Internet Appendix to "Short-Term Interest Rates and Stock Market Anomalies"

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1 ICAPM based on TB

We summarize here the key results for the version of the ICAPM based on the T-bill rate (TB). The results (for the value-weighted portfolios) are presented in Table A.1.

The fit for the augmented test with all 70 portfolios is 48%, which is strongly statistically significant (1% level), and only slightly lower than the fit obtained for the version based on FFR. Across anomalies, apart from the IVG deciles, we can see that the R^2 estimates vary between 40% (estimation with EP and PIA deciles) and 74% (DUR). Moreover, these estimates are statistically significant at the 5% or 1% level in the estimation with the BM, DUR, IA, and PIA deciles, whereas for the EP, REV, and IVG deciles there is significance at the 10% level.

Similarly to the model corresponding to FFR, this version of the ICAPM passes the specification test (based on both types of standard errors) in all cases as indicated by the p-values clearly above 5%. Furthermore, the risk price estimates for the interest rate factor are negative and largely significant (at the 5% or 1% level) in most cases. The sole exception is in the estimation with the IVG deciles where the Shanken's t-ratio indicates significance at the 10% level (although there is significance at the 5% level based on the empirical p-value). Overall, these results show that the performance of the ICAPM based on TB are qualitatively similar to the version corresponding to FFR.

2 Sensitivity analysis

We conduct several robustness checks to the main results discussed in Section 4 in the main paper. To save space, we report only the Shanken's t-ratios. Moreover, unless noted otherwise, we focus on the estimation with value-weighted portfolios.

2.1 Alternative interest rate factors

We estimate both versions of the ICAPM by using new definitions of the interest rate factors. Following Hahn and Lee (2006) and Maio and Santa-Clara (2012), the innovation in the Fed funds rate corresponds to the first-difference in this variable, $\widetilde{FFR}_{t+1} \equiv FFR_{t+1} - FFR_t$, and similarly for $\widetilde{TB}$. The objective is to assess whether the fit of the ICAPM is driven by the way the hedging factors are constructed.

The results are displayed in Table A.2 below. We can see that both the explanatory ratios and risk price estimates are very similar to the corresponding values in the benchmark specification, and this holds for both versions of the model. These results are not surprising since both short-term interest rates are quite persistent as shown by the estimates of the AR(1) coefficients presented in Section 3 of the paper, thus the innovations constructed from the two methods are highly correlated.

2.2 Restricted sample

We estimate the ICAPM for a subsample that ends in 2006:12. The goal is to evaluate the impact of the recent financial crisis on the fit of the ICAPM given the large spike in stock market volatility observed during the 2007–2009 period.

The results are presented in Table A.3. Overall, the fit of the ICAPM is larger in the restricted sample than in the full sample. In the tests with all 70 portfolios the explanatory ratios are 64% and 60% in the versions based on FFR and TB, respectively, which represents a relevant rise in explanatory power for the later case. As for the full sample both versions of the model pass the specification test by a good margin. Moreover, the risk price estimates for both interest rate factors are strongly significant (1% level). These results suggest that the financial crisis has had a negative effect on the performance of the ICAPM, which might be related to the fact that during this period the Fed funds rate has hit the zero lower bound.[1]

[1] This lead to a change in monetary policy, which was known by "quantitative easing" (see Wright (2012) and Swanson and Williams (2014) for a discussion of the effect on asset markets).

2.3 Additional anomalies

We estimate the ICAPM with portfolios related with two additional anomalies. We employ deciles sorted on cash-flow-to-price ratio (CFP, Lakonishok, Shleifer, and Vishny (1994)) and investment growth (IG, Xing (2008)). We employ both value- and equal-weighted portfolios and these data are available from Lu Zhang.

The results are presented in Table A.4. We can see that the performance of the ICAPM for the value-weighted portfolios associated with these two anomalies is modest. The largest fit obtained in the estimation with the CFP deciles is 24% (version with FFR) while in the test with the IG deciles we obtain an explanatory ratio of 31% (version based on TB). However, in the estimation with equal-weighted portfolios the performance of the ICAPM for these two anomalies improves sharply. In the tests with CFP, the R^2_{OLS} estimates are 87% and 80% in the versions with FFR and TB, respectively, while in the test with the IG deciles these estimates are 82% and 76%, respectively.

In all cases (both value- and equal-weighted portfolios) the two-factor model passes the specification test with asymptotic p-values largely above 5%. In most cases the risk price estimates for the interest rate factor are strongly significant (5% or 1% level), the exceptions being the version based on FFR when tested on the IG deciles (with significance at the 10% level). Therefore, these results indicate that the ICAPM has strong explanatory power for the equal-weighted portfolios associated with the CFP and IG anomalies.

2.4 Alternative statistical inference

We conduct alternative methods of statistical inference for the risk price estimates associated with the two-factor model. Specifically, we compute the t-ratios employed in Fama and MacBeth (1973), Jagannathan and Wang (1998), and Kan, Robotti, and Shanken (2013). The method used in Jagannathan and Wang (1998) accounts for the error-in-variables (EIV) problem (originated from the estimated betas), but assumes a correctly specified model (similarly to Shanken (1992)). On the other hand, the standard errors used in Kan, Robotti, and Shanken (2013) are robust to model's misspecification. The t-ratios from Fama and MacBeth (1973) are less conservative than the Shanken's t-ratios since there is no correction for the EIV bias.

The results are presented in Table A.5. We can see that the interest rate risk prices are strongly significant (1% level) by using the three alternative types of t-ratios, and this holds for both versions of the model. In particular, the t-ratios of Kan, Robotti, and Shanken (2013) are not significantly smaller (in magnitude) than the corresponding statistics from Jagannathan and Wang (1998) and Shanken (1992) (in some cases the magnitudes are actually higher). This means that accounting for model misspecification does not have an effect on the statistical significance of the risk price estimates for the interest rate factors.

2.5 Unrestricted zero-beta rate

We estimate the ICAPM by specifying an alternative second-pass OLS cross-sectional regression. Following Kan, Robotti, and Shanken (2013), we work with portfolio returns (instead of excess returns) and include an intercept in the cross-sectional regression,

$$\overline{R_i} = \lambda_0 + \lambda_M \beta_{i,M} + \lambda_{FFR} \beta_{i,FFR} + \alpha_i, \tag{1}$$

where λ_0 represents an estimate of the zero-beta rate. The t-ratio associated with λ_0 tests the null hypothesis that the zero-beta rate in excess of the average risk-free rate (one-month T-bill rate) is equal to zero.

The results are shown in Table A.6. The estimates for the excess zero-beta rate are largely insignificant in both versions of the model. On the other hand, while the market risk price estimates lose their significance it turns out that the risk price estimates for both interest rate factors are significant at the 5% level. Moreover, the explanatory ratios are very similar to the corresponding values in the benchmark regression with no intercept. This represents another sign that allowing for an unrestricted zero-beta rate does not have a significant effect on the performance of the ICAPM. Thus, the model is able to match the zero-beta rate, and thus, there is no misspecification of this form.

Unreported results for the alternative factor models indicate that the estimates for λ_0 assume larger values (above 1% per month) and are statistically above the average risk-free rate in most cases (namely for the CAPM, FF3, PS4, and HXZ4 models). This suggests a misspecification of those factor models. However, the results of this subsection should be interpreted with some caution given the multicollinearity induced by including the intercept in the cross-sectional regression (see Jagannathan and Wang (2007)).

2.6 Double-sorted portfolios

We estimate the model by using double-sorted portfolios on size and other anomalies. Specifically, we use 25 portfolios sorted on size and book-to-market ratio (SBM25), 25 portfolios sorted on size and asset growth (SIA25), and 25 portfolios sorted on size and long-term return reversal (SREV25). The portfolio returns are value-weighted and are available from Kenneth French's website. This analysis represents an additional control for the role of size on those three market anomalies.[2]

The results are displayed in Table A.7. The two-factor model has a large fit for the SBM25 portfolios as indicated by the explanatory ratios above 60%, which represents a similar fit to the estimation with the BM deciles in the benchmark case. The model's performance for the size-return reversal portfolios is around 50%, which is also close to the sample R^2 obtained in the estimation with the REV deciles. For these two portfolio groups (and for both versions of the model) the estimates for the hedging risk prices are negative and strongly significant (1% level). Moreover, the ICAPM is not rejected by the specification test as indicated by the p-values above 5%. According to unreported results, among these 50 portfolios there is only one portfolio with statistically significant pricing errors for the version based on FFR, the small-past winner portfolio. Hence, all the size-BM portfolios

[2] For example, Fama and French (2008) show that some anomalies are not pervasive across size groups.

have insignificant pricing errors, including the problematic small-growth and small-value portfolios (for a related discussion see Campbell and Vuolteenaho (2004), among others).

The two-factor model has a lower fit when it comes to explain the size-asset growth portfolios with R^2 estimates around 30% for both versions of the model. Still, the interest rate factors are strongly priced (1% level). In the augmented cross-sectional test including all 75 portfolios (SBM25+SIA25+SREV25), the model (based on FFR) explains around 50% of the cross-sectional variation in risk premia, which represents only a marginally smaller fit than the benchmark augmented test with 70 decile portfolios. Further, both versions of the model are not rejected by the χ^2-test, and the interest factor risk price estimates are largely significant (1% level) in the estimation with the 75 portfolios. In sum, these results suggest that the ICAPM offers a high explanatory power for these double-sorted portfolios (related to size).

2.7 Additional evaluation measures

We compute two additional metrics to evaluate the performance of the ICAPM. First, we use an alternative cross-sectional OLS R^2,

$$\widehat{\rho}^2 = 1 - \frac{\mathrm{Var}_N(\hat{\alpha}_i)}{S_N(\overline{R_i - R_f})}, \tag{2}$$

where $S_N(\cdot)$ stands for the cross-sectional second-moment.[3] Contrary to the benchmark R^2 measure used in the paper (R^2_{OLS}), $\widehat{\rho}^2$ always lies between zero and one. However, the new measure is less informative about the explanatory power of a model for the cross-sectional dispersion in risk premia. In fact, a model can have a large value of $\widehat{\rho}^2$ just by fitting well the cross-sectional mean despite not explaining any cross-sectional dispersion in risk premia (indicated by low or negative R^2_{OLS}). Following Kan, Robotti, and Shanken (2013), we compute asymptotic p-values for the null hypotheses $H_0 : \rho^2 = 1$ and $H_0 : \rho^2 = 0$.

[3] Kan, Robotti, and Shanken (2013) employ this measure in the analysis with excess returns and restricted zero-beta rate.

The second evaluation measure is the $\widehat{Q}_c$-statistic proposed by Kan, Robotti, and Shanken (2013), which tests the null hypothesis that the pricing errors are jointly equal to zero. This statistic is similar to the χ^2-statistic used in the paper, but has an approximate F-distribution in finite samples.[4]

The results associated with the augmented test (with 70 portfolios) are presented in Table A.8. Surprisingly, the estimate of $\widehat{\rho}^2$ associated with the CAPM is large (0.92), which compares to a negative value of R^2_{OLS} (-0.59) reported in the paper. This stems from the fact that the CAPM (i.e., the market factor) picks the cross-sectional mean risk premium, but does not explain any cross-sectional dispersion in risk premia among these portfolios. Despite the large estimate of $\widehat{\rho}^2$, the null hypothesis that $\rho^2 = 1$ is clearly rejected with a p-value around zero. Moreover, the CAPM is rejected by the $\widehat{Q}_c$-statistic at the 5% level.

The estimates of $\widehat{\rho}^2$ associated with the ICAPM are around 0.98. For both versions of the model we cannot reject the null hypothesis that $\rho^2 = 1$, with p-values clearly above 5%. On the other hand, the null that $\rho^2 = 0$ is strongly rejected in both cases. Further, the model is not rejected by the specification test associated with the F-statistic as indicated by the large p-values. Overall, these two additional evaluation metrics lend further support to the ICAPM.

2.8 Covariance representation

We define and test the ICAPM in expected return-covariance representation,

$$\begin{aligned} \mathrm{E}(R_{i,t+1} - R_{f,t+1}) = {} & \gamma_M \,\mathrm{Cov}(R_{i,t+1} - R_{f,t+1}, RM_{t+1}) \\ & + \gamma_{FFR} \,\mathrm{Cov}(R_{i,t+1} - R_{f,t+1}, \widetilde{FFR}_{t+1}), \end{aligned} \tag{3}$$

where (γ_M, γ_{FFR}) denote the covariance risk prices associated with the market and interest rate factors, respectively.

[4] We thank Raymond Kan and Cesare Robotti for providing the corresponding MATLAB code.

This version of the model is equivalent to an expected return-single beta pricing equation. Thus, the model should fit as well as the version with multiple-regression betas, although the risk price estimates might have different signs, given possible correlation among the factors in the model. We estimate specification (3) by first-stage GMM (Hansen (1982) and Cochrane (2005)). This method uses equally-weighted moments, which is conceptually equivalent to running an OLS cross-sectional regression of average excess returns on factor covariances (right-hand side variables).

The GMM system has $N + 2$ moment conditions, where the first N sample moments correspond to the pricing errors for each of the N testing returns:

$$g_T(\mathbf{b}) \equiv \frac{1}{T}\sum_{t=0}^{T-1} \left\{ \begin{array}{c} (R_{i,t+1} - R_{f,t+1}) - \gamma_M (R_{i,t+1} - R_{f,t+1})\,(RM_{t+1} - \mu_M) \\ -\gamma_{FFR}(R_{i,t+1} - R_{f,t+1})\left(\widetilde{FFR}_{t+1} - \mu_{FFR}\right) \\ RM_{t+1} - \mu_M \\ \widetilde{FFR}_{t+1} - \mu_{FFR} \end{array} \right. = \mathbf{0}.$$

$$i = 1, ..., N. \tag{4}$$

In this system, the last two moment conditions enable us to estimate the factor means. Thus, the estimated covariance risk prices (obtained from the first N moment conditions) account for the estimation error in the factor means, as in Cochrane (2005) (Chapter 13), Yogo (2006), and Maio and Santa-Clara (2012). There are $N - 2$ overidentifying conditions ($N + 2$ moments and 2×2 parameters to estimate). By defining the first N residuals from the GMM system as the pricing errors associated with the N testing assets, $\widehat{\alpha}_i, i = 1, ..., N$, the $\boldsymbol{\chi}^2$ and R^2_{OLS} statistics are defined analogously to the formulas presented in Section 3 of the paper.

The GMM estimation results are displayed in Table A.9. As expected, the R^2 estimates are the same as in the benchmark test of the beta pricing equation. As in the benchmark case, the model passes the $\boldsymbol{\chi}^2$ test as indicated by the p-values clearly above 5%. We can see that the covariance risk price estimates for the market factor are largely insignificant. However, the covariance risk prices for the hedging factors are negative and strongly significant (1% or 5% level), which is in line with the results for the beta representation. Overall, the estimation results for the covariance pricing equation are relatively consistent with those arising from the beta representation of the model.

2.9 SDF representation

We define and estimate the ICAPM in the stochastic discount factor (SDF) representation:

$$\begin{aligned}\mathbf{1} &= \mathrm{E}(M_{t+1}\mathbf{R_{t+1}}), \qquad (5)\\ M_{t+1} &= b_1 + b_2 RM_{t+1} + b_3 \widetilde{FFR}_{t+1}, \qquad (6)\end{aligned}$$

where $\mathbf{1}$ is a vector of ones, $\mathbf{R}_{t+1}$ is a vector of gross returns, and M_{t+1} denotes the linear SDF associated with the ICAPM.

We estimate the model by first-step GMM, where the weighting matrix is associated with the Hansen and Jagannathan (1997) distance metric,[5]

$$\mathbf{W}_{HJ} = \left(\frac{1}{T}\sum_{t=1}^{T}\mathbf{R}_t\mathbf{R}_t'\right)^{-1}. \qquad (7)$$

Under this procedure, assets with a larger second moment in returns receive a lower weight in the estimation. The Hansen-Jagannathan (HJ) distance is equal to

$$HJ = (\hat{\boldsymbol{\alpha}}'\mathbf{W}_{HJ}\hat{\boldsymbol{\alpha}})^{\frac{1}{2}}, \qquad (8)$$

where $\hat{\boldsymbol{\alpha}}$ is the vector of pricing errors. This metric can be interpreted as the minimum distance between a given candidate SDF and the set of all true SDFs. HJ also represents

[5]The Hansen and Jagannathan (1997) metric has been employed in asset pricing tests by Jagannathan and Wang (1996), Hodrick and Zhang (2001), and Jacobs and Wang (2004), among others.

a proxy for the misspecification of a given model, and thus can be used to compare the fit among alternative asset pricing models. The testing payoffs are the gross returns on the 70 equity portfolios in addition to the gross risk-free rate (one-month T-bill rate).

The estimates for HJ are presented in Table A.10. We can see that both versions of our two-factor model are not rejected by this specification test ($HJ = 0$) as the p-values are above 5% in both cases. On the other hand, the CAPM is strongly rejected with a p-value around zero. These results suggest that our ICAPM is correctly specified in contrast to the CAPM.

To assess the statistical significance of the SDF coefficient estimates, we employ the sequential procedure proposed by Gospodinov, Kan, and Robotti (2014). In this method, the factor with the lowest t-ratio (in magnitude) for which the null hypothesis of a zero SDF coefficient is not rejected is eliminated from the model. Then, the model is reestimated with the remaining factors and the process is repeated until all the remaining factors have statistically significant SDF coefficients. The individual statistical significance at each stage is assessed by using the Bonferroni method, which penalizes models with more factors. Specifically, if p_i is the p-value associated with testing $H_0 : b_i = 0, i = 1, ..., K$ (obtained from a $N(0, 1)$ distribution) it follows that the null is rejected if $p_i \leq \eta/K$ (rather than if $p_i \leq \eta$), where η is the (fixed) significance level and K is the total number of SDF coefficients ($K = 3$ in the case of the ICAPM).

The SDF coefficient estimates, and respective t-ratios, associated with the sequential procedure are presented in Table A.11. First, we consider the case of t-ratios computed under the assumption of correctly specified models (Panel A). We can see that for both versions of the ICAPM the market coefficient is largely insignificant. When we remove the market factor, and estimate a restricted version of the ICAPM containing only the interest rate factor (and the intercept), we obtain t-ratios around or higher than 2.90, which indicates significance at the 5% level (for an associated critical value of 2.39 with $K = 3$).

When we consider standard errors computed under misspecified models (Panel B), the t-

ratios for the interest factor coefficients have lower magnitudes (2.05 and 2.36 for the versions based on FFR and TB, respectively) and point only to marginal significance (10% level in the case of TB). However, the misspecified-robust t-ratio employed in combination with the Bonferroni method is likely too conservative when applied to our ICAPM. First, based on the HJ-distance the model is correctly specified as shown above. This implies that the t-ratios computed under the assumption of a correctly specified model are more appropriate in the case of the ICAPM. Second, as pointed out in Gospodinov, Kan, and Robotti (2014), the Bonferroni method tends to be conservative. Third, the sign of the SDF coefficients (or associated risk prices) for the interest rate factor is constrained by the ICAPM theory (positive, see the discussion in Section 5 of the paper).[6] This makes one-sided tests more appropriate to evaluate the significance of the interest rate SDF coefficient estimates.

3 Alternative ICAPM models

In this section, we perform several robustness checks to the analysis (for the alternative ICAPM models) conducted in Section 6 in the paper.

3.1 Augmented model

We estimate the following augmented ICAPM specification,

$$\begin{aligned} \mathrm{E}(R_{i,t+1} - R_{f,t+1}) &= \lambda_M \beta_{i,M} + \lambda_z \beta_{i,z} + \lambda_{TERM} \beta_{i,TERM} + \lambda_{DEF} \beta_{i,DEF} \\ &\quad + \lambda_{dp} \beta_{i,dp} + \lambda_{pe} \beta_{i,pe} + \lambda_{vs} \beta_{i,vs} + \lambda_{SVAR} \beta_{i,SVAR}, \end{aligned} \tag{9}$$

where $z \equiv FFR, TB$, and λ_{TERM}, λ_{DEF}, λ_{dp}, λ_{pe}, λ_{vs}, and λ_{SVAR} denote the risk price estimates for the innovations on the term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. The objective of testing this large-scale model is to check whether the interest rate risk prices remain

[6] Note that a negative covariance (or beta) risk price implies a positive SDF coefficient.

significant in the presence of all the alternative ICAPM factors. That is, we want to assess whether interest rate risk is subsumed by the alternative risk factors frequently employed in the ICAPM literature.

We estimate the model above for the joint seven market anomalies. The results reported in Table A.12 show that the risk price estimates for either $\widetilde{FFR}$ or $\widetilde{TB}$ remain strongly significant (at the 5% or 1% levels) when we add the alternative ICAPM factors. Moreover, the risk price estimates for the alternative factors are not significant at the 5% level in most cases. The exceptions are the risk prices associated with $TERM$ and vs. However, as referred in the paper, the explanatory power of vs for several of these portfolios is somewhat mechanical. We also conclude that the explanatory ratios of the augmented model are not dramatically higher than the corresponding estimates for our benchmark two-factor ICAPM, particularly the version based on FFR. This means that we don't loose much by excluding these other factors from our model, while enjoying the benefits of a much more parsimonious specification.

3.2 Alternative evaluation measures

We use the two additional performance metrics proposed by Kan, Robotti, and Shanken (2013), $\widehat{\rho}^2$ and $\widehat{Q}_c$, to evaluate the performance of the alternative ICAPM models. The results are presented in Table A.13. We can see that only two of the alternative ICAPM models (those based on $TERM$ and vs) are not rejected by the R^2-based specification test ($\rho^2 = 1$) at the 5% level. For the remaining four models the null is clearly rejected at the 1% or 5% level. On the other hand, all six alternative ICAPM models pass the $\widehat{Q}_c$-test at the 5% level (marginally so in the case of the ICAPM based on $SVAR$).

Furthermore, we compute the asymptotic pairwise tests of equality of $\widehat{\rho}^2$, proposed by Kan, Robotti, and Shanken (2013), among all ICAPM models (including our two-factor model). The results are displayed in Table A.14. It turns out that the ICAPM based on FFR dominates the ICAPM based on DEF, dp, pe, and $SVAR$ (at the 5% level) and

$TERM$ (at the 10% level) when we use standard errors computed under the assumption of correctly specified models. On the other hand, the ICAPM corresponding to TB dominates the models based on DEF, dp, and pe (at the 5% level) and $SVAR$ (at the 10% level). Among the alternative ICAPM specifications only the model associated with the value spread has a lower sample R^2 than our ICAPM, although this gap is largely insignificant.

When we employ standard errors computed under the assumption of a misspecified model there are no statistically significant differences in $\widehat{\rho}^2$ among any two models. This should arise from the large standard errors associated with $\widehat{\rho}^2$ for some of the alternative ICAPM models. Overall, if anything, these results provide further support for our two-factor model against other two-factor ICAPM specifications.

3.3 SDF representation

We estimate the alternative ICAPM models in the SDF representation by using the Hansen-Jagannathan (HJ) method. The results presented in Table A.10 indicate that most alternative ICAPM models are rejected by the HJ-specification test at the 5% level. The only exception is the version based on the value spread. This suggests that nearly all alternative ICAPM models are misspecified.

We also compute the parameter estimates, and associated t-ratios, under the sequential procedure employed by Gospodinov, Kan, and Robotti (2014) described above. The results presented in Table A.11 show that the SDF coefficients associated with the innovations in DEF and $SVAR$ are largely insignificant by using both types of t-statistics. This also happens for the coefficient corresponding to $\widetilde{vs}$ when we use misspecified-robust t-ratios. However, these statistics might be too restrictive in the case of $\widetilde{vs}$ (similarly to the case of the interest rate factors, as discussed in the last section) given the fact that the ICAPM based on the value spread passes the HJ-specification test (and thus, it is not misspecified).

4 Bootstrap simulation

The bootstrap algorithm associated with the cross-sectional regression consists of the following steps:

1. For each empirical test, we estimate the time-series regressions to obtain the factor loadings,

   $$R_{i,t+1} - R_{f,t+1} = \delta_i + \beta_{i,M} RM_{t+1} + \beta_{i,FFR} \widetilde{FFR}_{t+1} + \varepsilon_{i,t+1},$$

   and in a second step, the expected return-beta representation is estimated by an OLS cross-sectional regression,

   $$\overline{R_i - R_f} = \lambda_M \beta_{i,M} + \lambda_{FFR} \beta_{i,FFR} + \alpha_i.$$

   We compute and save both the t-statistics associated with the risk price estimates and the $\boldsymbol{\chi}^2$ statistic, both based on Shanken (1992) standard errors, $\left[t(\widehat{\lambda}_M), t(\widehat{\lambda}_{FFR}), \boldsymbol{\chi}^2\right]$. We also compute and save the cross-sectional coefficient of determination (R^2_{OLS}). Furthermore, we run the following auxiliary time-series regressions,

   $$R_{i,t+1} - R_{f,t+1} = \overline{R_i - R_f} + \xi_{i,t+1},$$

   and save the time-series average portfolio excess returns ($\overline{R_i - R_f}$) and the corresponding residuals, $\xi_{i,t+1}$.

2. In each replication $b = 1, ..., 5000$, we construct a pseudo-sample of the time-series residuals for each testing asset (of size T) by drawing with replacement:

   $$\{\xi^b_{i,t}, t = s^b_1, s^b_2, ..., s^b_T\}, i = 1, ..., N,$$

   where the time indices $s^b_1, s^b_2, ..., s^b_T$ are created randomly from the original time sequence $1, ..., T$. Notice that all residuals have the same time sequence in order to preserve the contemporaneous cross-correlation between asset returns.

3. For each replication $b = 1, ..., 5000$, we construct an independent pseudo-sample of the risk factors:

$$\{RM^b_{t+1}, \widetilde{FFR}^b_{t+1}, t = r^b_1, r^b_2, ..., r^b_T\},$$

where the time sequence $(r^b_1, r^b_2, ..., r^b_T)$ is independent from $s^b_1, s^b_2, ..., s^b_T$. The time sequence is the same for all factors to preserve their correlations.

4. For each replication, the pseudo asset excess returns are constructed by imposing the null that the factors do not explain asset returns:

$$(R_{i,t+1} - R_{f,t+1})^b = \overline{R_i - R_f} + \xi^b_{i,t+1}.$$

5. In each replication, we estimate the ICAPM by the two-step procedure, but using the artificial data rather than the original data:

$$(R_{i,t+1} - R_{f,t+1})^b = \delta^b_i + \beta^b_{i,M} RM^b_{t+1} + \beta^b_{i,FFR} \widetilde{FFR}^b_{t+1} + \varepsilon^b_{i,t+1},$$

$$\overline{(R_i - R_f)^b} = \lambda^b_M \beta^b_{i,M} + \lambda^b_{FFR} \beta^b_{i,FFR} + \alpha^b_i.$$

We compute and save both the t-statistics for the factor risk prices and the $\boldsymbol{\chi}^2$ statistic, $\left[t(\widehat{\lambda}^b_M), t(\widehat{\lambda}^b_{FFR}), \boldsymbol{\chi}^{2,b}\right]$, leading to an empirical distribution of these statistics. We also compute the cross-sectional OLS R^2 for each pseudo sample, $R^{2,b}_{OLS}$.

6. The empirical p-value associated with the risk price for $\widetilde{FFR}_{t+1}$ (for a two-sided test) is computed as

$$p(\widehat{\lambda}_{FFR}) = \begin{cases} \left[\#\left\{t(\widehat{\lambda}^b_{FFR}) \geq t(\widehat{\lambda}_{FFR})\right\} + \#\left\{t(\widehat{\lambda}^b_{FFR}) < -t(\widehat{\lambda}_{FFR})\right\}\right]/5000, if\ \widehat{\lambda}_{FFR} \geq 0 \\ \left[\#\left\{t(\widehat{\lambda}^b_{FFR}) \leq t(\widehat{\lambda}_{FFR})\right\} + \#\left\{t(\widehat{\lambda}^b_{FFR}) > -t(\widehat{\lambda}_{FFR})\right\}\right]/5000, if\ \widehat{\lambda}_{FFR} < 0 \end{cases},$$

and similarly for the market risk price. In the above expression, $\#\left\{t(\widehat{\lambda}_{FFR}^{b}) \geq t(\widehat{\lambda}_{FFR})\right\}$ denotes the number of replications in which the pseudo t-stats are greater than or equal to the t-ratio from the original sample. Since $\widehat{\lambda}_{FFR} < 0$, only the second expression for the p-value function above applies in the case of the interest rate factor.

The p-value for the $\boldsymbol{\chi}^2$ statistic is computed as

$$p(\chi^2) = \#\left\{\chi^{2,b} \geq \chi^2\right\}/5000,$$

and the p-value for the sample R^2 is constructed in a similar way:

$$p(R^2_{OLS}) = \#\left\{R^{2,b}_{OLS} \geq R^2_{OLS}\right\}/5000.$$

References

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Table A.1: Factor risk premia for ICAPM: T-bill rate

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). "All" refers to a test including all portfolio groups. λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis) and empirical p-values (in brackets) obtained from a bootstrap simulation. The interest rate factor is the innovation on the T-bill rate. The column labeled χ^2 presents the statistic (first row) and associated asymptotic (in parenthesis) and empirical (in brackets) p-values for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2 with the corresponding empirical p-value shown in brackets. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z	χ^2	R^2_{OLS}
BM	0.62	−0.53	4.84	0.69
	(**2.94**)	(<u>−2.33</u>)	(0.775)	
	[0.000]	[0.004]	[0.236]	[0.027]
DUR	0.63	−0.57	3.97	0.74
	(**2.99**)	(**−2.84**)	(0.860)	
	[0.000]	[0.001]	[0.399]	[0.008]
EP	0.63	−0.43	9.72	0.40
	(**2.98**)	(**−2.66**)	(0.285)	
	[0.000]	[0.001]	[0.082]	[0.087]
REV	0.68	−0.37	6.37	0.52
	(**3.22**)	(<u>−2.18</u>)	(0.606)	
	[0.000]	[0.006]	[0.138]	[0.051]
IA	0.59	−0.59	4.46	0.56
	(**2.82**)	(<u>−2.41</u>)	(0.813)	
	[0.001]	[0.002]	[0.444]	[0.014]
PIA	0.57	−0.73	6.09	0.39
	(**2.72**)	(<u>−2.08</u>)	(0.637)	
	[0.001]	[0.016]	[0.392]	[0.035]
IVG	0.61	−0.35	7.62	0.13
	(**2.92**)	(*−1.89*)	(0.472)	
	[0.000]	[0.024]	[0.205]	[0.086]
All	0.62	−0.49	47.92	0.48
	(**2.96**)	(**−3.00**)	(0.969)	
	[0.001]	[0.001]	[0.277]	[0.004]

Table A.2: Factor risk premia for ICAPM: alternative factors

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The column labeled $\boldsymbol{\chi}^2$ presents the statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z	χ^2	R^2_{OLS}
$\widetilde{FFR}$	0.60	−0.70	37.25	0.58
	(**2.87**)	(−**2.87**)	(0.999)	
$\widetilde{TB}$	0.62	−0.48	49.30	0.47
	(**2.97**)	(−**3.02**)	(0.957)	

Table A.3: Factor risk premia for ICAPM: restricted sample

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The column labeled $\boldsymbol{\chi}^2$ presents the statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2006:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z	χ^2	R^2_{OLS}
$\widetilde{FFR}$	0.57	−0.74	35.04	0.64
	(<u>2.53</u>)	(−**2.96**)	(1.000)	
$\widetilde{TB}$	0.58	−0.55	41.50	0.60
	(<u>2.56</u>)	(−**3.05**)	(0.995)	

Table A.4: Factor risk premia for ICAPM: additional anomalies

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are value-weighted (Panels A and B) and equal-weighted (Panels C and D) decile portfolios sorted on cash-flow-to-price ratio (CFP) and investment growth (IG). λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The column labeled $\boldsymbol{\chi}^2$ presents the statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z	χ^2	R^2_{OLS}
Panel A (CFP, VW)				
$\widetilde{FFR}$	0.613	−0.631	5.76	0.24
	(**2.88**)	(<u>−2.12</u>)	(0.674)	
$\widetilde{TB}$	0.630	−0.325	8.49	−0.00
	(**2.99**)	(<u>−2.30</u>)	(0.387)	
Panel B (IG, VW)				
$\widetilde{FFR}$	0.566	−0.473	13.60	−0.22
	(**2.72**)	(*−1.93*)	(0.093)	
$\widetilde{TB}$	0.579	−0.537	6.75	0.31
	(**2.77**)	(<u>−2.44</u>)	(0.564)	
Panel C (CFP, EW)				
$\widetilde{FFR}$	0.513	−0.989	4.74	0.87
	(<u>2.02</u>)	(<u>−2.50</u>)	(0.785)	
$\widetilde{TB}$	0.598	−0.687	5.00	0.80
	(<u>2.46</u>)	(**−2.84**)	(0.757)	
Panel D (IG, EW)				
$\widetilde{FFR}$	0.426	−1.696	1.72	0.82
	(1.19)	(*−1.75*)	(0.988)	
$\widetilde{TB}$	0.559	−0.962	4.04	0.76
	(<u>2.04</u>)	(<u>−2.44</u>)	(0.854)	

Table A.5: Factor risk premia for ICAPM: alternative statistical inference

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed alternative t-statistics (in parenthesis). t_{FM}, t_{JW}, and t_{KRS} represent the t-ratios proposed by Fama and MacBeth (1973), Jagannathan and Wang (1998), and Kan, Robotti, and Shanken (2013), respectively. $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z
Panel A ($\widetilde{FFR}$)		
Estimate	0.60	−0.71
t_{FM}	(**2.89**)	(**−4.45**)
t_{JW}	(**2.84**)	(**−2.68**)
t_{KRS}	(**2.84**)	(**−2.84**)
Panel B ($\widetilde{TB}$)		
Estimate	0.62	−0.49
t_{FM}	(**2.99**)	(**−4.24**)
t_{JW}	(**2.97**)	(**−3.32**)
t_{KRS}	(**2.97**)	(**−3.63**)

Table A.6: Factor risk premia for ICAPM: unrestricted zero-beta rate

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). λ_0 represents an estimate for the zero-beta rate. λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). The t-ratio for λ_0 is for the null that the zero-beta rate in excess of the average risk-free rate is zero. $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_0	λ_M	λ_z	R^2_{OLS}
$\widetilde{FFR}$	0.74	0.30	−0.61	0.61
	(0.78)	(0.65)	(<u>−2.49</u>)	
$\widetilde{TB}$	0.56	0.49	−0.45	0.48
	(0.33)	(1.00)	(<u>−2.37</u>)	

Table A.7: Factor risk premia for ICAPM: double-sorted portfolios

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are 25 double-sorted portfolios on size and book-to-market ratio (SBM25), size and asset growth (SIA25), and size and long-term reversal in returns (SREV25). "All" refers to a test including all portfolio groups. λ_M and λ_z denote the risk price estimates (in %) for the market and interest rate factors, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the model in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The column labeled $\boldsymbol{\chi}^2$ presents the statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_z	χ^2	R^2_{OLS}
Panel A (SBM25)				
$\widetilde{FFR}$	0.56	−0.86	22.75	0.67
	(<u>2.29</u>)	(**−2.69**)	(0.476)	
$\widetilde{TB}$	0.61	−0.58	31.53	0.61
	(<u>2.57</u>)	(**−2.83**)	(0.110)	
Panel B (SIA25)				
$\widetilde{FFR}$	0.59	−0.80	40.01	0.33
	(<u>2.49</u>)	(**−3.30**)	(0.015)	
$\widetilde{TB}$	0.64	−0.55	52.41	0.27
	(**2.74**)	(**−3.45**)	(0.000)	
Panel C (SREV25)				
$\widetilde{FFR}$	0.63	−0.61	23.30	0.49
	(**2.81**)	(**−2.76**)	(0.444)	
$\widetilde{TB}$	0.66	−0.41	27.04	0.49
	(**2.95**)	(**−3.23**)	(0.254)	
Panel D (All)				
$\widetilde{FFR}$	0.59	−0.79	69.11	0.50
	(<u>2.49</u>)	(**−3.12**)	(0.607)	
$\widetilde{TB}$	0.63	−0.53	90.03	0.45
	(**2.72**)	(**−3.31**)	(0.086)	

Table A.8: Additional evaluation measures

This table reports additional evaluation metrics for the two-factor ICAPM and the CAPM. $\widehat{\rho}^2$ denotes the sample cross-sectional R^2 with $p(\rho^2 = 1)$ and $p(\rho^2 = 0)$ representing the corresponding p-values for the tests of the null hypothesis $\rho^2 = 1$ and $\rho^2 = 0$, respectively. $\widehat{Q}_c$ denotes the statistic associated with the specification test of Kan, Robotti, and Shanken (2013), while $p(Q_c = 0)$ represents the respective p-value. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the ICAPM in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. The sample is 1972:01–2013:12.

	CAPM	$\widetilde{FFR}$	$\widetilde{TB}$
$\widehat{\rho}^2$	0.92	0.98	0.97
$p(\rho^2 = 1)$	0.000	0.902	0.545
$p(\rho^2 = 0)$	0.002	0.001	0.001
$\widehat{Q}_c$	0.21	0.12	0.15
$p(Q_c = 0)$	0.045	0.920	0.638

Table A.9: Factor risk premia for ICAPM: covariance representation

This table reports the estimation and evaluation results for the two-factor ICAPM. The estimation procedure is first-stage GMM with equally weighted errors. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). γ_M and γ_z denote the (covariance) risk price estimates for the market and interest rate factors, respectively. $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the ICAPM in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. Below the risk price estimates are displayed the GMM-based t-statistics (in parenthesis). The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The column labeled $\boldsymbol{\chi}^2$ presents the $\boldsymbol{\chi}^2$ statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	γ_M	γ_z	χ^2	R^2_{OLS}
$\widetilde{FFR}$	−0.79	−208.11	58.20	0.58
	(−0.35)	($\underline{-2.56}$)	(0.796)	
$\widetilde{TB}$	−0.09	−209.02	68.90	0.48
	(−0.05)	(**−3.55**)	(0.447)	

Table A.10: SDF representation: Hansen-Jagannathan distance

This table reports the Hansen-Jagannathan distance for the CAPM and alternative ICAPM models. The estimation procedure is first-stage GMM where the weighting matrix is the inverse of the second-moment matrix of asset returns. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG) in addition to the one-month T-bill rate. For each model, HJ represents the Hansen-Jagannathan distance while $p(HJ)$ denotes the p-value associated with the null hypothesis, $HJ = 0$. $\widetilde{FFR}$, $\widetilde{TB}$, $\widetilde{TERM}$, $\widetilde{DEF}$, $\widetilde{dp}$, $\widetilde{pe}$, $\widetilde{vs}$, and $\widetilde{SVAR}$ stands for the ICAPM in which the factors are the innovation on the Fed funds rate, T-bill rate, term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. The sample is 1972:01–2013:12.

	HJ	$p(HJ)$
CAPM	0.460	0.004
$\widetilde{FFR}$	0.419	0.299
$\widetilde{TB}$	0.437	0.061
$\widetilde{TERM}$	0.446	0.019
$\widetilde{DEF}$	0.459	0.003
$\widetilde{dp}$	0.459	0.004
$\widetilde{pe}$	0.459	0.005
$\widetilde{vs}$	0.428	0.138
$\widetilde{SVAR}$	0.460	0.004

Table A.11: SDF representation: parameter estimates

This table reports the estimation results for the SDF representation of alternative ICAPM models. The estimation procedure is first-stage GMM where the weighting matrix is the inverse of the second-moment matrix of asset returns. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG) in addition to the one-month T-bill rate. RM and $\widetilde{z}$ denote the market and hedging factors, respectively. For each factor, the SDF coefficient estimate and respective t-ratio are presented in the first and second columns, respectively. The t-ratios are computed under the assumption of a correctly specified model (Panel A) or misspecified model (Panel B). The factors selection follows the sequential procedure proposed by Gospodinov, Kan, and Robotti (2014). $\widetilde{FFR}$, $\widetilde{TB}$, $\widetilde{TERM}$, $\widetilde{DEF}$, $\widetilde{dp}$, $\widetilde{pe}$, $\widetilde{vs}$, and $\widetilde{SVAR}$ stands for the ICAPM in which the factors are the innovation on the Fed funds rate, T-bill rate, term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. The sample is 1972:01–2013:12. T-ratios market with * and ** indicate statistical significance at the 10% and 5% levels, respectively.

	RM	t	$\widetilde{z}$	t
Panel A (Correctly specified model)				
$\widetilde{FFR}$	−1.23	−1.03	81.49	2.65
			88.89	2.90**
$\widetilde{TB}$	−1.67	−1.52	67.96	2.60
			78.32	2.96**
$\widetilde{TERM}$	−1.92	−1.78	−82.86	−2.31
			−100.15	−2.80**
$\widetilde{DEF}$	−2.75	−2.65	−55.64	−0.75
	−2.66	−2.52**		
$\widetilde{dp}$	−1.32	−0.60	2.41	0.68
			4.29	2.44**
$\widetilde{pe}$	−1.14	−0.51	−2.70	−0.75
			−4.33	−2.45**
$\widetilde{vs}$	−4.16	−3.39**	5.45	2.83**
$\widetilde{SVAR}$	−2.37	−2.02	9.86	0.38
	−2.66	−2.52**		
Panel B (Misspecified model)				
$\widetilde{FFR}$	−1.23	−0.92	81.49	1.81
			88.89	2.05
$\widetilde{TB}$	−1.67	−1.43	67.96	2.00
			78.32	2.36*
$\widetilde{TERM}$	−1.92	−1.69	−82.86	−1.92
			−100.15	−2.42**
$\widetilde{DEF}$	−2.75	−2.61	−55.64	−0.57
	−2.66	−2.51**		
$\widetilde{dp}$	−1.32	−0.46	2.41	0.50
			4.29	2.29*
$\widetilde{pe}$	−1.14	−0.39	−2.70	−0.55
			−4.33	−2.31*
$\widetilde{vs}$	−4.16	−3.04	5.45	1.97
	−2.66	−2.51**		
$\widetilde{SVAR}$	−2.37	−1.92	9.86	0.35
	−2.66	−2.51**		

Table A.12: Factor risk premia for augmented ICAPM

This table reports the estimation and evaluation results for the augmented ICAPM. The estimation procedure is the two-pass regression approach. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). λ_M denotes the market risk price estimates (in %). λ_{FFR}, λ_{TB}, λ_{TERM}, λ_{DEF}, λ_{dp}, λ_{pe}, λ_{vs}, and λ_{SVAR} denote the risk price estimates for the innovations on the Fed funds rate, T-bill rate, term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. Below the risk price estimates are displayed t-statistics based on Shanken's standard errors (in parenthesis). The column labeled $\boldsymbol{\chi}^2$ presents the statistic (first line) and associated asymptotic p-value (in parenthesis) for the test on the joint significance of the pricing errors. The column labeled R^2_{OLS} denotes the cross-sectional OLS R^2. The sample is 1972:01–2013:12. Italic, underlined, and bold t-ratios indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	λ_M	λ_{FFR}	λ_{TB}	λ_{TERM}	λ_{DEF}	λ_{dp}	λ_{pe}	λ_{vs}	λ_{SVAR}	χ^2	R^2_{OLS}
1	0.59	−0.32		0.14	−0.01	−0.44	0.44	−1.48	−0.02	57.67	0.73
	(**2.84**)	(**−2.84**)		(<u>2.35</u>)	(−0.24)	(−0.90)	(0.92)	(<u>−2.29</u>)	(−0.30)	(0.632)	
2	0.59		−0.20	0.13	−0.01	−0.49	0.50	−1.64	−0.01	65.75	0.71
	(**2.86**)		(<u>−2.25</u>)	(<u>2.39</u>)	(−0.29)	(−1.01)	(1.07)	(**−2.62**)	(−0.10)	(0.348)	

Table A.13: Additional evaluation measures: other ICAPM models

This table reports additional evaluation metrics for alternative two-factor ICAPM models. $\widehat{\rho}^2$ denotes the sample cross-sectional R^2 with $p(\rho^2 = 1)$ and $p(\rho^2 = 0)$ representing the corresponding p-values for the tests of the null hypothesis $\rho^2 = 1$ and $\rho^2 = 0$, respectively. $\widehat{Q}_c$ denotes the statistic associated with the specification test of Kan, Robotti, and Shanken (2013), while $p(Q_c = 0)$ represents the respective p-value. The test portfolios are decile portfolios sorted on book-to-market ratio (BM), equity duration (DUR), earnings-to-price ratio (EP), long-term reversal in returns (REV), investment-to-assets (IA), changes in property, plant, and equipment scaled by assets (PIA), and inventory growth (IVG). $\widetilde{TERM}$, $\widetilde{DEF}$, $\widetilde{dp}$, $\widetilde{pe}$, $\widetilde{vs}$, and $\widetilde{SVAR}$ stand for the ICAPM in which the factors are the innovation on the term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. The sample is 1972:01–2013:12.

	$\widetilde{TERM}$	$\widetilde{DEF}$	$\widetilde{dp}$	$\widetilde{pe}$	$\widetilde{vs}$	$\widetilde{SVAR}$
$\widehat{\rho}^2$	0.96	0.92	0.94	0.94	0.98	0.94
$p(\rho^2 = 1)$	0.409	0.000	0.002	0.005	0.466	0.029
$p(\rho^2 = 0)$	0.001	0.002	0.002	0.002	0.001	0.002
$\widehat{Q}_c$	0.12	0.20	0.20	0.19	0.17	0.21
$p(Q_c = 0)$	0.943	0.079	0.096	0.138	0.356	0.051

Table A.14: Tests of equality of cross-sectional R^2

This table reports pairwise tests of equality in R^2_{OLS} among alternative factor models. $\widetilde{FFR}$ and $\widetilde{TB}$ stand for the version of the ICAPM in which the factor is the innovation on the Fed funds rate and T-bill rate, respectively. $\widetilde{TERM}$, $\widetilde{DEF}$, $\widetilde{dp}$, $\widetilde{pe}$, $\widetilde{vs}$, and $\widetilde{SVAR}$ stand for the ICAPM in which the factors are the innovation on the term spread, default spread, log dividend yield, smoothed log price-to-earnings ratio, value spread, and stock market variance, respectively. The p-values computed under the assumption of correctly specified and misspecified models are presented in parentheses and brackets, respectively. The sample is 1972:01–2013:12.

Model	$\widetilde{TB}$	$\widetilde{TERM}$	$\widetilde{DEF}$	$\widetilde{dp}$	$\widetilde{pe}$	$\widetilde{vs}$	$\widetilde{SVAR}$
$\widetilde{FFR}$	0.006	0.014	0.059	0.042	0.040	−0.004	0.043
	(0.073)	(0.087)	(0.000)	(0.000)	(0.002)	(0.205)	(0.025)
	[0.666]	[0.417]	[0.200]	[0.224]	[0.253]	[0.780]	[0.220]
$\widetilde{TB}$		0.008	0.053	0.036	0.034	−0.009	0.037
		(0.533)	(0.000)	(0.003)	(0.009)	(0.904)	(0.054)
		[0.614]	[0.197]	[0.262]	[0.299]	[0.503]	[0.240]
$\widetilde{TERM}$			0.045	0.028	0.026	−0.018	0.029
			(0.000)	(0.004)	(0.014)	(0.797)	(0.073)
			[0.250]	[0.360]	[0.408]	[0.448]	[0.351]
$\widetilde{DEF}$				−0.017	−0.019	−0.062	−0.016
				(0.029)	(0.014)	(0.000)	(0.020)
				[0.565]	[0.520]	[0.195]	[0.532]
$\widetilde{dp}$					−0.002	−0.046	0.001
					(0.002)	(0.002)	(0.822)
					[0.552]	[0.213]	[0.970]
$\widetilde{pe}$						−0.043	0.003
						(0.008)	(0.773)
						[0.239]	[0.868]
$\widetilde{vs}$							0.046
							(0.051)
							[0.196]