Online Appendix to

“Downside Risks and the Cross-Section of Asset Returns”

February 28, 2017

This appendix contains additional details that are omitted from the main text for brevity.

Contents

A.1 Derivation of the cross-sectional implications

In this section we outline the derivation of the cross-sectional implications of the GDA model and derive the sign restrictions on the risk prices.

A.1.1 Substituting out consumption

The logarithm of $M_{t-1,t}$ (denoted as $m_{t-1,t}$) and the disappointing event $\mathcal{D}_t$ are

$$m_{t-1,t} = \ln \delta - \gamma \Delta c_t - \left(\gamma - \frac{1}{\psi}\right) \Delta z_{Vt} \quad \text{and} \quad \mathcal{D}_t = \{\Delta c_t + \Delta z_{Vt} < \ln \kappa\} \ , \tag{A.1}$$

where

$$\Delta c_t \equiv \ln\left(\frac{C_t}{C_{t-1}}\right) = \ln C_t - \ln C_{t-1} \quad \text{and} \quad \Delta z_{Vt} \equiv \ln\left(\frac{V_t}{C_t}\right) - \ln\left(\frac{\mathcal{R}_{t-1}(V_t)}{C_{t-1}}\right) \tag{A.2}$$

represent the change in the log consumption level (or consumption growth) and the change in the log welfare valuation ratio (or welfare valuation ratio growth), respectively.

Following Epstein and Zin (1989), Hansen et al. (2007) and Routledge and Zin (2010) the log return on wealth is related to consumption growth and the welfare valuation ratio growth through

$$r_{Wt} = -\ln \delta + \Delta c_t + \left(1 - \frac{1}{\psi}\right) \Delta z_{Vt}. \tag{A.3}$$

Substituting out consumption growth using the above relationship, the equations in (A.1) can be rewritten as

$$m_{t-1,t} = (1-\gamma)\ln \delta - \gamma r_{Wt} - \left(\frac{\gamma - 1}{\psi}\right) \Delta z_{Vt} \quad \text{and} \quad \mathcal{D}_t = \{r_{Wt} + (1/\psi)\,\Delta z_{Vt} < \ln(\kappa/\delta)\}\,. \tag{A.4}$$

Note that the market return r_{Wt} is not directly observed by the econometrician. The return to a stock market index is sometimes used to proxy for this return as in Epstein and Zin

(1991). The welfare valuation ratios,

$$z_{Vt} \equiv \ln\left(V_t/C_t\right) \quad \text{and} \quad z_{\mathcal{R}t} \equiv \ln\left(\mathcal{R}_t\left(V_{t+1}\right)/C_t\right) \ , \tag{A.5}$$

are also unobservable. Following Hansen et al. (2008) and Bonomo et al. (2011), we can exploit the dynamics of aggregate consumption growth and the utility recursion, in addition to the definition of the certainty equivalent to solve for the unobserved welfare valuation ratios.

From equation (A.3) it follows that stochastic volatility of aggregate consumption growth is a sufficient condition for stochastic volatility of the market return. In that case, market volatility measures time-varying macroeconomic uncertainty. In all what follows, this additional assumption is coupled with our assumption on investors' preferences. More specifically, assume for example that the logarithm of consumption follows a heteroscedastic random walk as in Bonomo et al. (2011) were the stochastic volatility of consumption growth is an AR(1) process that can be well-approximated in population by a two-state Markov chain. Then it can be shown that the welfare valuation ratios satisfy

$$z_{Vt} = \varphi_{V0} + \varphi_{V\sigma}\sigma_{Wt}^2 \ \text{ and } \ z_{\mathcal{R}t} = \varphi_{\mathcal{R}0} + \varphi_{\mathcal{R}\sigma}\sigma_{Wt}^2 \tag{A.6}$$

were $\sigma_{Wt}^2 \equiv Var_t\left[r_{Wt+1}\right]$ is the conditional variance of the market return, and were the drift coefficients φ_{V0} and $\varphi_{\mathcal{R}0}$ and the loadings $\varphi_{V\sigma}$ and $\varphi_{\mathcal{R}\sigma}$ depend on investor's preference parameters and on parameters of the consumption growth dynamics. In this case, $m_{t-1,t}$ and the disappointing event in equation (A.4) may be written as

$$\begin{aligned} m_{t-1,t} &= (1-\gamma)\ln\delta^* - \gamma r_{Wt} - \left(\frac{\gamma-1}{\psi}\right)\varphi_{V\sigma}\Delta\sigma_{Wt}^2 \\ \mathcal{D}_t &= \left\{r_{Wt} + (1/\psi)\,\varphi_{V\sigma}\Delta\sigma_{Wt}^2 < \ln\left(\kappa/\delta^*\right)\right\}, \end{aligned} \tag{A.7}$$

where

$$\Delta\sigma^2_{Wt} \equiv \sigma^2_{Wt} - \frac{\varphi_{\mathcal{R}\sigma}}{\varphi_{V\sigma}}\sigma^2_{Wt-1} \quad \text{and} \quad \ln\delta^* = \ln\delta + \frac{1}{\psi}\left(\varphi_{V0} - \varphi_{\mathcal{R}0}\right).$$

Our definitions and notations for Δz_{Vt} and $\Delta\sigma^2_{Wt}$ presume that $z_{\mathcal{R}t} \approx z_{Vt}$, meaning that $\varphi_{\mathcal{R}\sigma} \approx \varphi_{V\sigma}$. This shows that changes in the welfare valuation ratio can empirically be proxied by changes in a stock market volatility index, where volatility can be estimated by a generalized autoregressive conditional heteroscedasticity (GARCH) model, can be computed from high-frequency index returns (realized volatility), or can be measured by the option-implied volatility (VIX). Disappointment may occur due to a fall in the market return. It may also occur following a rise in market volatility. This means that the coefficient $\varphi_{V\sigma}$ in the definition of disappointment in (A.7) is negative. In fact, when macroeconomic uncertainty rises, everything else being equal, the investor is pessimistic about the future. She then assigns a low valuation to the continuation value and is willing to accept with certainty a lower welfare to avoid the risk in future consumption. Therefore, the ratio of welfare valuation to current consumption falls. We take as given that $\varphi_{V\sigma} < 0$ and $\varphi_{\mathcal{R}\sigma} \approx \varphi_{V\sigma}$, and we show in our calibration assessment in Section A.8 of this Online Appendix that this important theoretical implication of the model holds for a broad range of reasonable values of preference parameters.

Finally, the disappointing event in equation (A.7) may also be expressed as

$$\mathcal{D}_t = \left\{ r_{Wt} - a\left(\sigma_W/\sigma_X\right)\Delta\sigma^2_{Wt} < b \right\}\ , \tag{A.8}$$

with

$$a \equiv -\left(1/\psi\right)\varphi_{V\sigma}\left(\sigma_X/\sigma_W\right) \quad \text{and} \quad b \equiv \ln\left(\kappa/\delta^*\right), \tag{A.9}$$

where $\sigma_W = Std\left[r_{Wt}\right]$ and $\sigma_X = Std\left[\Delta\sigma^2_{Wt}\right]$ are the respective unconditional volatilities of the market return and changes in market volatility. Note that $\varphi_{V\sigma} < 0$ implies $a > 0$.

A.1.2 Cross-sectional implications of GDA preferences

For every asset i, optimal consumption and portfolio choice by the representative investor induces a restriction on the simple excess return R_{it}^e that is implied by the Euler condition:

$$E_{t-1}\left[M_{t-1,t}^{GDA} R_{it}^e\right] = 0 \; , \tag{A.10}$$

where $R_{it}^e = R_{it} - R_{ft}$ denotes the excess return, R_{it} is the simple gross return of asset i, and R_{ft} denotes the risk-free simple gross return. Using the definition of $M_{t-1,t}^{GDA}$, equation (A.10) can be written as

$$\begin{aligned} E_{t-1}\left[M_{t-1,t}\left(\frac{1+\ell I\left(\mathcal{D}_t\right)}{1+\kappa^{1-\gamma}\ell E_{t-1}\left[I\left(\mathcal{D}_t\right)\right]}\right) R_{it}^e\right] &= 0 \\ E_{t-1}\left[M_{t-1,t}\left(1+\ell I\left(\mathcal{D}_t\right)\right) R_{it}^e\right] &= 0 \; . \end{aligned} \tag{A.11}$$

By the law of iterated expectations, the above expression also holds unconditionally:

$$E\left[M_{t-1,t}\left(1+\ell I\left(\mathcal{D}_t\right)\right) R_{it}^e\right] = 0 \; . \tag{A.12}$$

Dividing both sides by $E\left[M_{t-1,t}\right]$, we get

$$E\left[H_{t-1,t}\left(1+\ell I\left(\mathcal{D}_t\right)\right) R_{it}^e\right] = 0 \; , \tag{A.13}$$

where $H_{t-1,t}$ denotes the risk-adjustment density defined by

$$H_{t-1,t} \equiv \frac{M_{t-1,t}}{E\left[M_{t-1,t}\right]} \approx 1 + m_{t-1,t} - E\left[m_{t-1,t}\right] . \tag{A.14}$$

The log-linear approximation of the nonlinear risk-adjustment density $H_{t-1,t}$ as shown in equation (A.14) is common in the asset pricing literature (see for example Yogo, 2006).

After some algebraic manipulation, (A.13) may be written as

$$E\left[R_{it}^e\right] = \frac{1}{1+\ell\pi^{\mathbb{H}}}\left[Cov\left(R_{it}^e, -H_{t-1,t}\right) + \ell Cov\left(R_{it}^e, -H_{t-1,t} I\left(\mathcal{D}_t\right)\right)\right] \tag{A.15}$$

where $E^{\mathbb{H}}[\cdot]$ denotes the expectation under the risk-adjustment density $H_{t-1,t}$ and $\pi^{\mathbb{H}} \equiv E^{\mathbb{H}}\left[I\left(\mathcal{D}_t\right)\right]$ is the risk-adjusted disappointment probability. Equation (A.15) shows that an asset premium is the sum of two covariances. The first covariance $Cov\left(R_{it}^e, -H_{t-1,t}\right)$ is the compensation for regular risks, while the second covariance $Cov\left(R_{it}^e, -H_{t-1,t} I\left(\mathcal{D}_t\right)\right)$ reveals compensation for downside risks conditional upon disappointment.

Using the approximation (A.14) in the pricing relation (A.15), we obtain the cross-sectional linear factor model from the main text:

$$E\left[R_{it}^e\right] = p_W \sigma_{iW} + p_{\mathcal{D}} \sigma_{i\mathcal{D}} + p_{W\mathcal{D}} \sigma_{iW\mathcal{D}} + p_X \sigma_{iX} + p_{X\mathcal{D}} \sigma_{iX\mathcal{D}} \ , \tag{A.16}$$

where the risk prices are given by:

$$\begin{aligned}
p_W &= \frac{1}{1+\ell\pi^{\mathbb{H}}}\gamma \\
p_{\mathcal{D}} &= -\frac{1}{1+\ell\pi^{\mathbb{H}}}\ell\left(1+\gamma\mu_W + \left(\frac{\gamma-1}{\psi}\right)\varphi_{V\sigma}\mu_X\right) \\
p_{W\mathcal{D}} &= \frac{1}{1+\ell\pi^{\mathbb{H}}}\ell\gamma \\
p_X &= \frac{1}{1+\ell\pi^{\mathbb{H}}}\left(\frac{\gamma-1}{\psi}\right)\varphi_{V\sigma} \\
p_{X\mathcal{D}} &= \frac{1}{1+\ell\pi^{\mathbb{H}}}\ell\left(\frac{\gamma-1}{\psi}\right)\varphi_{V\sigma} \ ,
\end{aligned} \tag{A.17}$$

and where $\mu_W \equiv E\left[r_{Wt}\right]$ and $\mu_X \equiv E\left[\Delta\sigma_{Wt}^2\right]$ are the means of the market return and changes in market volatility, respectively.

Let us consider the signs of these risk prices. The consumption-based asset pricing literature generally agrees on $\gamma > 1$, which implies $p_W > 0$. Thus, investors require a premium for a security that has positive covariance with the market return. Maintaining the assumption that $\gamma > 1$, it follows from equation (A.17) that $p_X \neq 0$ if and only if $\psi < \infty$. Thus, compensation for covariance with changes in market volatility is due to imperfect intertemporal substitution. The representative investor's risk aversion $\gamma > 1$ and imperfect intertemporal substitution $\psi < \infty$ together imply that $p_{X,t} < 0$. The next observation is that $p_{\mathcal{D}} \neq 0$ if and only if $\ell \neq 0$, regardless of the values of γ and ψ. Compensation for covariance with the downstate factor $I(\mathcal{D}_t)$ is exclusively due to disappointment aversion. Since $\ell \geq 0$, the associated risk price is negative, $p_{\mathcal{D},t} < 0$. Next, $p_{W\mathcal{D}} \neq 0$ if and only if both $\gamma \neq 0$ and $\ell \neq 0$. Both risk aversion and disappointment aversion are needed to explain the required compensation for covariance with the market downside factor. Risk aversion $\gamma > 1$ and disappointment aversion $\ell > 0$ together imply that $p_{W\mathcal{D}} > 0$. Finally, $p_{X\mathcal{D}} \neq 0$ if and only if $\gamma \neq 1$, $\ell \neq 0$, and $\psi \neq \infty$ are all satisfied. Thus, risk aversion, disappointment aversion, and imperfect intertemporal substitution of the representative investor are all needed to explain the required compensation for covariance with the volatility downside factor. Recall that we take $\varphi_{V\sigma} < 0$ as given , so $\gamma > 1$, $\ell > 0$, and $\psi < \infty$ together imply that $p_{X\mathcal{D}} < 0$.

There are two cross-price restrictions that are implied by the risk prices in (A.17). First, it can be easily seen that

$$\frac{p_{W\mathcal{D}}}{p_W} = \frac{p_{X\mathcal{D}}}{p_X} \ . \tag{A.18}$$

Second, using the equations for $p_{W\mathcal{D}}$ and $p_{X\mathcal{D}}$, and the definition of a in (A.9), we can write

$$p_{X\mathcal{D}} = -a\frac{\sigma_W}{\sigma_X}\frac{\gamma - 1}{\gamma}p_{W\mathcal{D}} \ . \tag{A.19}$$

If we further assume that the risk aversion, γ, of the representative investor is high enough, then $\frac{\gamma-1}{\gamma} \approx 1$, and (A.19) simplifies to

$$p_{X\mathcal{D}} = -a\frac{\sigma_W}{\sigma_X}p_{W\mathcal{D}} \ . \tag{A.20}$$

When estimating the GDA5 model in the paper, we use the assumption $\frac{\gamma-1}{\gamma} = 1$. We also considered $\frac{\gamma-1}{\gamma} = 0.75$ (which corresponds to $\gamma = 3$), and the (unreported) empirical results are similar to those in the main text.

A.2 Additional restriction that the market is perfectly priced

When the test asset is the market return ($i = W$), the GDA5 model can be written as

$$E\left[R^e_{Wt}\right] = \lambda_W \beta_{WW} + \lambda_{\mathcal{D}} \beta_{W\mathcal{D}} + \lambda_{W\mathcal{D}} \beta_{WW\mathcal{D}} + \lambda_X \beta_{WX} + \lambda_{X\mathcal{D}} \beta_{WX\mathcal{D}} \ , \tag{A.21}$$

where the betas are calculated from the regression

$$R^e_{Wt} = \alpha_W + \beta_{WW} r_{Wt} + \beta_{W\mathcal{D}} I\left(\mathcal{D}_t\right) + \beta_{WW\mathcal{D}} r_{Wt} I\left(\mathcal{D}_t\right) + \beta_{WX} \Delta\sigma^2_{Wt} + \beta_{WX\mathcal{D}} \Delta\sigma^2_{Wt} I\left(\mathcal{D}_t\right) + \varepsilon_{Wt} \tag{A.22}$$

Since the return to be explained (the simple excess return on the market, R^e_{Wt}) and the market factor (the log-return on the market, r_{Wt}) are not exactly the same, non of the betas from the above regression will be zero. Hence, for (A.21) to hold, we can impose the following restriction on the downstate premium:

$$\lambda_{\mathcal{D}} = \frac{E\left[R^e_{Wt}\right]}{\beta_{W\mathcal{D}}} - \lambda_W \frac{\beta_{WW}}{\beta_{W\mathcal{D}}} - \lambda_{W\mathcal{D}} \frac{\beta_{WW\mathcal{D}}}{\beta_{W\mathcal{D}}} - \lambda_X \frac{\beta_{WX}}{\beta_{W\mathcal{D}}} - \lambda_{X\mathcal{D}} \frac{\beta_{WX\mathcal{D}}}{\beta_{W\mathcal{D}}} \ . \tag{A.23}$$

A similar restriction can be derived if we do not pick the downstate premium, but another one instead (e.g., λ_W or $\lambda_{W\mathcal{D}}$). Also, it is straightforward to derive a similar restriction for the GDA3 model. When requiring the market to be perfectly priced, we impose the linear restriction in (A.23) on the downstate premium.

If the market factor is the simple excess return on the market, then (A.22) becomes

$$R^e_{Wt} = \alpha'_W + \beta'_{WW} R^e_{Wt} + \beta'_{W\mathcal{D}} I\left(\mathcal{D}_t\right) + \beta'_{WW\mathcal{D}} R^e_{Wt} I\left(\mathcal{D}_t\right) + \beta'_{WX} \Delta\sigma^2_{Wt} + \beta'_{WX\mathcal{D}} \Delta\sigma^2_{Wt} I\left(\mathcal{D}_t\right) + \varepsilon_{Wt} \ . \tag{A.24}$$

It is easy to see that in this case $\beta'_{WW} = 1$ and $\alpha'_W = \beta'_{W\mathcal{D}} = \beta'_{WW\mathcal{D}} = \beta'_{WX} = \beta'_{WX\mathcal{D}} = 0$. Hence, (A.21) becomes

$$E\left[R^e_{Wt}\right] = \lambda_W \ . \tag{A.25}$$

That is, imposing the restriction that the market is priced correctly is equivalent to setting the market premium equal to the expected excess return on the market. Table A.1 shows the risk premium estimates for the GDA models with the restriction that the market return is correctly priced when R^e_{Wt} is used as the market factor.

A.3 Further risk premium estimates

This section provides risk premium estimates from various specifications that are left out from the main text for brevity.

Table 3 of the main text reports risk premium estimates for the GDA3, GDA5, and unrestricted GDA5 models without imposing the restriction that the market portfolio is perfectly priced using five selected sets of portfolios. Results for the other five sets of portfolios from the benchmark analysis are presented in Table A.2.

Table 4 of the main text reports risk premium estimates for alternative models using five selected sets of portfolios from our benchmark analysis. Results for the other five sets of portfolios from the benchmark analysis are presented in Table A.3.

Table 6 of the main text shows risk premium estimates for the GDA models when corporate bonds, sovereign bonds, and commodities are added to the set of test assets. Corresponding results for the alternative models considered in the paper are presented in Table A.4.

We also consider the robustness of our results when different test portfolios (compared to the main text) are chosen to represent a given asset class. The sources of the return data are described in Appendix A of the main text. There are two additional sets of portfolios used here: 10 US stock portfolios sorted by industry (10 Ind) from Kenneth French's website and six currency portfolios from Lustig et al. (2011). Lustig et al. (2011) use 35 currencies to create six portfolios by sorting them based on their respective interest rates. The sample period of the original paper is from November 1983 to December 2009, but the authors provide an updated version of the return data on their website.* We use data up to December 2013. The risk premium estimates for the GDA3 and GDA5 models are presented in Table A.5. Conclusions regarding the signs, magnitudes, and statistical significances of the risk premiums are very similar to those obtained in the main text for the benchmark test portfolios.

A.4 Different disappointment thresholds

For our main results the disappointment threshold is set to $b = -0.03$. Table A.6 and Table A.7 present risk premium estimates for the GDA models using the values $b \in \{0, -0.015, -0.04\}$. In the following discussion, we focus our attention to the results corresponding to the GDA5 in Table A.7.

When $b = -0.04$, the disappointment threshold becomes lower. The disappointment probability with $\mathcal{D}_t = \{r_{Wt} < -0.04\}$ and using the period between 1964 and 2013 is 12.3%, which is very close to the 16.3% obtained in our benchmark scenario with $b = -0.03$. Consequently, the results remain similar: all the estimated risk premiums in Panel C of Table A.7 are statistically significant and have the expected signs (the single exception is $\lambda_{\mathcal{D}}$ for the size/book-to-market portfolios, which is not statistically significant, but has the expected sign). The magnitudes of the premiums are similar to the benchmark scenario. In terms of model fit, the $b = -0.04$ specification provides lower RMSPE for the size/book-to-market and the option portfolios, but the $b = -0.03$ specification provides lower pricing errors for the other three portfolios.

As the threshold becomes higher, disappointment is triggered more easily. The disappointment probability with $\mathcal{D}_t = \{r_{Wt} < b\}$ is 26.7% for $b = -0.015$, and 38.5% for $b = 0$.

*Return data on the currency portfolios of Lustig et al. (2011) are obtained from Adrien Verdelhan's website at http://web.mit.edu/adrienv/www/Data.html

Risk premium estimates for the GDA5 with these thresholds are reported in Panel A and B of Table A.7, respectively. The estimated risk premiums, with the exception of $\lambda_{\mathcal{D}}$, have the expected sign and the estimates are statistically significant. As the disappointment threshold increases, the premium on the downstate factor becomes insignificant. In some cases it becomes positive and statistically significant. That is, disappointing events should be sufficiently out in the left tail so that the downstate factor is priced in the cross-section. In terms of model fit, the lowest RMSPE is provided by the models with low disappointment threshold (either $b = -0.03$ or $b = -0.04$) for all five sets of portfolios reported in Table A.7.

A.5 Different measures of market volatility

In this section we explore how the estimates for the GDA5 model change if different measures of market volatility are considered. In the main text, monthly volatility is measured as the realized volatility of the daily market returns during the month:

$$\sigma_{Wt}^2 = \sum_{\tau=1}^{N_t} \left(r_{Wt,\tau} - \mu_{Wt}\right)^2 \ , \tag{A.26}$$

where $r_{Wt,\tau}$ is the daily market return on the τ-th trading day of month t, μ_{Wt} is the mean of the daily market returns in month t, and N_t is the number of trading days in month t.

The alternative measures considered here are the option-implied volatility index (VIX), realized volatility calculated from intra-daily market returns, and a model implied volatility calculated using an EGARCH specification. The option-implied monthly volatility is calculated as

$$\sigma_{Wt}^{2,VIX} = \frac{1}{N_t} \sum_{\tau=1}^{N_t} \left(\frac{VIX_{t,\tau}}{100 \cdot \sqrt{12}}\right)^2 \ , \tag{A.27}$$

where $VIX_{t,\tau}$ is the value of the VIX index on the τ-th trading day of month t. The daily value of the VIX index is obtained from CBOE through the WRDS service. Monthly realized volatility from intra-daily market returns is calculated as

$$\sigma_{Wt}^{2,RV} = \sum_{\tau=1}^{N_t} \sum_{j=1}^{N_\tau} r_{Wt,\tau,j}^2 \ , \tag{A.28}$$

where $r_{Wt,\tau,j}$ denotes the 10-minute log return series on the τ-th trading day of month t and N_τ is the number intra-daily returns within a trading day. We use intra-daily return series of the S&P 500. The data comes from Olsen Financial Technologies. Finally, in the model based approach, we fit a model with conditional heteroskedasticity to the daily log market return series $r_{W\tau}$. We consider the EGARCH(1,1,1) by Nelson (1991),

$$\begin{aligned} r_{W\tau} &= \mu + \sigma_{W\tau}\varepsilon_\tau \ , \quad \text{with} \ \ \varepsilon_\tau \overset{\text{iid}}{\sim} \mathcal{N}(0,1) \\ \ln\left(\sigma_{W\tau}^2\right) &= \omega + \nu\left(|\varepsilon_\tau| - \sqrt{2/\pi}\right) + \theta\varepsilon_\tau + \phi\ln\left(\sigma_{W\tau-1}^2\right) \end{aligned} \tag{A.29}$$

Then the model-implied monthly volatility is calculated as

$$\sigma_{Wt}^{2,EGARCH} = \sum_{\tau=1}^{N_t} \hat{\sigma}_{Wt,\tau}^2 \ , \tag{A.30}$$

where $\hat{\sigma}_{Wt,\tau}^2$ is the estimated daily variance on the τ-th trading day of month t. Change in monthly volatility for all of the above measures is calculated as

$$\Delta\sigma_{Wt}^2 = \sigma_{Wt}^2 - \sigma_{Wt-1}^2 \ . \tag{A.31}$$

Note that the measures are available for different time periods. The VIX data is available starting from 1986 and our intra-daily return data covers only the period from February 1986 to September 2010. The model implied volatility is available for the entire sample period. We use the longest possible sample for each specification.

Risk premium estimates are presented in Table A.8. The results are similar across different volatility measures. The signs on the risk premiums are as expected and, apart from a few cases, the estimated risk premiums are statistically significant. It is hard to compare the model fit across volatility measures, since the panels in Table A.8 correspond to different sample periods. However, the RMSPE to root-mean-squared-returns ratios (reported in brackets) are similar across the different measures.

A.6 Additional scatter plots of results in the main text

Figure A.1 to Figure A.4 show scatter plots of actual versus predicted returns corresponding to three different sets of portfolios and seven asset pricing models. The models are the same as in Figure 1 of the main text, and the portfolios are also from the main text (for detailed description see Appendix A of the main text):

- 6 (3×2) size/book-to-market, 6 option, and 6 currency portfolios in Figure A.1,
- 25 (5×5) size/book-to-market portfolios in Figure A.2,
- 25 (5×5) size/momentum portfolios in Figure A.3, and
- 54 option portfolios from Constantinides et al. (2013) in Figure A.4.

A.7 Option sensitivities to the GDA factors

In the emprical analysis we use the index option portfolios of Constantinides et al. (2013), who create leverage-adjusted (to have a target CAPM beta of one) portfolios of S&P 500 index options sorted on moneyness. To achieve a target CAPM beta of one, they approximate the elasticity of the options with respect to the market index with the elasticity implied by the Black and Scholes (1973) model:

$$\vartheta_W \equiv \left.\frac{\partial \pi}{\partial S}\right|_{S=S_0} \frac{S_0}{\pi_0} \ , \tag{A.32}$$

where S_0 is the current price of the underlying, π_0 is the current price of the option, and the partial derivative is calculated from the Black-Scholes formula. Then they create a hypothetical portfolio that invests ϑ_W^{-1} dollars in the option and $1 - \vartheta_W^{-1}$ dollars in the risk-free rate. In our empirical analysis, we use these hypothetical portfolios. Panel A of Figure A.5 shows the ϑ_W values of options with different moneyness (K/S_0) levels.[†] Note that the elasticity is $\vartheta_W > 1$ for call options and $\vartheta_W < -1$ for put options. Therefore, a leverage-adjusted call option portfolio consists of a long position in a fraction of a call and some investment in the risk-free rate, while a leverage-adjusted put portfolio consists of a short position in a fraction of a put and more than 100% investment in the risk-free rate.

To assess the options' sensitivity to the market downside factor, we calculate a measure inspired by the ϑ_W of Constantinides et al. (2013): the sensitivity to changes in the price of the underlying after a 5% drop in the price of the underlying. That is, we calculate

$$\vartheta_{W\mathcal{D}} \equiv \left.\frac{\partial \pi}{\partial S}\right|_{S=0.95S_0} \frac{S_0}{\pi_0} . \tag{A.33}$$

Since the index option portfolios we analyze invest ϑ_W^{-1} fraction into the option, the sensitivity of these portfolios to the market downside factor is $\vartheta_W^{-1}\vartheta_{W\mathcal{D}}$. This value is shown in Panel B of Figure A.5 for different moneyness levels. OTM put options have the largest sensitivity, followed by ITM puts, then ITM calls, and finally OTM calls. For comparison, we show various betas of the option portfolios in Table A.9. The market downside beta, $\beta_{iW}^{-} = \frac{Cov\left(R_{it}^e, r_{Wt}|\mathcal{D}_t\right)}{Var(r_{Wt}|\mathcal{D}_t)}$, measures the portfolio's sensitivity to the market, given disappointment. Note that since $\vartheta_{W\mathcal{D}}$ is only an approximation based on the Black-Scholes formula, we do not expect the $\vartheta_W^{-1}\vartheta_{W\mathcal{D}}$ and β_{iW}^{-} values to exactly coincide. However, it is clear that the ordering of the β_{iW}^{-} values in Table A.9 is the same as that of the $\vartheta_W^{-1}\vartheta_{W\mathcal{D}}$ values in Panel B of Figure A.5.

[†]We use $S_0 = 10$, $T = 1/12$ (one month maturity), 30% annual volatility for the underlying, and a risk-free rate of zero when creating the plots in Figure A.5. The general conclusions do not hinge on these particular parameter values.

To assess the options' sensitivity to volatility, we calculate

$$\vartheta_X \equiv \frac{\partial \pi}{\partial \sigma}\bigg|_{S=S_0} \frac{S_0}{\pi_0} \ , \tag{A.34}$$

where σ denotes the volatility of the underlying. Again, the sensitivity of the option portfolios can be calculated as $\vartheta_W^{-1}\vartheta_X$. This value is shown in Panel C of Figure A.5. OTM put options have the lowest sensitivity, followed by ITM puts, then ITM calls, and finally OTM calls have the highest sensitivity. This is in line with the ordering of the volatility betas in Table A.9, measured as $\beta_{iX} = \frac{Cov\left(R_{it}^e, \Delta\sigma_{Wt}^2\right)}{Var\left(\Delta\sigma_{Wt}^2\right)}$.

Finally, to assess the sensitivity of these portfolios to the volatility downside factor, we calculate the sensitivity to changes in the volatility after the price of the underlying drops by 5%:

$$\vartheta_{X\mathcal{D}} \equiv \frac{\partial \pi}{\partial \sigma}\bigg|_{S=0.95S_0} \frac{S_0}{\pi_0} \tag{A.35}$$

The $\vartheta_W^{-1}\vartheta_{X\mathcal{D}}$ values are shown in Panel D of Figure A.5. The sensitivities have the same ordering as in Panel C, which is in line with the ordering of the volatility downside betas in Table A.9, measured as $\beta_{iX}^- = \frac{Cov\left(R_{it}^e, \Delta\sigma_{Wt}^2 | \mathcal{D}_t\right)}{Var\left(\Delta\sigma_{Wt}^2 | \mathcal{D}_t\right)}$.

A.8 Calibration assessment and estimation with individual stocks

In this section, we further strengthen our main empirical results by showing that they reflect a rational economic model where agents care about the level and volatility of consumption, and are aware of downside risk in consumption growth. In other words, in this section, we rationalize, in the context of a consumption-based reduced-form general equilibrium setting, the empirical evidence on cross-sectional asset pricing by GDA factors as presented and discussed in the main text.

We analyze the factor risk premiums, λ_f with $f \in \{W, X, \mathcal{D}, W\mathcal{D}, X\mathcal{D}\}$, generated by a GDA endowment economy, reasonably calibrated to match the risk-free rate and the aggregate stock market behavior. In setting up the calibration, we closely follow Bonomo et al. (2011). They study an asset pricing model with generalized disappointment aversion and long-run volatility risk and show that it produces first and second moments of price-dividend ratios and asset returns as well as return predictability patterns in line with the data. Using the same endowment dynamics, we focus on the cross-sectional implications by studying the model-implied disappointment probability and factor risk premiums.

We assume that consumption and equity dividend growth are conditionally normal, unpredictable, and their conditional variances fluctuate according to a two-state Markov chain:

$$\begin{aligned} \Delta c_t &= \mu + \sqrt{\omega_c\left(s_{t-1}\right)}\varepsilon_{ct} \\ \Delta d_t &= \mu + \nu_d\sqrt{\omega_c\left(s_{t-1}\right)}\varepsilon_{dt} \ , \end{aligned} \tag{A.36}$$

where Δc_t is the aggregate consumption growth, Δd_t is the equity dividend growth, s_{t-1} indicates the state of the world, and ε_{ct} and ε_{dt} follow a bivariate IID standard normal process with mean zero and correlation ρ. The two states of the economy naturally correspond to a low (L) and a high (H) volatility state.

The endowment dynamics is calibrated at the monthly frequency to match the sample mean, volatility, and first-order autocorrelation of the real annual US consumption growth and stock market dividend growth from 1930 to 2012. These moments remain stable if the data are updated until more recently. Panel A of Table A.10 shows the parameters of the calibrated endowment process. The state transition probabilities are $p_{LL} = 0.9989$ and $p_{HH} = 0.9961$, and the corresponding long-run probabilities are 78.9% and 21.1% for the low and high volatility states, respectively. We set the preference parameters similar to the benchmark calibration of Bonomo et al. (2011). The values are presented in Panel B of Table A.10. For the GDA3 model, we simply set $\psi = \infty$, everything else being equal.

The first set of results in Panel C shows that our calibration matches well the first and second moments of consumption and dividend growth in the data. The model-implied annualized (time-averaged) mean, volatility, and first-order autocorrelation of consumption growth are respectively 1.80%, 2.07%, and 0.25, and are consistent with the observed annual values of 1.84%, 2.20%, and 0.48, respectively. The mean, volatility, and first-order autocorrelation of dividend growth are respectively 1.80%, 13.29%, and 0.25, and the observed annual values are 1.05%, 13.02%, and 0.11, respectively.

Given these endowment dynamics, we solve for welfare valuation ratios in closed form, which we combine with consumption growth to derive the endogenous market return and market variance processes. We refer the reader to Bonomo et al. (2011) for formal derivations. The second set of results in Panel C of Table A.10 shows that the model generates moments of asset prices that are consistent with empirical evidence. The level of the risk-free rate, 0.46% for GDA3 and 0.76% for GDA5, is close to the actual value of 0.57%. The equity premium, 8.06% for GDA3 and 6.61% for GDA5, is slightly larger than the actual value of 5.50%, but remains comparable to other sample values estimated in the literature, for example 7.25% in Bonomo et al. (2011). The equity volatility generated by the model, 17.65% for GDA3 and 16.84% for GDA5, is also comparable to the actual value of 20.25%.

As mentioned earlier, the main purpose of this calibration is to study the model implications for the disappointing event and the GDA factor risk premiums. The model-implied disappointment probability and factor risk premiums are reported in Panel D of Table A.10. The unconditional model-implied monthly disappointment probability is 17.43% for the GDA3 model and 16.06% for the GDA5 model. These numbers are closely related to their corresponding empirical values of 16.3% and 16.0% respectively, as discussed in Section 3.2.1. of the main article. Let us focus now on the monthly model-implied factor risk premiums in Panel D of Table A.10. The market risk premium is equal to $\lambda_W = 0.0065$ for the GDA3 model, and $\lambda_W = 0.0042$ for the GDA5, while the volatility risk premium is $\lambda_X = 0$ for the GDA3, and $\lambda_X = -1.38 \times 10^{-6}$ in the GDA5 model. The market downside risk premium is $\lambda_{W\mathcal{D}} = 0.0038$ for the GDA3 model, and $\lambda_{W\mathcal{D}} = 0.0023$ for the GDA5, while the volatility downside risk premium is $\lambda_{X\mathcal{D}} = 0$ for the GDA3, and $\lambda_{X\mathcal{D}} = -1.16 \times 10^{-6}$ for the GDA5.

Finally, the downside risk premium is $\lambda_{\mathcal{D}} = -0.3494$ for the GDA3, and $\lambda_{\mathcal{D}} = -0.3010$ for the GDA5.

The λ values from the calibration are to be compared to their data counterparts estimated in the empirical section of the main text. Our benchmark for comparison are factor risk premium estimates when all three asset classes (stocks, index options, and currencies) are included in the estimation. The results are reported in the last two columns of Table 2 in the main text. The model-implied values of the market risk premium and the downstate risk premium compare favorably to their data counterparts as they lie within one or two standard errors around their estimated data counterparts. The remaining model-implied factor risk premiums are much lower in magnitude than the empirical estimates. However, the estimated values must be considered with care due to at least two main sources of bias. First, as discussed in Section 3 of the main article, the estimation uses an empirical proxy of the true market return with potentially very different properties, especially moments and dynamics. Second, our estimation in the main article uses standard sets of few portfolios as test assets. Ang et al. (2016), and Gagliardini et al. (2016) discuss cross-sectional tests using a large cross-section of individual stocks versus fewer portfolios. They prove theoretically and observe empirically that using portfolios may destroy important information necessary for obtaining efficient estimates of the cross-sectional risk premiums, and those risk premium estimates obtained from a large cross-section of individual stocks can substantially depart from risk premium estimates on standard sets of portfolios. Their main point is that individual stocks provide a much larger dispersion in betas, an important prior to cross-sectional tests. To illustrate the effect of the second point, we carry out an empirical exercise in the following subsection, where we use individual stocks to estimate factor risk premiums in the GDA models.

A.8.1 Risk premium estimates using individual stocks

We follow the methodology used by Ang et al. (2006). In particular, we use the two-stage cross-sectional regression method of Fama and MacBeth (1973). In the first stage, we use short-window regressions to estimate the stocks' sensitivities (betas) to the factors. For every month $t \geq 12$ in the sample, we use twelve months of daily data from month $t-11$ to month t to run a time-series regression for each stock i that has return data over the given period. For example, in case of the GDA5, we run the regression

$$R^e_{i,\tau} = \alpha_{i,t} + \beta_{iW,t} r_{W,\tau} + \beta_{iW\mathcal{D},t} r_{W,\tau} I\left(\mathcal{D}_\tau\right) + \beta_{i\mathcal{D},t} I\left(\mathcal{D}_\tau\right) + \beta_{iX,t} \Delta\sigma^2_{W,\tau} + \beta_{iX\mathcal{D},t} \Delta\sigma^2_{W,\tau} I\left(\mathcal{D}_\tau\right) + \varepsilon^i_\tau \tag{A.37}$$

where τ refers to daily observations over the one-year period and t refers to the current month. The second stage of the Fama-Macbeth procedure corresponds to estimating the cross-sectional regressions

$$R^e_{i,t+1} = \beta_{iW,t} \lambda_{W,t} + \beta_{iW\mathcal{D},t} \lambda_{W\mathcal{D},t} + \beta_{i\mathcal{D},t} \lambda_{\mathcal{D},t} + \beta_{iX,t} \lambda_{X,t} + \beta_{iX\mathcal{D},t} \lambda_{X\mathcal{D},t} + \eta^i_t, \tag{A.38}$$

where the dependent variable is the excess return for stock i in month $t+1$. That is the betas, calculated using data from months $t-11$ to t, are related to stock returns in the following moth $(t+1)$. These two steps are repeated for all months in the sample. The unconditional factor risk premiums are obtained by averaging the lambdas over the sample period, i.e., $\hat{\lambda}_f = \hat{E}\left[\lambda_{f,t}\right]$ for factor f. Since this approach uses overlapping information when calculating the betas, we calculate standard errors using the Newey and West (1987) estimator (with 12 lags).

We use all common stocks traded on the NYSE, AMEX and NASDAQ markets (the data comes from CRSP). The sample period is from July, 1963 to December, 2013. To measure daily market volatility used in the first stage regressions, we fit an exponential GARCH to the time series of daily market returns. Note that our unreported analysis shows that the risk premium estimates are robust to using alternatives ways to measure market volatility, including the options-implied volatility index (VIX), realized volatility from intra-daily market returns, or the volatility implied by different GARCH specifications. The disappointing event in the first-stage regressions is defined as $\mathcal{D}_\tau = \left\{ r_{W,\tau} - a\frac{\sigma_W}{\sigma_X}\Delta\sigma^2_{W,\tau} < q_{0.16} \right\}$. Note that the disappointment threshold, $q_{0.16}$, is set in each one-year period for the first-stage regressions so that the disappointment probability (i.e., the percentage of disappointing days) is 16%. We apply this definition to match the 16% unconditional probability of disappointment from the empirical section of the main text. Also note that results are robust to varying the probability of disappointment between 15% and 20%.

Table A.11 shows the risk premium estimates for the GDA3 and several GDA5 models. We use $a = 0$ for the GDA3 and $a \in \{0, 0.5, 1\}$ for the GDA5. All the estimated risk premiums are statistically significant and have the expected signs. Moreover, for all risk factors, the estimated values are comparable in magnitude to the calibration-implied factor risk premiums in Panel D of Table A.10.

A.8.2 Sensitivity of the calibration results

We also conduct a sensitivity analysis of our calibration results. We study how the quantities of interest vary as preference parameters change within reasonable ranges. We set the regular risk aversion parameter γ and GDA threshold parameter κ to their base case values ($\gamma = 2.5$ and $\kappa = \delta = 0.998$) and vary the disappointment aversion parameter $\ell \in [1, 4]$ and the elasticity of intertemporal substitution $\psi \in \{0.75, 1, 1.5, \infty\}$. Results are shown in Figures A.6 and A.7. Panels A and B of Figure A.6 show that the model-implied annualized mean and volatility of the risk-free rate belong to a reasonable range of values used in the asset pricing literature. The same goes for the mean and volatility of the equity excess return in Panels G and H.

Panels C and D of Figure A.6 show that the welfare valuation ratios loads negatively on market volatility, consistent with the economic intuition that asset values and, consequently, investor's wealth and welfare fall in periods of high uncertainty in financial markets. The model-implied loadings of the welfare valuation ratios onto market volatility are $\varphi_{V\sigma}$ and $\varphi_{\mathcal{R}\sigma}$ are very close, as the ratio of loadings $\varphi_{\mathcal{R}\sigma}/\varphi_{V\sigma}$ is close to one. Thus, panels C and D confirm that $\varphi_{\mathcal{R}\sigma} < 0$ and $\varphi_{\mathcal{R}\sigma} \approx \varphi_{V\sigma}$ hold for reasonable preference parameter values.

Figure A.7 shows the sensitivity of the factor risk premiums. Again, the lower magnitudes of model-implied premiums compared to their estimated data counterparts may directly result from the fact that our empirical proxy of the market return, the return on a stock market index may have different time series properties than the true (but unobservable) market return, besides other sources of estimation bias such as the use of standard sets of fewer portfolios rather than a large cross-section of individual stocks. Factor risk premiums in Figure A.7 are order of magnitude comparable to estimates based on individual stocks reported in Table A.11. The signs of the risk premiums are, however, all consistent with economic intuition and our estimation results in the main text. Finally, Panel F of Figure A.7 shows the disappointment probability when we vary the disappointment aversion parameter ℓ.

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Table A.1: Risk premiums when the market is priced correctly and R_W^e is used

Stocks	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Options			54	6	6
Currencies				6	6
A. GDA3					
λ_W	0.0050^i	0.0050^i	0.0052^i	0.0050^i	0.0050^i
$\lambda_{\mathcal{D}}$	0.0726	-0.2790	-0.1596	-0.1217	-0.2274*
	(0.1606)	(0.3145)	(0.3270)	(0.1499)	(0.1300)
$\lambda_{W\mathcal{D}}$	0.0096	0.0245***	0.0173*	0.0182***	0.0203***
	(0.0102)	(0.0079)	(0.0098)	(0.0060)	(0.0044)
RMSPE	27.4 [0.36]	22.2 [0.29]	12.3 [0.20]	22.4 [0.32]	22.2 [0.31]
B. GDA5					
λ_W	0.0050^i	0.0050^i	0.0052^i	0.0050^i	0.0050^i
$\lambda_{\mathcal{D}}$	-0.3276***	-0.2206*	-0.2351	-0.3039**	-0.2344**
	(0.1261)	(0.1209)	(0.1697)	(0.1303)	(0.1123)
$\lambda_{W\mathcal{D}}$	0.0256**	0.0198**	0.0196***	0.0234***	0.0192***
	(0.0129)	(0.0085)	(0.0052)	(0.0052)	(0.0041)
λ_X	-0.0011^i	-0.0013^i	-0.0014^i	-0.0012^i	-0.0013^i
$\lambda_{X\mathcal{D}}$	-0.0020^i	-0.0018^i	-0.0018^i	-0.0018^i	-0.0013^i
a	0.5012	0.4361	0.3826	0.3691	0.1154
	(0.5193)	(1.1508)	(0.8836)	(0.5489)	(0.6698)
RMSPE	24.0 [0.32]	19.8 [0.26]	11.7 [0.19]	22.1 [0.31]	20.8 [0.29]

The table shows risk premium estimates for the GDA models using various sets of test portfolios (in columns; the same sets of portfolios as in Table 4 of the main text). The simple excess return on the market (R_W^e) is used as the market factor as opposed to our benchmark specification, where the log market return (r_W) is used. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are imposed by the restriction that the market portfolio should be correctly priced (and by cross-price restrictions for the GDA5). RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.2: Risk premiums when the perfect market pricing restriction is not imposed

Stocks	10 S,B,M	25 S×OP	25 S×INV	25 S×BM	25 S×Mom
Options				24	24
A. GDA3					
λ_W	0.0072***	0.0069***	0.0067***	0.0067**	0.0068**
	(0.0021)	(0.0022)	(0.0021)	(0.0031)	(0.0032)
$\lambda_{\mathcal{D}}$	-0.3075***	-0.2068**	0.0935	-0.1460*	-0.1847*
	(0.0984)	(0.0832)	(0.0784)	(0.0831)	(0.0955)
$\lambda_{W\mathcal{D}}$	0.0210***	0.0152*	0.0060	0.0167***	0.0178***
	(0.0062)	(0.0085)	(0.0064)	(0.0042)	(0.0040)
RMSPE	17.4 [0.27]	17.4 [0.24]	21.9 [0.29]	21.5 [0.31]	21.1 [0.30]
B. GDA5					
λ_W	0.0073***	0.0072***	0.0076***	0.0074**	0.0076***
	(0.0019)	(0.0022)	(0.0022)	(0.0032)	(0.0028)
$\lambda_{\mathcal{D}}$	-0.2662**	-0.1826**	-0.0427	-0.2266***	-0.1835
	(0.1134)	(0.0916)	(0.0966)	(0.0862)	(0.1183)
$\lambda_{W\mathcal{D}}$	0.0192***	0.0187**	0.0181**	0.0202***	0.0180***
	(0.0062)	(0.0094)	(0.0089)	(0.0051)	(0.0053)
λ_X	-0.0006^i	-0.0014^i	-0.0026^i	-0.0007^i	-0.0011^i
$\lambda_{X\mathcal{D}}$	-0.0012^i	-0.0019^i	-0.0033^i	-0.0020^i	-0.0019^i
a	0.5885	0.5336	0.7776	0.7026	0.6178
	(0.4240)	(0.5340)	(0.6250)	(0.4563)	(0.4908)
RMSPE	16.3 [0.26]	16.5 [0.23]	19.7 [0.26]	18.7 [0.27]	17.8 [0.25]
C. Unrestricted GDA5					
λ_W	0.0077***	0.0078***	0.0103***	0.0076**	0.0070**
	(0.0020)	(0.0021)	(0.0023)	(0.0032)	(0.0030)
$\lambda_{\mathcal{D}}$	-0.2697***	-0.3868***	-0.0376	-0.1883**	-0.1162
	(0.0929)	(0.1186)	(0.0892)	(0.0937)	(0.0964)
$\lambda_{W\mathcal{D}}$	0.0215***	0.0274***	0.0323***	0.0188***	0.0124**
	(0.0057)	(0.0096)	(0.0088)	(0.0064)	(0.0056)
λ_X	-0.0008	-0.0045***	-0.0055***	-0.0029***	-0.0031***
	(0.0008)	(0.0013)	(0.0009)	(0.0011)	(0.0011)
$\lambda_{X\mathcal{D}}$	-0.0013	-0.0054***	-0.0073***	-0.0040***	-0.0036***
	(0.0008)	(0.0016)	(0.0011)	(0.0015)	(0.0010)
RMSPE	16.2 [0.25]	13.6 [0.19]	17.0 [0.22]	16.6 [0.24]	16.5 [0.23]

The table shows risk premium estimates for GDA models using various sets of test portfolios *without* imposing the restriction that the market portfolio is perfectly priced. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are imposed by cross-price restrictions for the GDA5. RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.3: Risk premiums for alternative models

Stocks Options	10 S,B,M	25 S×OP	25 S×INV	25 S×BM 24	25 S×Mom 24
A. VOL					
λ_W	0.0053***	0.0054***	0.0055***	0.0057***	0.0058***
	(0.0005)	(0.0005)	(0.0005)	(0.0002)	(0.0001)
λ_X	-0.0019^i	-0.0021^i	-0.0025^i	-0.0026^i	-0.0028^i
RMSPE	23.4 [0.37]	19.1 [0.27]	22.6 [0.30]	24.1 [0.35]	26.4 [0.38]
B. Ang et al. (2006)					
λ_W	0.0066***	0.0065***	0.0065***	0.0069***	0.0069***
	(0.0007)	(0.0019)	(0.0015)	(0.0005)	(0.0004)
$\lambda_{\mathcal{D}}$	0^i	0^i	0^i	0^i	0^i
$\lambda_{W\mathcal{D}}$	0.0142^i	0.0132^i	0.0137^i	0.0135^i	0.0132^i
RMSPE	21.9 [0.34]	19.0 [0.26]	23.4 [0.31]	24.3 [0.35]	26.0 [0.37]
C. Lettau et al. (2014)					
λ_W	0.0062***	0.0063***	0.0066***	0.0068***	0.0068***
	(0.0009)	(0.0018)	(0.0015)	(0.0005)	(0.0004)
$\lambda_{\mathcal{D}}$	0.0360^i	0.0457^i	0.0577^i	0.0519^i	0.0480^i
$\lambda_{W\mathcal{D}}$	0.0095^i	0.0105^i	0.0118^i	0.0111^i	0.0107^i
RMSPE	23.0 [0.36]	19.3 [0.27]	23.0 [0.30]	26.7 [0.39]	28.7 [0.41]
D. Carhart (1997)					
λ_W	0.0051***	0.0054***	0.0053***	0.0058***	0.0055***
	(0.0000)	(0.0002)	(0.0001)	(0.0004)	(0.0001)
λ_{SMB}	0.0020^i	0.0014^i	0.0016^i	0.0021^i	0.0026^i
λ_{HML}	0.0033	0.0080**	0.0075***	0.0045**	0.0061
	(0.0025)	(0.0033)	(0.0018)	(0.0023)	(0.0070)
λ_{WML}	0.0062***	0.0194	0.0151	0.0289	0.0067*
	(0.0023)	(0.0171)	(0.0117)	(0.0330)	(0.0039)
RMSPE	9.7 [0.15]	10.8 [0.15]	9.5 [0.13]	32.1 [0.46]	32.4 [0.46]

The table shows risk premium estimates for different models using various sets of test portfolios. The details of the test portfolios are provided in Appendix A of the main paper. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are imposed by the restriction that the market portfolio should be correctly priced (and by restrictions that are discussed in detail in the main text for the models in Panel B and Panel C). RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.4: Risk premiums with additional asset classes

Stocks	6 S×BM	6 S×BM	6 S×BM	6 S×BM
Options	6	6	6	6
Currencies	6	6	6	6
Corp. bonds	5			5
Sov. bonds		6		6
Commodities			6	6
A. CAPM				
λ_W	0.0051^i	0.0051^i	0.0051^i	0.0051^i
RMSPE	45.5 [0.71]	44.5 [0.71]	48.2 [0.73]	42.4 [0.75]
B. Ang et al. (2006)				
λ_W	0.0073***	0.0068***	0.0069***	0.0066***
	(0.0005)	(0.0005)	(0.0007)	(0.0006)
$\lambda_{\mathcal{D}}$	0^i	0^i	0^i	0^i
$\lambda_{W\mathcal{D}}$	0.0177^i	0.0140^i	0.0146^i	0.0128^i
RMSPE	24.1 [0.38]	33.2 [0.53]	28.5 [0.43]	30.9 [0.55]
C. Lettau et al. (2014)				
λ_W	0.0073***	0.0066***	0.0066***	0.0064***
	(0.0005)	(0.0005)	(0.0007)	(0.0006)
$\lambda_{\mathcal{D}}$	0.0901^i	0.0560^i	0.0549^i	0.0429^i
$\lambda_{W\mathcal{D}}$	0.0146^i	0.0112^i	0.0111^i	0.0099^i
RMSPE	27.9 [0.44]	35.8 [0.57]	32.5 [0.49]	32.9 [0.58]
D. VOL				
λ_W	0.0057***	0.0057***	0.0057***	0.0056***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)
λ_X	-0.0035^i	-0.0034^i	-0.0034^i	-0.0033^i
RMSPE	26.0 [0.41]	26.9 [0.43]	26.4 [0.40]	26.6 [0.47]
E. Carhart (1997)				
λ_W	0.0054***	0.0055***	0.0054***	0.0054***
	(0.0002)	(0.0004)	(0.0002)	(0.0001)
λ_{SMB}	0.0025^i	0.0020^i	0.0024^i	0.0022^i
λ_{HML}	0.0041	0.0045*	0.0044	0.0047
	(0.0030)	(0.0027)	(0.0032)	(0.0033)
λ_{WML}	0.0158	0.0238	0.0148	0.0168
	(0.0159)	(0.0295)	(0.0167)	(0.0121)
RMSPE	41.4 [0.65]	40.7 [0.65]	44.1 [0.66]	38.3 [0.68]

The table shows risk premium estimates for the GDA models when we add corporate bond, sovereign bond, and commodity futures portfolios to our benchmark set of test assets. The benchmark set of test assets consists of 6 stock portfolios (size/book-to-market), 6 option portfolios, and 6 currency portfolios. The premiums are estimated using GMM. Standard errors are in parenthesis. RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.5: Risk premiums for additional test portfolios

Stocks	10 S,B,M	25 S×OP	25 S×INV	10 Ind	6 S×BM	6 S×Mom	10 Ind	6 S×Mom	10 Ind
Options	24	24	24	6	6	6	6	6	6
Currencies				6 Lettau et al.	6 Lustig et al.	6 Lustig et al.	6 Lustig et al.	6 Lettau et al.	6 Lettau et al.
Corp. bonds								5	5
Sov. bonds								6	6
Commodities								6	6
A. GDA3									
λ_W	0.0067***	0.0068***	0.0068***	0.0069***	0.0070***	0.0068***	0.0073***	0.0066***	0.0066***
	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0006)	(0.0006)
$\lambda_{\mathcal{D}}$	-0.1681^i	-0.1577^i	-0.1444^i	-0.1130^i	-0.2359^i	-0.2806^i	-0.1229^i	-0.1642^i	-0.1009^i
$\lambda_{W\mathcal{D}}$	0.0172***	0.0171***	0.0168***	0.0187***	0.0212***	0.0215***	0.0199***	0.0182***	0.0161***
	(0.0040)	(0.0056)	(0.0059)	(0.0045)	(0.0054)	(0.0043)	(0.0045)	(0.0044)	(0.0048)
RMSPE	17.5 [0.27]	20.1 [0.29]	21.2 [0.30]	24.9 [0.37]	20.6 [0.29]	20.3 [0.28]	24.8 [0.36]	28.4 [0.50]	29.0 [0.51]
B. GDA5									
λ_W	0.0067***	0.0069***	0.0069***	0.0068***	0.0069***	0.0068***	0.0071***	0.0066***	0.0066***
	(0.0006)	(0.0007)	(0.0011)	(0.0004)	(0.0006)	(0.0008)	(0.0004)	(0.0005)	(0.0005)
$\lambda_{\mathcal{D}}$	-0.1688^i	-0.1471^i	-0.1666^i	-0.1786^i	-0.2772^i	-0.3145^i	-0.1681^i	-0.2101^i	-0.1549^i
$\lambda_{W\mathcal{D}}$	0.0169***	0.0169***	0.0174**	0.0199***	0.0215***	0.0217***	0.0195***	0.0193***	0.0175***
	(0.0042)	(0.0062)	(0.0082)	(0.0040)	(0.0044)	(0.0052)	(0.0038)	(0.0035)	(0.0043)
λ_X	-0.0014^i	-0.0014^i	-0.0012^i	-0.0018^i	-0.0009^i	-0.0006^i	-0.0019^i	-0.0014^i	-0.0016^i
$\lambda_{X\mathcal{D}}$	-0.0017^i	-0.0021^i	-0.0020^i	-0.0021^i	-0.0013^i	-0.0009^i	-0.0022^i	-0.0017^i	-0.0019^i
a	0.4008	0.6178	0.6188	0.3454	0.3004	0.2532	0.3153	0.3171	0.3375
	(1.1999)	(1.3008)	(1.5671)	(0.5851)	(0.5550)	(0.5721)	(0.4546)	(0.6538)	(0.4698)
RMSPE	16.8 [0.26]	18.7 [0.27]	20.2 [0.29]	22.2 [0.33]	19.0 [0.27]	18.1 [0.25]	22.2 [0.32]	26.7 [0.47]	27.0 [0.48]

The table shows risk premium estimates for the GDA models using different sets of portfolios. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are imposed by the restriction that the market portfolio should be correctly priced (and by cross-price restrictions for the GDA5). RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.6: Risk premiums for the GDA3 with alternative disappointment thresholds

	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Stocks	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Options			54	6	6
Currencies				6	6
A. $b = 0$					
λ_W	0.0063***	0.0065***	0.0069***	0.0073***	0.0071***
	(0.0006)	(0.0006)	(0.0005)	(0.0006)	(0.0005)
$\lambda_{\mathcal{D}}$	-0.0046^i	-0.1026^i	0.0345^i	0.2780^i	0.1661^i
$\lambda_{W\mathcal{D}}$	0.0144***	0.0177***	0.0148***	0.0170***	0.0166***
	(0.0047)	(0.0041)	(0.0037)	(0.0040)	(0.0033)
RMSPE	25.8 [0.34]	23.2 [0.30]	12.6 [0.20]	17.6 [0.25]	22.6 [0.32]
B. $b = -0.015$					
λ_W	0.0054***	0.0068***	0.0069***	0.0072***	0.0069***
	(0.0007)	(0.0004)	(0.0005)	(0.0005)	(0.0006)
$\lambda_{\mathcal{D}}$	-0.2547^i	-0.1276^i	-0.0899^i	0.1276^i	-0.0202^i
$\lambda_{W\mathcal{D}}$	0.0104	0.0205***	0.0156***	0.0164***	0.0168***
	(0.0093)	(0.0048)	(0.0052)	(0.0043)	(0.0032)
RMSPE	25.4 [0.34]	23.5 [0.31]	12.6 [0.20]	21.8 [0.31]	23.8 [0.33]
C. $b = -0.04$					
λ_W	0.0066***	0.0071***	0.0069***	0.0070***	0.0069***
	(0.0016)	(0.0007)	(0.0005)	(0.0006)	(0.0004)
$\lambda_{\mathcal{D}}$	0.1962^i	-0.2206^i	-0.2370^i	-0.1697^i	-0.2096^i
$\lambda_{W\mathcal{D}}$	0.0051	0.0256***	0.0217*	0.0218***	0.0229***
	(0.0135)	(0.0077)	(0.0114)	(0.0057)	(0.0066)
RMSPE	20.9 [0.28]	25.3 [0.33]	11.6 [0.19]	22.6 [0.32]	24.1 [0.34]

The table shows risk premium estimates for the GDA3 model when the disappointing event is defined as $\mathcal{D}_t = \{r_{W,t} < b\}$. The value of b varies across panels. The test portfolios are the same as in Table 4 of the main text. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are imposed by the restriction that the market portfolio should be correctly priced. RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.7: Risk premiums for the GDA5 with alternative disappointment thresholds

	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Stocks	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Options			54	6	6
Currencies				6	6
A. $b = 0$					
λ_W	0.0075***	0.0064***	0.0068***	0.0067***	0.0069***
	(0.0015)	(0.0004)	(0.0006)	(0.0008)	(0.0005)
$\lambda_{\mathcal{D}}$	0.2182^i	-0.1639^i	-0.0214^i	0.2496^i	0.1304^i
$\lambda_{W\mathcal{D}}$	0.0206*	0.0155***	0.0139***	0.0121**	0.0147*
	(0.0106)	(0.0050)	(0.0034)	(0.0051)	(0.0077)
λ_X	-0.0028^i	-0.0009^i	-0.0017^i	-0.0031^i	-0.0024^i
$\lambda_{X\mathcal{D}}$	-0.0033^i	-0.0013^i	-0.0018^i	-0.0029^i	-0.0026^i
a	0.4590	0.3673	0.2338	0.6317	0.2973
	(0.7554)	(0.5533)	(1.1975)	(0.8769)	(1.2784)
RMSPE	22.5 [0.30]	19.2 [0.25]	12.9 [0.21]	20.5 [0.29]	23.2 [0.33]
B. $b = -0.015$					
λ_W	0.0076***	0.0069***	0.0069***	0.0071***	0.0069***
	(0.0015)	(0.0007)	(0.0007)	(0.0006)	(0.0004)
$\lambda_{\mathcal{D}}$	-0.1470^i	-0.0870^i	-0.1235^i	0.1086^i	0.0519^i
$\lambda_{W\mathcal{D}}$	0.0235*	0.0186**	0.0156***	0.0153**	0.0145***
	(0.0139)	(0.0087)	(0.0037)	(0.0071)	(0.0031)
λ_X	-0.0017^i	-0.0019^i	-0.0015^i	-0.0027^i	-0.0023^i
$\lambda_{X\mathcal{D}}$	-0.0030^i	-0.0022^i	-0.0019^i	-0.0028^i	-0.0027^i
a	0.6799	0.3451	0.4072	0.1714	0.4094
	(0.4869)	(1.0155)	(0.9192)	(0.6534)	(1.7059)
RMSPE	22.1 [0.29]	20.7 [0.27]	13.0 [0.21]	21.6 [0.30]	24.5 [0.34]
C. $b = -0.04$					
λ_W	0.0068***	0.0071***	0.0069***	0.0067***	0.0066***
	(0.0017)	(0.0006)	(0.0009)	(0.0006)	(0.0007)
$\lambda_{\mathcal{D}}$	0.0388^i	-0.2720^i	-0.2940^i	-0.2000^i	-0.2915^i
$\lambda_{W\mathcal{D}}$	0.0131	0.0272***	0.0231***	0.0210***	0.0237***
	(0.0199)	(0.0080)	(0.0031)	(0.0058)	(0.0079)
λ_X	-0.0029^i	-0.0020^i	-0.0006^i	-0.0017^i	-0.0009^i
$\lambda_{X\mathcal{D}}$	-0.0029^i	-0.0022^i	-0.0015^i	-0.0017^i	-0.0014^i
a	0.1288	0.2422	0.5741	0.1025	0.3860
	(0.2882)	(0.7454)	(0.7205)	(1.0316)	(0.7472)
RMSPE	23.9 [0.32]	21.1 [0.28]	9.2 [0.15]	21.1 [0.30]	21.0 [0.30]

The table shows risk premium estimates for the GDA5 model when the disappointing event is defined as $\mathcal{D}_t = \left\{ r_{W,t} - a\frac{\sigma_W}{\sigma_X}\Delta\sigma^2_{W,t} < b \right\}$. The value of b varies across panels. The test portfolios are the same as in Table 4 of the main text. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are not estimated, but are imposed. RMSPE is the root-mean-squared pricing error of the model in basis points (bps) per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.8: Risk premiums for the GDA5 using alternative volatility measures

Stocks	25 S×BM	25 S×Mom		6 S×BM	6 S×Mom
Options			54	6	6
Currencies				6	6
A. Option implied volatility (VIX)					
λ_W	0.0081***	0.0079***	0.0065***	0.0065***	0.0065***
	(0.0009)	(0.0008)	(0.0014)	(0.0011)	(0.0009)
$\lambda_{\mathcal{D}}$	-0.1071^i	-0.1310^i	-0.3226^i	-0.2698^i	-0.2470^i
$\lambda_{W\mathcal{D}}$	0.0152*	0.0160**	0.0209***	0.0207*	0.0201**
	(0.0083)	(0.0076)	(0.0063)	(0.0111)	(0.0089)
λ_X	-0.0010^i	-0.0012^i	-0.0005^i	-0.0008^i	-0.0009^i
$\lambda_{X\mathcal{D}}$	-0.0016^i	-0.0014^i	-0.0008^i	-0.0010^i	-0.0010^i
a	1.2625	0.4006	0.4546	0.2778	0.1595
	(2.0932)	(1.4324)	(0.8337)	(1.2991)	(1.2682)
RMSPE	23.8 [0.30]	23.6 [0.29]	12.6 [0.20]	21.4 [0.30]	20.3 [0.29]
B. Realized volatlity (intra-daily)					
λ_W	0.0058***	0.0065***	0.0063***	0.0067***	0.0064***
	(0.0012)	(0.0007)	(0.0010)	(0.0004)	(0.0007)
$\lambda_{\mathcal{D}}$	0.1079^i	-0.1728^i	-0.2112^i	-0.1944^i	-0.2820^i
$\lambda_{W\mathcal{D}}$	0.0037	0.0170*	0.0177***	0.0194***	0.0211***
	(0.0109)	(0.0099)	(0.0034)	(0.0040)	(0.0053)
λ_X	-0.0011^i	-0.0008^i	-0.0006^i	-0.0008^i	-0.0006^i
$\lambda_{X\mathcal{D}}$	-0.0010^i	-0.0009^i	-0.0008^i	-0.0011^i	-0.0008^i
a	0.9802	0.2201	0.4378	0.4429	0.3235
	(2.2929)	(0.6148)	(1.8549)	(1.1562)	(1.1562)
RMSPE	23.7 [0.34]	25.0 [0.36]	12.4 [0.21]	19.6 [0.28]	18.1 [0.25]
C. Model implied volatility (EGARCH)					
λ_W	0.0069***	0.0070***	0.0068***	0.0066***	0.0065***
	(0.0017)	(0.0009)	(0.0022)	(0.0004)	(0.0008)
$\lambda_{\mathcal{D}}$	-0.0060^i	-0.1715^i	-0.2701^i	-0.1978^i	-0.2736^i
$\lambda_{W\mathcal{D}}$	0.0155	0.0214***	0.0206*	0.0196***	0.0212***
	(0.0132)	(0.0076)	(0.0109)	(0.0048)	(0.0049)
λ_X	-0.0010^i	-0.0008^i	-0.0004^i	-0.0004^i	-0.0002^i
$\lambda_{X\mathcal{D}}$	-0.0012^i	-0.0010^i	-0.0006^i	-0.0006^i	-0.0004^i
a	0.8603	0.4252	0.4020	0.2069	0.1105
	(0.8198)	(0.7559)	(2.4298)	(1.3322)	(0.8260)
RMSPE	20.6 [0.27]	19.7 [0.26]	11.4 [0.18]	20.5 [0.29]	19.3 [0.27]

The table shows risk premium estimates for the GDA5 model when market volatility is measured in different ways (in panels). The test portfolios are the same as in Table 3 of the main text. The premiums are estimated using GMM. Standard errors are in parenthesis. Values with the superscript i are not estimated, but are imposed. RMSPE is the root-mean-squared pricing error of the model in basis points per month and the RMSPE to root-mean-squared returns ratio is reported in brackets.

Table A.9: Betas of the option portfolios

	Return	Betas			
	$E[R^e_{it}]$	β_{iW}	β^-_{iW}	β_{iX}	β^-_{iX}
Call, 5% OTM	-3.45	0.64	0.26	0.33	0.71
Call, ATM	-1.32	0.75	0.36	-0.25	0.35
Call, 5% ITM	1.13	0.80	0.45	-0.78	-0.03
Put, 5% ITM	5.78	0.92	0.76	-2.64	-1.60
Put, ATM	8.99	0.97	0.88	-3.35	-2.13
Put, 5% OTM	16.02	1.01	0.99	-4.13	-2.76

The table presents retunrs and betas of various index option portfolios. The first column presents the annual average excess return of the portfolios. The rest of the table reports the market beta $\beta_{iW} = \frac{Cov(R^e_{it}, r_{Wt})}{Var(r_{Wt})}$, the market downside beta $\beta^-_{iW} = \frac{Cov(R^e_{it}, r_{Wt}|\mathcal{D}_t)}{Var(r_{Wt}|\mathcal{D}_t)}$, the volatility beta $\beta_{iX} = \frac{Cov\left(R^e_{it}, \Delta\sigma^2_{Wt}\right)}{Var\left(\Delta\sigma^2_{Wt}\right)}$, and the volatility downside beta $\beta^-_{iX} = \frac{Cov\left(R^e_{it}, \Delta\sigma^2_{Wt}|\mathcal{D}_t\right)}{Var\left(\Delta\sigma^2_{Wt}|\mathcal{D}_t\right)}$ of the portfolios. The disappointing event is $\mathcal{D}_t = \{r_{Wt} < -0.03\}$.

Table A.10: Model calibration

A. Endowment parameters

$\mu = 0.15\%,\ \sqrt{\omega_c(L)} = 0.46\%,\ \sqrt{\omega_c(H)} = 1.32\%,$
$\nu_d = 6.42,\ \rho = 0.3,\ p_{HH} = 0.9961,\ p_{LL} = 0.9989$

B. Preference parameters

$\delta = 0.998,\ \gamma = 2.5,\ \ell = 2.33,\ \kappa = 0.998$

C. Endowment and asset pricing moments

	Sample	GDA3	GDA5
$E[\Delta c_t]$ (%)	1.84	1.80	1.80
$\sigma[\Delta c_t]$ (%)	2.20	2.07	2.07
$AC1(\Delta c_t)$	0.48	0.25	0.25
$E[\Delta d_t]$ (%)	1.05	1.80	1.80
$\sigma[\Delta d_t]$ (%)	13.02	13.29	13.29
$AC1(\Delta d_t)$	0.11	0.25	0.25
$Corr(\Delta c_t, \Delta d_t)$	0.52	0.30	0.30
$E[pd]$ (%)	3.33	2.72	2.89
$\sigma[pd]$ (%)	0.44	0.20	0.11
$E[r_f]$ (%)	0.57	0.46	0.76
$\sigma[r_f]$ (%)	3.77	0.15	1.55
$E[r - r_f]$ (%)	5.50	8.06	6.61
$\sigma[r - r_f]$ (%)	20.25	17.65	16.84

D. Downside event and factor risk premiums

	GDA3	GDA5
ψ	∞	1.5
a	0.00	1.38
b (%)	0.00	-0.10
$Prob(\mathcal{D})$ (%)	17.43	16.09
λ_W	0.0065	0.0042
$\lambda_{\mathcal{D}}$	-0.3494	-0.3010
$\lambda_{W\mathcal{D}}$	0.0038	0.0023
λ_X		-1.38E-6
$\lambda_{X\mathcal{D}}$		-1.16E-6

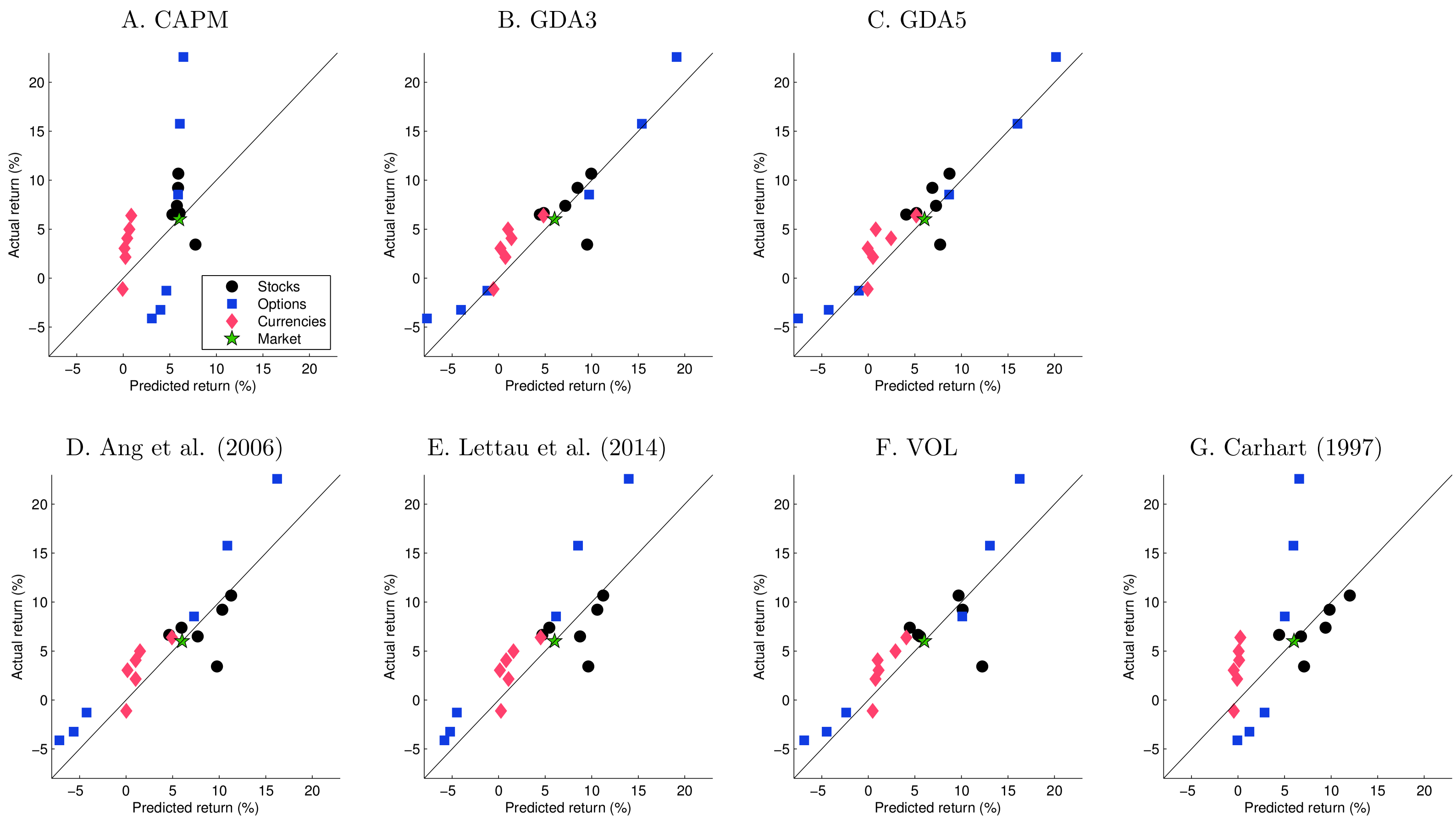
The top panels of the table present the parameter values used for the calibration assesment. Panel A shows the parameters of the endowment dynamics from (A.36), while Panel B presents the values of the preference parameters. Panel C presents the model implied mean (E), standard deviation (σ), and first order autocorrelation ($AC1$) of consumption growth (Δc_t) and dividend growth (Δd_t), and the first and second moments of the log price-dividend ratio (pd), log risk-free rate (r_f), and excess log equity return ($r - r_f$). The first column presents annualized data counterparts over the period from January 1930 to December 2012. Finally, Panel D shows the characteristics of the downside event (parameters a and b from equation (A.4) and the unconditional disappointment probability) and the factor risk premiums (λ-s), as implied by the GDA model.

Table A.11: Risk premium estimates using individual stocks

	GDA3 $a = 0$	GDA5 $a = 0$	GDA5 $a = 0.5$	GDA5 $a = 1$
λ_W	0.0054**	0.0051**	0.0051**	0.0052**
	(0.0024)	(0.0023)	(0.0023)	(0.0023)
$\lambda_{\mathcal{D}}$	-0.2112**	-0.1906**	-0.3249***	-0.3561***
	(0.1017)	(0.0957)	(0.1228)	(0.1240)
$\lambda_{W\mathcal{D}}$	0.0045***	0.0041**	0.0044***	0.0040***
	(0.0017)	(0.0016)	(0.0016)	(0.0013)
λ_X		-1.03e-5***	-1.03e-5***	-1.01e-5***
		(3.65e-6)	(3.76e-6)	(3.84e-6)
$\lambda_{X\mathcal{D}}$		-3.15e-6***	-6.57e-6***	-8.31e-6***
		(9.38e-7)	(1.93e-6)	(2.47e-6)

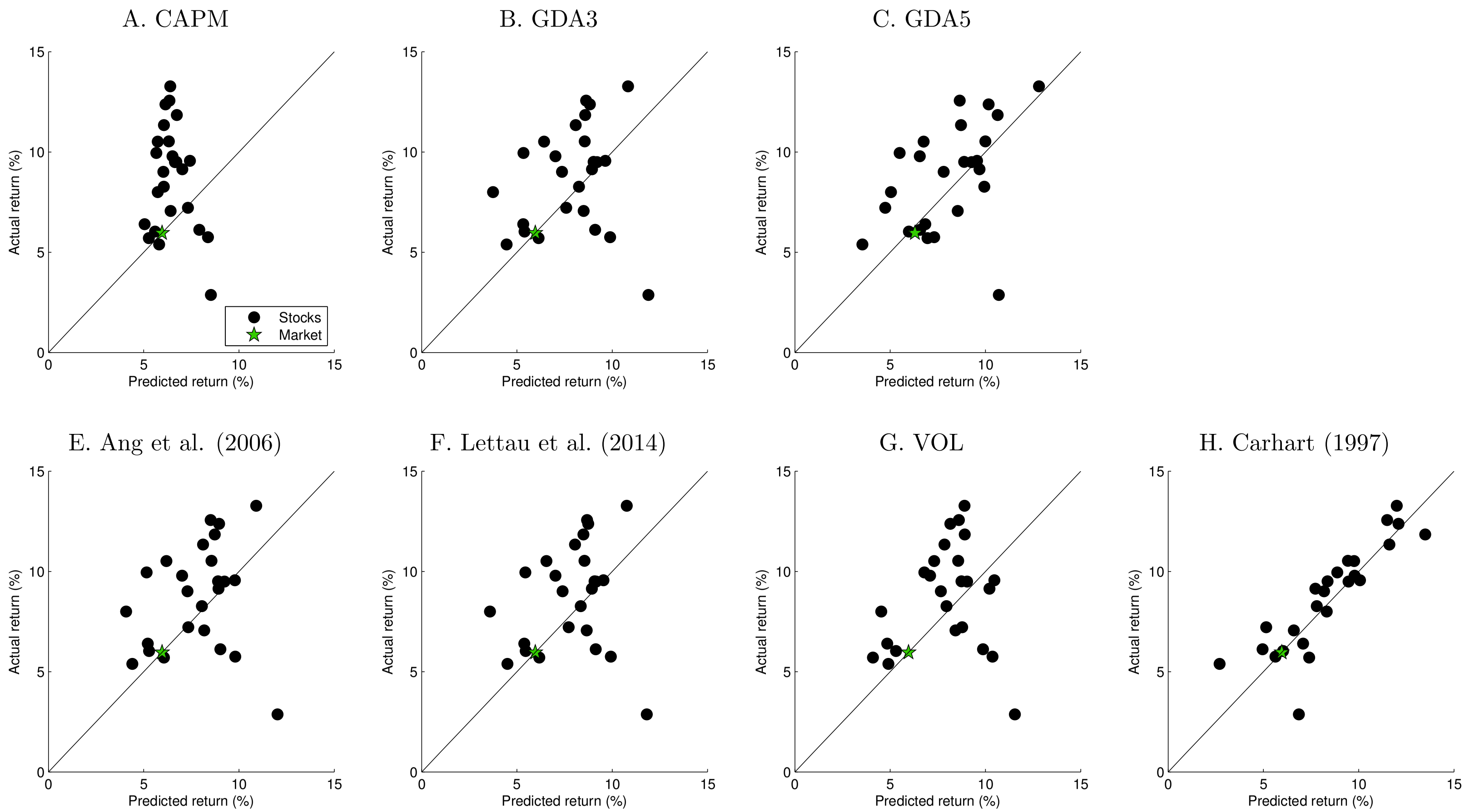
The Table presents results of Fama-MacBeth regressions. For each month $t \geq 12$ the β-s are calculated using daily data over the previous 12 months (months $t - 11$ to t). The dependent variable in the cross-sectional regression for each month t is the average monthly excess return over the next month $(t + 1)$. The standard errors (in parenthesis) are corrected for 12 Newey-West (1987) lags. The sample period is from July, 1963 to December, 2013.

Figure A.1: Actual versus predicted returns for stock (size/book-to-market), option, and currency portfolios



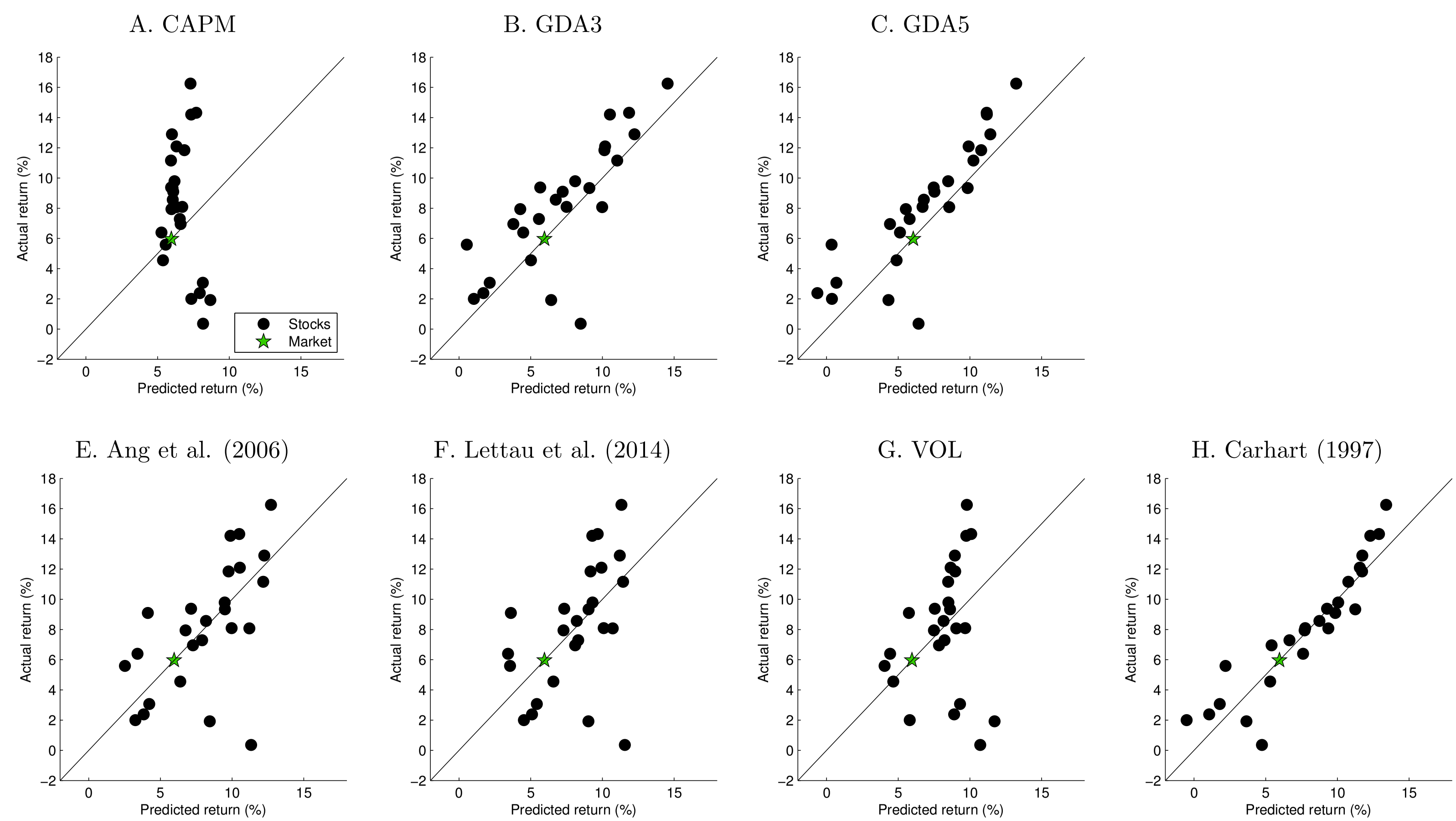
The figure shows the realized average excess returns for 6 (3×2) size/book-to-market, 6 option, 6 currency, and the market portfolio (see the legend in Panel A) against the predicted average excess returns from various models. The sample period is April 1986 – March 2010.

Figure A.2: Actual versus predicted returns for size/book-to-market portfolios



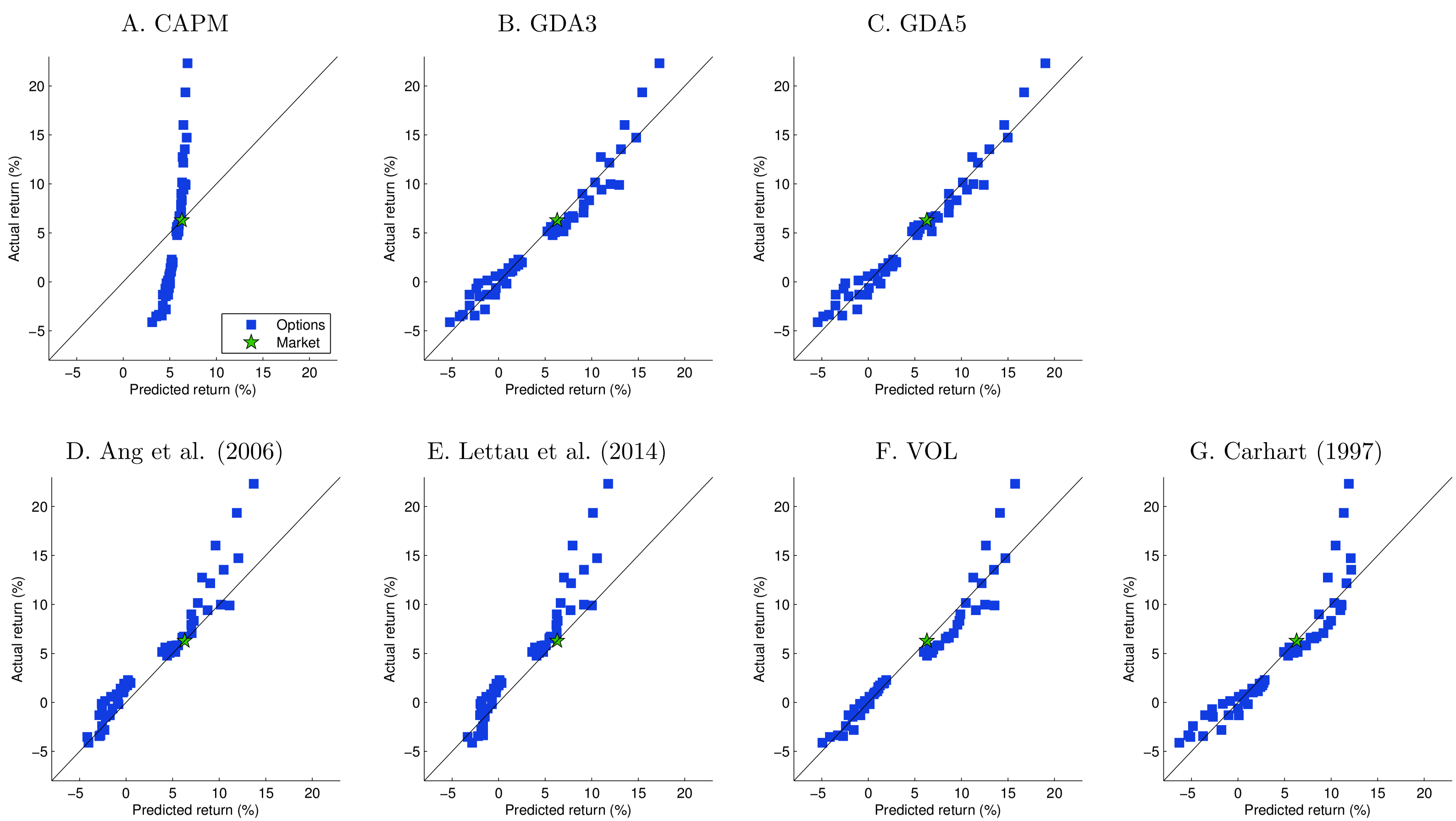
The figure shows the realized average excess returns for the 25 (5×5) size/book-to-market portfolios and the market portfolio (see the legend in Panel A) against the predicted average excess returns from various models. The sample period is July 1964 – December 2016.

Figure A.3: Actual versus predicted returns for size/momentum portfolios



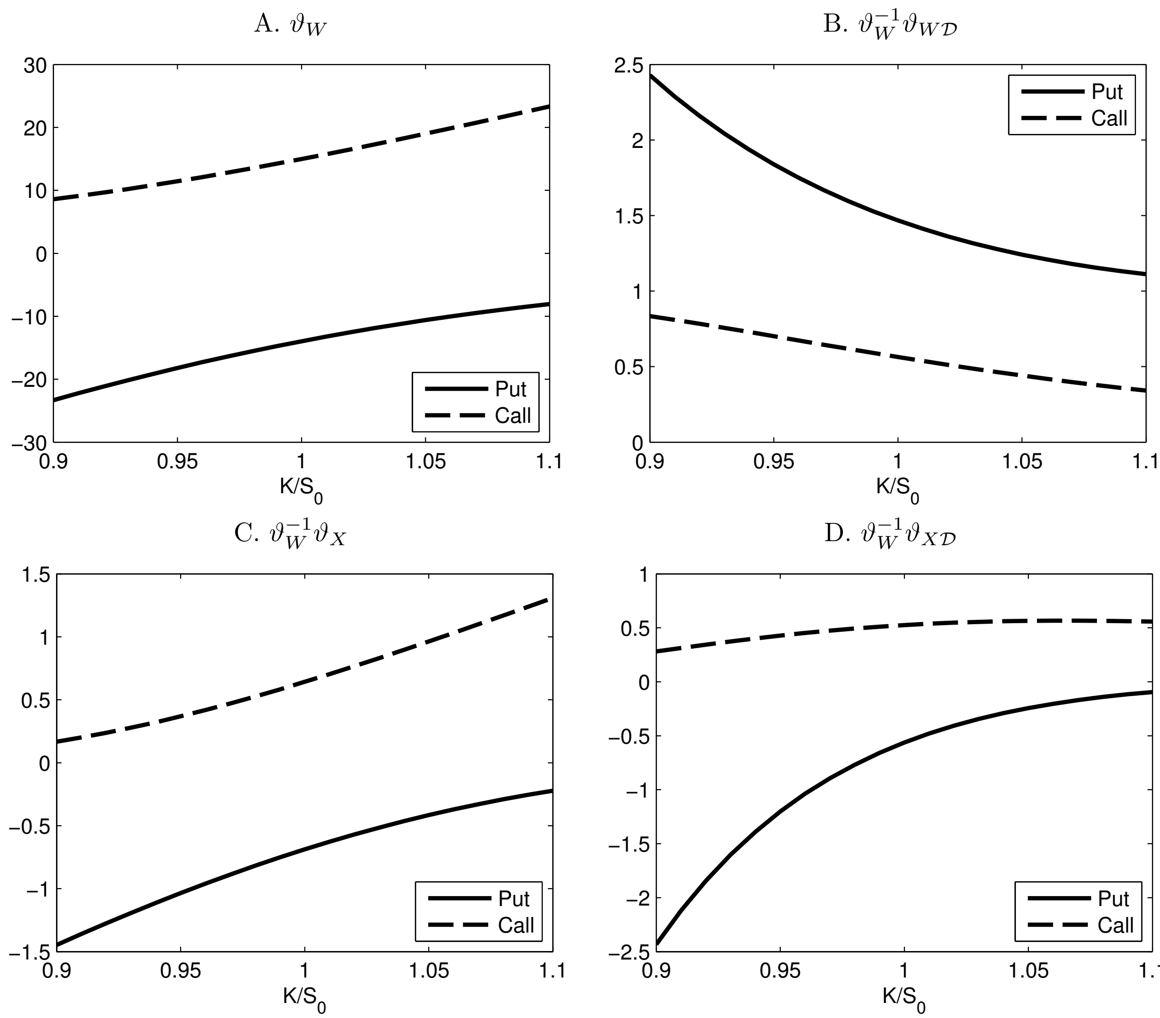
The figure shows the realized average excess returns for the 25 (5×5) size/momentum portfolios and the market portfolio (see the legend in Panel A) against the predicted average excess returns from various models. The sample period is July 1964 – December 2016.

Figure A.4: Actual versus predicted returns for option portfolios



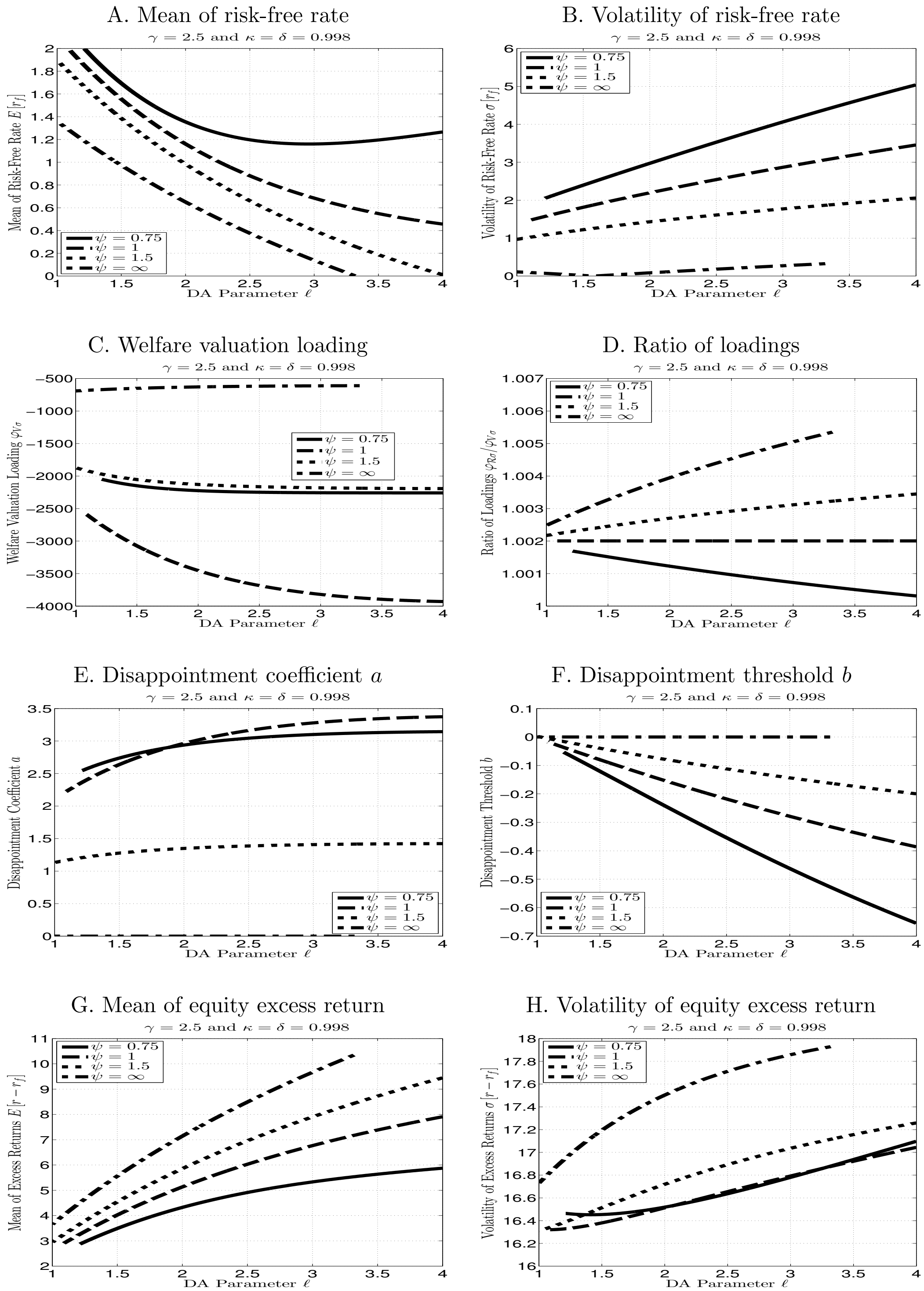
The figure shows the realized average excess returns for the 54 option portfolios of Constantinides et al. (2013) and the market return (see the legend in Panel A) against the predicted average excess returns from various models. The sample period is April 1986 – January 2012.

Figure A.5: Sensitivities of the option portfolios



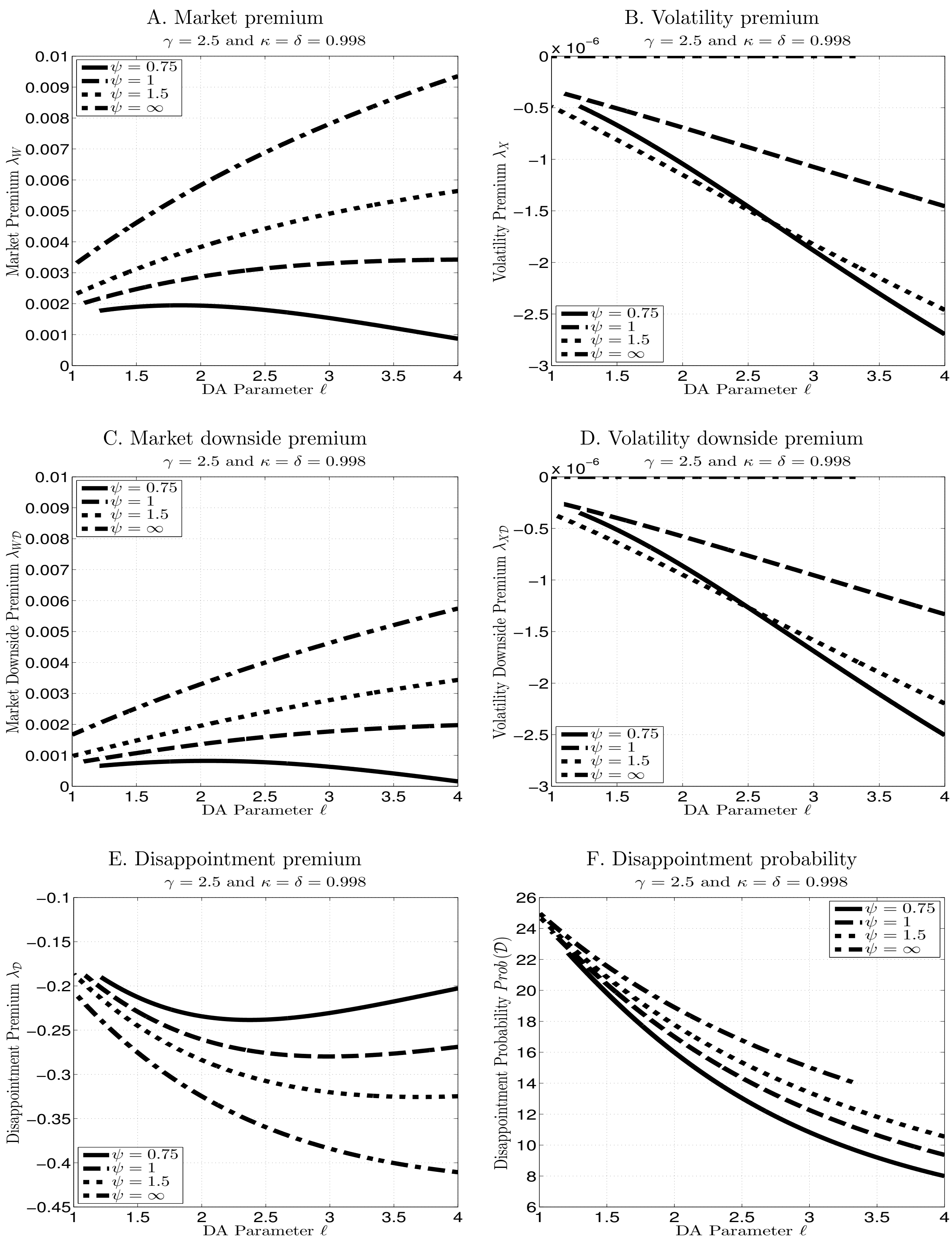
The figure shows option sensitivtes, implied by the Black-Scholes formula, of options with different moneyness (K/S_0) levels. The sensitivities are defined by the equations from (A.32) to (A.35). The parameter values used are $S_0 = 10$, $T = 1/12$ (one month maturity), 30% annual volatility for the underlying, and a risk-free rate of zero. The strike price, K, varies along the horizontal axis of each graph.

Figure A.6: Asset Prices Sensitivity to Disappointment Aversion



The figure displays model-implied annualized mean and volatility of the risk-free rate in Panels A and B, loadings of the welfare valuation ratios onto market volatility and their ratio in Panels C and D, and coefficients that determine the disappointing region in Panels E and F. The equity premium and the equity volatility are finally shown in Panels G and H. All quantities are plotted against the degree of disappointment aversion ℓ, and for different values of the elasticity of intertemporal substitution ψ.

Figure A.7: Factor Risk Premia Sensitivity to Disappointment Aversion



The figure displays model-implied factor risk premiums in Panels A to E, and the disappointment probability in Panel F. All quantities are plotted against the degree of disappointment aversion ℓ, and for different values of the elasticity of intertemporal substitution ψ.