LAG	IST	ERET	R^2	IST	ΔTFP		R^2
Panel A: Consumption in Model				Panel B: Excess Market Returns			
0.611	-0.0002		0.375	0.417***			0.192
(10.549)	(-0.386)			(4.479)			
0.615		0.047	0.470		0.494		0.016
(12.425)		(5.432)			(1.432)		
0.618	-0.003	0.075	0.532	0.429***	0.547*		0.221
(13.904)	(-4.788)	(7.609)		(4.278)	(1.846)		
Panel C: Consumption				Panel D: Consumption with IV			
DV_LAG	IST	ERET	R^2	DV_LAG	IST	ERET	R^2
0.408***	0.001		0.130	0.408***	0.001		0.130
(3.360)	(0.184)			(3.360)	(0.184)		
0.590***		0.032***	0.338	0.934		0.091*	0.272
(4.597)		(2.787)		(3.402)		(1.947)	
0.605***	-0.014**	0.039***	0.367	0.819***	-0.030*	0.081**	0.326
(5.075)	(-1.983)	(3.527)		(3.632)	(-1.834)	(2.374)	

TABLE A9

IST Factors

The table describes the variables that we use to construct the IST shock proxies. Unless otherwise indicated, variables in italic and bold are from Compustat and CRSP, respectively.

Variable	Definition
IK	IK is the investment-capital ratio. We measure investment as the difference between capital expenditure and PPE sales or *CAPX-SPPE*. We measure capital using lagged PPE, *PPEGT*. *SPPE* is set to zero when missing.
Tobin's Q	Tobin's Q is the market value of assets divided by their replacement costs. The market value is the difference between (*INVT+TXDITC*) and (MKCAP12+*DLTT+PSTKRV*). The replacement cost is the book value of PPE, *PPEGT*. We set *TXDITC* to zero when missing. MKCAP12 is the market capitalization, the product of the share price **PRC** with shares outstanding **SHROUT**, at the calendar year end.
PE	PE is the ratio of a firm's market value (MKCAP12+*DLTT+PSTKRV-TXDB*) to the sum of operating income, *IB*, and interest expenses, *XINT*. MKCAP12 is the market capitalization, the product of the share price **PRC** with shares outstanding **SHROUT**, at the end of the calendar year.
IMC	IMC is the return difference between the value-weighted portfolio of investment-goods producers and the value-weighted portfolio of consumption-goods producers. We use June-end market capitalization for weights.
β_{MKT}	We estimate market beta by regressing daily excess stock returns on a constant and concurrent daily excess stock market returns using a one-year rolling window. We include only stocks that have at least 200 valid daily returns in a calendar year.
β_{IMC}	We estimate IMC beta by regressing daily excess stock returns on a constant and concurrent daily IMC using a one-year rolling window. We include only stocks that have at least 200 valid daily returns in a calendar year.
IMCIV	IMCIV is the square root of the sum of squared residuals from the regression of daily excess stock returns on a constant, daily value-weighted IMC, and daily excess market returns. We include only stocks that have at least 200 valid daily returns in a calendar year.

TABLE A10

Summary Statistics for monthly ICCs

The table reports the summary statistics of ICC measures

ICC	PSS	GLS	Easton	OJ	Gordon
Mean	0.107	0.091	0.116	0.118	0.071
Std Dev	0.021	0.021	0.029	0.029	0.020
Kurtosis	3.310	1.715	3.914	1.424	2.227
Skew	1.654	1.301	1.914	1.407	1.346
PSS	1				
GLS	0.969	1			
Easton	0.957	0.955	1		
OJ	0.894	0.921	0.963	1	
Gordon	0.968	0.987	0.928	0.871	1

TABLE A11

IST Shocks and Long-Run Analyst Earnings Growth Forecast

The table reports the OLS estimation results of regressing the change in long-run analyst earnings growth forecast on its own lag (DV_LAG), IST shocks (IST), lagged IST shocks (IST_LAG), excess stock market returns (ERET), and lagged excess stock market returns (ERET_LAG). We construct long-run analyst earnings growth forecast using I/B/E/S long-term earnings growth forecast data and include only firms with the December fiscal year end. We construct daily stock return difference between investment-goods producers and consumption-goods producers, IMC, and then form portfolios on IMC betas. We use the return difference between high IMC-beta stocks and low IMC-beta stocks as a proxy for IST shocks. The annual sample spans the 1983 to 2015 period. In parentheses we report t-statistics constructed using Newey-West standard errors with two lags.

DV_LAG	IST	IST_LAG	ERET	ERET_LAG	R^2
0.226	0.011	0.043			0.520
(2.557)	(1.782)	(6.321)			
0.071			0.013	0.047	0.457
(0.856)			(2.075)	(5.279)	
0.184	0.012	0.032	0.011	0.033	0.726
(3.231)	(2.663)	(4.626)	(1.671)	(5.746)	

TABLE A12

Summary Statistics of Selected Variables

The table reports the quarterly summary statistics for the stock market price (Panel A), the implied cost of capital (Panel B), variances (Panel C), and asset returns (Panel D). In Panel A, PD, PPO, and PE are log dividend-price ratio, log net payout-price ratio, and log earning-price ratio, respectively. In Panel B, PSS, GLS, Easton, OJ, and GG are the implied cost of capital measures constructed following Pastor et al. (2008), Gebhardt et al. (2001), Easton (2004), Ohlson and Juettner-Nauroth (2005), and Gordon and Gordon (1997), respectively. AICC is the average of these five ICC measures. LNS is the ICC measure used in Li et al. (2013). In Panel C, VIK, VTobinQ, VPE, VIMCIV, Vβ_{IMC}, VIMC, Vβ_{MKT}, and VHML are realized variances of daily returns on portfolios formed on IK, Tobin' Q, PE ratio, idiosyncratic volatility, IMC beta, IMC spread, Market Beta, and book-to-market equity ratio, respectively. VFPC and VAVE are realized variances of the first principle component and average of these eight daily portfolio returns, respectively. FPCV and AVEV are the first principle component and average, respectively, of VIK, VTobinQ, VPE, VIMCIV, Vβ_{IMC}, VIMC, Vβ_{MKT}, VHML, VFPC, and VAVE. VWASV and EWASV are value-weighted and equal-weighted average stock variances, respectively. VMKT is stock market variance. In Panel D, IK, TobinQ, PE, IMCIV, β_{IMC}, β_{MKT}, and HML are returns on long-short portfolios formed by IK, Tobin's Q, PE ratio, idiosyncratic volatility, IMC beta, Market Beta, and book-to-market ratio, respectively. AVE is the average of these seven portfolio returns. CMA, RMW, and SMB are the Fama and French (2015) conservative-minus-aggressive, robust-minus-weak, and small-minus-big factors, respectively. ERET is the excess stock market return. RF is the risk-free rate. Mean and standard errors in Panel B, C and D are reported in percentage. VPC1 is scaled by 10^{-4}, and PC1V and AVEV are scaled by 10^{-2}.

Variable	Mean	Std Err	Kurt	Skew	AR(1)	Sampling Period
Panel A: Stock Market Price						
PD	3.704	0.030	-0.577	-0.345	0.979	1963Q1-2016Q4
PPO	2.203	0.016	18.615	-3.742	0.940	1963Q1-2016Q4
PE	1.697	0.029	-0.502	0.385	0.982	1963Q1-2016Q4
Panel B: Implied Costs of Capital						
PSS	1.602	0.053	-0.873	0.527	0.909	1981Q1-2016Q4
GLS	1.128	0.052	-0.965	0.342	0.923	1982Q1-2016Q4
Easton	1.830	0.046	-0.896	-0.015	0.895	1981Q1-2016Q4
OJ	1.881	0.040	-0.809	-0.168	0.891	1981Q1-2016Q4
GG	0.711	0.056	-0.799	0.412	0.904	1981Q1-2016Q4
AICC	1.444	0.048	-0.906	0.265	0.910	1982Q1-2016Q4
LNS	1.806	0.059	-0.751	-0.019	0.866	1981Q1-2011Q4

Variable	Mean	Std Err	Kurt	Skew	AR(1)	Sampling Period
Panel C: Stock Return Variances						
VIK	0.080	0.005	13.517	3.327	0.592	1963Q1-2016Q4
VTobinQ	0.136	0.009	8.730	2.711	0.630	1963Q1-2016Q4
VPE	0.095	0.005	3.634	1.895	0.545	1963Q1-2016Q4
Vβ_{MKT}	0.144	0.010	15.822	3.532	0.632	1963Q1-2016Q4
Vβ_{IMC}	0.192	0.017	17.898	3.952	0.559	1963Q1-2016Q4
VIMCIV	0.188	0.018	37.512	5.329	0.556	1963Q1-2016Q4
VIMC	0.128	0.015	50.097	6.107	0.693	1963Q1-2016Q4
VHML	0.109	0.010	43.494	5.847	0.633	1963Q1-2016Q4
VFPC	0.003	0.026	20.698	4.155	0.688	1963Q1-2016Q4
VAVE	0.042	0.004	30.959	5.009	0.559	1963Q1-2016Q4
FPCV	0.000	0.068	16.067	3.629	0.649	1963Q1-2016Q4
AVEV	0.000	0.058	15.388	3.556	0.652	1963Q1-2016Q4
VWASV	0.029	0.022	7.588	2.582	0.647	1963Q1-2016Q4
EWASV	0.082	0.051	12.780	2.959	0.745	1963Q1-2016Q4
TYVIX	0.001	0.008	8.090	2.511	0.696	2003Q1-2016Q4
VMKT	0.653	0.042	6.960	2.466	0.503	1963Q1-2016Q4
Panel D: Asset Returns						
IK	0.714	0.299	2.110	0.356	0.057	1963Q1-2016Q4
TobinQ	0.888	0.413	1.869	-0.208	0.124	1963Q1-2016Q4
PE	0.879	0.306	1.327	-0.235	0.134	1963Q1-2016Q4
IMCIV	0.249	0.554	1.901	0.552	0.048	1963Q1-2016Q4
β_{MKT}	0.177	0.475	2.391	0.338	-0.006	1963Q1-2016Q4
β_{IMC}	0.177	0.475	2.391	0.338	-0.006	1963Q1-2016Q4
HML	1.108	0.390	1.703	0.439	0.121	1963Q1-2016Q4
AVE	0.587	0.341	3.125	-0.050	0.085	1963Q1-2016Q4
CMA	0.922	0.274	1.911	0.907	0.048	1963Q1-2016Q4
RMW	0.735	0.283	7.035	0.915	0.143	1963Q1-2016Q4
SMB	0.788	0.379	-0.080	0.142	-0.001	1963Q1-2016Q4
ERET	1.638	0.576	0.815	-0.505	0.062	1963Q1-2016Q4
RF	0.334	0.037	-0.364	0.268	0.865	1963Q1-2016Q4

TABLE A13

Forecasting Excess Stock Market Returns Using Variances

The table reports the OLS estimation results of forecasting one-quarter-ahead excess stock market returns using stock variances. VIK, VTobinQ, VPE, VIMCIV, Vβ_{IMC}, VIMC, Vβ_{MKT}, and VHML are realized variances of daily returns on portfolios formed on IK, Tobin's Q, PE ratio, idiosyncratic volatility, IMC beta, IMC spread, Market Beta, and book-to-market equity ratio, respectively. VFPC and VAVE are realized variances of the first principle component and average of these eight daily portfolio returns, respectively. FPCV and AVEV are the first principle component and average, respectively, of VIK, VTobinQ, VPE, VIMCIV, Vβ_{IMC}, VIMC, Vβ_{MKT}, VHML, VFPC, and VAVE. VWASV and EWASV are value-weighted and equal-weighted average stock variances, respectively. VMKT is stock market variance. TYVIX is the options-implied Treasury bond variance. TYVIX is available over the 2003Q1 to 2016Q4 period and the other variance measures are available over the 1963Q1 to 2016Q4 period. Panel A reports the univariate regression results. Panel B reports the bivariate regression results with stock market variance and a euphoria variance measure as the forecasting variables. Panel C reports the out-of-sample forecast results. For TYVIX, we use the 2003Q1 to 2009Q4 period for the initial in-sample estimation and make the out-of-sample forecast recursively for the 2010Q1 to 2016Q4 period using an expanding sample. For the other euphoria variance measures, we use the 1963Q1 to 1989Q4 period for initial in-sample estimation and make the out-of-sample forecast recursively for the 1990Q1 to 2016Q4 period using an expanding sample. We use two standard measures to gauge the out-of-sample performance. MSER is the mean squared forecasting errors ratio of the forecasting model to a benchmark model in which conditional equity premium equals average equity premium in historical data. ENC_NEW is the encompassing test proposed by Clark and McCracken (2001). t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Variable	Panel A All Variance	Panel A R^2	Panel B Euphoria Variance	Panel B Market Variance	Panel B R^2	Panel C MSER	Panel C ENC_NEW Statistics	Panel C 5% BSCV
VMKT	2.799**	3.707						
	(2.054)							
VIK	-11.408*	0.641	-26.902***	4.338***	8.192	0.957	11.699	2.381
	(-1.831)		(-5.060)	(2.851)				
VTobinQ	-3.993	-0.069	-11.062**	3.776***	5.833	0.997	10.846	2.370
	(-1.013)		(-2.043)	(2.997)				
VPE	-11.042	0.477	-29.331***	4.526***	8.368	0.927	15.510	2.331
	(-1.112)		(-2.927)	(3.543)				
VIMCIV	-1.535	-0.235	-4.807***	3.612***	5.208	1.171	2.667	2.525
	(-0.933)		(-3.467)	(2.614)				
$V\beta_{IMC}$	-4.414*	1.280	-9.446***	4.557***	9.650	0.931	12.380	2.379
	(-1.662)		(-2.725)	(4.904)				
VIMC	-3.020	0.136	-5.761**	3.381**	5.286	1.048	6.239	2.503
	(-1.583)		(-2.551)	(2.523)				
$V\beta_{MKT}$	0.773	-0.451	-8.748**	4.025***	4.877	1.006	5.426	2.379
	(0.220)		(-2.419)	(2.960)				
VHML	-8.357**	1.852	-19.934***	5.442***	12.781	0.823	31.010	2.484
	(-2.291)		(-6.038)	(6.088)				
VFPC	-1.634	0.076	-4.756***	4.165***	6.895	0.963	8.892	2.414
	(-1.233)		(-4.707)	(3.078)				
VAVE	-4.564	-0.377	-20.845***	3.586**	4.857	1.033	4.255	2.436
	(-0.523)		(-2.661)	(2.301)				
FPCV	-0.740	0.300	-2.247***	4.699***	8.448	0.917	12.985	2.380
	(-1.454)		(-4.389)	(4.295)				
AVEV	-0.898	0.347	-2.715***	4.765***	8.679	0.913	13.586	2.370
	(-1.481)		(-4.339)	(4.453)				
VWASV	-0.065	-0.440	-2.096***	8.979***	13.473	0.825	21.880	2.330
	(-0.168)		(-4.063)	(6.849)				
EWASV	0.078	-0.241	-0.211	3.897**	4.279	1.013	5.104	2.406
	(0.644)		(-1.515)	(2.474)				
TYVIX	-24.718	5.722	-53.546***	4.658***	17.143	0.771	8.849	2.629
	(-1.495)		(-2.798)	(5.699)				

TABLE A14

Forecasting One-Quarter-Ahead Excess Stock Market Returns

The table reports the OLS estimation results of forecasting excess stock market returns with implied cost of capital measures and scaled stock market prices. We de-trend the implied cost of capital by a linear time trend. PSS, GLS, Easton, OJ, and GG are the implied cost of capital measures constructed following Pastor et al. (2008), Gebhardt et al. (2001), Easton (2004), Ohlson and Juettner-Nauroth (2005), and Gordon and Gordon (1997), respectively. AICC is the average of these five ICC measures. LNS is the ICC measure used in Li et al. (2013). LNS is available over the 1981Q1 to 2011Q4 period, GLS and AICC are available over the 1982Q1 to 2016Q4 period, and the other ICC measures are available over the 1981Q1 to 2016Q4 period. PD is the price-dividend ratio. PPO is the price-payout ratio. PE is the price-earnings ratio. PD, PPO, and PE are available over the 1963Q1 to 2016Q4 period. In the column under the name"Original Value," we use the raw data of implied cost of capital measures and the scaled stock market prices as the predictor variables. We also decompose implied cost of capital measures and the scaled stock market prices by regressing them on a constant, stock market variance, and a euphoria variance measure. We use the fitted value as the forecasting variable in the column under the name "Fitted Value" and use the residual value as the forecasting variable in the column under the name "Residual Value." t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Original Value	R^2	Fitted Value	R^2	Residual Value	R^2
Panel A: First Principle Component of Euphoria Variance Measures						
PSS	1.348	0.348	16.242***	9.461	0.287*	-0.690
	(1.173)		(4.504)		(1.803)	
GLS	1.563	0.593	14.954***	10.179	1.069	-0.427
	(1.416)		(5.150)		(0.584)	
Easton	1.540	0.296	18.967***	9.481	0.222	-0.693
	(1.230)		(4.976)		(0.146)	
OJ	2.531*	1.385	19.119***	9.767	0.942	-0.474
	(1.851)		(5.095)		(0.568)	
GG	1.809*	1.378	14.793***	9.762	1.266	-0.259
	(1.703)		(5.070)		(0.710)	
AICC	1.476	0.297	16.703***	10.167	0.672	-0.607
	(1.217)		(5.126)		(0.390)	
LNS	2.332**	2.212	13.075***	10.297	0.915	-0.408
	(1.957)		(4.407)		(0.653)	
PD	-0.018	0.479	-0.085***	3.984	0.001	-0.468
	(-1.315)		(-3.876)		(0.049)	
PPO	-0.050***	1.535	-0.118***	3.658	-0.009	-0.425
	(-2.740)		(-3.820)		(-0.196)	
PE	-0.016	0.144	-0.126***	6.305	0.007	-0.370
	(-1.057)		(-4.297)		(0.426)	

	Original Value	R^2	Fitted Value	R^2	Residual Value	R^2
Panel B: Average of Euphoria Variance Measures						
PSS	1.348	0.348	16.617***	9.685	0.288	-0.689
	(1.173)		(4.618)		(0.160)	
GLS	1.563	0.593	15.322***	10.483	1.056	-0.433
	(1.416)		(5.287)		(0.578)	
Easton	1.540	0.296	19.641***	9.824	0.224	-0.693
	(1.230)		(5.081)		(0.148)	
OJ	2.531*	1.385	19.591***	10.064	0.933	-0.478
	(1.851)		(5.230)		(0.563)	
GG	1.809*	1.378	15.177***	10.054	1.256	-0.264
	(1.703)		(5.205)		(0.704)	
AICC	1.476	0.297	17.145***	10.464	0.667	-0.608
	(1.217)		(5.262)		(0.387)	
LNS	2.332**	2.212	13.364***	10.577	0.907	-0.413
	(1.957)		(4.551)		(0.648)	
PD	-0.018	0.479	-0.088***	4.191	0.001	-0.466
	(-1.315)		(-4.945)		(0.073)	
PPO	-0.050***	1.535	-0.122***	3.848	-0.009	-0.432
	(-2.740)		(-3.876)		(-0.178)	
PE	-0.016	0.144	-0.129***	6.573	0.007	-0.360
	(-1.057)		(-4.367)		(0.447)	
Panel C: Value-Weighted Average Stock Variance						
PSS	1.348	0.348	16.684***	15.302	-1.212	-0.388
	(1.173)		(6.532)		(-0.704)	
GLS	1.563	0.593	13.819***	14.972	-0.533	-0.664
	(1.416)		(5.760)		(-0.309)	
Easton	1.540	0.296	17.934***	15.303	-0.938	-0.443
	(1.230)		(4.903)		(-0.649)	
OJ	2.531*	1.385	19.132***	15.631	-0.226	-0.697
	(1.851)		(5.845)		(-0.152)	
GG	1.809*	1.378	14.074***	15.632	-0.397	-0.670
	(1.703)		(5.768)		(-0.229)	
AICC	1.476	0.297	15.62***	14.968	-0.686	-0.614
	(1.217)		(5.845)		(-0.425)	
LNS	2.332**	2.212	14.304***	15.004	0.405	-0.741
	(1.957)		(6.358)		(0.302)	
PD	-0.018	0.479	-0.137***	8.562	0.007	-0.369
	(-1.315)		(-3.726)		(0.478)	
PPO	-0.050***	1.535	-0.158***	8.341	0.036	-0.116
	(-2.740)		(-3.706)		(0.651)	
PE	-0.016	0.144	-0.221***	12.322	0.008	-0.322
	(-1.057)		(-4.485)		(0.564)	

TABLE A15

Forecasting One-Quarter-ahead Anomaly Returns

The table reports the OLS estimation results of forecasting one-quarter-ahead anomaly returns. IK, TobinQ, PE, IMCIV, β_{IMC}, β_{MKT}, and HML are returns on long-short portfolios formed by investment-capital ratio, Tobin's Q, price-earnings ratio, idiosyncratic volatility, IMC beta, Market Beta, and book-to-market equity ratio, respectively. AVE is the average of these seven portfolio returns. CMA, RMW, and SMB are the Fama and French (2015) conservative-minus-aggressive, robust-minus-weak, and small-minus-big factors, respectively. We use three proxies for euphoria variance. We use the first principle component and the average of the 10 IST-based euphoria variance measures in Panels A and B, respectively. We use the value-weighted average sock variance in Panel C. Data span the 1963Q1 to 2016Q4 period. t-values are reported in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Euphoria Variance	Market Variance	R^2
Panel A: The First Principle Component of Euphoria Variance Measures			
IK	0.442	-1.857**	4.193
	(1.098)	(-2.130)	
Tobin Q	0.794*	-1.975*	2.086
	(1.727)	(-1.833)	
PE	0.604*	-1.778***	3.423
	(1.757)	(-2.976)	
IMC IV	1.106*	-4.808***	9.099
	(1.681)	(-3.736)	
β_{IMC}	1.075	-3.643***	6.461
	(1.347)	(-2.837)	
β_{MKT}	0.826*	-4.490***	11.402
	(1.950)	(-4.638)	
HML	0.64	-2.271***	3.539
	(1.102)	(-3.101)	
AVE	0.786*	-2.965***	9.086
	(1.845)	(-3.874)	
CMA	0.674**	-0.715	1.202
	(2.272)	(-1.302)	
RMW	0.894**	-1.169**	2.896
	(2.272)	(-2.029)	
SMB	0.185	0.974	0.737
	(0.461)	(1.465)	
Panel B: The Average of Euphoria Variance Measures			
IK	0.551	-1.882**	4.276
	(1.164)	(-2.149)	
TobinQ	0.971*	-2.007*	2.175
	(1.768)	(-1.857)	
PE	0.734*	-1.799***	3.496
	(1.783)	(-2.996)	
IMC IV	1.332*	-4.837***	9.15
	(1.712)	(-3.741)	

	Euphoria Variance	Market Variance	R^2
Panel B: The Average of Euphoria Variance Measures			
AVE	0.952*	-2.990***	9.175
	(1.884)	(-3.875)	
CMA	0.810**	-0.731	1.271
	(2.109)	(-1.320)	
RMW	1.060**	-1.180**	2.914
	(2.252)	(-2.025)	
SMB	0.2	0.986	0.723
	(0.413)	(1.474)	
Panel C: Value-Weighted Average Stock Variance			
IK	0.489*	-2.926**	5.519
	(1.672)	(-2.402)	
TobinQ	0.824*	-3.734**	3.899
	(1.911)	(-2.291)	
PE	0.865**	-3.819***	8.249
	(2.560)	(-3.696)	
IMC IV	1.169**	-7.321***	11.178
	(2.445)	(-4.016)	
β_{IMC}	1.089**	-5.946***	8.701
	(2.100)	(-2.950)	
β_{MKT}	0.931**	-6.537***	13.334
	(2.539)	(-4.832)	
HML	0.835*	-4.189***	6.201
	(1.824)	(-2.963)	
AVE	0.890***	-4.922***	12.578
	(2.605)	(-4.019)	
CMA	0.672***	-2.124**	3.813
	(2.764)	(-2.292)	
RMW	0.776**	-2.701**	5.334
	(2.133)	(-2.303)	
SMB	0.301	0.245	1.148
	(1.152)	(0.286)	

TABLE A16

Cross-Section of Portfolio Returns and Variances

The table reports the Fama and MacBeth (1973) cross-sectional regression results. In Panel A, we use the 32 triple-sorted portfolios formed on market capitalization, operation profit, and total asset growth. In Panel B, we use the 32 triple-sorted portfolios formed on market capitalization, book-to-market equity ratios, and total asset growth. In the Fama and MacBeth regression, we first regress returns on each test portfolio on lagged stock market variance and lagged euphoria variance, and use the estimated loadings in the second-stage cross-sectional regressions. We include two lags of stock market variance and two lags of euphoria variance in the first-stage regression, and the loadings are the sum of the coefficients on two lags of stock market variance or two lags of euphoria variance. VMKT is stock market variance. We use three proxies of euphoria variance. FPCV is the first principle component of ten standardized IST-based euphoria variance measures. AVEV is the average of ten standardized IST-based euphoria variance measures. VWASV is the value-weighted average stock variance. The data span the 1963Q1 to 2016Q4 period. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Constant	Euphoria Variance	Market Variance	R^2
Panel A: 32 Portfolios Sorted by Size, Profitability, and Asset Growth				
FPCV	0.011**	1.164***	0.003*	57.279
	(2.142)	(4.221)	(1.858)	
AVEV	0.012**	0.996***	0.003*	57.600
	(2.206)	(4.221)	(1.877)	
VWASV	0.018***	0.022***	0.003*	61.867
	(3.390)	(3.384)	(1.946)	
Panel B: 32 Portfolios sorted by Size, BM, and Asset Growth				
FPCV	0.003	1.084***	0.005**	51.925
	(0.569)	(3.616)	(2.536)	
AVEV	0.003	0.925***	0.005**	51.967
	(0.617)	(3.618)	(2.543)	
VWASV	0.011*	0.023***	0.005**	59.010
	(1.797)	(3.275)	(2.475)	