The US Trading Model forecasts equity portfolio risk over daily horizons. First released in 1997, it has become a popular tool among trading desks and hedge funds for risk monitoring and control. This paper describes revisions to the model that improve its risk forecasts and the timeliness and reliability of its input data sources. The revised model is called USTM2.
1. Introduction

MSCI Barra’s US Trading Model (USTM) forecasts equity risk over horizons from one day to several. Its horizon range makes the model appropriate for trading desks and high-frequency hedge fund applications. These horizons distinguish USTM from the more traditional USE3L/S models, which are suited to longer-term portfolio management. This whitepaper describes a revised version of USTM called USTM2.

The years since USTM’s introduction have seen the culmination of a technology bubble and its subsequent collapse, accompanied by dramatic changes in risk. These events have shown that although the model handles short-lived outbursts in market risk relatively well, it could better accommodate variations that occur over months or years. USTM2 automatically re-fits the parameters of its GARCH market volatility forecasting apparatus every month. The new GARCH system adapts readily to changing conditions. Forecasts of non-market common factor risk in USTM and USTM2 are based on an exponentially weighted moving average. The half-life of data weightings in the moving average has been shortened from 120 trading days to 90 to improve responsiveness.

The new model incorporates revisions to its data sources. USTM bases its risk forecasts on daily returns and market data. Formerly a pre-model process compiled these daily numbers from tick-by-tick transaction data delivered through a real-time feed. During episodes of intense activity, the system sometimes dropped trades and data quality suffered. Occasionally the feed itself failed. USTM2 does not depend on the live feed. Instead, it uses the same daily summary data employed by MSCI Barra’s other US models. The new data sources improve overall quality and make model updates more reliable and timely.

The style factor set has been expanded in USTM2, and style factors carried over from the earlier version have been revised. The Momentum factor in USTM is based on returns performance over one or two weeks. In USTM2 the original momentum factor has been re-named “Short-term Momentum” and has been supplemented with a “Long-term Momentum” factor based on performance over several months. The original USTM Volatility factor has been divided into “Market Sensitivity” and “Volatility” to reflect market and non-market volatility separately.

Other changes at the factor level include a new method for eliminating style exposure outliers, and the introduction of a “thin industry” correction to the factor return estimation. The thin industry correction attempts to produce better behaved factor returns for industries that are represented by only a few assets. Both techniques have appeared frequently in MSCI Barra risk models since the initial release of USTM.

The remaining sections of this paper explain the revisions to USTM and their effects on model performance. Section 2 reviews the USTM2 factors, and discusses the question of whether the addition of statistical factors would improve the model. Section 3 treats changes in the standardization of the style factors. The thin industry correction to factor
return estimation is described in Section 4. Section 5 treats revisions to the factor covariance forecast, particularly to the GARCH market volatility submodel. Model performance is reviewed in Section 6. Conclusions appear in Section 7.

2. The USTM Factor Structure

USTM is a fundamental factor model like its longer-term USE3L/S counterparts, with which it shares a common industry factor structure. The USTM industry factors remain unchanged in USTM2.

Because the goal of the USTM2 factors is to capture commonality in daily returns rather in returns across monthly (or longer) horizons, the style factors differ from those of the USE3 family. For example, while the USE3 factors include styles based on fundamental financial ratios like earnings yield, these are less relevant over daily horizons and do not appear in USTM2. Two USTM2 factors have direct counterparts among the USE3 factors: Size and Nonlinear Size. They express commonalities based on capitalization and liquidity, categories obviously applicable to returns over short horizons. The other USTM2 styles express technical, returns-oriented concepts: volatility and momentum. They differ from the corresponding USE3 style factors in timescale. Technical factors in USE3 depend on returns histories of a year or longer. In USTM2, the technical factors use historical data lengths that range from a trading week to several months. The much shorter histories are useful in capturing evanescent asset groupings. A list of style factors and their descriptor content in USTM and USTM2 appears in Table 1.

The USTM2 Momentum style factors group assets by relative performance. The Short-term Momentum descriptors are 5-day alpha and 10-day price performance (price performance is defined as the difference between the most recent price and the 10-day average price, divided by the most recent price). They remain as they were in the original USTM Momentum factor. Here “days” refer to trading days.

A Long-term Momentum factor enters USTM2 as part of the model revision. It categorizes assets according to their performance over several months. Its descriptors are 60-day alpha and 60-day relative strength (the relative strength descriptor is based on 60-day cumulative returns). Sixty trading days is a relatively long time in the context of a model for risk over horizons of a day. These longer-term descriptors nevertheless capture a source of significant returns commonality on day-long timescales that is not represented by the other model factors.

The remaining technical style factors in USTM2 categorize assets by their returns volatility. The Market Sensitivity style has exposures based on the amount of market volatility present in an asset. Its descriptor is 60-day beta. In contrast, the Volatility style factor exposure is oriented toward volatility in non-market return. Its descriptors are 10-day volatility and 30-day sigma, where sigma is the standard deviation of residual (i.e., non-market) returns. The 10-day volatility descriptor is a market-independent measure of
volatility, calculated as the difference between high and low prices over the past 10 trading days divided by the average price over the same period. Since asset-specific risk is typically the dominant contributor to volatility at the asset level, although the 10-day volatility descriptor contains a contribution from market risk, non-market risk influences it most strongly.

A model’s explanatory power quantifies the amount asset-level return that can be attributed to the common factors. The higher its explanatory power, the more effective the model will be in forecasting portfolio risk. The explanatory power of USTM2’s style and the industry factors is depicted in Figure 1. The figure contains plots of 20-day rolling averages of adjusted r-squareds for three different models: one with only a market factor, another with industry factors but no style factors, and a third with both industry and style factors. The use of industry and style factors gives USTM2 twice the explanatory power of a “market-only” factor model.

The adjusted r-squareds of USTM2 and USTM differ historically by about half of a percent, as shown in Figure 2. The difference is thus significant but not large. This is unsurprising. The industry structure, which accounts for most of the model’s explanatory power, is the same in both model versions. The new factors represent minor improvements that should improve the model’s risk forecasts for active risk in highly diversified portfolios.

It is worth remarking that it would be difficult to capture USTM’s technical style factors with purely statistical methods; e.g., with a principal components analysis. Principal components analyses are only sensitive to factors that are sufficiently strong and persistent. A simple example makes the point. Statistical factor methods extract both factor returns and factor exposures from patterns in the historical record of returns. Suppose that half of the work is complete and that a history of $T$ independent factor returns already exists. A regression of historical asset returns on the factor returns produces regression coefficients that are the estimated exposures for each asset. These estimated exposures $\hat{X}$ are equal to the true exposures $X$, plus estimation error:

$$\hat{X} = X + \frac{1}{\sqrt{T}} \sigma_f \sigma_s^{-1}.$$

Note that the estimation error decreases as the history length $T$ increases, and that the error is proportional to the ratio of asset-specific risk $\sigma_s$ to the factor return standard deviation $\sigma_f$. This ratio is of order 20 for the USTM technical factors. A history of roughly 1000 observations therefore would be required for the errors in exposure not to dominate the true exposures; i.e., for the noise in the estimation of exposures not to dominate the signal. Since the technical factors are based on data lengths from 5 to 60 days, a purely statistical approach is unlikely to capture the USTM factors unless based on high-frequency returns data and confined to very liquid stocks. Unsurprisingly given these statistical considerations, experimental attempts to improve USTM risk forecasts by
appending daily returns-based statistical factors to the existing model factors have proved unsuccessful.

3. Changes in Style Exposure Standardization

Style factor exposures are weighted averages of one or more descriptors that represent characteristics related to the style. Each descriptor is standardized. The standardization controls the distribution of style exposures in the estimation universe or ESTU\(^1\). A descriptor has a capitalization-weighted average value of zero in the model’s ESTU, so that the market portfolio itself has an aggregate descriptor value of zero; the market is “style neutral.” The equally weighted standard deviation of descriptor values in the estimation universe is scaled to one, so that each descriptor places assets on a convenient relative scale. (After the descriptors are combined to produce raw style exposures, the style exposures themselves are also standardized.)

If left untreated, outliers in the raw descriptors could produce abnormally large style exposures, which in turn would attribute undesirably large factor returns to individual assets. To combat this, outlying descriptor values are winsorized; that is, they are replaced with a substitute “truncation” value that is considered the most extreme value acceptable.

Prior to this revision, USTM truncated descriptor values 5 standard deviations above or below the capitalization-weighted mean. This technique sometimes suffers when assets with very large capitalizations lie near one side of the distribution, since a very large number of values may be pushed beyond the truncation limit on the other side. The excessive truncation causes descriptor values to cluster at the far end of the distribution. In turn, when the descriptor enters a style exposure, the cluster of descriptor values can produce an undesirable cluster of exposures — the exposure fails to distinguish assets which could have been productively differentiated.

USTM2 applies a more robust technique based on Median Absolute Deviation as a measure of dispersion. The median absolute deviation (MAD) is the median of absolute separations from the median of the descriptor distribution. The MAD technique sets truncation bounds 7.4 MADs in either direction from the median.

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\(^1\) As described in Section 4, the USTM and USTM2 models calculate daily factor returns from regressions of asset returns against asset-level factor exposures. Not all of the model assets are used in the daily regression. The regression uses only assets in the estimation universe or ESTU. The ESTU contains assets for which the model factors are expected to work particularly well. These assets are relatively liquid, come from the same asset class or market, and have few data problems.
In addition to the change in standardization methodology, the construction of the USTM Size style exposure has changed. The Size style acts as a broad measure of relative liquidity. It formerly included descriptors based on the relative spread (an asset’s relative spread is a daily average of \( \frac{\text{ask-bid}}{\text{ask+bid}} \)), the log of capitalization, and volatility-adjusted trading volume. The relative spread descriptor has been dropped from the Size index in the revised model. The log-capitalization and volatility-adjusted volume descriptors remain. The volatility-adjusted volume is \( \frac{V}{\sigma} \), the trailing 5-day average of trading volume divided by the 20-day average standard deviation of logarithmic returns. USTM used \( \frac{V}{\sigma} \) directly as its descriptor. USTM2 replaces the volatility-adjusted volume with its logarithm, \( \log(V/\sigma) \). This modification gives the revised descriptor a smoother, less sharply peaked distribution.

Figure 3 illustrates the effect of the style exposure revisions on the Size exposure distribution within the estimation universe; the data are from 1 June 2005. Note that the new and old distributions are very similar. The changes are more pronounced outside the estimation universe, as shown by Figure 4. Here the revisions have eliminated a number of sharp peaks within the distribution; they were associated with excessive truncation in the component Size descriptors. Thus, revisions in the style exposures have left the estimation universe exposure distribution largely intact, while improving behavior outside the estimation universe.

How great are the asset-by-asset exposure differences within the estimation universe? Figure 5 plots the new and old Size exposures against one another. The changes in descriptor content and truncation methodology produce some differences, but the old and new exposures are closely related.

Figure 6 shows the relation between old and new Nonlinear Size exposures. The Nonlinear Size style factor employs the cube of the Size exposure as its sole descriptor, so all changes in Nonlinear Size are due solely to changes in the Size exposures.

4. Factor Return Estimation: Thin Industries

In fundamental factor models, the exposures of assets to the model factors are assigned at the beginning of a returns period. At the end of the period, the factor returns for the period are calculated in a regression of asset returns on factor exposures. USTM2 exposures for a trading day thus are assigned before it begins, and USTM2 factor returns are calculated after the end of the day’s trading.

The regression finds a set of factor returns that explains as much of the cross section of asset returns as possible. In particular, the attribution equation

\[
    r_j = \sum_{k=1}^{M} X_{jk} f_k + s_j
\]
expresses the return $r_j$ to asset $j$ as a sum of the specific return $s_j$ and contributions from the factor returns. The specific return represents the part of the asset return unexplained by model factors. The regression selects factor returns to minimize the sum $\sum w_j s_j^2$, where $w_j$ is the regression weight attached to asset $j$. The weights are set to zero outside of the set of stocks that comprise the estimation universe.

The factor returns produced by the regression are in essence weighted averages of asset returns. These averages are unusual in the sense that some weights may be negative, but are otherwise straightforward. This means that the estimated factor returns contain not only the actual factor return itself, but also estimation error in the form of the diversified specific returns to assets in the average. If an industry has only a few representative assets in the estimation universe, the specific returns of those assets do not diversify well in the average and significantly contaminate the estimated return. This contamination makes the factor for the thin industry appear much more variable (i.e., more risky) than it actually is.

A “thin industry correction” reduces the contamination. If an industry factor enjoys less specific return diversification than would arise from five equally weighted assets, the industry is considered to be too thinly populated. The correction introduces an artificial asset to the estimation universe that is exposed only to the “thin” industry; the asset’s exposures to the style factors and to other industries are set to zero. It carries a return that represents a Bayesian prior (a “best uninformed guess”) for the industry factor return. In USTM2 this is simply the market return. The artificial asset has a regression weight that is just large enough to achieve the required level of specific return diversification, so that the industry no longer appears thin. The result of this is essentially to blend the uncorrected factor return estimate with the prior. Blending reduces the level of specific return contamination in the estimated factor return. It also typically moves the estimated beta of the industry factor toward 1, the beta of the market.

5. Revisions in the Factor Covariance Forecast

Large absolute daily returns to US equities cluster in time, so that fluctuations in volatility levels tend to persist beyond a single day. Another qualitative regularity is that volatility levels are more likely to rise after down-market days than after up days. Extended GARCH models capture these empirical regularities. Both USTM and USTM2 employ an extended GARCH model to improve their risk forecasts.

The GARCH methodology is applied to the single most important common factor, the market. The model creates a market risk forecast, divides the factor covariance forecast into market and non-market components, and adjusts the market component to match the GARCH forecast. It then reassembles the factor covariance forecast (see the Appendix for a fuller description of the covariance forecast adjustment).
The extended GARCH model in USTM takes the following form:

\[ \text{Var}(\tilde{r}_m)_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta \text{Var}(\tilde{r}_m)_{t-1} + \theta \varepsilon_{t-1} \]

Its forecast for the variance of the market return at a time \( t \), \( \text{Var}(\tilde{r}_m)_t \), is a linear combination of the previous day’s forecast, an underlying level \( \omega \), and innovations represented by the previous day’s unexpected market return \( \varepsilon_{t-1} \equiv r_{m,t-1} - E(r_{m,t-1}) \) and its square. The model parameters (the underlying level and the coefficients of the other terms) set the average long-term forecast level of risk, among other things.

In USTM2 the GARCH parameters are re-estimated monthly. The periodic refitting of the parameters allows the model to adjust quickly to changes in both the long-term behavior of market risk and in its short-term dynamics.

Figure 7 illustrates the forecast improvement from the new GARCH implementation. It overlays daily market returns with ±2-sigma market risk forecasts from both USTM and USTM2. Both models forecast similarly over 2004–2005. However, the revised model performs better over the 2002–2003 period when volatility levels surge and then decline. The inflexible GARCH implementation of the original model causes it to under-forecast risk in that period.

Tables 2A and 2B explore differences in factor level risk forecasts between the two model versions. The data are from 1 November 2005. Overall, the forecasts are quite similar. The most conspicuous differences occur in two thin industries: Gold and Tobacco. As expected, the factor level risk forecasts of USTM2 for these industries are substantially lower than those of USTM.

### 6. Model Performance

Bias statistics help quantify the effects of the model revisions on forecast quality. A bias statistic is the standard deviation of normalized returns called z-scores, which in the present case are daily portfolio returns, each divided by its risk forecast for that day: \( z_i = r_i / \hat{\sigma}_i \). Ideally, a bias statistic should have a value close to 1. Given a sample of normally distributed z-scores over \( T \) days, an unbiased forecast should produce a bias statistic between \( 1 - \sqrt{2/T} \) and \( 1 + \sqrt{2/T} \), with 95% probability. If the returns distribution is fat-tailed (the usual case in financial markets), the “no bias” confidence interval can be somewhat wider. Thus, the range \( 1 - \sqrt{2/T} \) and \( 1 + \sqrt{2/T} \) is conservative.

Figure 8 shows bias statistics collected over 3-month intervals for the market risk forecasts of both the original and revised models. It confirms the improvement in market risk forecasts for 2002–2003 shown by Figure 7.
In addition to the market portfolio, we also computed bias statistics for a large number of other portfolios. These included 12 style tilts (in USTM2; there are 8 in USTM) and 110 sector tilts on the industry factors, and 30 portfolios whose constituents were chosen randomly from the model’s estimation universe. Style tilt portfolios are equally weighted collections of either the top 20% or the bottom 20% of ESTU assets by style exposure. Industry tilt portfolios are capitalization weighted collections of the top 20% or bottom 20% of ESTU names in an industry.

Bias statistics for the original and revised model over 3-month periods are shown in Tables 3A, 3B, 4A, and 4B. Tables 3A and 3B summarize bias statistics for total return, whereas Tables 4A and 4B show the results for active return risk forecasts. In each of the tables, bias statistics are displayed for overall risk and also for its decomposition into common factor and specific risk components. The “no bias” confidence interval for these 3-month intervals lies between 0.82 and 1.18.

Tables 5–8 show bias statistics for S&P portfolios. Bias statistics outside the 95% confidence interval are marked by an asterisk.

The bias statistics indicate that over most of the study period, both USTM and USTM2 generally perform well throughout the full range of portfolios. They also show that the revised model improves on the existing model when long-term risk levels move significantly. The improvement is due mainly to the revised model’s improved GARCH implementation.

7. Summary

USTM2 preserves the virtues of its predecessor while offering a number of enhancements. The most conspicuous revisions are to the model’s market risk forecasts and to its factor structure. Changes to the model’s GARCH implementation improve the accuracy of its risk forecasts, especially when the risk environment changes rapidly. The revised model uses an enlarged set of style factors that allows it to differentiate diversifiable risk from undiversifiable risk more cleanly.

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2 The USTM estimation universe is used as the benchmark portfolio in computing the active risk forecasts.
Figures

Figure 1. Explanatory Power of the USTM2 Factors

Figure 2. Comparison of Adjusted R-Squareds in USTM2 and USTM
**Figure 3.** Distribution of USTM Size Exposures in the ESTU (June 1, 2005)

**Figure 4.** Distribution of USTM Size Exposures outside the ESTU (June 1, 2005)
**Figure 5.** USTM2 and USTM Size Exposures in the ESTU (June 1, 2005)

![USTM2 and USTM Size Exposures](image)

**Figure 6.** USTM2 and USTM Nonlinear Size Exposures in the ESTU (June 1, 2005)

![USTM2 and USTM Nonlinear Size Exposures](image)
**Figure 7.** Daily Market Returns and ±2-Sigma Market Risk Forecasts

![Chart showing daily market returns and ±2-sigma market risk forecasts from January 2002 to October 2005.](chart)

**Figure 8.** 3-Month Average Market Bias Statistics

![Chart showing 3-month average market bias statistics from January 2002 to October 2005.](chart)
Tables

Table 1. Style Exposure Revision Summary

<table>
<thead>
<tr>
<th></th>
<th>USTM Descriptor</th>
<th>USTM2 Descriptor</th>
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</thead>
<tbody>
<tr>
<td><strong>Size</strong></td>
<td>ln(capitalization)</td>
<td>Unchanged</td>
</tr>
<tr>
<td></td>
<td>volatility-adjusted volume</td>
<td>In(volatility-adjusted volume)</td>
</tr>
<tr>
<td></td>
<td>average relative spread</td>
<td></td>
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<td><strong>Nonlinear Size</strong></td>
<td>Size style factor, cubed</td>
<td>Unchanged</td>
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<td><strong>Short-term Momentum</strong></td>
<td>5-day alpha</td>
<td>Unchanged</td>
</tr>
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<td></td>
<td>10-day price performance</td>
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<td><strong>Long-term Momentum</strong></td>
<td>Not used; new in USTM2</td>
<td>60-day alpha</td>
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<td>60-day relative strength</td>
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<td><strong>Volatility</strong></td>
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<td>30-day sigma</td>
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<td></td>
<td>10-day volatility</td>
<td>Unchanged</td>
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<td><strong>Market Sensitivity</strong></td>
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<td>60-day beta</td>
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Table 2A. Style Factor Risk, 1 November 2005 (Annual %)

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<th>Style</th>
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<td>Size</td>
<td>1.98%</td>
<td>2.40%</td>
<td>0.42%</td>
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<td>Nonlinear Size</td>
<td>2.46%</td>
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<td>Short-term Momentum*</td>
<td>1.55%</td>
<td>1.41%</td>
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<td>Market Sensitivity</td>
<td>-</td>
<td>3.61%</td>
<td>-</td>
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<tr>
<td>Long-term Momentum</td>
<td>-</td>
<td>1.91%</td>
<td>-</td>
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* The Momentum factor in USTM
Table 2B. Industry Factor Risk, 1 November 2005 (Annual %)

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<th>Industry</th>
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<th>USTM2</th>
<th>Difference</th>
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<tr>
<td>Gold</td>
<td>30.06%</td>
<td>12.84%</td>
<td>-17.22%</td>
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<td>Tobacco</td>
<td>21.86%</td>
<td>12.71%</td>
<td>-9.15%</td>
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<td>Heavy Machinery</td>
<td>22.22%</td>
<td>17.09%</td>
<td>-5.13%</td>
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<td>Semiconductor</td>
<td>24.66%</td>
<td>20.64%</td>
<td>-4.02%</td>
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<td>Railroads</td>
<td>20.74%</td>
<td>16.89%</td>
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<td>Department Stores</td>
<td>19.43%</td>
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<td>Heavy Electrical Equipment</td>
<td>19.78%</td>
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<td>Entertainment</td>
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<td>17.72%</td>
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<td>29.13%</td>
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<td>17.74%</td>
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### Table 2B. Industry Factor Risk, 1 November 2005 (Annual %)

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### Table 3A. Portfolio Total Return Bias Statistics (July – September 2002)

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* 8 Style tilt portfolios were used for USTM, 12 Style tilt portfolios for USTM2.

Table 4A. Portfolio Active Return Bias Statistics (July – September 2002)

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*8 Style tilt portfolios were used for USTM, 12 Style tilt portfolios for USTM2.
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*8 Style tilt portfolios were used for USTM, 12 Style tilt portfolios for USTM2.

Table 5. SAP100 Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.
## Table 6A. SAP500 Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.

## Table 6B. SAP500 Growth Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.
### Table 6C. SAP500 Value Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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<td>1.035</td>
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<td>0.842</td>
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Asterisks indicate statistically significant biases.

### Table 7A. SAP400 Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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<td>Total</td>
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Asterisks indicate statistically significant biases.
### Table 7B. SAP400 Growth Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.

### Table 7C. SAP400 Value Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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<td>Jan. 2004 – Mar. 2004</td>
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<td>0.814</td>
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<td>Oct. 2004 – Dec. 2004</td>
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Asterisks indicate statistically significant biases.
### Table 8A. SAP600 Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.

### Table 8B. SAP600 Growth Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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Asterisks indicate statistically significant biases.
Table 8C. SAP600 Value Portfolio Bias Statistics (Benchmark: USTM Estimation Universe)

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<td>Total</td>
<td>Active</td>
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<td>0.913</td>
<td>1.006</td>
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</table>
Appendix

USTM2 uses a GARCH model to improve its forecasts of common factor risk. Specifically, market risk is modeled as a GARCH process, and the GARCH forecast for market risk over the coming day modifies the USTM2 factor risk forecast.

Let \( \hat{F} \) denote the pre-GARCH factor covariance matrix. It is computed from historical factor returns using an exponentially weighted moving average with a 90-day half-life. It can be decomposed into market and non-market components:

\[
\hat{F} = \beta \beta' \sigma_{MF}^2 + G
\]

Here \( \beta \) is the vector of factor betas with respect to the market, \( \sigma_{MF}^2 \) is the pre-GARCH market factor risk forecast, and \( G \) is the covariance matrix of non-market factor risks.

The USTM2 GARCH sub-model makes a risk forecast for the market portfolio, \( \sigma_{m,GARCH}^2 \). A very small part of this market risk forecast can be attributed to specific risk. Subtracting the specific risk contribution from the GARCH market risk forecast yields a forecast for market factor risk, \( \sigma_{MF,GARCH}^2 \). USTM2 modifies its factor covariance forecast \( \hat{F} \) as to become

\[
\hat{F} = \beta \beta' \sigma_{MF,GARCH}^2 + G
\]

In this way the model impounds information about short-term risk level variations into its factor risk forecasts.