Online Appendix: Conditional Currency Risk Premia

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Not for Publication

We include in this appendix a number of details and robustness checks that are omitted in the main text for brevity.

I Data

In our benchmark sorting we use bilateral real-dollar currency excess-returns for 53 countries: Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, China, Colombia, Czech Republic, Denmark, Egypt, Euro, Finland, France, Germany, Greece, Hong Kong, Hungary, India, Indonesia, Ireland, Israel, Italy, Japan, Jordania, Korea, Kuwait, Malaysia, Mexico, Morocco, The Netherlands, New Zealand, Norway, Pakistan, Peru, Philippines, Poland, Portugal, Russia, Saudi Arabia, Singapore, Sri Lanka, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Arab Emirates, United Kingdom, Venezuela, and South Africa.

In an alternative sorting we use the bilateral real-dollar currency excess-returns for 23 developed countries: Australia, Austria, Belgium, Canada, Denmark, Euro, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, and United Kingdom.

For details on the construction of the data see Maggiori (2012) who merges public and private data to obtain the full sample. These data includes more currencies, a longer time span for many individual currencies, and overall higher quality sources than used in a number of previous studies.

In our benchmark analysis, sorting currencies into 6 baskets ensures that each portfolio consists of at least 3 currencies over our sample period.[1] We assign the same number of currencies to each basket whenever possible. If the number of currencies is not a multiple of 6, additional currencies are allocated to the corner portfolios 1 and 6 with priority for the high interest rate portfolio 6.

Our sorting has on average 5.5 currencies in each basket. The average turnover is 29%. We define turnover as the ratio of portfolio switches over the total number of currencies in a basket and take first the average across portfolios and then over time.

Figure 1 plots the cumulative excess-return of investing 1 dollar on January 1st 1974 in either the low yielding currencies (portfolio 1), the high yielding currencies (portfolio

[1] At the start in January 1974 only 18 currencies are available.

6A) or the market portfolio. The black vertical lines are months that our definition categorizes as downstates. The high yield currencies strongly outperform the low yield currencies over the sample period.

Table 1 shows the 10 worst market and carry trade monthly returns. Panel A sorts the 10 worst monthly market excess-returns and then reports the carry trade returns for the same months. Panel B sorts the 10 worst monthly carry trade returns and then reports the market excess-returns for the same months. While a certain degree of idiosyncrasy between market and carry trade returns is to be expected, we overall find that market and carry trade returns co-move over a number of well known adverse economic events: the 1998 crisis, the 2002 bear stock market following the dot.com boom and the 2008 crisis.

II Further Robustness Checks

We explore whether our results are sensitive to the threshold for subdividing high inflation currencies in portfolio 6B. We show consistently that our results are robust but weakened by the inclusion of high inflation currencies. This is not surprising since not only there are concerns on the effective nature of currency returns during periods of economic turmoil, but also in light of the result of Bansal and Dahlquist (2000) that finds high inflation currencies behaving very differently from other currencies. We show that high inflation currencies are not as strongly associated with the risk factors and are extremely volatile in sample.

Figure 2 and Table 2 present our results using all currencies in portfolio 6. The inclusion of currencies with very high inflation produces prices of risk that are larger than those in our benchmark analysis. This occurs because the high-inflation currencies' returns are less associated with market risk and in particular with downside risk, as shown in the first-stage estimates in the main text, and therefore lower the overall downstate beta of portfolio 6.

For completeness we also report in Figure 10-12 and Table 10-11 the performance of our model across asset classes when portfolio 6 instead of 6A is used in the currency portfolios. All our results are robust to including high inflation countries.

To further highlight the behavior of basket 6B we restrict our attention to the longest sample for which we have a continuos time-series for this basket: June 1980 to March 2010, for a total of 358 observations.

We first establish our benchmark results using portfolios 1-6A on this subsample in Figure 6 and Table 6. We find very similar results to our full sample: the DR-CAPM explains over 80% of the variation in returns. These subsample results are not only useful

as a starting point for our robustness checks below but also as an independent subsample test. Many existing papers in the currency return literature, in fact, have used a similar starting date (January 1983) for their sample due to data availability. While we view our full sample results, that use more data to overcome the sample limitations in the literature, as an improvement, we also confirm that our results are not driven by the different sample period.

Figure 7 and Table 7 present the performance of our model when both basket 6A and 6B are included as test assets; while Figure 8 and Table 8 present the results when only basket 6A is included in the estimation and basket 6B is only included in the computation of R^2 and pricing errors. These results highlight that basket 6B is an outlier: it is not as strongly associated with the risk factors but has a high return in sample. Our model correspondingly produces a larger pricing error for this portfolio.

As detailed in the paper, the DR-CAPM does not correctly price the small-growth portfolio (portfolio 1) in the 6 Fama & French portfolios sorted on size and book-to-market. We further document here that a similar pattern occurs when using the 25 Fama & French portfolios sorted on size and book-to-market. Figure 14 plots the 25 portfolios average excess return against their relative downside betas ($\beta^- - \beta$). Notice that while these returns are broadly positively associated with the relative downside beta, portfolios 1, 6, and 11 are clear outliers. In fact, these portfolios contain the smallest, second smallest, and third smallest quintiles of growth stocks, respectively. As discussed in the paper, a number of authors have documented that these small-growth portfolios are generally mispriced by asset pricing models (including the Fama & French three factor model) and provided reasons why the returns of these portfolios might not be measured accurately.

III Alternative Model Specification

In the main text we specified the econometric model to neatly nest CAPM in order to easily highlight the incremental contribution of downside risk. In this section we report that our results do not hinge on this particular specification and are robust to using the empirical specification in Ang et al. (2006).

Ang et al. (2006) specify the model as:

$$
\begin{aligned}
E[r_i] &= \beta_i^+ \lambda^+ + \beta_i^- \lambda^- \qquad i = 1, \ldots, N, \qquad (1)\\
\beta_i^+ &= \frac{cov(r_i, r_m | r_m \geqslant \delta)}{var(r_m | r_m \geqslant \delta)},\\
\beta_i^- &= \frac{cov(r_i, r_m | r_m < \delta)}{var(r_m | r_m < \delta)},
\end{aligned}
$$

The corresponding first-stage regressions are:[2]

$$
\begin{aligned}
r_{it} &= a_i^+ + \beta_i^+ r_{mt} + \epsilon_{it}^+, \qquad \text{whenever} \quad r_{mt} \geqslant \bar{r}_m - \sigma_{r_m}, \qquad (2)\\
r_{it} &= a_i^- + \beta_i^- r_{mt} + \epsilon_{it}^-, \qquad \text{whenever} \quad r_{mt} < \bar{r}_m - \sigma_{r_m}, \qquad (3)
\end{aligned}
$$

The second-stage regression is given by:

$$
\bar{r}_i = \hat{\beta}_i^+ \lambda^+ + \hat{\beta}_i^- \lambda^- + \alpha_i, \quad i = 1, \ldots, N, \qquad (4)
$$

Notice that the estimates of λ^- in this specification are not comparable to those in the main text.

We briefly note that the performance of our model is robust to this change in specification. We leave the detailed results for all asset classes for the reader to explore in Tables 9-12 and Figures 9-12.

In Figure 13 and Table 13 we further check the robustness of our benchmark results to variations in the threshold for the downstate by dividing the state-space into three regions: upstate, midstate, and downstate. The three regions are defined by the descending thresholds of the sample average of the market return, plus or minus 0.5 standard deviations. We present results both using the currency portfolios 1-6A and using jointly the currency portfolios and the 6 Fama & French equity portfolios sorted on size and book-to-market.

The model can jointly explain the cross-section of both currency and equity returns. Similarly to our benchmark case, we find a high and statistically significant price of risk for the downstate. However, we find only mixed results for the price of risk of the midstate and upstate. When we estimate the model using only currencies we find, as expected, a monotonically increasing price of risk from the upstate to the downstate. The same, however, is not true for the model jointly estimated on equities and currencies where the

[2]Ang et al. (2006) actually use the average market return as a threshold. Here, while we follow their specification, we maintain the lower threshold of one standard deviation below the average market return for consistency with our benchmark analysis.

midstate has a lower price of risk than the upstate.

IV Principal Component Analysis on Currency, Equity, and Commodity Portfolios

We include here the loadings of the principal component analysis (PCA) performed jointly on the currency, equity and commodity portfolios that is omitted in the main text for brevity. In Table 14 the loadings of the first three principal components reveal that they can be interpreted as level factors for equities, commodities, and currencies respectively. These three components explain 75% of the time series variation of these portfolios.

V Other Models of Currency Returns

In the main draft we compared our model to the leading principal component analysis (PCA) based models in the literature. For completeness, in this section we also report results for the extension of the Durable Consumption CAPM (DC-CAPM) that Lustig and Verdelhan (2007) applied to currencies in addition to the PCA-based model of Lustig et al. (2011). We estimate the DC-CAPM model employing the two stage procedure of Fama and MacBeth (1973). We use monthly personal consumption expenditures on durables and non-durables and services from FRED and the same market excess-return as in our DR-CAPM estimation.

Tables 15 and 16 summarizes the performance of the models cited above on our sample. Consistent with the previous evidence we find that the DC-CAPM fits the cross section of currency returns.[3] Across asset classes, the model produces R^2 that are generally higher than those of PCA-based model, but the estimated prices of risk are often not statistically significant.

[3]However, note the debate in Burnside (2011) and Lustig and Verdelhan (2011) on the statistical robustness of the association of currency returns with consumption growth in the first-stage regression of the DC-CAPM.

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Ang, A., J. Chen, and Y. Xing (2006). Downside risk. *Review of Financial Studies 19*(4), 1191–1239.

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Fama, E. F. and J. D. MacBeth (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy 81*(3), pp. 607–636.

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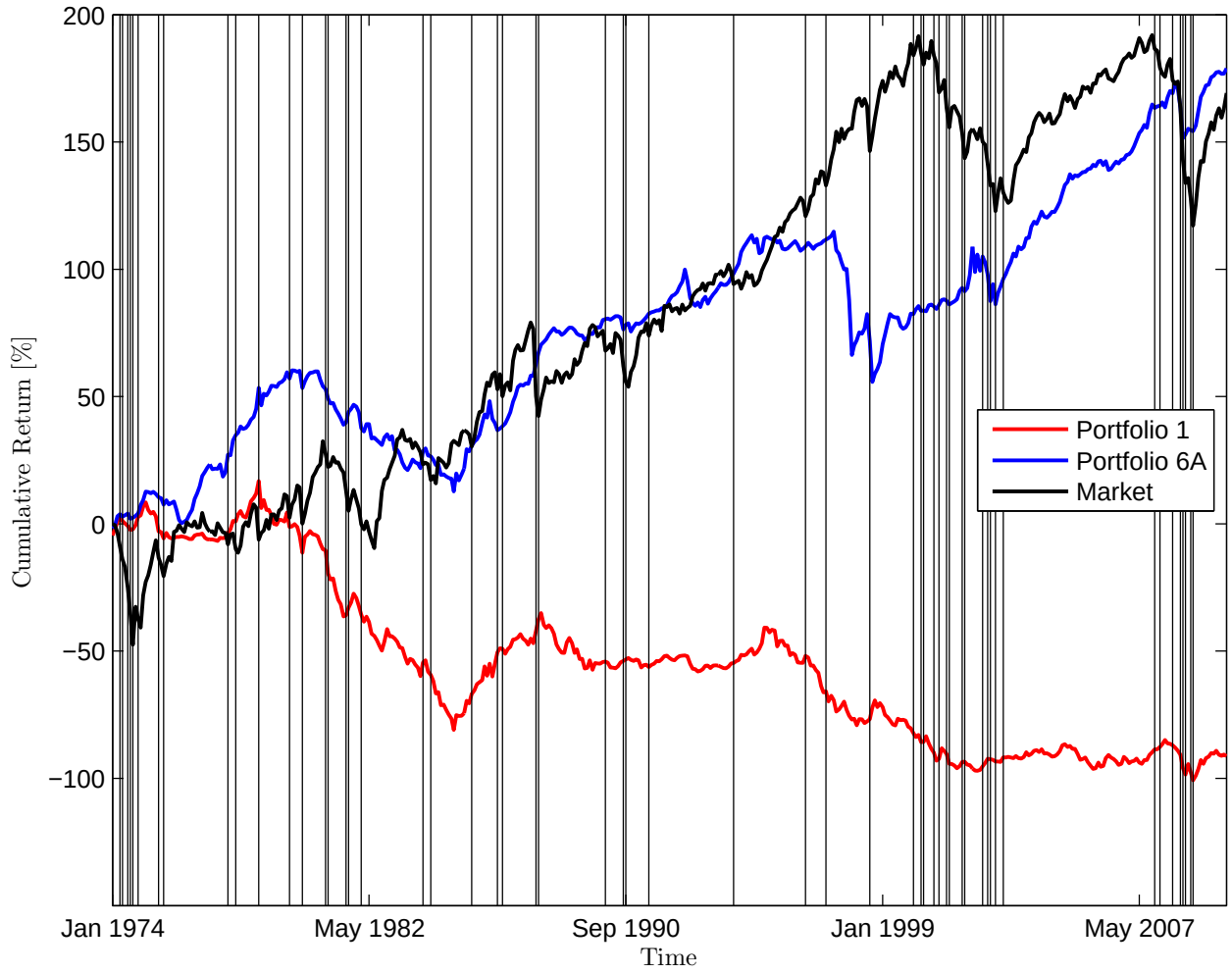
Lustig, H. and A. Verdelhan (2011). The cross-section of foreign currency risk premia and consumption growth risk: Reply. *American Economic Review 101*(7), 3477–3500.

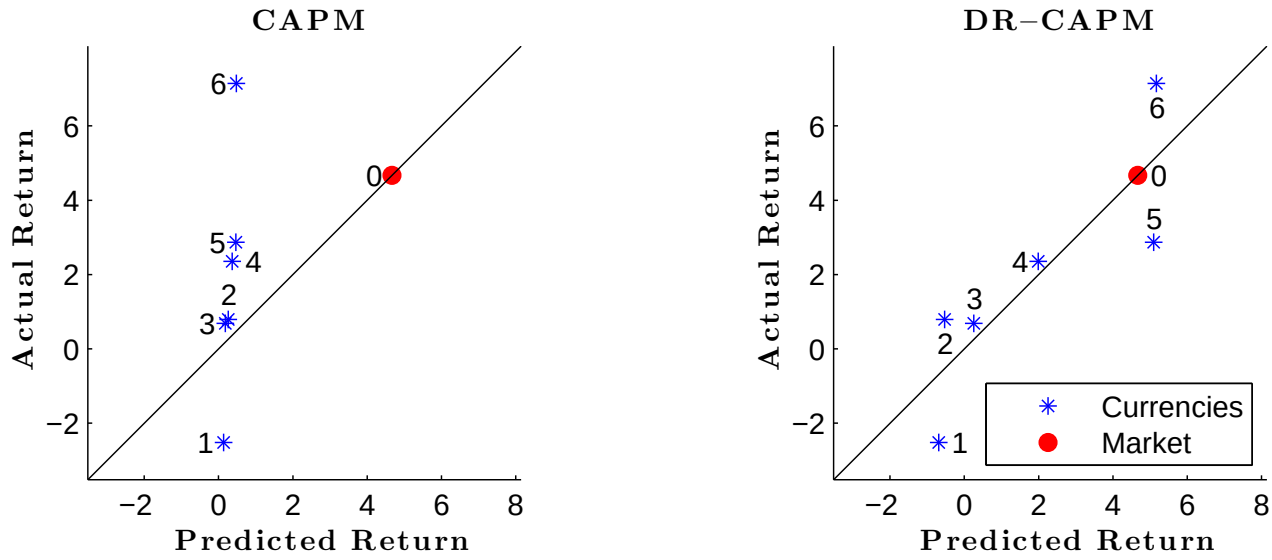
Maggiori, M. (2012). A note on currency returns. *Unpublished manuscript, UC Berkeley*.

Figure 1: **Cumulative Market and Carry Trade Returns**



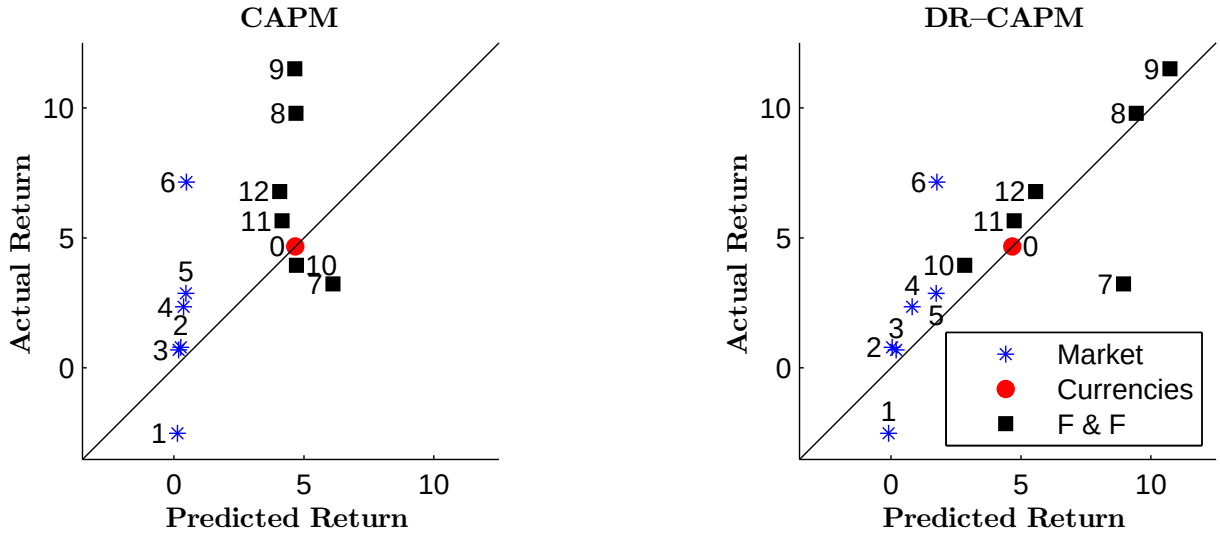
Cumulative excess-return of investing 1 dollar in January 1974 in the low yield currencies (portfolio 1), the high yield currencies (portfolio 6A) and the market excess-return. The proceeds are reinvested on a monthly basis. The sample period is January 1974 to March 2010 for a total of 435 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The black vertical lines indicate months in which the market return is more than one standard deviation below its sample mean.

Figure 2: **Model Robustness: Currencies, All Countries**



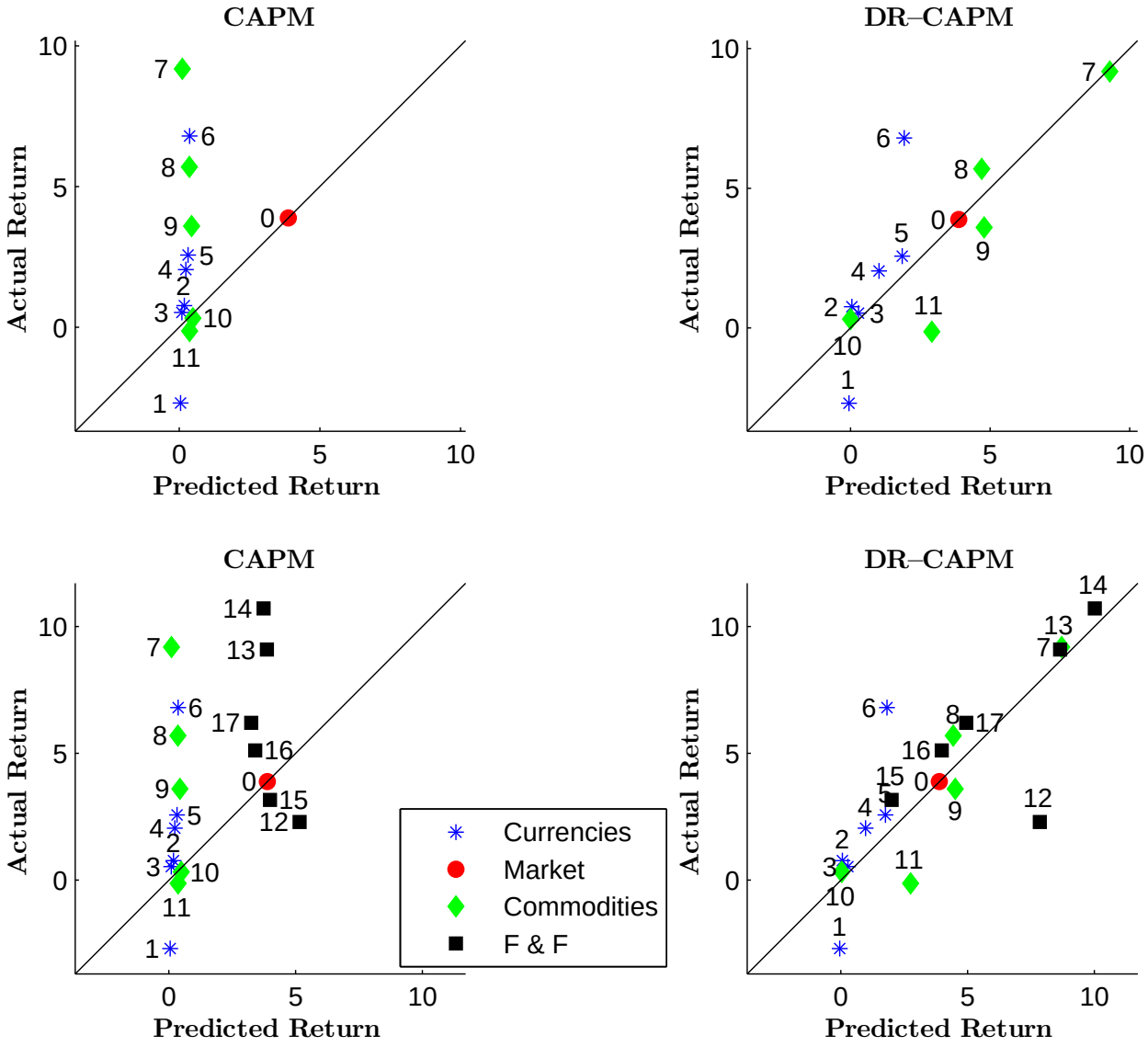
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are six currency portfolios (1-6), monthly re-sampled based on the interest rate differential with the US. The market excess-return is included as a test asset (0) The sample period is January 1974 to March 2010 for a total of 435 observations.

Figure 3: **Model Robustness: Currencies and Equities, All Countries**



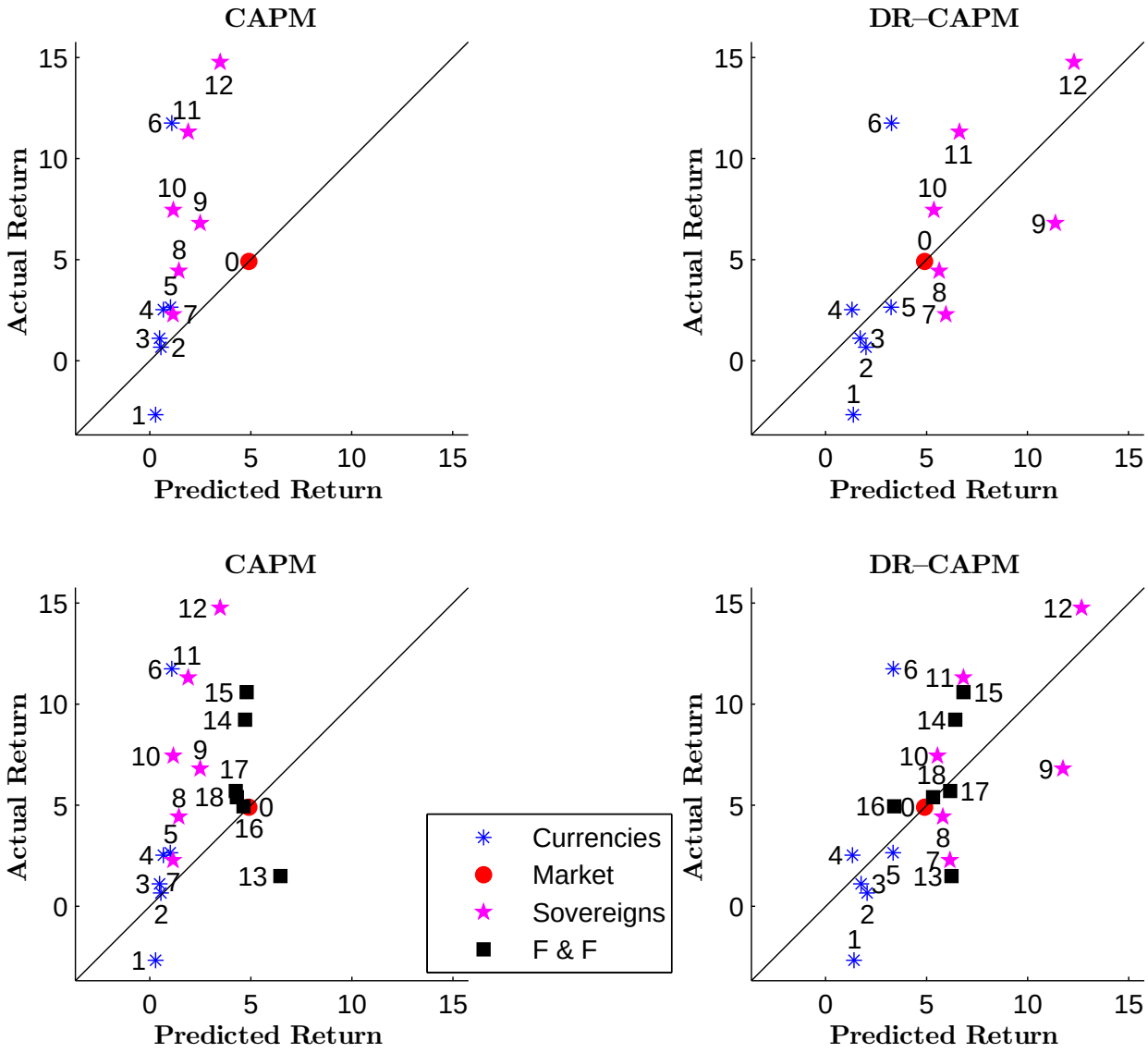
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are six currency portfolios (1-6), monthly re-sampled based on the interest rate differential with the US and the six Fama & French portfolios sorted on size and book-to-market (7-12). The market excess-return is included as a test asset (0). The sample period is January 1974 to March 2010 for a total of 435 observations.

Figure 4: **Model Robustness: Currencies, Equities and Commodities, All Countries**



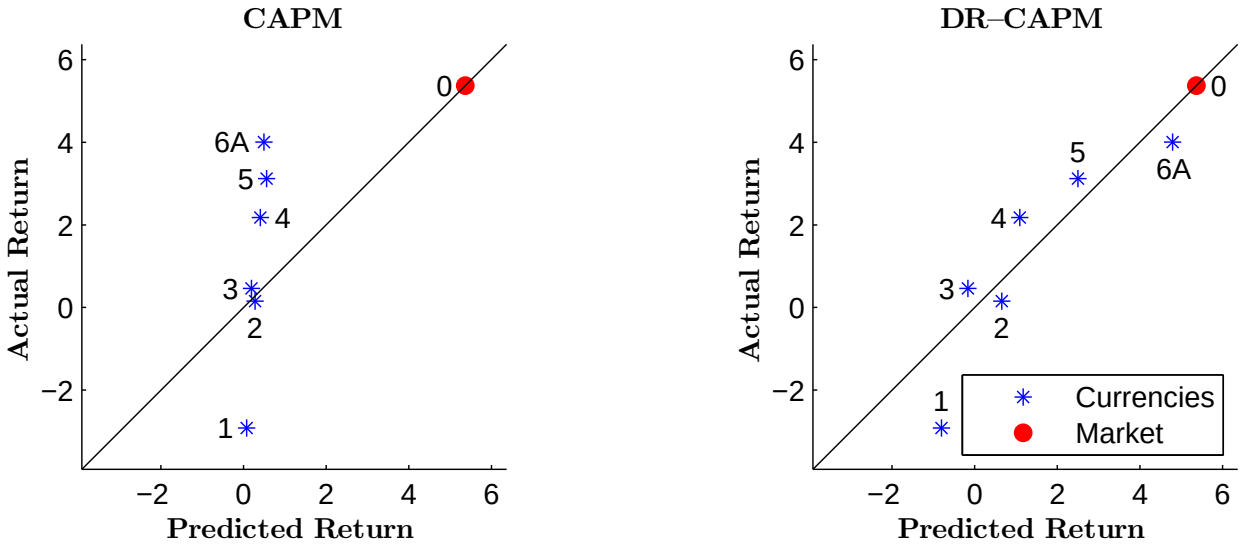
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panels and the downside risk CAPM (DR-CAPM) in the right panels. Test assets are six currency portfolios (1-6), monthly re-sampled based on the interest rate differential with the US, five commodity futures portfolios monthly re-sampled based on the commodity basis (7-11), and the six Fama & French portfolios sorted on size and book-to-market (12-17). The market excess-return is included as a test asset (0). The sample period is January 1974 to December 2008 for a total of 420 observations.

Figure 5: **Model Robustness: Currencies, Equities and Sovereigns, All Countries**



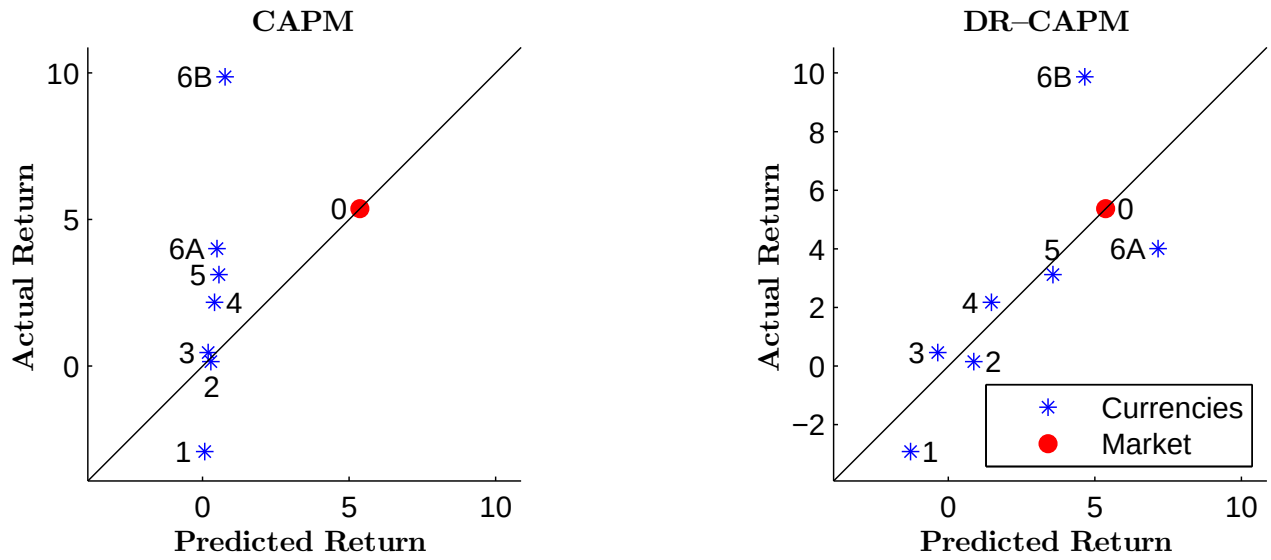
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panels and the downside risk CAPM (DR-CAPM) in the right panels. Test assets are six currency portfolios (1-6), monthly re-sampled based on the interest rate differential with the US, six sovereign bond portfolios (7-12), monthly re-sampled based on their probability of default and bond beta, and the six Fama & French (7-13) portfolios sorted on size and book-to-market. The market excess-return is included as a test asset (0). The sample period is January 1995 to March 2010 for a total of 183 observations.

Figure 6: **Model Robustness: Currencies, Subsample**



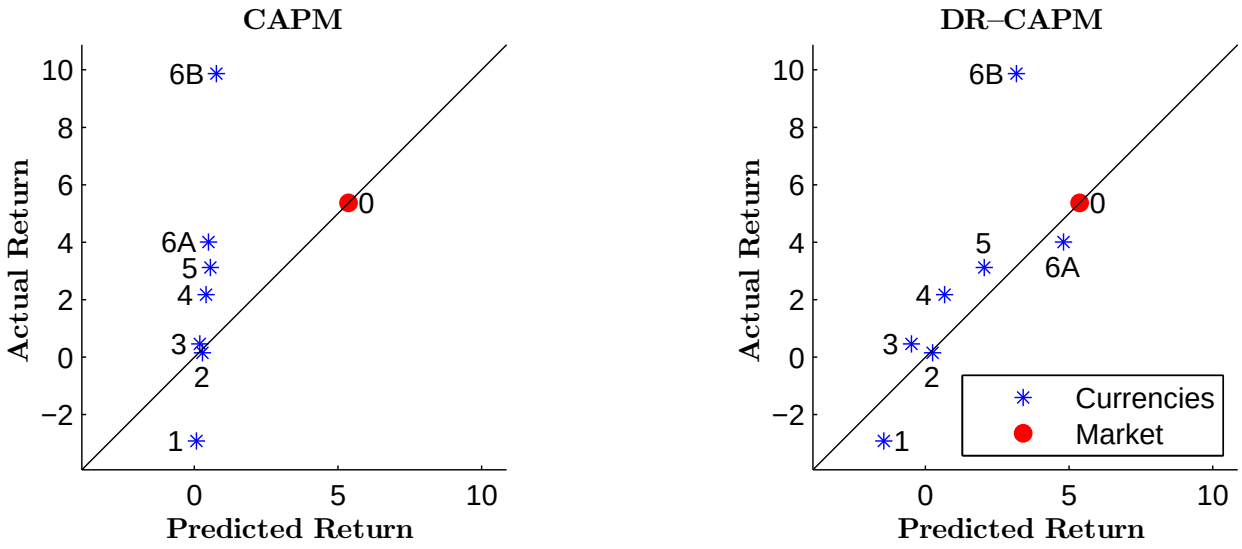
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US. The sample period is June 1980 to March 2010 for a total of 358 observations. High inflation countries in the last portfolio are excluded. The market excess-return in included as a test asset (0). A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation.

Figure 7: **Model Robustness: Currencies, Including basket 6B, Subsample**



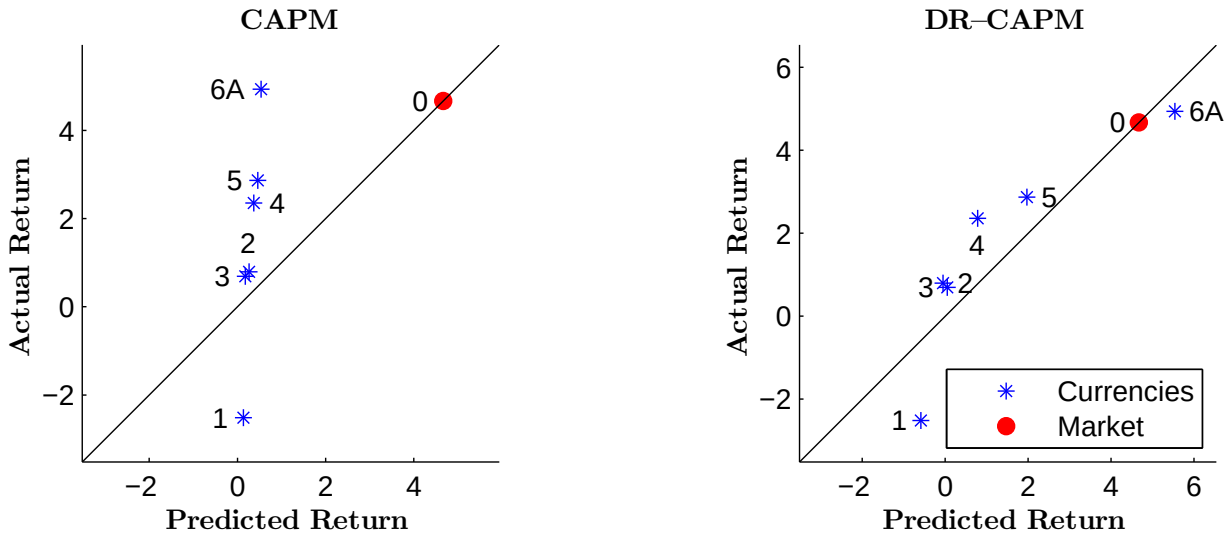
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are seven currency portfolios (1-5, 6A, 6B). Currencies are first sorted into 6 baskets monthly based on their interest rate differential with the US. Then high inflation countries in the sixth portfolio are subdivided into basket 6B. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The remaining countries in basket 6 are labelled 6A. The market excess-return in included as a test asset (0). The sample period is January 1974 to March 2010 for a total of 435 observations.

Figure 8: **Model Robustness: Currencies, Estimated on Baskets 1-6A, Basket 6B Included Only in the Fit, Subsample**



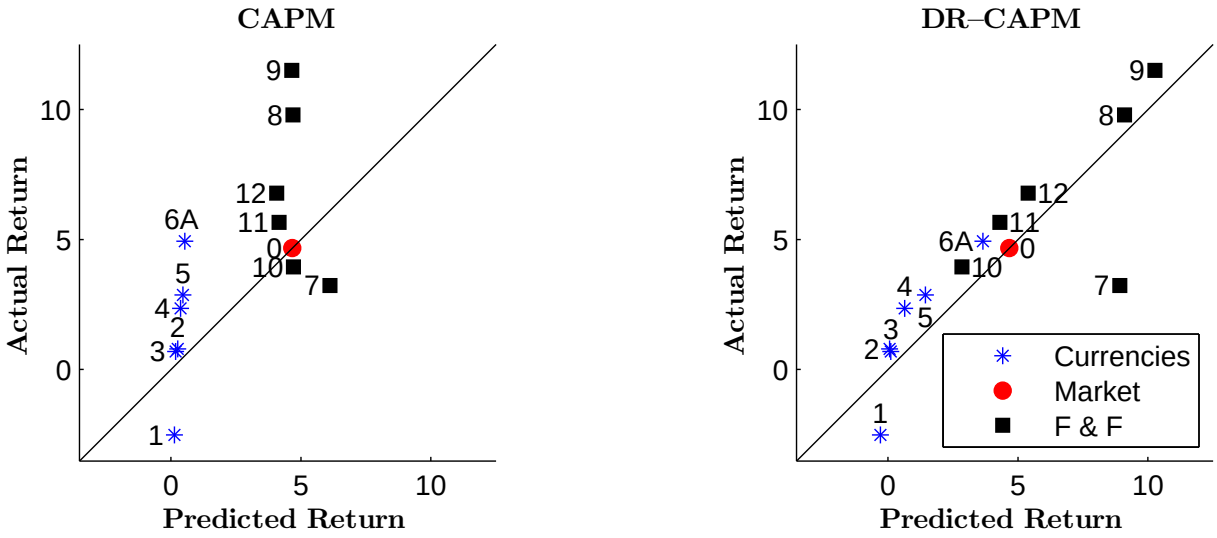
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are seven currency portfolios (1-5, 6A, 6B). Currencies are first sorted into 6 baskets monthly based on their interest rate differential with the US. Then high inflation countries in the sixth portfolio are subdivided into basket 6B. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The remaining countries in basket 6 are labelled 6A. The models are estimated using the currency baskets 1-6A, then basket 6-B is included in the figure to asses its fit. The market excess-return in included as a test asset (0). The sample period is June 1980 to March 2010 for a total of 358 observations.

Figure 9: **Model Performance: Currencies, Alternative Specification**



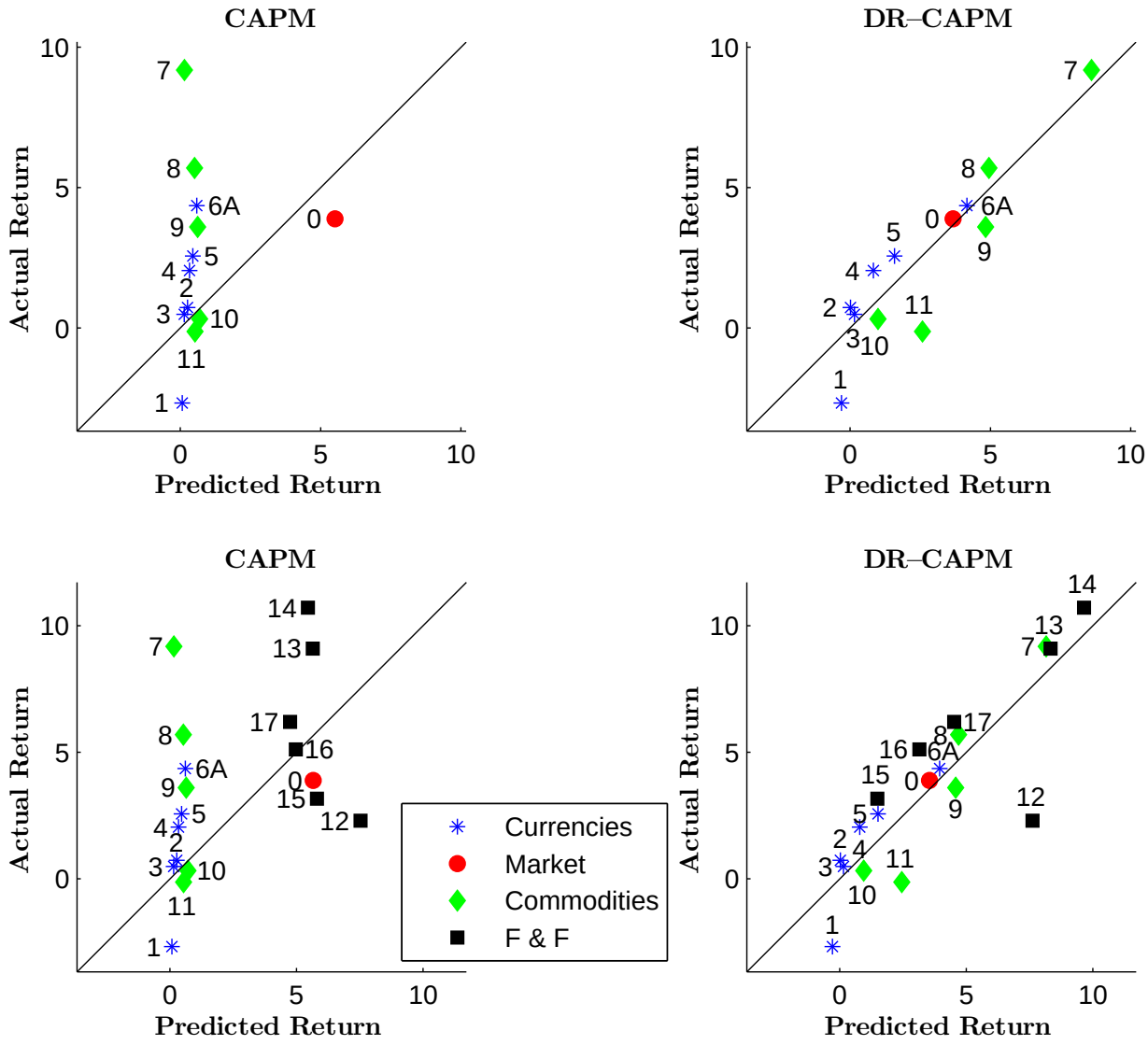
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panel and the downside risk CAPM (DR-CAPM) in the right panel. Test assets are six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The market excess-return is included as a test asset (0).The sample period is January 1974 to March 2010 for a total of 435 observations.

Figure 10: **Model Performance: Currencies and Equities, Alternative Specification**



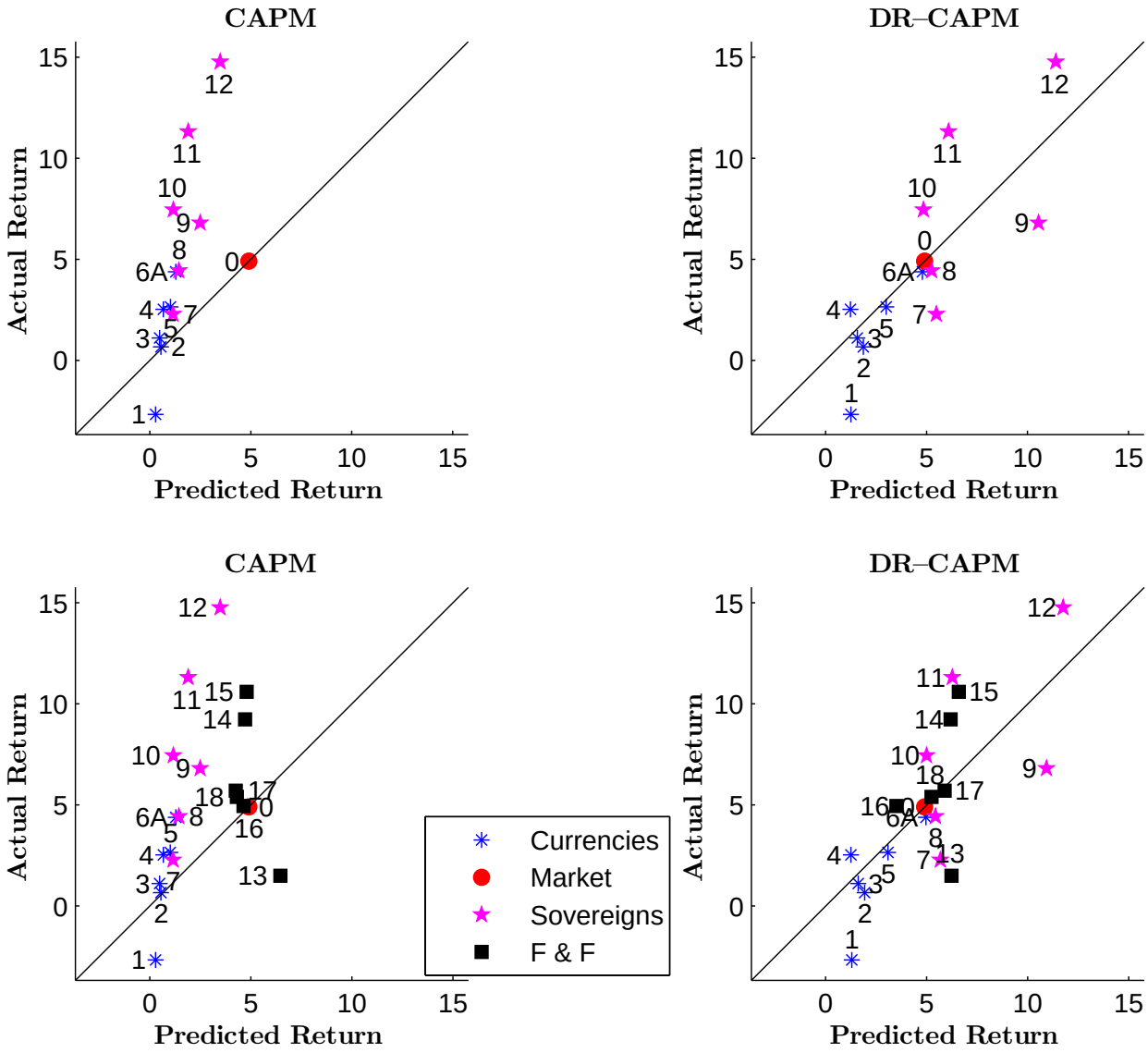
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panels and the downside risk CAPM (DR-CAPM) in the right panels. Test assets are six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US as well as the six Fama & French portfolios sorted on size and book-to-market (7-12). The market excess-return is included as a test asset (0). The sample period is January 1974 to March 2010 for a total of 435 observations. High inflation countries in the last currency portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation.

Figure 11: **Model Performance: Currencies, Equities, and Commodities, Alternative Specification**



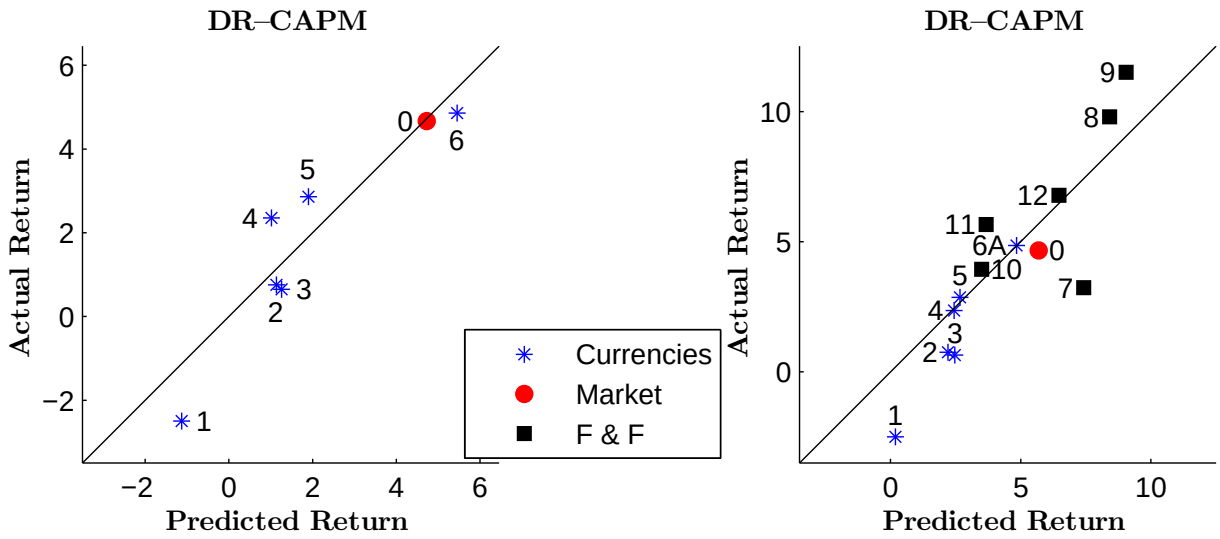
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panels and the downside risk CAPM (DR-CAPM) in the right panels for six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US, five commodity futures portfolios monthly re-sampled based on basis (7-11) as well as six Fama & French portfolios sorted on size and book-to-market (12-17). The market excess-return is included as a test asset (0). The sample period is January 1974 to December 2008 for a total of 420 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has an annualized monthly inflation of 10% higher than the US.

Figure 12: **Model Performance: Currencies, Equities, and Sovereign Bonds, Alternative Specification**



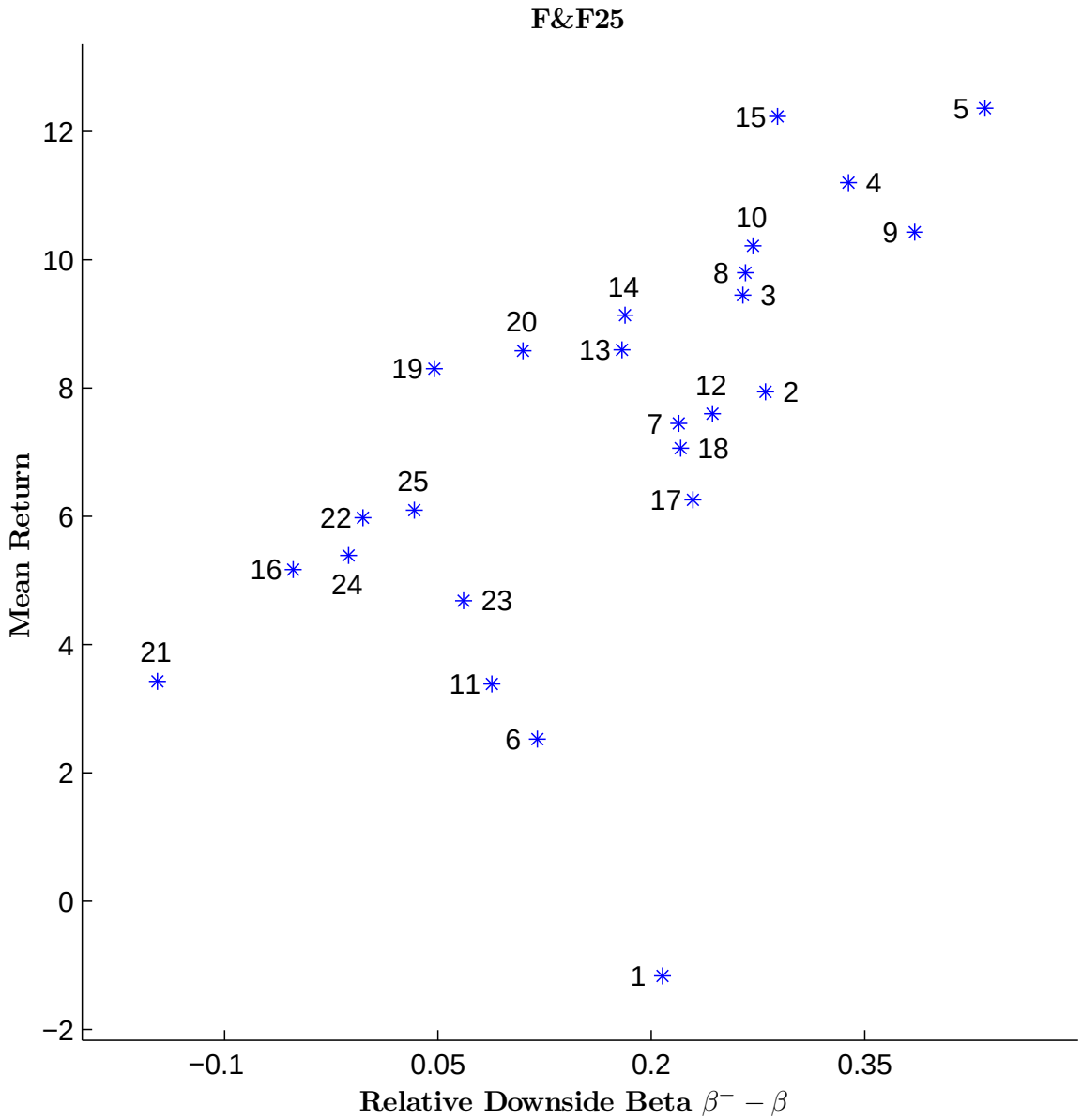
Annualized mean excess-returns versus the predicted excess-returns in percent for the unconditional CAPM in the left panels and the downside risk CAPM (DR-CAPM) in the right panels for six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US, six sovereign bond portfolios monthly re-sampled based on their probability of default and bond beta (7-12) as well as six Fama & French portfolios sorted on size and book-to-market (13-18). The market excess-return is included as a test asset (0). The sample period is January 1995 to March 2010 for a total of 183 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has an annualized monthly inflation of 10% higher than the US inflation.

Figure 13: **Model Robustness: Currencies, Three States**



Annualized mean excess-returns versus the predicted excess-returns in percent for the three-state downside risk CAPM (DR-CAPM). Test assets are six currency portfolios (1-6A), monthly re-sampled based on the interest rate differential with the US. The right panel also includes the six Fama & French portfolios (7-12) sorted on size and book-to-market as test assets. The sample period is January 1974 to March 2010 for a total of 435 observations. The market excess-return is included as a test asset (0). High inflation countries in the last currency portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. Downstates (upstates) are all months in which the market return is more than 0.5 standard deviation below (above) its sample mean with intermediate states defined as all remaining observations.

Figure 14: **Risk-Return Relations: 25 Fama & French Portfolios**



Risk-return relations for twenty-five Fama & French equity portfolios sorted on size and book-to-market. The figure plots the realized mean excess-return versus the relative downside betas ($\beta^- - \beta$). The sample period is January 1974 to March 2010 for a total of 435 observations.

Table 1: **Worst Returns for Market and Carry Trade**

Panel A: the 10 worst monthly market excess-returns and the carry trade returns for the same months. Panel B: the 10 worst monthly carry trade returns and the market excess returns for the same months. The sample period is January 1974 to March 2010 for a total of 435 observations.

	Worst	2	3	4	5	6	7	8	9	10th Worst
	Panel A. 10 Worst Month for Market Excess-Return									
Date	10/1987	10/2008	08/1998	03/1980	09/1974	10/1978	11/2000	02/2001	09/2002	02/2009
Market	-26.32%	-20.51%	-17.67%	-14.19%	-12.53%	-12.53%	-11.38%	-10.89%	-10.69%	-10.67%
Carry Trade	-0.17%	-6.57%	-11.51%	0.00%	0.13%	3.26%	0.94%	0.58%	-7.27%	2.80%
	Panel B. 10 Worst Month for Carry Trade									
Date	09/1998	01/1998	08/1998	07/2002	12/1997	01/2002	07/1986	09/2002	01/1995	03/2002
Market	5.75%	0.02%	-17.67%	-8.62%	1.29%	-1.76%	-6.71%	-10.69%	1.61%	4.25%
Carry Trade	-20.66%	-20.20%	-11.51%	-10.25%	-9.83%	-9.12%	-7.29%	-7.27%	-7.18%	-6.70%

Table 2: **Estimation of Linear Pricing Models: Currencies, All Countries**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US. The market excess-return is included as a test asset. The sample period is January 1974 to March 2010 for a total of 435 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	CAPM	DR-CAPM
λ_{market}	0.39*	0.39*
λ_-		5.32
		(1.37)
χ^2	49.96	27.25
p-val	0.00%	0.01%
RMSPE	0.25	0.12
R^2	-7.41%	75.11%

Table 3: **Estimation of Linear Pricing Models: Currencies and Equities, All Countries**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, and the six Fama & French portfolios sorted on size and book-to-market. The market excess-return is included as a test asset. The sample period is January 1974 to March 2010, for a total of 435 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	CAPM	DR-CAPM
λ_{market}	0.39*	0.39*
λ_-		1.46
		(0.43)
χ^2	123.58	72.01
p-val	0.00%	0.00%
RMSPE	0.29	0.20
R^2	13.46%	57.00%

Table 4: **Estimation of Linear Pricing Models: Currencies, Equities and Commodities, All Countries**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, five commodity futures portfolios, monthly re-sampled based on the commodity basis, and the six Fama & French portfolios sorted on size and book-to-market. The market excess-return is included as a test asset. The rightmost two columns include the six Fama & French portfolios. The sample period is January 1974 to December 2008 for a total of 420 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	Currencies and Commodities		Currencies, Commodities and Stocks	
	CAPM	DR-CAPM	CAPM	DR-CAPM
λ_{market}	0.32*	0.32*	0.32*	0.32*
λ_-		1.53		1.44
		(0.56)		(0.40)
χ^2	59.80	35.79	136.42	72.86
p-val	0.00%	0.02%	0.00%	0.00%
RMSPE	0.32	0.16	0.33	0.18
R^2	-46.89%	63.30%	-24.09%	63.50%

Table 5: **Estimation of Linear Pricing Models: Currencies, Equities and Sovereigns, All Countries**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, six sovereign bond portfolios, monthly re-sampled based on their probability of default and bond beta, and the six Fama & French portfolios, sorted on size and book-to-market. The rightmost include columns use the six Fama & French portfolios. The market excess-return is included as a test asset. The sample period is January 1995 to March 2010 for a total of 183 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	Currencies and Sovereigns		Currencies, Sovereigns and Stocks	
	CAPM	DR-CAPM	CAPM	DR-CAPM
λ_{market}	0.41*	0.41*	0.41*	0.41 *
λ_-		0.58		0.61
		(0.21)		(0.21)
χ^2	59.74	58.76	112.58	110.23
p-val	0.00%	0.00%	0.00%	0.00%
RMSPE	0.47	0.29	0.43	0.28
R^2	-36.88%	46.73%	-37.97%	41.97%

Table 6: **Estimation of Linear Pricing Models: Currencies, Subsample**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 5% higher than US inflation. The market excess-return is included as a test asset. The sample period is June 1980 to March 2010 for a total of 358 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	CAPM	DR-CAPM
λ_{market}	$0.45^{\star}$	$0.45^{\star}$
λ_{-}		2.15
		(0.97)
χ^2	33.75	10.85
p-val	0.00%	9.32%
RMSPE	0.18	0.09
R^2	32.75%	84.23%

Table 7: **Estimation of Linear Pricing Models: Currencies, Including Basket 6B, Subsample**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are seven currency portfolios (1-5, 6A, 6B). Currencies are first sorted into 6 baskets monthly based on their interest rate differential with the US. Then high inflation countries in the sixth portfolio are subdivided into basket 6B. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The market excess-return is included as a test asset. The sample period is June 1980 to March 2010 for a total of 358 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	CAPM	DR-CAPM
λ_{market}	$0.45^{\star}$	$0.45^{\star}$
λ_{-}		3.34
		(1.00)
χ^2	42.85	15.80
p-val	0.00%	2.70%
RMSPE	0.31	0.19
R^2	-9.92%	59.80%

Table 8: **Estimation of Linear Pricing Models: Currencies, Estimated on Baskets 1-6A, Basket 6B Included Only in the Fit, Subsample**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are seven currency portfolios (1-5, 6A, 6B). Currencies are first sorted into 6 baskets monthly based on their interest rate differential with the US. Then high inflation countries in the sixth portfolio are subdivided into basket 6B. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The market excess-return is included as a test asset.. The sample period is Jun 1980 to March 2010 for a total of 358 observations. The models are estimated using the currency baskets 1-6A, basket 6B is included only to assess the model fit. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	CAPM	DR-CAPM
λ_{market}	$0.45^{\star}$	$0.45^{\star}$
λ_{-}		1.95
		(0.72)
χ^2	42.85	14.35
p-val	0.00%	4.53%
RMSPE	0.31	0.21
R^2	-9.92%	49.72%

Table 9: **Estimation of Linear Pricing Models: Currencies, Alternative Specification**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). In the two left columns, test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. In the two right columns, test assets are five currency portfolios of developed countries. The market excess-return is included as a test asset. The sample period is January 1974 to March 2010 for a total of 435 observations. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	All Currencies		Developed Currencies	
	CAPM	DR-CAPM	CAPM	DR-CAPM
λ_{market}	$0.39^{\star}$	$0.39^{\star}$	$0.39^{\star}$	$0.39^{\star}$
λ_{-}		1.88		2.20
		(0.59)		(0.79)
χ^2	42.28	21.19	22.36	7.78
p-val	0.00%	0.17%	0.04%	9.98%
RMSPE	0.19	0.09	0.17	0.07
R^2	8.77%	78.88%	-1.94%	84.08%

Table 10: **Estimation of Linear Pricing Models: Currencies and Equities, Alternative Specification**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, and the six Fama & French portfolios sorted on size and book-to-market. The sample period is January 1974 to March 2010, for a total of 435 observations. The market excess-return is included as a test asset. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. Starred estimates impose the restriction that the market excess-return is exactly priced and consequently no standard errors are reported.

	Fama & French PF	
	CAPM	DR-CAPM
λ_{market}	$0.39^{\star}$	$0.39^{\star}$
λ_{-}		1.20
		(0.33)
χ^2	114.54	63.32
p-val	0.00%	0.00%
RMSPE	0.26	0.17
R^2	24.31%	69.45%

Table 11: **Estimation of Linear Pricing Models: Currencies, Equities and Commodities, Alternative Specification**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, five commodity futures portfolios, monthly re-sampled based on the commodity basis, and the six Fama & French portfolios, sorted on size and book-to-market. The market excess-return is included as a test asset. The two rightmost columns use the six Fama & French portfolios. The sample period is January 1974 to December 2008 for a total of 420 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation.

	Currencies and Commodities		Currencies, Equities, and Commodities	
	CAPM	DR-CAPM	CAPM	DR-CAPM
λ_{market}	0.32*	0.32*	0.32*	0.32*
λ_-		1.31		1.22
		(0.47)		(0.33)
χ^2	52.66	24.41	128.27	64.47
p-val	0.00%	1.11%	0.00%	0.00%
RMSPE	0.30	0.11	0.31	0.15
R^2	-42.93%	82.13%	-17.38%	71.92%

Table 12: **Estimation of Linear Pricing Models: Currencies, Equities, and Sovereigns, Alternative Specification**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the unconditional CAPM and the downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, six sovereign bond portfolios, monthly re-sampled based on the probability of default and bond beta, and the six Fama & French portfolios, sorted on size and book-to-market. The market excess-return is included as a test asset. The sample period is January 1995 to March 2010 for a total of 183 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation.

	Currencies and Sovereigns		Currencies, Equities, and Sovereigns	
	CAPM	DR-CAPM	CAPM	DR-CAPM
λ_{market}	0.41*	0.41*	0.41*	0.41*
λ_-		0.51		0.54
		(0.20)		(0.19)
χ^2	40.26	37.64	88.31	84.52
p-val	0.01%	0.02%	0.00%	0.00%
RMSPE	0.41	0.22	0.38	0.23
R^2	-20.81%	65.01%	-22.66%	56.19%

Table 13: **Model Robustness: Currencies, Three States**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for a three state downside risk CAPM (DR-CAPM). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US, and the six Fama & French portfolios, sorted on size and book-to-market. The market excess-return is included as a test asset. The sample period is January 1974 to March 2010 for a total of 435 observations. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. Downstates (upstates) are all months in which the market return is more than 0.5 standard deviation below (above) its sample mean with intermediate states defined as all remaining observations.

	Currencies	Currencies and Equities
λ_+	-1.22	-0.69
	(0.44)	(0.32)
λ_0	-0.52	-0.78
	(0.41)	(0.32)
λ_-	2.14	1.95
	(0.65)	(0.49)
χ^2	11.56	63.95
p-val	2.09%	0.00%
RMSPE	0.07	0.15
R^2	86.26%	74.34%

Table 14: **PCA: Currencies, Equities and Commodities**

Loadings (PC1 – PC16) and percentage of the total variance explained by each principal component of a principal components analysis on the covariance matrix of six currencies portfolios (Cur-PF1 – Cur-PF6A), monthly re-sampled based on the interest rate differential with the US, five commodity futures portfolios (Com-PF1 – Com-PF6), monthly re-sampled based on basis and six stock portfolios (FF-PF1 – FF-PF6), sorted on size and book to market. High inflation countries in the last currency portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The sample period is January 1974 to December 2008, a total of 420 observations.

	PC1	PC2	PC3	PC4	PC5	PC6	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16
Cur-PF1	-0.01	0.05	0.39	-0.03	0.07	-0.03	0.01	-0.01	0.06	0.25	0.54	0.08	0.16	-0.41	-0.26	-0.46	-0.03
Cur-PF2	-0.02	0.05	0.39	-0.02	0.06	-0.03	0.00	0.01	0.06	0.19	0.38	0.07	-0.23	-0.05	0.47	0.61	0.00
Cur-PF3	-0.01	0.06	0.40	-0.03	0.06	-0.01	0.04	0.03	0.09	0.17	-0.09	-0.18	0.00	0.67	0.32	-0.45	-0.06
Cur-PF4	-0.02	0.05	0.36	-0.02	0.07	0.01	0.02	0.02	0.07	0.14	-0.11	-0.11	0.10	0.31	-0.73	0.41	0.04
Cur-PF5	-0.03	0.05	0.40	-0.03	0.05	0.05	0.00	0.00	0.08	0.19	-0.73	0.13	-0.10	-0.46	0.11	-0.05	0.05
Cur-PF6A	-0.04	0.06	0.42	-0.02	0.06	0.03	0.16	-0.24	-0.33	-0.78	0.02	0.05	0.07	-0.02	0.02	-0.02	0.00
Com-PF1	-0.06	0.49	-0.11	-0.71	0.18	0.33	-0.31	-0.05	0.06	-0.05	0.02	0.02	0.00	0.01	0.00	0.00	0.01
Com-PF2	-0.08	0.41	-0.08	-0.11	-0.32	-0.35	0.52	-0.13	0.53	-0.11	-0.01	0.01	0.03	-0.02	0.00	0.02	0.00
Com-PF3	-0.08	0.47	-0.01	0.05	-0.32	0.00	0.22	0.36	-0.66	0.22	-0.01	-0.05	0.04	-0.01	0.01	0.01	0.00
Com-PF4	-0.08	0.38	0.05	0.33	-0.08	-0.48	-0.69	-0.09	0.03	-0.11	-0.02	0.01	-0.03	0.01	-0.02	-0.02	0.01
Com-PF5	-0.08	0.42	-0.12	0.57	0.49	0.42	0.17	-0.03	0.16	-0.01	0.02	0.01	0.02	-0.01	0.02	0.00	0.00
FF-PF1	-0.54	-0.09	-0.06	-0.12	0.39	-0.31	0.12	0.35	-0.03	-0.09	0.00	0.20	-0.43	0.04	-0.13	-0.09	-0.20
FF-PF2	-0.42	-0.07	-0.06	-0.05	0.14	-0.12	0.06	-0.22	-0.11	0.11	0.02	-0.25	0.09	-0.02	0.07	-0.02	0.79
FF-PF3	-0.41	-0.06	-0.08	-0.03	0.08	-0.09	0.03	-0.45	-0.16	0.23	-0.07	-0.09	0.46	-0.03	0.10	0.13	-0.52
FF-PF4	-0.35	-0.11	0.10	0.04	-0.18	0.18	-0.15	0.56	0.27	-0.21	0.00	0.09	0.55	-0.01	0.14	0.08	0.06
FF-PF5	-0.32	-0.05	0.07	0.08	-0.34	0.31	-0.09	-0.03	0.12	-0.10	0.05	-0.64	-0.39	-0.17	-0.07	-0.05	-0.19
FF-PF6	-0.32	-0.04	0.02	0.11	-0.41	0.33	-0.07	-0.30	0.00	0.11	0.04	0.63	-0.21	0.20	-0.09	-0.07	0.09
Explained	47.02%	21.16%	7.06%	5.45%	4.12%	3.44%	2.94%	2.50%	2.11%	1.81%	0.52%	0.48%	0.43%	0.35%	0.27%	0.23%	0.12%

Table 15: **Estimation of Linear Pricing Models: Other Risk-based Models, Currencies and Equities**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the extended Durable Consumption CAPM (DC-CAPM) and the model of Lustig, Roussanov and Verdelhan (LRV). In the two left columns, test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US. High inflation countries in the last portfolio are excluded. A country is considered to have high inflation if it has annualized monthly inflation 10% higher than US inflation. The next two columns use five currency portfolios of developed countries as test assets and the rightmost two columns add the six Fama & French equity portfolios sorted on size and book-to-market. The market excess-return is included as a test asset. The sample period is January 1974 to March 2010 for a total of 435 observations.

	All Currencies		**Developed Currencies**		**Currencies and Equities**	
	EZ-DCAPM	LRV	EZ-DCAPM	LRV	EZ-DCAPM	LRV
λ_{market}	0.42		0.41		0.46	
	(0.23)		(0.23)		(0.23)	
λ_{nondur}	-0.06		-0.12		-0.18	
	(0.19)		(0.24)		(0.13)	
λ_{dur}	3.11		4.39		2.21	
	(1.39)		(1.91)		(0.77)	
λ_{RX}		0.14		0.09		0.20
		(0.10)		(0.11)		(0.11)
λ_{HML}		0.54		0.57		
		(0.16)		(0.17)		(0.38)
χ^2	36.55	25.14	14.27	3.51	95.71	97.40
p-val	0.00%	0.01%	0.26%	47.56%	0.00%	0.00%
RMSPE	0.15	0.14	0.10	0.06	0.21	0.30
R^2	42.57%	51.29%	70.26%	89.24%	53.25%	1.07%

Table 16: **Estimation of Linear Pricing Models: Other Risk-Based Models, Currencies, Equities, Commodities, and Sovereign Bonds**

Prices of risk, Fama&MacBeth standard errors in parentheses, χ^2 statistics testing for joint significance of pricing errors, root mean squared pricing errors (RMSPE) and the cross sectional R^2s for the extended Durable Consumption CAPM (DC-CAPM) and the model of Lustig, Roussanov and Verdelhan (LRV). Test assets are six currency portfolios, monthly re-sampled based on the interest rate differential with the US. The leftmost four columns also include five commodity futures portfolios, monthly re-sampled based on basis, as test assets. The rightmost four columns also include six sovereign bond portfolios, monthly re-sampled based on their probability of default and bond beta, as test assets. The six Fama & French portfolios sorted on size and book-to-market are included when indicated. The market excess-return is always included as a test asset. The sample period is January 1974 to March 2008 for a total of 420 observations in the leftmost four columns, January 1995 to March 2010 for a total of 183 observations in the rightmost four columns.

	Currencies and Commodities				**Currencies and Sovereigns**			
			incl Equities				incl Equities	
	EZ-DCAPM	LRV	EZ-DCAPM	LRV	EZ-DCAPM	LRV	EZ-DCAPM	LRV
λ_{market}	0.37		0.37		0.66		0.42	
	(0.23)		(0.23)		(0.39)		(0.37)	
λ_{nondur}	0.20		0.17		-0.24		-0.33	
	(0.14)		(0.13)		(0.10)		(0.12)	
λ_{dur}	2.59		1.27		2.79		1.88	
	(1.37)		(0.66)		(0.83)		(0.74)	
λ_{RX}		0.17		0.19		0.35		0.33
		(0.11)		(0.11)		(0.15)		(0.19)
λ_{HML}		0.55		1.00		0.70		0.65
		(0.17)		(0.39)		(0.34)		(0.35)
χ^2	47.61	37.63	117.58	113.23	35.35	37.36	83.63	85.41
p-val	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.00%	0.00%
RMSPE	0.23	0.26	0.26	0.31	0.18	0.32	0.26	0.31
R^2	13.87%	-11.60%	17.40%	-15.19%	76.35%	25.19%	40.48%	18.87%