Equities

9 May 2011 | 32 pages

Citi Asia Pacific Risk Attribute Model (APRAM) Version 2.0

Improved Relevance and Accuracy of Macro and Style Exposure Estimation of Your Asia-Pac Portfolio

- **Improved Relevance** — Since the launch of APRAM in 2001, Asian markets have come a long way in terms of their development and integration into the global arena. This has led to new sources of risk exposures. Furthermore, we have developed new tools since, which can be used successfully in conjunction with APRAM.
- **Credit Default Swap as a new macro factor** — We add a credit default swap as a new factor into our Asia Pacific model, in line with the Global RAM model. Our testing and analysis shows that CDS spreads of APxJ Investment Grade companies have a statistically significant impact on the local APxJ market.
- **QuantIFI replaces traditional Size and Style measures** — Our QuantIFI suite of indices represents excess returns to a pure style factor like *Value, Growth etc*. We replace the earlier size and style indices with these and find a significant change in risk attributed to investment styles with an increase in the explanatory power.
- **More frequent updates** — Going forward, we plan to update the model monthly instead of quarterly. The global financial crisis (GFC) showed us that markets can change rapidly during times of stress, and hence a more up-to-date model will help us pick up the changes in the risk environment faster.
- **APRAM applications** — APRAM can be used in many applications beyond risk analysis, which we discuss in brief in this report and also refer the readers to more detailed reports.

■ Quantitative Analysis

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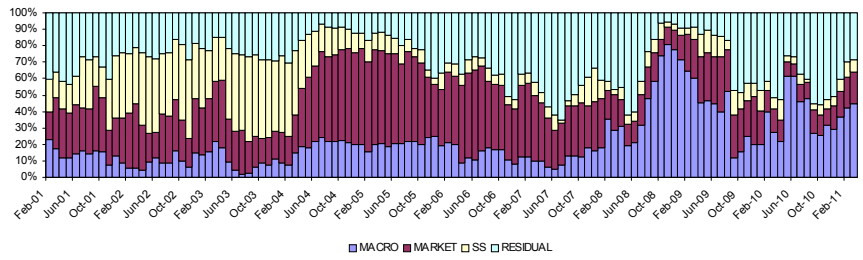
Figure 1. Risk Decomposition of Forward Earnings Yield using APRAM



Source: Citi Investment Research and Analysis

See Appendix A-1 for Analyst Certification, Important Disclosures and non-US research analyst disclosures.

Contents

APRAM v 2.0

The Asia Pacific Risk Attribute Model (APRAM) is one of the key offerings of the Risk Attribute Models (RAM) suites that we offer to our clients, concentrating on Asia Pacific Ex Japan markets. The RAM suite of risk models is a time series risk model, based on macro economic data. The first RAM model was launched for the US market in 1989. Currently, the following models are available:

- Global
- US
- Europe
- UK
- Japan
- Asia Pacific ex Japan
- Australia

Launched in July 2001, APRAM enables portfolio and risk managers to examine their portfolios from a macro-risk perspective and answer the following:

- What is the total and active risk (tracking error) of my portfolio?
- What are the most significant macro exposures of my portfolio?
- Which stocks contribute the most to my total and active portfolio risk?
- What is the sensitivity of my portfolio to various macro factors like falling interest rates, rising oil prices, a weaker dollar, or a widening credit spread?
- Which stocks have the highest and the lowest sensitivities to these economic changes?
- Given that I have a good understanding or a view on how a macro factor like Interest Rates or Yen-Dollar x-rate will pan out, how can I tilt my portfolio to benefit from this?
- What impact do country and sector selection have on the risk profile of my portfolio?

Why a new version?

While the original APRAM continues to be useful for its mandate, the last 10 years have seen an exponential growth in Asian markets in all facets – from returns and tradeability to investor friendly legislation and integration globally. This has led to a change in the risk structure of the Asian universe especially from a global investor's standpoint. The Asian markets today are pretty much where the European markets were 20 years ago – growing, fast moving and volatile.

We have, over time developed newer tools which we feel can be incorporated into the APRAM model giving us a better idea of the risk exposure of a given portfolio. The changes that we are incorporating into our new risk model are the following:

- Addition of credit risk as a macro factor
- Replacing Size and Style Factors with our QuantIFI series of Style Indexes
- Moving to a monthly recalculation of exposures and covariances

In this report we discuss the changes we are making and how they affect the overall analysis and performance of APRAM. In APPENDIX 1, we provide a general description of the model framework.

Model Changes

While the original APRAM model continues to be a useful tool in the hands of portfolio and risk managers, we believe that Asian markets have come a long way since 2001. Asian economies have grown by leaps and bounds and their integration into the global economy continues at a rapid pace. This, obviously, has impacted the Asian equity markets and necessitates some tweaks to the risk framework we have for APRAM. The changes we propose are detailed below.

Adding credit risk as a macro factor

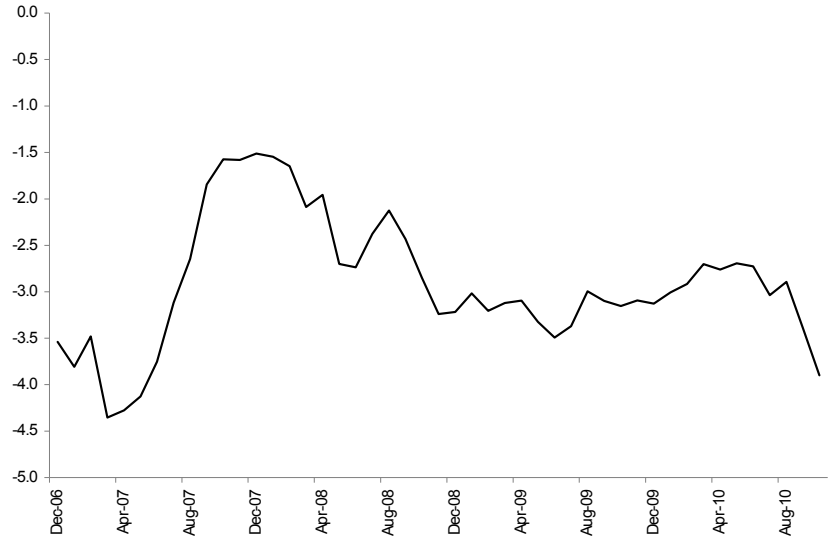
The global financial crisis (GFC) highlighted the importance of credit markets in the global arena, and the role played by credit conditions in the downfall of the global economy. Given this background, we feel that we need to add a "Credit Risk Factor" to our model – bringing the Asian model more in line with the Global Risk Attribute Model (GRAM). Another reason, equally important but far more intangible, is the focus of the investor populace on credit as a risk factor impacting equity markets. We feel that if investors are focusing on credit spreads as a source of risk, it is bound to play an important role – a sort of self-fulfilling prophecy.

Consequently, in the new version of APRAM, we have added a credit risk factor in the form of the Markit Credit Indices for APACxJ (CDX, 5-year Investment Grade). This factor is markedly different from the US Credit factor already present in APRAM. While the US Credit factor captures the cost of borrowing for firms, in a way presenting an indicator of economic conditions prevailing in the US, the CDS factor essentially measures the cost of buying a protection or an insurance policy against the risk of default of its underlying asset.

Testing the fitness of CDS as a contributor to macro risk in Asia

The first test we performed is to check for the importance of the CDS Factor in explaining the returns of MSCI APACxJ Index. The chart below (Figure 2) highlights that the CDS factor plays a statistically significant role in explaining the returns of the index - leaving no doubt as to its importance. A large negative t-stat is an indication of the fact that positive moves in CDS (worsening credit conditions) have a negative impact on Asian markets.

Figure 2. T-Stat of CDS Factor in explaining movements in MSCI APACxJ Index

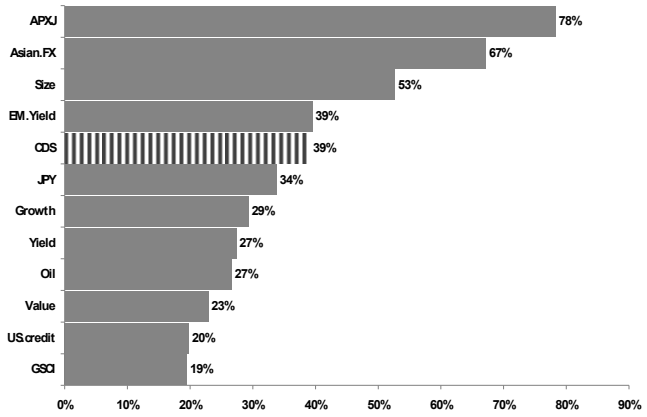


Source: Citi Investment Research and Analysis

Next we examined how significant the CDS factor is in explaining the returns at the stock level. The chart in Figure 3 shows how many of the stocks in the S&P APACxJ BMI universe have a significant t-stat (at 90%) to the macro factors as of end of last month. It is amply evident that CDS comes out to be in top half of the list with approximately 39% of stocks having a significant t-stat.

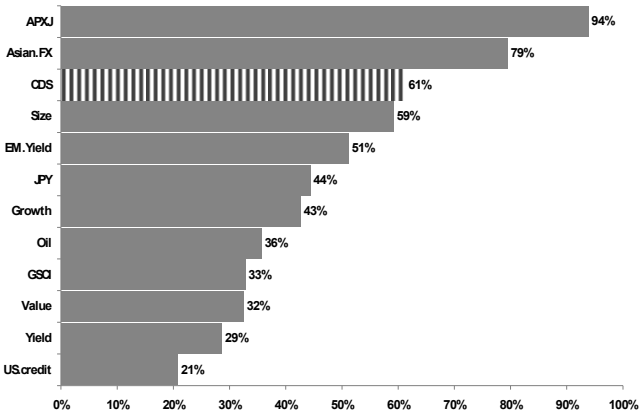
Another way to look at the importance of a macro factor is the percentage of total market cap for which it is significant. This is an important criterion as even though the factor might have a significant t-stat to a lower number of stocks, but if each of this is a large cap – it will be an important factor.

Figure 3. Percentage of Stocks having a significant t-stat at 90% level to the macro factors



Source: Citi Investment Research and Analysis

Figure 4. Percentage of Market Cap having a significant t-stat at 90% level to the macro factors

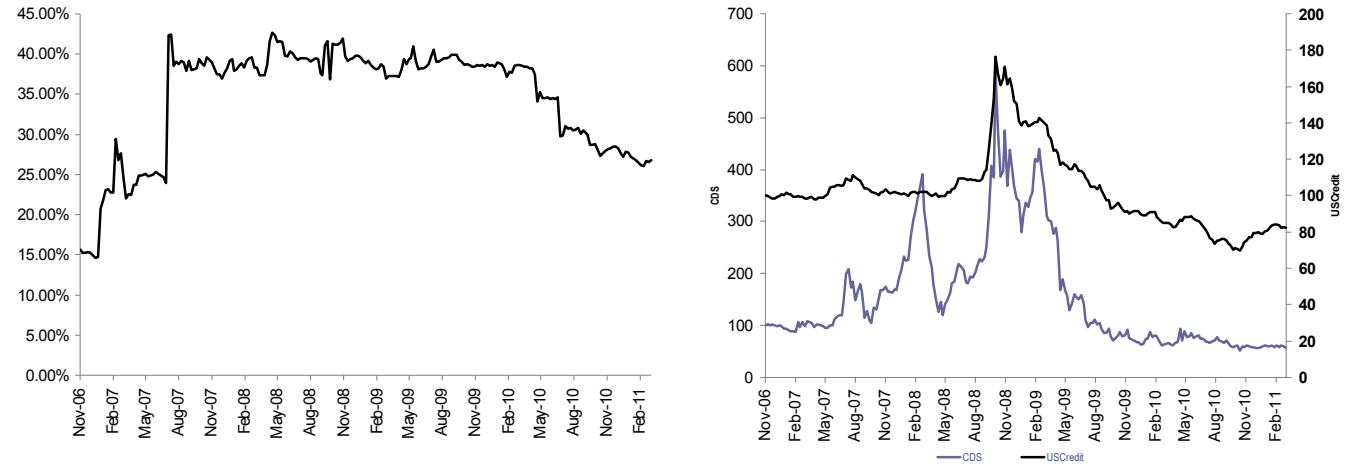


Source: Citi Investment Research and Analysis

The chart in Figure 4 raises some interesting conclusions. While in terms of the number of stocks, CDS was important in explaining ~39%, in terms of market cap it explains close to 61%. This highlights the fact that CDS plays a particularly important role in explaining the returns of the Large and Mid Cap space (the liquid and the investable in APxJ) which will be a larger portion for most of the portfolios.

There can be a valid concern about CDS and US Credit reporting the same phenomenon. To alleviate the concern, Figure 5 below shows the rolling 3 year correlation of the two based on weekly returns along with the index levels. While the correlation went up to 40% during the GFC, it is now coming down gradually.

Figure 5. Correlation between CDS Index and US Credit



Source: Citi Investment Research and Analysis

Replacing Size and Style Indices with QuantIFI

When we launched APRAM in 2001, we constructed size and style indices as factors to capture style and size biases in portfolios. The factors were defined as:

Size: Excess returns of S&P APACxJ EMI (Small Cap) over S&P APACxJ PMI (Large and Mid Cap)

Style: Excess returns of S&P APACxJ PMI Growth Index over S&P APACxJ PMI Value Index

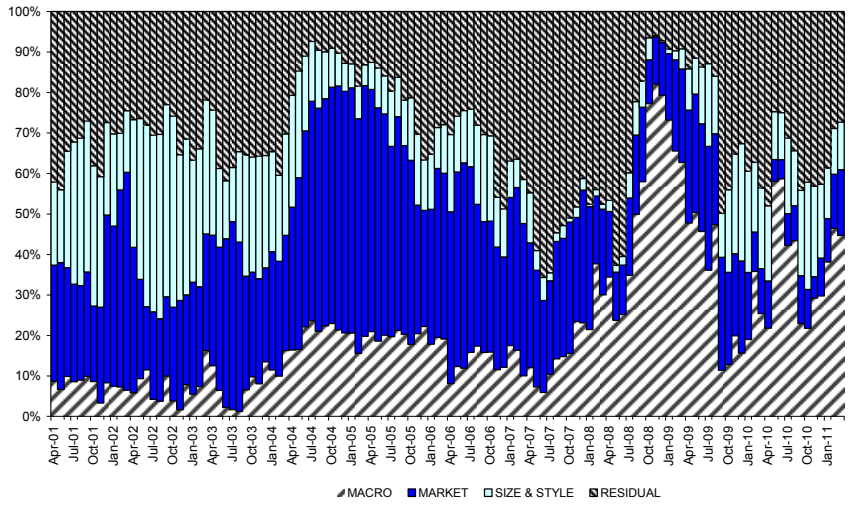
For our new model, we replace Size and Style with their equivalents in our QuantIFI suite of Indices. The QuantIFI Indices reflect the payoff from six different investing styles: Size, Value, Growth, Quality, Risk and Momentum. The returns to each QuantIFI index represents the "pure" payoff to a given equity style, orthogonalized for the effects of other styles as well as sector and country effects.[1]

For the model, we used size, value and growth QuantIFI indices to maintain continuity with our previous models and also because size/growth/value have been traditional styles on which portfolio managers have been benchmarked.

Figure 6 show risk decomposition of a systematic investment style which uses 1 year Fwd PE to decide on stocks to invest in.

[1] For more details on Quantifi style indices refer to our report dated 19th April 2010: **Asia Equity Style Investing with Citi QuantIFI**

Figure 6. Risk Decomposition of 1 yr EY Forward Strategy using QuantIFI Indices



Source: Citi Investment Research and Analysis

A look at the average contribution to risk of various risk components over the last 5 years in Figure 7 shows that QuantIFI indices have been better at picking up contribution of styles to the risk composition of the strategy.

Figure 7. Average Contribution in Risk Decomposition (2006-2011)

	Macro	Region	Styles	Sector	Country	Residual
Size/Style (Quarterly)	30%	9%	7%	7%	10%	37%
QuantIFI	31%	9%	11%	5%	9%	35%

Source: Citi Investment Research and Analysis

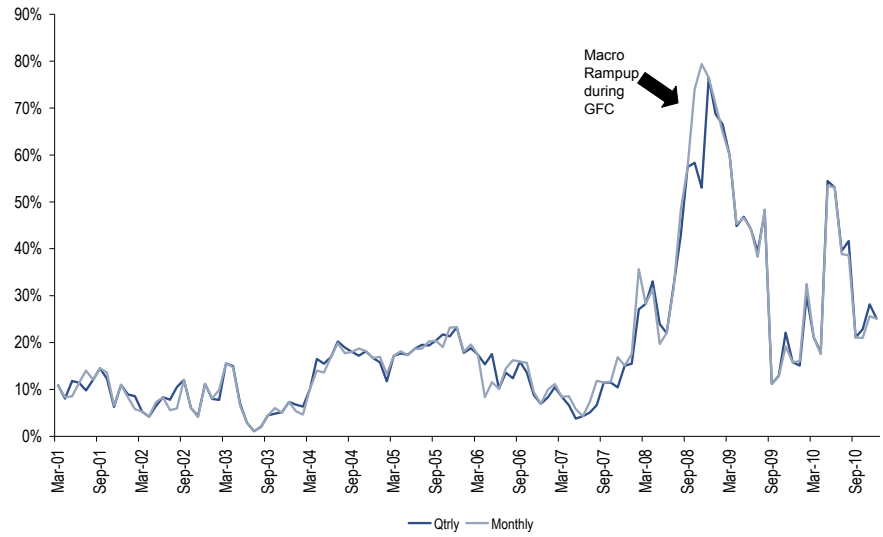
As is evident, QuantIFI does help explain more of the risk as compared to Size/Style Indices (a move of positive 4% in the risk contribution with 2% of it coming from decrease in the residual variance).

Moving to a monthly update frequency

The original APRAM model was updated quarterly. The new APRAM will now be updated at monthly frequencies. The reason for this is that while in stable times betas change relatively slowly, such that the difference between a quarterly and a monthly update is minimal - in volatile times like today, risk characteristics can change fairly fast causing the quarterly model to lag behind. This is evident from Figure 8.

The chart shows the macro risk component of investing in the forward Earnings Yield strategy (long top quintile, short bottom quintile). As is evident, the ramp up in macro risk during GFC in the monthly model is much faster than the quarterly update which tends to lag behind.

Figure 8. Comparison of macro risk component based on two update frequencies



Source: Citi Investment Research and Analysis

Figure 9 below shows the forecast accuracy of quarterly and monthly updates. We measure this by constructing 1,000 random portfolios with a 5% predicted tracking error. The forecast accuracy then is simply the difference between the ex-post and the ex-ante tracking errors.

The comparison clearly shows that using a monthly update with QuantIFI Indices produces the best results.

Figure 9. Tracking errors of various APRAM Models

Mean Percentage Errors	Quarterly Size and Style	Monthly Size and Style	Monthly QuantIFI Styles
2001-2011	11.1	10.85	9.55
2001-2007	5.05	5.190	3.48
2008-2011	24.26	22.93	22.50

Source: Citi Investment Research and Analysis

Summary Statistics for APRAM Version 2.0 Model

In this section we present summary statistics for the new APRAM model, which are:

- Explanatory power of APRAM model in different market cap categories
- Statistical significance of factors
- Predictive accuracy through tracking errors
- Ex-post R-square to gauge the real effectiveness of APRAM model

Explanatory Power

Figure 10 below shows the average R-square in various market cap bins (in millions of USD) for the APRAM model. There is evidence of increasing explanatory power with rising market caps.

Figure 10. R Squared distribution by Market Capitalization Ranges

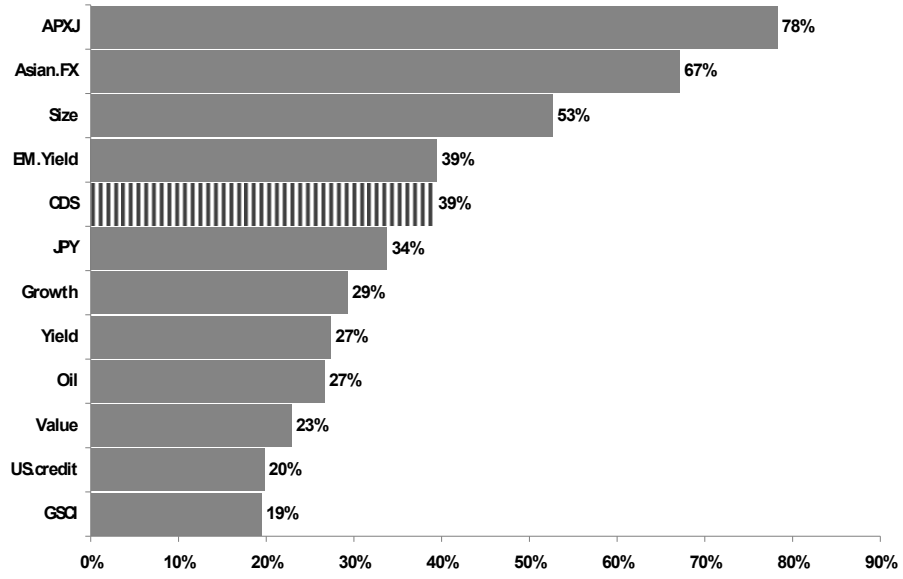
	$200M-500M	$500M-$1000M	>$1000M
1st Quartile	30%	32%	39%
Median	39%	41%	49%
Mean	39%	41%	50%
3rd Quartile	48%	51%	61%
Number of stocks	855	409	702

Source: Citi Investment Research and Analysis

Statistical significance of factor sensitivities

Figure 11 shows the fraction of S&P APACxJ BMI stocks for which the indicated factor is statistically significant at 90% level.

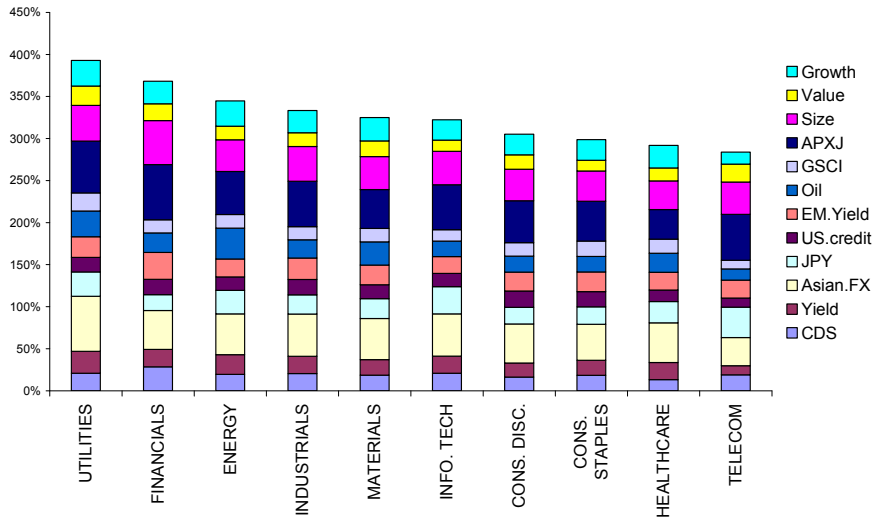
Figure 11. Percentage of S&P BMI Stocks which are sensitive to a given factor at 90% significance



Source: Citi Investment Research and Analysis

Figure 12 shows the percentage of BMI stocks by sectors which have a significant beta to a given factor at the 90% significance level. Utilities and Financials have the most systematic risk while Healthcare and Telecommunication Services the least. As expected, Utilities and Energy are most exposed to GSCI and Oil. Financials is most exposed to CDS and Emerging Market Yields. The order of the factors in the legend and the bar charts is the same. So Growth is the top slot and CDS the bottom most.

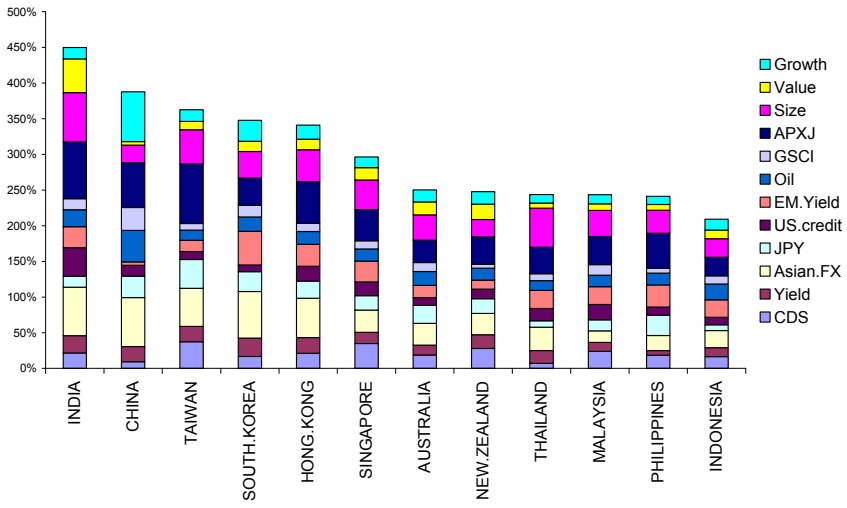
Figure 12. Factor Beta Significance by Sector



Source: Citi Investment Research and Analysis

Figure 13 shows the same chart but this time along country lines. India and China have the most systematic risk while Philippines and Indonesia the least (which should not be surprising considering the liquidity, or the lack thereof, in these two markets). It's interesting to note the level of Growth exposure China has. India has the highest exposure to the other two styles of Value and Size.

Figure 13. Factor Beta Significance by Country

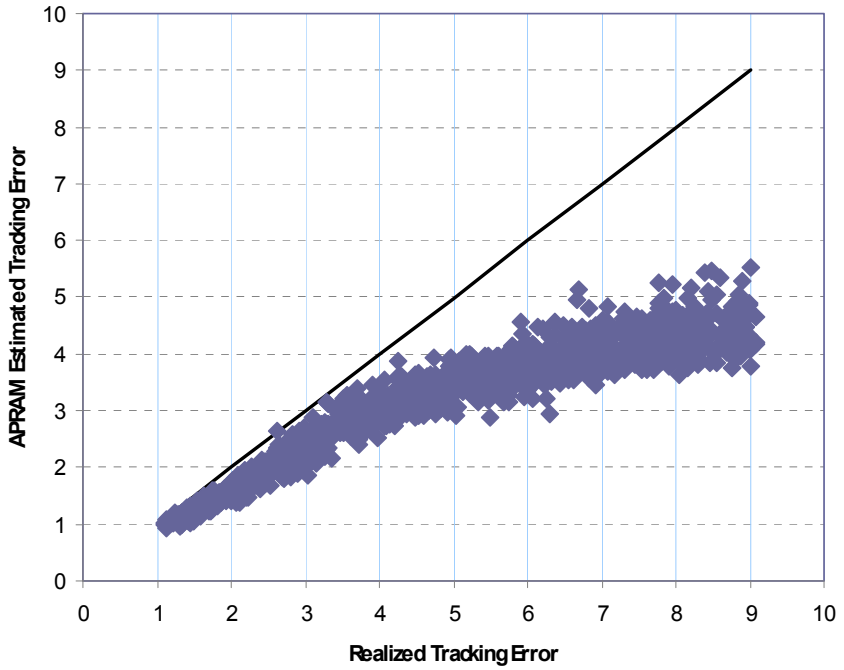


Source: Citi Investment Research and Analysis

Predictive Accuracy of APRAM model

Figure 14 shows the comparison of ex-ante (APRAM calculated) and ex-post (realized) tracking errors of 1000 random portfolios which were created with a tracking error range of 1-9% with respect to S&P APACxJ BMI index. Various constraints were added to ensure that the random portfolios reflect a truly investable portfolio. We used the September 2010 model to forecast the tracking errors and then used the returns until the end of last month to calculate realized tracking errors. Over the last 6 months, the model has had a tendency to over-estimate tracking errors. A comparison of Ex-Post vs. Ex-Ante Tracking Errors over the last 10 years is presented in Appendix 2.

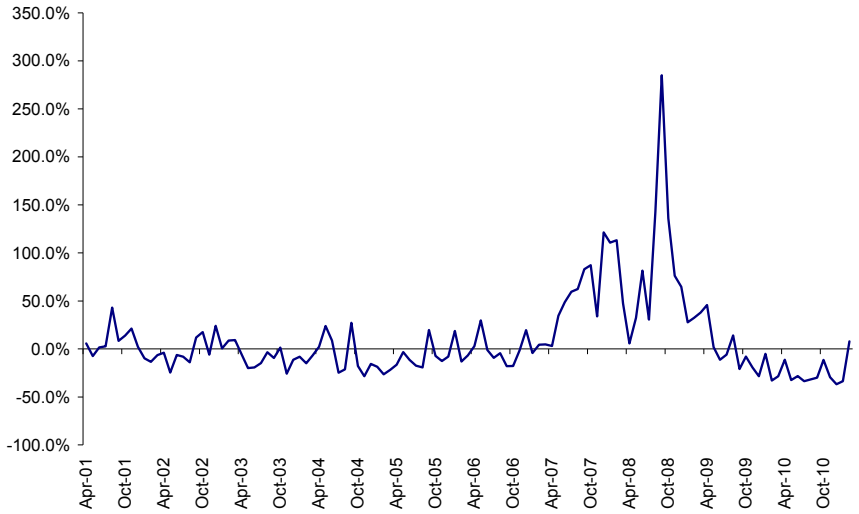
Figure 14. Predicted vs Realized Tracking Errors



Source: Citi Investment Research and Analysis

Figure 15 on the next page shows the mean percentage error at a target of 5% tracking error over the last 10 years. During the global financial crisis, the model wasn't able to ramp up the variance fast enough and hence under predicted the risk. Since 2009, the errors are back to their historical levels, though the model has been slightly over predicting risk as shown by Figure 14.

Figure 15. Mean Percentage Error since April 2001



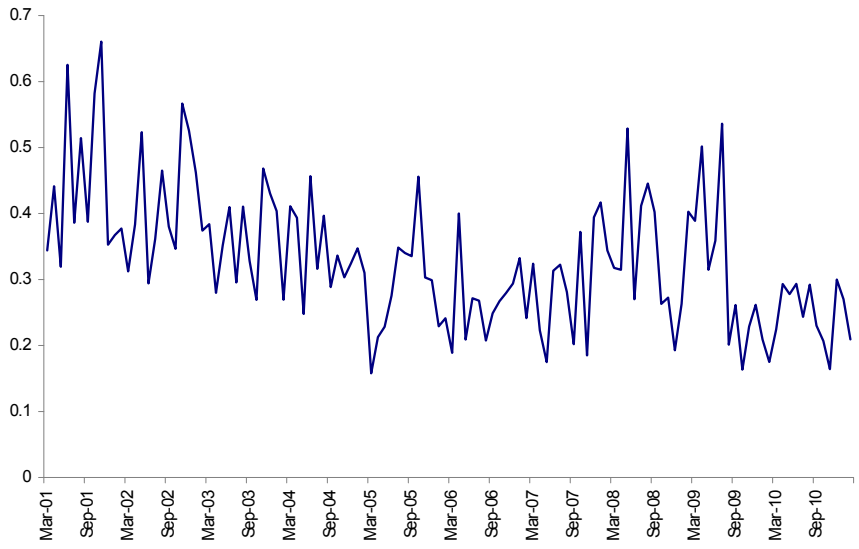
Source: Citi Investment Research and Analysis

Ex-post R-Square of APRAM

Ex-post R-Square is a useful parameter for checking a model's explanatory power. The basic idea is to check the variance of stock returns as captured by the risk model against the actual realized variance. Figure 16 shows the ex-post R-square of APRAM model over the last 10 years. Both the mean and median R-square have been stable at 32% through this period.

The exact calculation methodology is discussed in Appendix 3.

Figure 16. Ex-post explanatory power of APRAM



Source: Citi Investment Research and Analysis

Applications of APRAM

Other than risk reports which are generated using the APRAM model in conjunction with our GRAM-X platform (discussed in more detail in Appendix 4), APRAM models are used by us and many of our clients for various purposes like portfolio optimization, tilting portfolios to specific macro exposures, understanding analyst biases and taking a closer look at the existing macro environment.

Portfolio Optimization

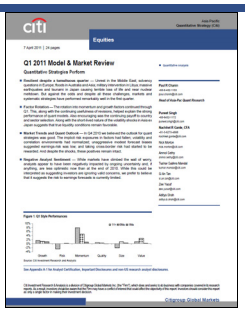
The APRAM model can be easily used for optimizing a portfolio either using a standalone optimizer or the built-in quadratic optimization process. The model performance with respect to other risk models based on fundamental or statistical factors has been especially superior where cross country/sector investments are concerned. We published a report on minimum variance portfolios in APACxJ, which established the superiority of the APRAM macro risk model when compared with other risk models. More details can be found at: Minimum Variance in Asia.

Taking specific macro tilts

The APRAM model can be used for tilting portfolios to macro factors depending on the view of the manager. We wrote a report earlier this year discussing how APRAM can be used to hedge inflation risks which are a rising concern in Asia. More details can be found at: Inflation Fears Loom Large.

Understanding Analyst Biases

Analyst estimates and forecasts are inevitably biased to certain macro factors depending on the stage of the economic cycle. However, by using regression analysis and our APRAM model we can estimate the magnitude and direction of these Macro biases: and neutralize them if we wish. The report can be accessed here: Neutralizing Forecast Bias.



Deeper understanding of macro environment

We frequently use the APRAM model for analyzing the risk decomposition of various systematic investment strategies. Markets go through various phases where they are driven by different factors. This has a knock on effect on the kind of risk exposures (macro, sector, and style) different systematic strategies have. This in turn can be useful for changing the method of portfolio construction e.g. Unrestricted versus Country Sector Neutral.

One can also use the changing percentages of significant t-stats over time to understand which factors are gaining in significance and which are declining. This can then be used for hedging or taking tilts appropriately.

More details can be found at: Q1 2011 Model & Market Review.

APPENDIX 1 – APRAM Model Framework

In this section, we describe the general framework of APRAM model and the risk attribution and decomposition methodology.

APRAM is a macroeconomic time series factor model, which can be represented by the following equation for an individual stock *i*:

$$r_{it} = a_i + \sum_j b_{ij}^{ME} F_{jt}^{ME} + b_i^{EM} F^{EM} + \sum_j b_{ij}^{QI} F_{jt}^{QI} + b_i^{S} F_t^{S} + b_i^{C} F_t^{C} + e_{it}$$

where:

t = time period under consideration

r_{it} = Total return of the stock

a_i = Expected total return of the stock when all of the factors equal zero

F_{jt}^{ME} = Return to the macroeconomic factor j in time period t

b_{ij}^{ME} = Sensitivity of the stock to macroeconomic factor j

F^{EM} = Return to the regional equity market factor j in time period t

b_i^{EM} = Sensitivity of the stock to equity market factor j

F_{jt}^{QI} = Return to the QuantIFI style factor j in time period t

b_{ij}^{QI} = Sensitivity of the stock to Quantifi style factor j

F_t^{S} = Return of the Sector (the stock belongs) factor

b_i^{S} = Sensitivity of the stock to its sector factor

F_t^{C} = Return of the Local market (of the stock) factor

b_i^{C} = Sensitivity of the stock to its local market factor

e_{it} = Unsystematic (idiosyncratic) component of the stock's total return that is independent of the factors used in the model

The risk model assumes that systematic changes in stock prices are generated only by changes in the values of the risk factors. Any component of a stock's return that is not generated by changes in the values of the *common factors* is assumed to be specific to that particular stock. Furthermore, the specific component of a stock's return is uncorrelated to the specific component of every other stock's return. In this way, any correlation or co-movement of stock returns comes only through their joint reaction to changes in the risk factors.

With this structure of stock returns, the dimensionality of analyzing a large universe of stocks is thereby vastly reduced because we no longer need to determine the interactions between every pair of stocks; we need only determine the interactions between every pair of risk factors as well as the sensitivity of each stock return to each factor.

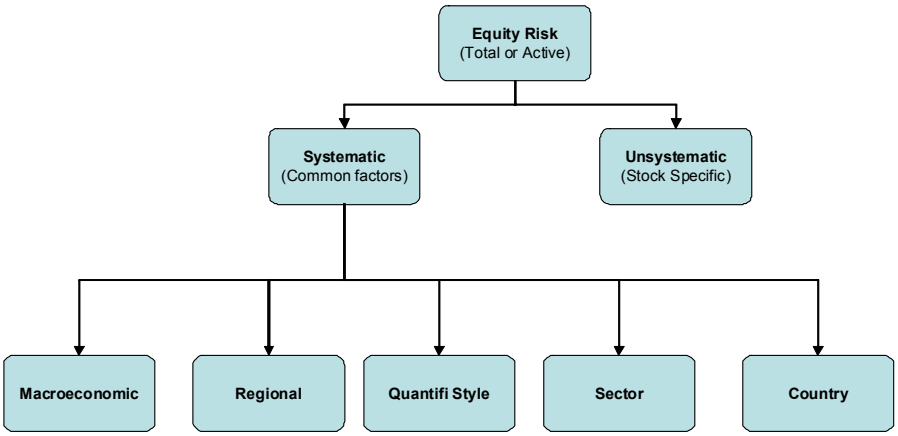
Based on equation (1), the total risk, or the variance of the stock return, can be represented by the following equation:

$$Var(r_i) = \sum_j b_{ij}^2 Var(F_j) + \sum_{k \neq j} b_{ik} b_{ij} Cov(F_k, F_j) + Var(e_i)$$

where the first term is the components attributable to each of the risk factors, the second term is the risk contribution from the correlations among the factors, and the last term is the stock's residual variance or idiosyncratic risk.

Similarly, the risk decomposition for a portfolio can be shown schematically (Figure 17). Note that *total risk* is the variance of the portfolio returns, while the *active risk* is the tracking variance, which is the variance of the difference between the portfolio and benchmark returns.

Figure 17. Risk Decomposition by APRAM



Source: Citi Investment Research and Analysis

More specifically, a portfolio's return can be expressed as follows:

$$r_{pt} = \sum_i w_i a_i + \sum_j (\sum_i w_i b_{ij}^{ME}) F_{jt}^{ME} + \sum_i w_i b_i^{EM} + \sum_j (\sum_i w_i b_{ij}^{QI}) F_{jt}^{QI} + (\sum_i w_i b_i^S) F_t^S + (\sum_i w_i b_i^C) F_t^C + \sum_i w_i e_{it}$$

where w_i is the weight of the stock ***i*** in the portfolio.

And its variance or total risk can be decomposed as follows:

$$Var(r_p) = \sum_j b_{pj}^2 Var(F_j) + \sum_{k \neq j} b_{pk} b_{pj} Cov(F_k, F_j) + Var(e_p)$$

where:

$b_{pj} = \sum_i w_i b_{ij}$ is the portfolio's beta to factor j, and

$Var(e_p)$ is the stock specific component of the portfolio risk.

Factors in APRAM

Emerging Markets Bond Yield

A negative portfolio beta to this factor implies that the portfolio is more vulnerable to rising emerging market yields.

The emerging market bond yield factor is the weekly percentage change of the yield of the Citi Emerging Market Sovereign-Capped Bond Index (ESBI-C).

Rising emerging market bond yield is typically associated with increasing emerging market risk aversion.

Short Term Rate

Short term rates can have a significant impact on financing of working capital and other balance sheet items of the companies.

Short term rate is defined as the market cap weighted short term rate (3 month) of various countries in the Asia Pacific ex Japan region.

Credit Default Swap

A positive portfolio beta to this factor implies that the portfolio is more defensive towards rising credit risk, or has relatively lower credit risk.

The credit default factor is defined as the Markit Credit Indices for APACxJ (CDX, 5-year Investment Grade). This credit factor reflects the default risk of Asia Pacific ex Japan investment grade corporate bonds.

US Credit

A positive beta to this factor usually indicates that the said stocks (or portfolio) will benefit from worsening US economic conditions.

The US credit factor in GRAM is defined as the spread of BAA Rated US Corporate bonds over 10 year treasury yields. This factor is an indicator of US economic conditions with widening US Credit Spreads usually indicating a de-rating of BAA Credit indicating worsening economic outlook.

Oil Price

A positive portfolio beta to this factor implies that the portfolio is likely to benefit from rising oil prices.

The oil price factor is the percentage change of the spot price (in US dollars) of the Brent Crude Oil.

Other than the direct impact of oil prices on energy costs, changes in oil prices also serve as an important proxy for global inflation and growth expectations.

Commodities Price

A positive portfolio beta to this factor implies that the portfolio is likely to benefit from rising commodity (excluding energy) prices.

The commodity price factor is the weekly percentage change of the S&P GSCI All Commodities Ex-Energy Index.

We have observed decoupling of Energy and other commodities prices which warrants the inclusion of a separate commodities price risk factor in addition to the oil price factor.

Currency - JPY/US$ Exchange Rate

Competitiveness of Yen can have a major impact on the stocks in this region as growth in many companies is export oriented.

We have included JPY/US$, measured as the weekly percentage changes of the exchange rates in the model.

A positive portfolio beta to the Yen/US$ implies that the portfolio is likely to benefit from a stronger USD vs. Yen.

Asian FX factor captures many aspects of the Asian economies including fund flows and global competitiveness with respect to other regions like LatAm and CCEEMA.

Currency – Asian FX Exchange Rate

We define the Asian FX as the difference in total returns of MSCI APACxJ Local Currency Index and MSCI APACxJ US$ denominated index. In a way, this would be same as market cap weighted returns of Asian currencies.

Regional Equity Market (residual)

The market factor is based on the weekly total returns of the MSCI APACxJ Index in US dollars. We perform an OLS regression of this variable on the above seven macroeconomic variables. We then use the residuals of this regression as the final regional equity market factor.

QuantIFI APACxJ Size, Growth and Value Indices (residual)[2]

The QuantIFI suite of Indices that reflect the payoff from six different investing styles of Size, Value, Growth, Quality, Risk and Momentum. The returns to each QuantIFI index represents the "pure" payoff to a given equity style, orthogonalized for the effects of other styles as well as sector and country effects. In our model, we include three of these indices, namely Size, Value and Growth.

Sector Factors (residual)

The sector factor for a given individual stock is based on the weekly total return in US dollars of the sector indexes derived by using MSCI index as the main constituent list and MSCI GICS Classification for grouping these stocks into different sectors. We then perform an OLS regression of sector indices on the seven macroeconomic factors, one regional factor and six Quantifi indices. The residuals of this regression are the final sector factor. There are ten GICS sectors.

Local Market/Country Factors (residual)

The local market/country factor for a given individual stock is based on the weekly total return in local currency of the MSCI country index to which that stock belongs, except for stocks from the frontier markets. We perform an OLS regression of these indices on the seven macroeconomic factors and the residualized regional market, QuantIFI and Sectoral indices as defined above. The residuals from this regression are the local market factor.

[2] For more details on Quantifi style indices refer to our report dated 19th April 2010: **Asia Equity Style Investing with Citi QuantIFI**

Model Estimation

For each stock, we have identified eight macroeconomic factors and six equity market factors.

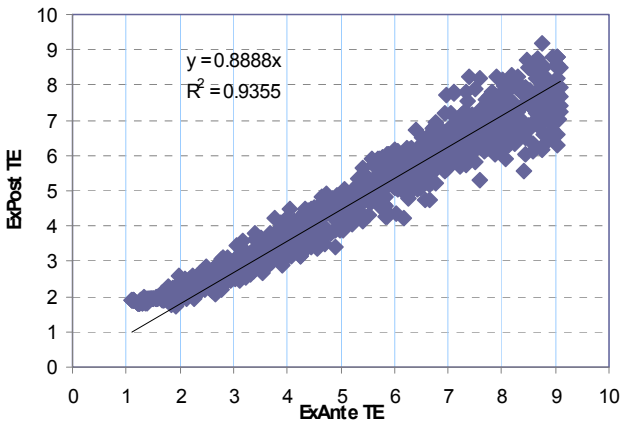
Currently the model covers close to 13,000 equity securities from 14 countries in Asia Pacific ex Japan.

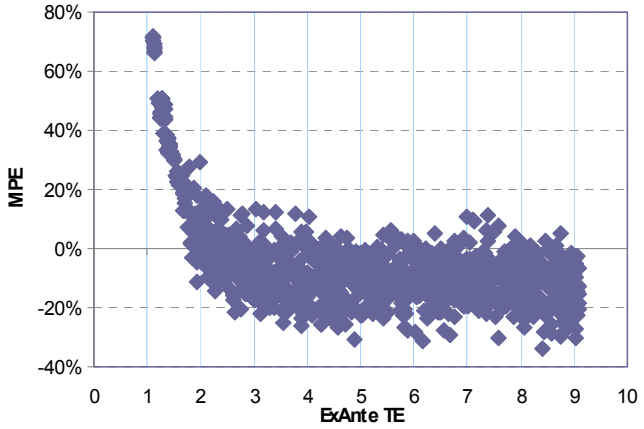
For each individual stock, we have identified eight macroeconomic factors, one regional equity market factor, three QuantIFI indices, one sector index and one market index. The factor sensitivities, or betas, and the stock specific variance are estimated for every stock by regressing three years of weekly stock total returns in its local currency on the weekly values of the 14 factors. The weekly data points are equally weighted in the regression analysis. We use a robust regression technique to mitigate impacts of potential outliers. In addition, we require a minimum of 52 weeks of returns to perform the regression analysis. Stocks with less than 52 weeks of returns will use the average exposures and residual variance of other stocks from its corresponding sector of its local country as substitutes.

APPENDIX 2 – Tracking Error Comparisons

The charts below (Figure 18 – 27) present the ex-ante vs. ex-post tracking error comparison over the last ten years for APRAM. 1,000 random portfolios with a tracking error range of 1-9% with respect to S&P APACxJ BMI index were generated using various constraints to ensure that they do reflect a truly investable portfolio. We used the September model of every year since 2001 to forecast the tracking errors and then used the returns until March end of the following year to calculate realized tracking errors. Ex-Post vs. Ex-Ante Tracking Error comparisons are on the left and the Mean Percentage Error (MPE) vs. Ex-Ante Tracking Error comparison in on the right.

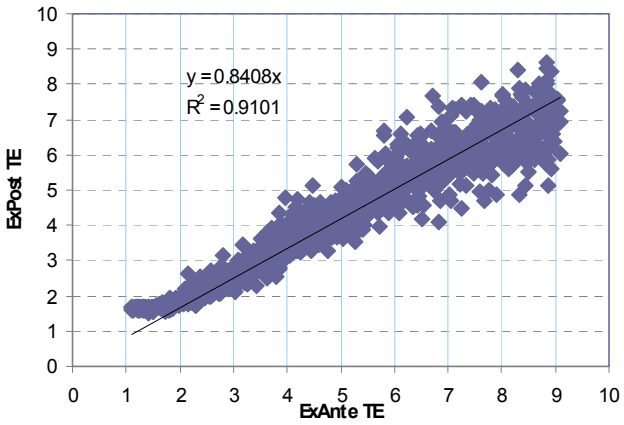
Figure 18. Sep 2001-Mar 2002

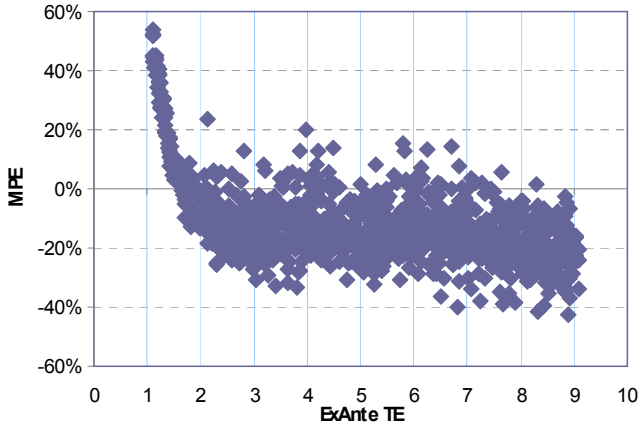




Source: Citi Investment Research and Analysis

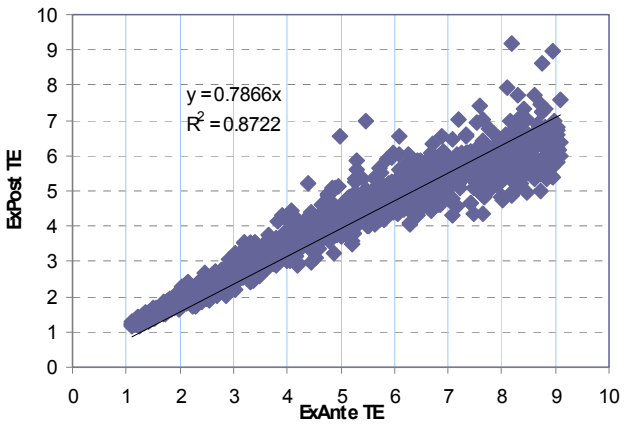
Figure 19. Sep 2002-Mar 2003

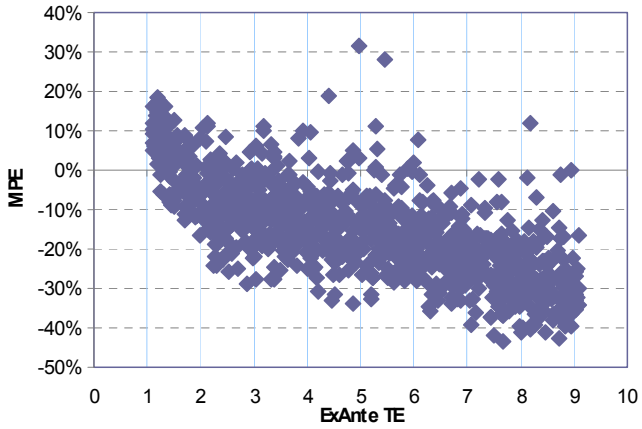




Source: Citi Investment Research and Analysis

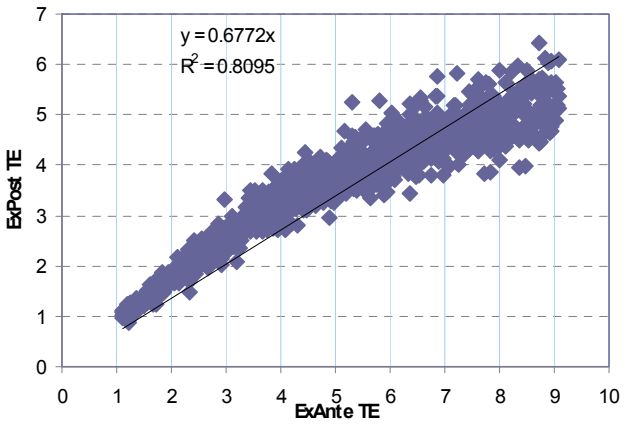
Figure 20. Sep 2003-Mar 2004

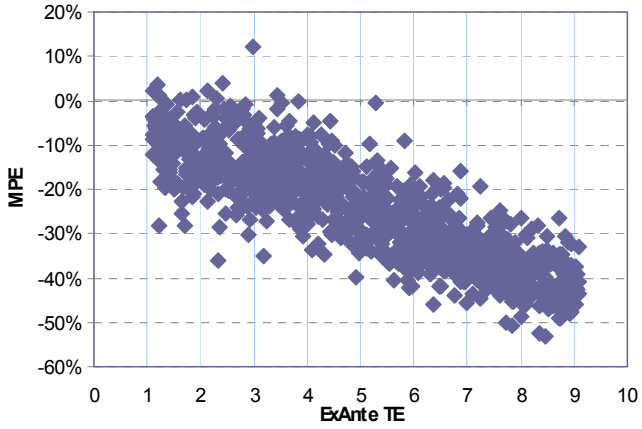




Source: Citi Investment Research and Analysis

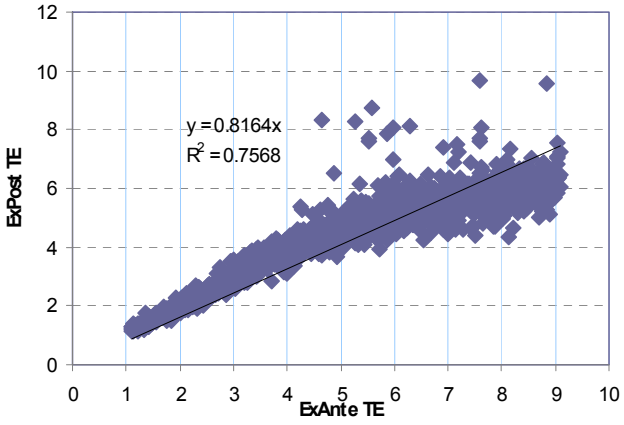
Figure 21. Sep 2004-Mar 2005

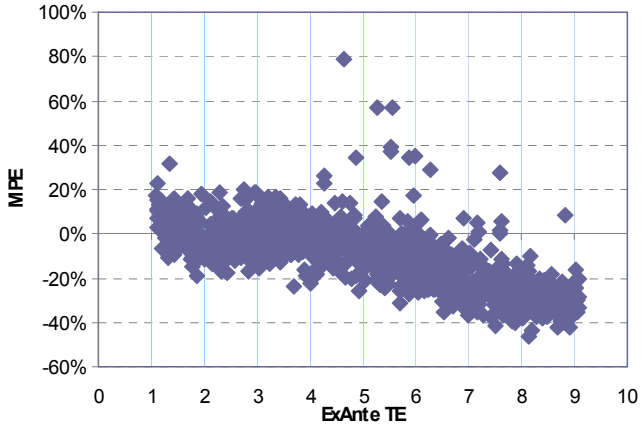




Source: Citi Investment Research and Analysis

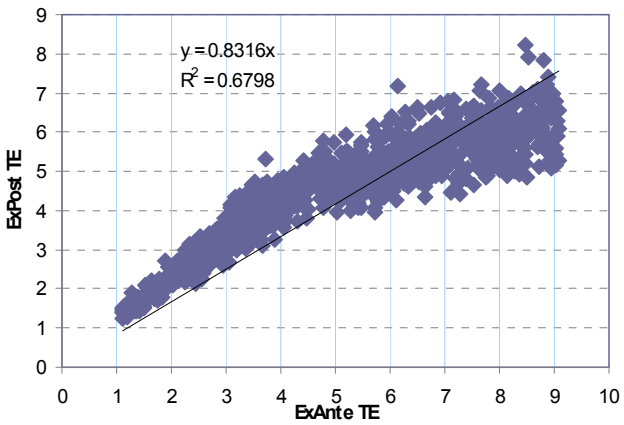
Figure 22. Sep 2005-Mar 2006

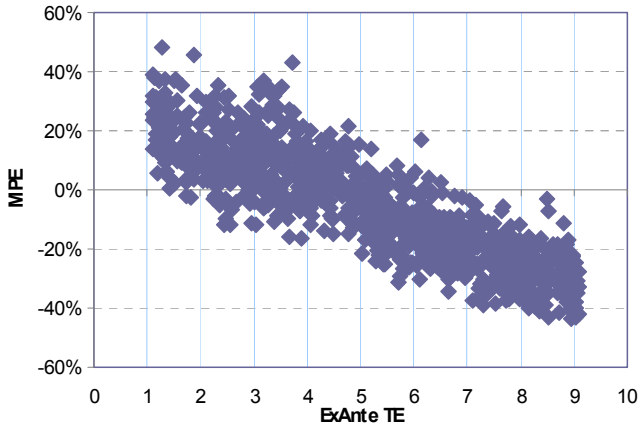




Source: Citi Investment Research and Analysis

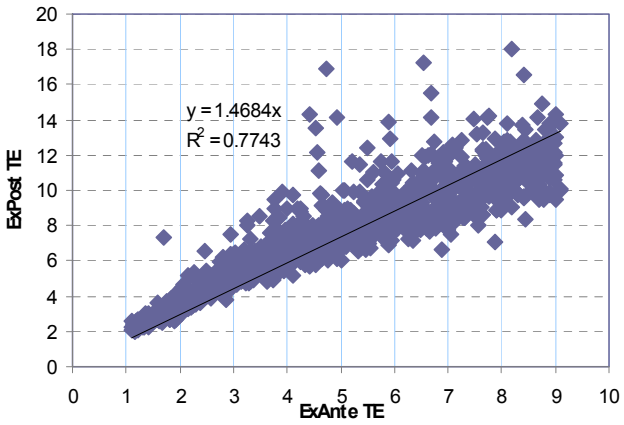
Figure 23. Sep 2006-Mar 2007

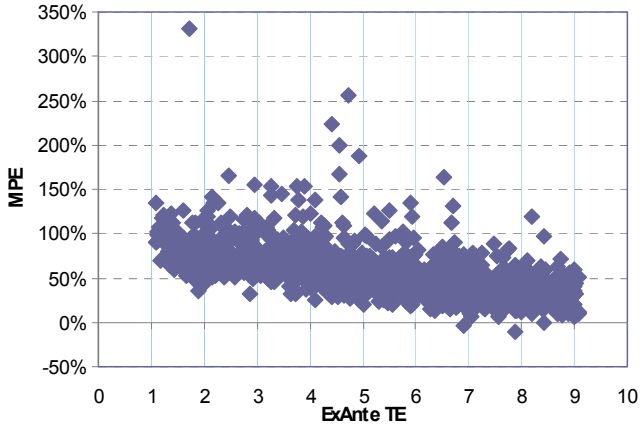




Source: Citi Investment Research and Analysis

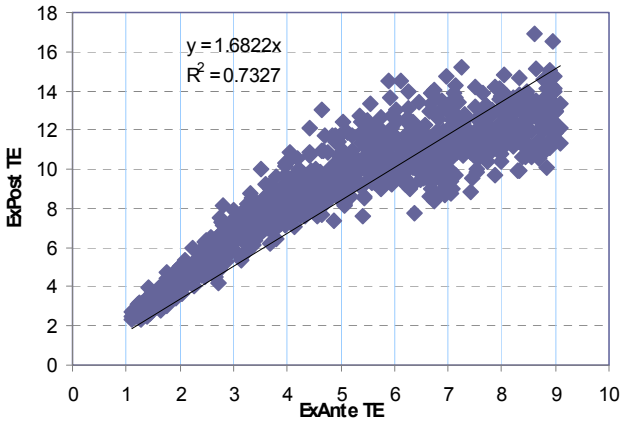
Figure 24. Sep 2007-Mar 2008

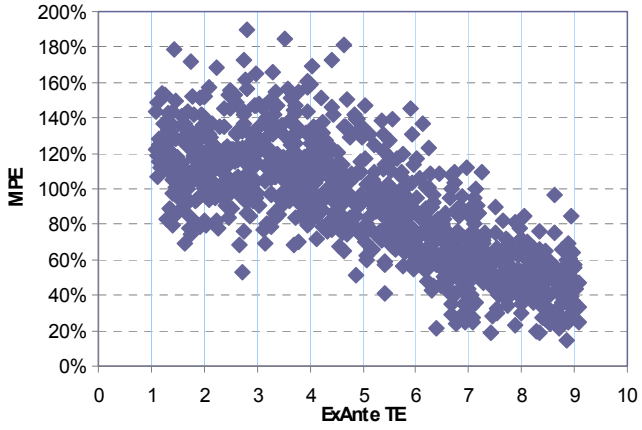




Source: Citi Investment Research and Analysis

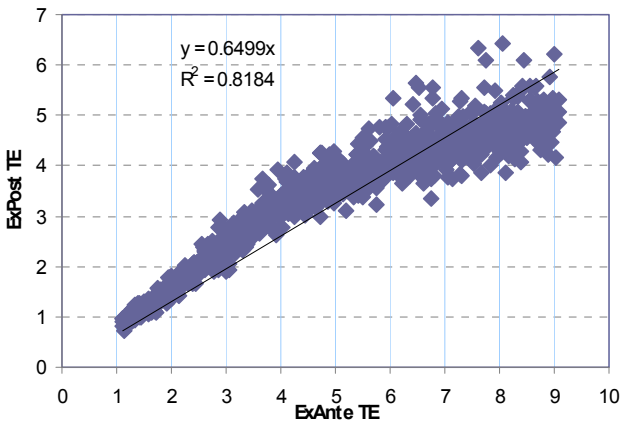
Figure 25. Sep 2008-Mar 2009

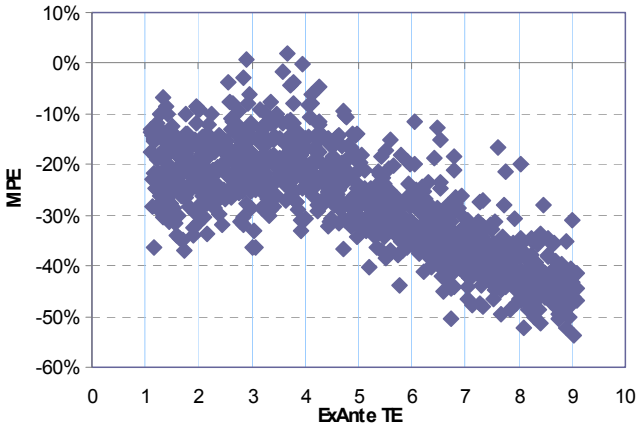




Source: Citi Investment Research and Analysis

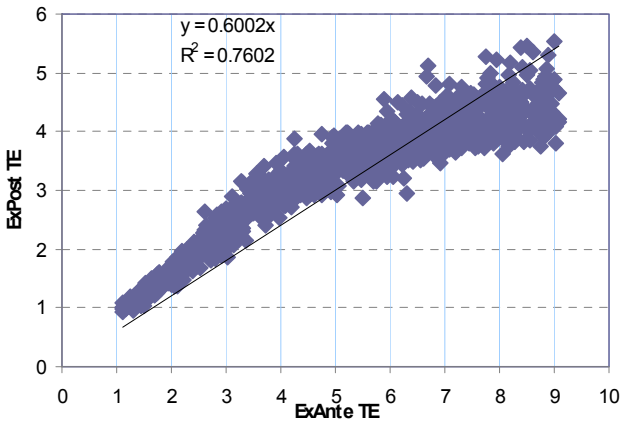
Figure 26. Sep 2009-Mar 2010

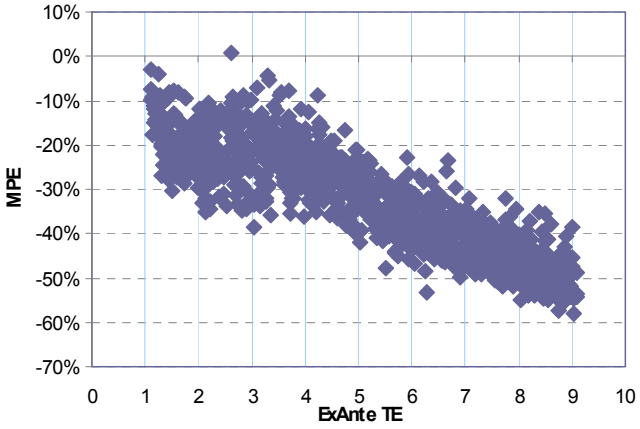




Source: Citi Investment Research and Analysis

Figure 27. Sep 2010-Mar 2011





Source: Citi Investment Research and Analysis

APPENDIX 3 – Calculating Ex-post R-Squared

We undertake a two step process in determining ex-post r-square of the risk model.

Pure Factor Returns

We can express stock returns over any period using the following regression equation

$$R = XF + u$$

Where R – Stock returns of every stock in the universe

X – Matrix of the betas of stocks to the different APRAM factors

F – Returns of the APRAM factors

u – Stock specific returns

Pure factor portfolios are then computed as

$$P_X = (x^T x)^{-1} \cdot (x^T)$$

Pure factor returns are then estimated by cross multiplying the factor portfolios into the next period returns of each stock

$$F = P_X \cdot R$$

Once we have this we can calculate the realized contribution of APRAM factors to stock returns (***XF*** above)

The ex-post r-square then can be calculated as:

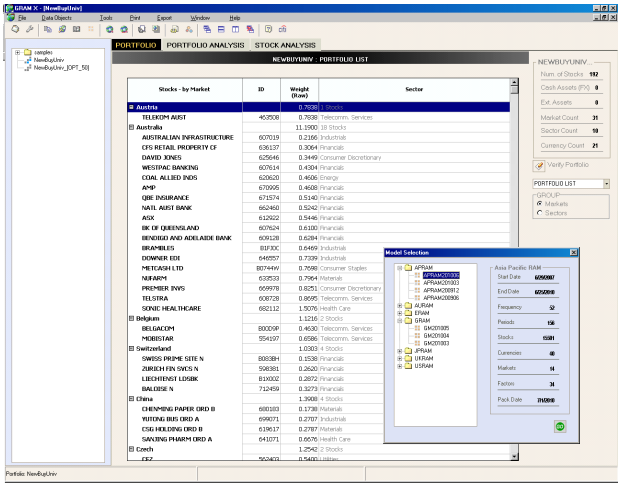
$$\sum (XF - \overline{R})^2 / \sum (R - \overline{R})^2$$

where $\overline{R}$ is the mean of realized stock returns.

APPENDIX 4 – GRAM-X software

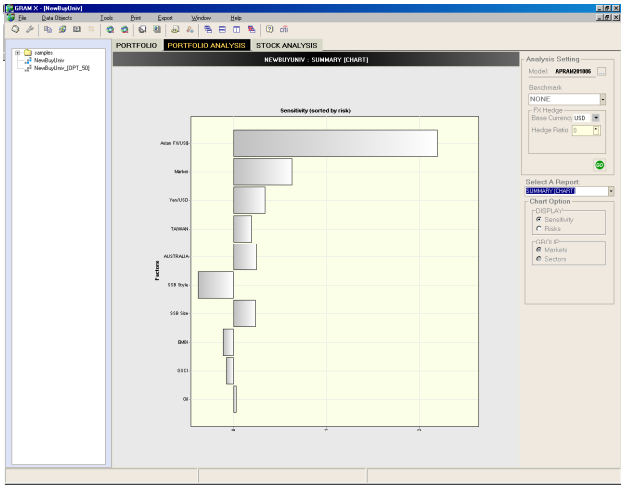
GRAM X – Global Ram (Extended) is our delivery platform for RAM models. One can use this software for both the risk analysis of the portfolios and building portfolios with specific macro exposures. We provide the latest models through our website, which clients can download. Below are a few screenshots from the software.

Figure 28. Main screen with user defined portfolio and model to use



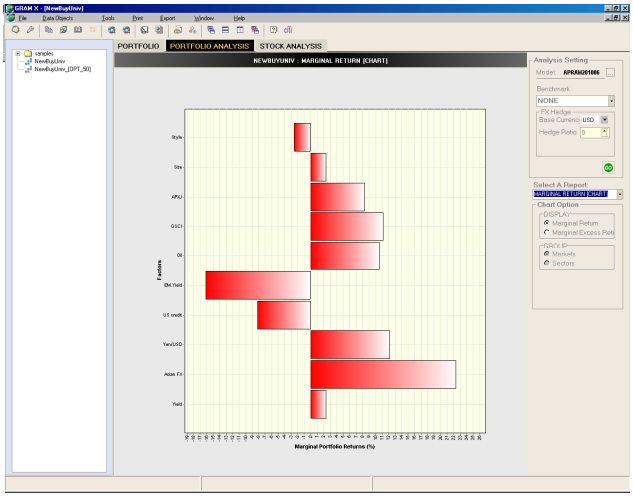
Source: Citi Investment Research and Analysis

Figure 29. Summary screenshot showing main exposures



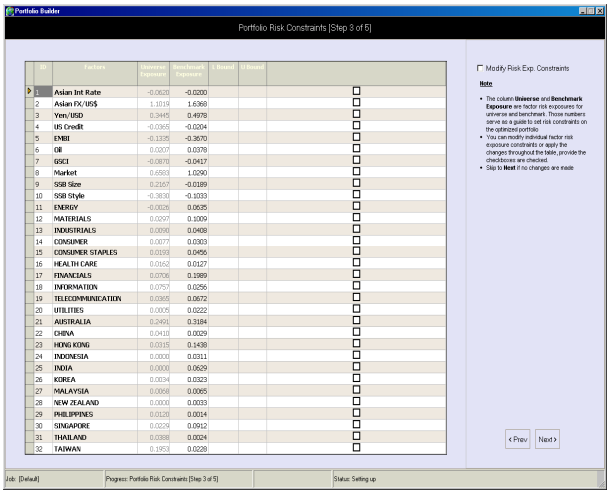
Source: Citi Investment Research and Analysis

Figure 30. Screen showing marginal portfolio returns



Source: Citi Investment Research and Analysis

Figure 31. Optimizer to help take macro bets



Source: Citi Investment Research and Analysis

In the following pages, we show the Summary Active Risk Report, which gives the active risk (tracking error) of a portfolio relative to its benchmark and the major sources of the active risk. Then, we show the detailed Risk Decomposition Report, which lists the total and active risk (tracking error) of a portfolio vs. its benchmark, as well as the risk contributed by each of the factors. Third, we show the Factor Exposure Report, which provides the factor sensitivities of the portfolio and its benchmark, as well as the estimated effects on portfolio returns of marginal increases in the risk factors. The link to our website for accessing the software is provided at the end of the section.

Summary Active Risk Report

In Figure 32, we show the RAM Summary Active Risk Report. The first two rows of the report contain the active risk, or tracking error, of the portfolio and the portfolio tracking variance (square of the tracking error). The remainder of the top half of the report lists the amount and percentage of tracking variance contributed by the factors and the amount and percentage of the stock specific (unsystematic) component. The bottom half of the report lists the factors that explain the most tracking variance and shows the difference between the portfolio and benchmark factor sensitivities.

Figure 32. APRAM Summary Active Risk Report

Risk from factors defined in APRAM

Residual Risk

Factors contributing most significantly to risk

Tracking Error with respect to a user defined benchmark

Analysis Summary		
Tracking Error/Volatility	8.69%	
Portfolio Benchmark Correlation	0.99	
	Variance	% of Variance
Total	75.44	100.00%
Systematic	19.82	26.27%
MACRO	20	26.51%
SECTOR	6.48	8.60%
COUNTRY	1.84	2.43%
Covariance	-8.5	-11.27%
Unsystematic	55.62	73.73%

Most Significant Factors	Sensitivity	% of Variance
QUANTIFI Size Index	-0.53	5.41%
EMBI	-0.1	4.91%
GSCI	0.09	4.67%
Market	-0.16	4.00%
Asia CDS	0.02	3.42%
FINANCIALS	-0.25	3.21%
INFORMATION TECHNOLOGY	-0.1	2.49%
MATERIALS	0.11	1.91%
Asian FX/US$	-0.13	1.71%
Oil	-0.03	1.59%
AUSTRALIA	-0.12	0.99%

Source: Citi Investment Research and Analysis

Risk Decomposition Report

The APRAM Risk Decomposition report, shown in Figure 33, provides complete details for the risk breakdown. In addition to the tracking variance displayed in the Summary Report, the Risk Decomposition report includes the Benchmark Variance and Portfolio Variance decompositions. This report also contains the complete set of factors showing percent contributions.

Figure 33. Risk Decomposition Report

A more detailed look at the risk analysis with list of all the factors with categorizati

Model R-Square of the portfolio

	Portfolio (%)		**Benchmark** (%)		**Tracking** (%)	
Tracking Error/Volatility	32.21%		31.86%		8.69%	
Total	1037.77	100%	1014.75	100%	75.44	100%
Systematic	974.38	94%	1005.73	99%	19.82	26%
Factors	544.34	52%	611.76	60%	28.32	38%
Covariance	430.04	41%	393.97	39%	-8.5	-11%
Unsystematic	63.38	6%	9.02	1%	55.62	74%
MACRO						
Asia CDS	21.95	2%	39.59	4%	2.58	3%
Asian Int Rate	0.46	0%	0.19	0%	0.06	0%
Asian FX/US$	362.63	35%	407.19	40%	1.29	2%
Yen/USD	12.05	1%	10.98	1%	0.03	0%
US Credit	0.57	0%	0.03	0%	0.32	0%
EMBI	45.94	4%	23.56	2%	3.7	5%
Oil	0.15	0%	0.5	0%	1.2	2%
GSCI	1.45	0%	0.45	0%	3.52	5%
Market	80.3	8%	114.47	11%	3.02	4%
QUANTIFI Size Index	8.48	1%	0.8	0%	4.08	5%
QUANTIFI Value Index	0.03	0%	0.01	0%	0.08	0%
QUANTIFI Growth Index	0.14	0%	0	0%	0.11	0%
SECTOR						
ENERGY	0.07	0%	0.46	0%	0.17	0%
MATERIALS	5.14	0%	1.14	0%	1.44	2%
INDUSTRIALS	0	0%	0.42	0%	0.35	0%
CONSUMER DISCRETIONARY	0.16	0%	0.37	0%	0.04	0%
CONSUMER STAPLES	0.02	0%	0.14	0%	0.05	0%
HEALTH CARE	0	0%	0.02	0%	0.02	0%
FINANCIALS	0.01	0%	2.73	0%	2.42	3%
INFORMATION TECHNOLOGY	0.08	0%	2.73	0%	1.88	2%
TELECOMMUNICATION SERVICES	0	0%	0.09	0%	0.07	0%
UTILITIES	0	0%	0.03	0%	0.03	0%
COUNTRY						
AUSTRALIA	0.54	0%	2.55	0%	0.74	1%
CHINA	0	0%	0	0%	0	0%
HONG KONG	0.37	0%	1.25	0%	0.26	0%
INDONESIA	0	0%	0.16	0%	0.16	0%
INDIA	3.7	0%	1.47	0%	0.51	1%
SOUTH KOREA	0	0%	0.03	0%	0.01	0%
MALAYSIA	0	0%	0.03	0%	0.03	0%
NEW ZEALAND	0	0%	0	0%	0	0%
PHILIPPINES	0.01	0%	0.01	0%	0	0%
SINGAPORE	0.03	0	0.24	0	0.1	0
THAILAND	0	0	0	0	0	0
TAIWAN	0.03	0	0.1	0	0.02	0

Source: Citi Investment Research and Analysis

Factor Exposure Report

APRAM also provides a Factor Exposures report (Figure 34). This provides an analysis which includes the Marginal Excess Return, or the excess return relative to the benchmark that the portfolio would realize if the factor changed by one standard deviation. A positive (negative) number implies that the portfolio is likely to outperform (underperform) the benchmark when the value of the risk factor is positive. Also shown are the Factor Standard Deviation (the annualized standard deviation of the individual factor) and the Marginal Portfolio Return (the expected return that the portfolio would realize if the factor increased by one standard deviation). The first three columns contain the Portfolio Beta (the factor sensitivities of the portfolio), the Benchmark Beta (the factor sensitivities of the benchmark), and the Difference in Beta (the difference between the portfolio beta and the benchmark beta for each factor).

Figure 34. Factor Exposure Report

Expected portfolio return if factor rises by 1 sd

Annualized volatilty of the factor

	Portfolio	Benchmark	Difference	Factor SD (%)	Marginal Portfolio Return (%)	Marginal Excess Return (%)
MACRO						
Asia CDS	-0.06	-0.08	0.02	83.89	-24.61	0.59
Asian Int Rate	-0.04	-0.03	-0.01	17.03	-0.1	-0.11
Asian FX/US$	2.13	2.25	-0.13	8.95	28.32	-0.32
Yen/USD	0.29	0.28	0.01	11.95	12.18	-0.39
US Credit	-0.03	-0.01	-0.02	24.35	-10.38	-1
EMBI	-0.35	-0.25	-0.1	19.36	-23.29	-1.06
Oil	-0.01	0.02	-0.03	43.19	12.03	-0.08
GSCI	0.06	-0.03	0.09	21.21	16.77	1.22
Market	0.82	0.98	-0.16	10.9	8.96	-1.74
QUANTIFI Size Index	-0.77	-0.23	-0.53	3.8	-2.76	-1.87
QUANTIFI Value Index	-0.06	0.03	-0.09	3.15	0.14	-0.07
QUANTIFI Growth Index	-0.12	-0.01	-0.1	3.27	0.59	0.32
SECTOR						
ENERGY	0.03	0.07	-0.04	9.98	0.27	-0.42
MATERIALS	0.21	0.1	0.11	11.02	2.27	1.2
INDUSTRIALS	0.01	0.09	-0.08	7.32	0.06	-0.59
CONSUMER DISCRETIONARY	0.04	0.06	-0.02	10.19	0.41	-0.2
CONSUMER STAPLES	0.02	0.05	-0.03	8.31	0.15	-0.22
FINANCIALS	0.02	0.26	-0.25	6.32	0.1	-1.56
INFORMATION TECHNOLOGY	0.02	0.12	-0.1	14.28	0.28	-1.37
COUNTRY						
AUSTRALIA	0.1	0.21	-0.12	7.42	0.73	-0.86
HONG KONG	0.06	0.1	-0.05	10.68	0.61	-0.51
INDIA	0.13	0.08	0.05	14.77	1.92	0.71
PHILIPPINES	0.01	0.01	0	18.64	0.12	0.01
SINGAPORE	0.02	0.05	-0.03	10.85	0.17	-0.32
THAILAND	0.01	0	0	8.13	0.06	0.03
TAIWAN	-0.02	-0.03	0.02	9.77	-0.17	0.15

Source: Citi Investment Research and Analysis

Additional Reports

Other APRAM reports provide the following additional information for every stock in a portfolio:

- Sensitivities for the Risk Factors (Betas),
- Marginal and Total Contribution to Portfolio Risk, and
- Implied Alpha

How to Access APRAM and Reports

APRAM models and reports are provided through the GRAM X software. This software is available to Citi clients and can be downloaded from our website, http://www.gqr.ssmb.com/. To access the website, your Citi GEO ID and password can be used. If you need a GEO ID, please contact your Citi sales representatives.

Appendix A-1

Analyst Certification

The research analyst(s) primarily responsible for the preparation and content of this research report are named in bold text in the author block at the front of the product except for those sections where an analyst's name appears in bold alongside content which is attributable to that analyst. Each of these analyst(s) certify, with respect to the section(s) of the report for which they are responsible, that the views expressed therein accurately reflect their personal views about each issuer and security referenced and were prepared in an independent manner, including with respect to Citigroup Global Markets Inc and its affiliates. No part of the research analyst's compensation was, is, or will be, directly or indirectly, related to the specific recommendation(s) or view(s) expressed by that research analyst in this report.

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Citi Investment Research & Analysis Ratings Distribution

	12 Month Rating			*Relative Rating*		
Data current as of 31 Mar 2011	**Buy**	**Hold**	**Sell**	**Buy**	**Hold**	**Sell**
Citi Investment Research & Analysis Quantitative World Radar Screen Model Coverage	30%	40%	30%			
% of companies in each rating category that are investment banking clients	25%	20%	19%			
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