Equities

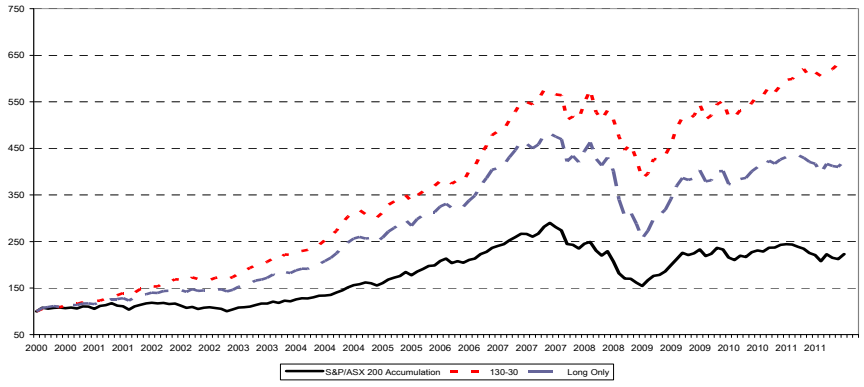
9 February 2012 | 36 pages

Shedding the Tyranny of the Benchmark

Introducing an Alternative Means of Constructing Portfolios

- **Benchmark Agnostic** — We propose a portfolio construction approach for active Australian equities investors that involves building separately a risk aware (rather than market cap driven) core portfolio and a long short liquidity and risk weighted stock selection satellite. We show how this approach can lead to strong alpha, a more intuitive portfolio, and greater flexibility in product design and dynamic strategy allocation than more traditional optimization approaches.
- **Risk Weighted Satellite** — We show how to weight stocks such that the conviction or alpha of a position is proportional to its contribution to overall risk.
- **Core Portfolio** — is designed to exploit the risk inefficiency of the cap weighted benchmark. We examine Minimum Variance and Risk Parity in detail.
- **Potent Combination** — Core and Satellite are typically uncorrelated strategies with relatively few overlapping positions.
- **Strong Performance** — Different quantities of core and satellite lead to differing amounts of leverage. We consider a simple case where some degree of shorting is allowed – akin to a 130-30 portfolio. We show an IR of 1.21 in backtest since 2000 on an investible portfolio that combines both Minimum Variance at the core and Australian Radar as a satellite.
- **Key Advantages** — the approach has the advantage of **accountability** (every position can be mapped to an alpha call), **dynamism** (different quantities of core and satellite may reflect strategy conviction) and **flexibility** (it lends itself easily to product design).

Figure 1. 13030 (red, dotted), long only (blue, dashed) versus S&P/ASX 200 (black, full)



Source: Citi Investment Research and Analysis

■ Quantitative Analysis

Paul R Chanin
+65-6657-1153
paul.chanin@citi.com
Head of Asia-Pac Quant Research

Nick Morton
+61-2-8225-4810
nick.morton@citi.com

Zee Yusuf
+61-2-8225-4895
zee.yusuf@citi.com

Nachiket R Garde, CFA
nachiket.garde@citi.com

Puneet Singh
puneet.singh@citi.com

Masayoshi Yoshihara
masayoshi.yoshihara@citi.com

Anmol Sethy
anmol.sethy@citi.com

Tushar Subhra Mandal
tushar.mandal@citi.com

Si An Tan
si.an.tan@citi.com

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

Contents

Shedding the Tyranny of the Benchmark

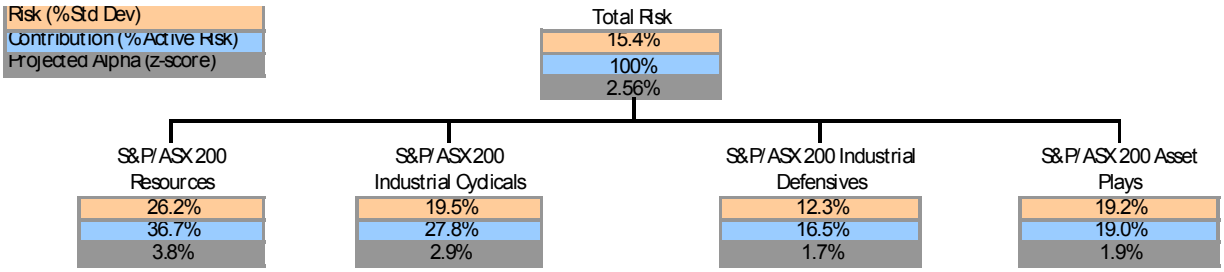
The tyranny of the benchmark is increasingly recognized as a problem for active investors. We propose an alternative way of constructing portfolios, one which we believe is more effective, while also being scalable, flexible and is more easily implemented. It draws active managers away from responding to benchmark weight or constituent changes, without sacrificing relative performance.

Our Approach in a Nutshell

We construct core and satellite portfolios separately. At the heart of the satellite is our Australian Radar Screen multi-factor stock selection model, while the core is more focused on exploiting cap-weighted index inefficiencies. These two differing objectives are complementary as we will show.

We weight assets on the satellite such that our conviction or expected return on a super-sector[1] is proportional to the risk budget expended. This approach is commonly referred to as **Risk Contribution** (RC). This is a significant departure from the traditional mean-variance optimisation approach, which tends to take rather extreme solutions that therefore tend to depend to a larger extent on the accuracy of the risk and return forecasts. An example of our approach is laid out below in Figure 2, and a full description and background is supplied in Appendix I.

Figure 2. Example Risk Contribution portfolio with alpha or conviction (grey) proportional to risk weight (blue)



Source: Citi Investment Research and Analysis

Meanwhile the aims of the core portfolio are different. We look closely at two different approaches, **Minimum Variance** (MV) and **Risk Parity** (RP). Risk Parity is a special case of the risk contribution approach, where all super-sectors contribute the same risk weight to the overall total risk of the portfolio. Minimum Variance has been covered in detail back in February 2011, and looks to minimize the total risk of the portfolio by using the full extent of the forecast correlation matrix. Both have typically led to improved risk-adjusted performance.

Our final step is to combine quantities of core and satellite into a final portfolio, reflecting leverage constraints and risk or return targets. Key advantages of this approach:

- **Attribution:** Risk Weights directly map to alpha or conviction levels.
- **Flexibility:** Different products (long-only, 130-30, low vol) require only changes to core and satellite weighting.

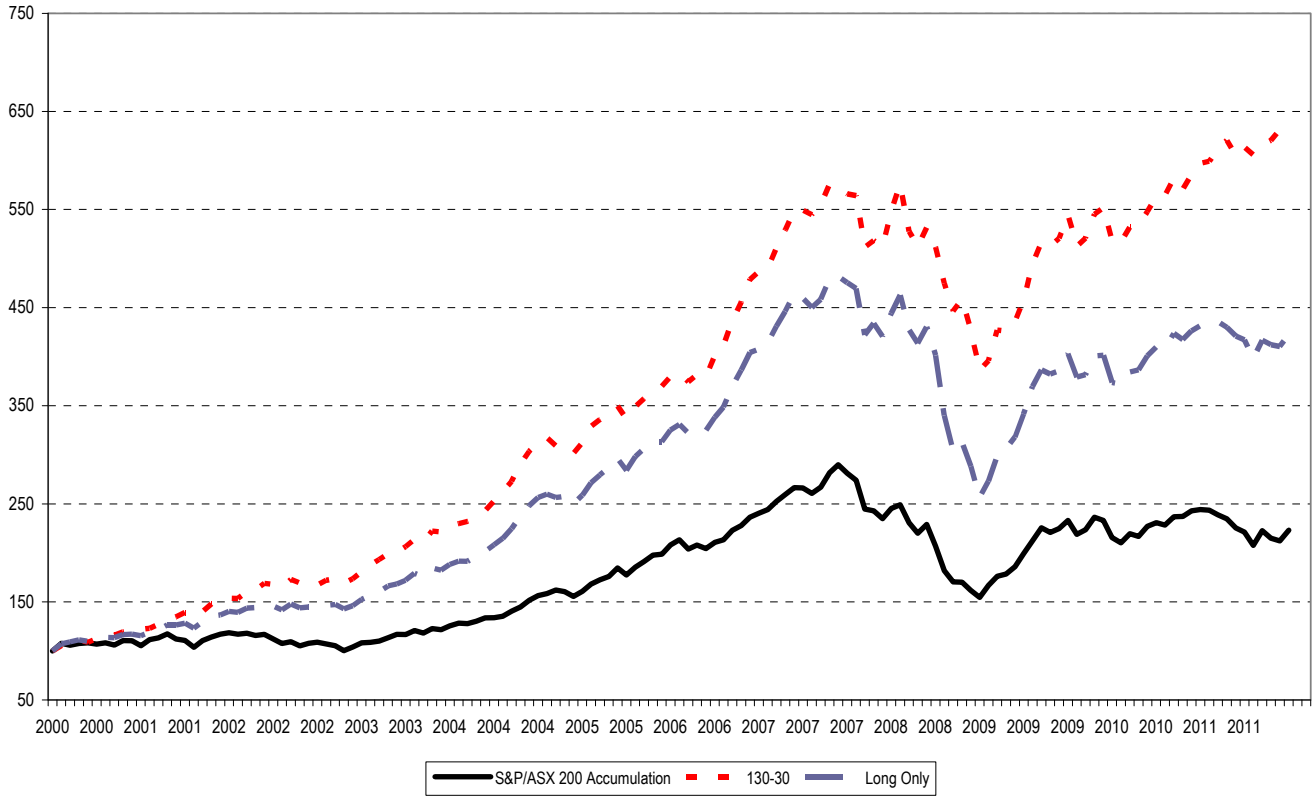
Dynamism: the potential to weight between core and satellite based on model conviction or market regime.

[1] We split the Australian equity market into 5 super-sectors: Financials, Resources, Industrial Cyclicals, Industrial Defensives and Asset Plays

Performance

Figure 3 and Figure 4 below show the performance of our approach on simple 130-30 and long only implementations of core and satellite.

Figure 3. Minimum Variance with Radar Overlay, 130-30 (dotted, red) long-only (dashed, blue) versus S&P/ASX 200 accumulation (dotted, black)



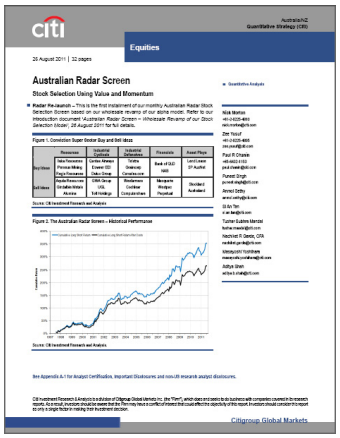
Source: Citi Investment Research and Analysis

Figure 4. Summary Statistics (Minimum Variance plus Radar Overlay, Two implementations, June 2000-Dec 2011)

	130-30	Long Only	S&P/ASX 200	130-30 Active	Long Only Active
Annualised Total Return	17.10%	13.15%	7.12%	9.98%	6.03%
Annualised Total Risk	11.23%	13.28%	13.24%	8.27%	6.05%
Information Ratio	1.47	1.00	0.59	1.06	0.92
Sharpe Ratio	1.52	0.99	0.54	1.21	1.00
Maximum Drawdown	-9.48%	-15.24%	-12.23%	-5.59%	-6.58%
Maximum Drawdown Date	Feb-09	Oct-08	Oct-08	Oct-11	Feb-09
Return to Drawdown Ratio	1.80	0.86	0.58	1.79	0.92
Average Return in Up Market	3.0%	3.2%	3.2%	-0.2%	0.1%
Average Return in Down Market	-1.1%	-2.1%	-3.2%	2.2%	1.1%
Market Beta	0.66	0.90	1.00	-0.34	-0.10
Hit Rate	72.9%	67.9%	60.7%	65.7%	66.4%

Source: Citi Investment Research and Analysis

Figure 5. Australian Radar Screen



Source: Citi Investment Research and Analysis

The Satellite in Detail

Alpha Model: Australian Radar Screen

The Citigroup Quantitative Research team has developed an alpha model known as the Australian Radar screen which is published on a monthly basis. This proprietary model screens the universe of S&P/ASX 200 for stocks that exhibit good relative value and momentum.

Our Value model specifically adjusts for the relative cyclicality of stocks, using DuPont profitability decomposition. This is the key differentiating element of our approach, and particularly vital in a market that is more and more driven by global macro forces, be it commodities, credit or currency.

Since a backtest starting from August 1997 our stock selection model has returned an annualized 11.51% per annum at an attractive information ratio of 1.22 on an equal weighted basis.

The Australian Radar model is based on a number of Value and Momentum factors:

- **Value:** Earnings Yield, Book to Price, Margin, Asset Turnover, Efficiency, Write Down and Total Liabilities
- **Momentum:** 100 day T-Stat and Earnings Revision Ratio

The Value and Momentum scores from within the model are used to assign each stock to a bucket, or 'quadrant' based on its relative rating across these two dimensions.

- **Attractive:** Cheap with strong momentum
- **Glamour:** Expensive with strong momentum
- **Contrarian:** Cheap with weak momentum
- **Unattractive:** Expensive with weak momentum

For complete details and backtesting results for the Australian Radar model see Australian Radar Screen - Wholesale Revamp of Our Stock Selection Model, Citigroup Australian Quantitative Research, 25 August 2011.

Two Independent Legs

We construct long and short portfolios separately. We consider only those stocks currently in the Attractive quadrant for the long portfolio and in the Unattractive quadrant for the short portfolio.

Liquidity Banding

Given the diversity in liquidity across the universe, it would be unrealistic to expect us to apply an equal weight across the Unattractive universe. Such a portfolio would limit the amount of assets under management and the tradability of the strategy. We therefore apply a liquidity banding scheme within our macro clusters rather than take an equal weighted approach.

Under this scheme, the macro cluster is split into 5 groups according to their rolling value traded. Each band is pre-determined to contribute as close to a certain percentage of the total capital as possible:

1. **Highly liquid, weight 35%**: stocks in the highest 20% traded by value over preceding 90 days.
2. **Liquid, weight 30%**: stocks in the high 20% traded by value over preceding 90 days.
3. **Medium liquidity, weight 20%**: stocks in the mid 20% traded by value over preceding 90 days.
4. **Illiquid, weight 10%**: stocks in the low 20% traded by value over preceding 90 days.
5. **Highly illiquid, weight 5%**: stocks in the lowest 20% traded by value over preceding 90 days.

We use a similar approach on both long and short sides.

Risk Budget Allocation

We pre-define a target risk budget for the macro-clusters that mirrors our conviction or alpha in each. In our case we calculate this risk budget based on a weighted sum of a Grinold and Kahn adjusted alpha score for the particular cluster.

$$\alpha = \sigma \cdot IC \cdot z$$

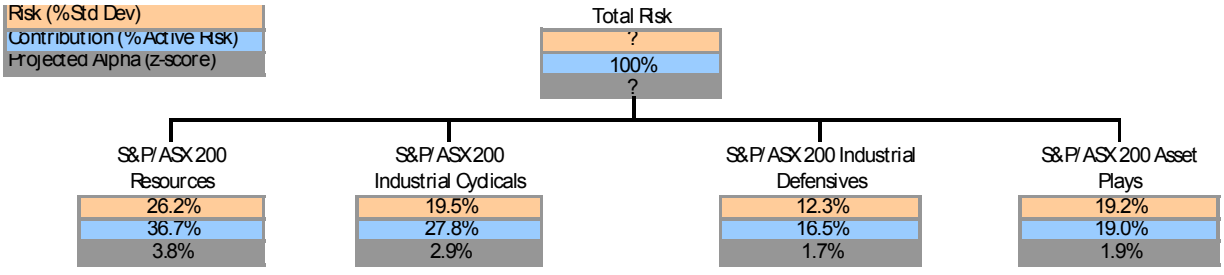
Where *z* is the total score, σ is the stock residual volatility and *IC* is the forecast information coefficient of the strategy.

More sophisticated adjustments may be called for under this framework. It is firstly debatable whether the volatility adjustment is still required – given we are no longer prey to the optimiser's fetish for stocks with a low proportion of stock specific to total volatility.

And secondly we may be required to add a uniform equity risk premium to the alpha, given we are in total return space.

An independent optimal risk budget is estimated on both long and short sides.

Figure 6. Setting the target risk budget based on conviction – end of December 2011



Source: Citi Investment Research and Analysis

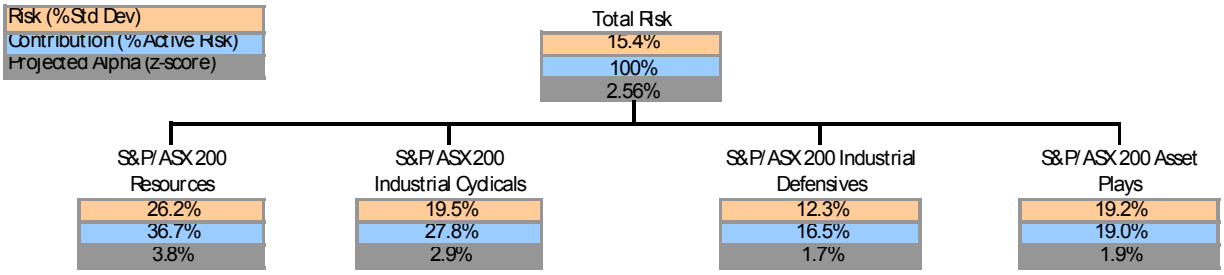
Our approach in many ways reflects the fact that we have quantified alphas. **An analogous approach is definitely possible without quantified alphas. It would be up to the portfolio manager to determine a risk budget based on a level of confidence or conviction in a particular cluster**.

Determining the Optimal cluster allocation

The next step is to find the numerical solution to the optimal risk budget. The exact full technical approach is outlined in **Appendix II: Practical Risk Budgeting Using Multi-Factor Risk Models.**

We use the Australian RAM risk model (see appendix IV – AURAM risk model) to determine the covariance of assets in the universe.

Figure 7. Solution

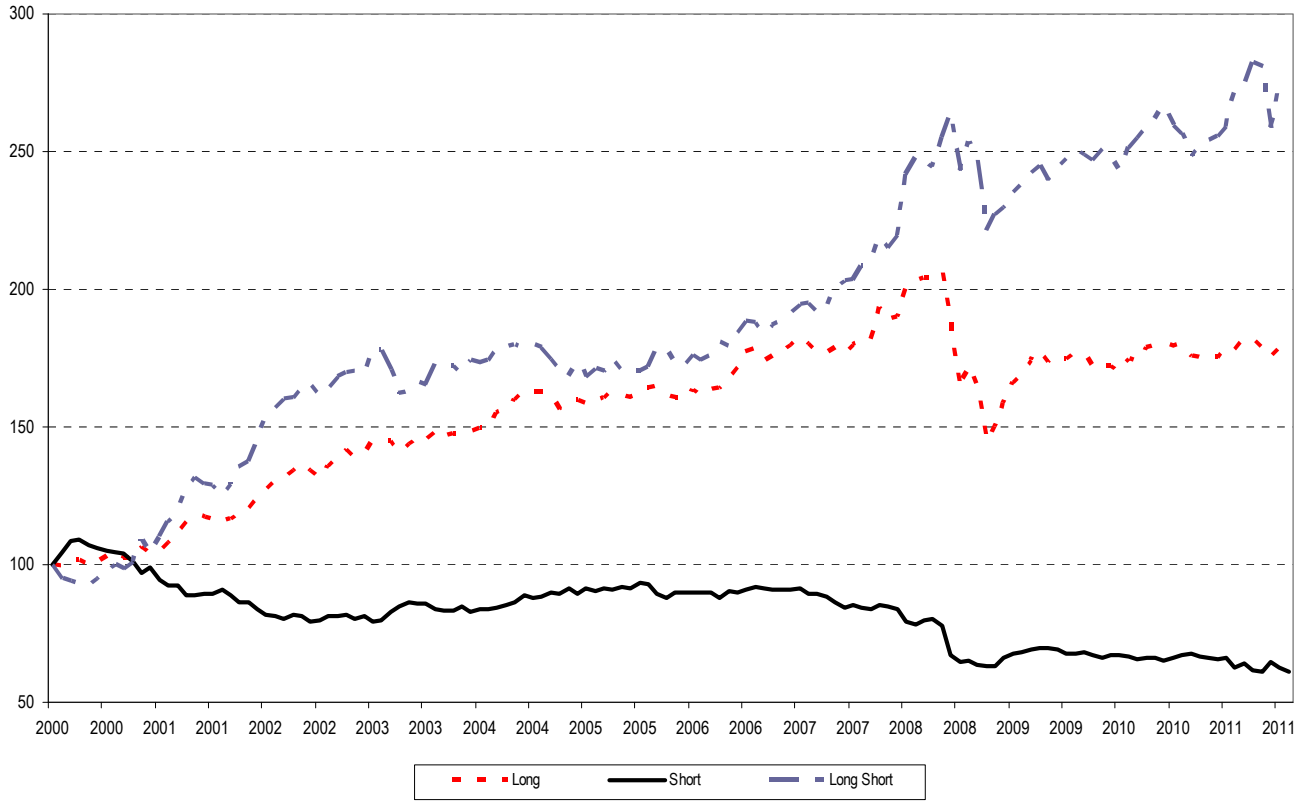


Source: Citi Investment Research and Analysis

The Backtest

We test our construction approach through time from 2001, each month end using the alphas, rolling 90 day value traded, and latest available RAM covariance matrix at each point in time.

Figure 8. Australian Radar Screen – Conviction Risk Budget Weighted Overlay



Source: Citi Investment Research and Analysis

Figure 9. Summary Statistics - Conviction Risk Budget Weighted Overlay

	Long Side	Short Side	Long Short Dollar Neutral Overlay	S&P/ASX 200
Annualised Total Return	5.04%	-3.93%	8.85%	7.12%
Annualised Total Risk	8.89%	7.92%	10.12%	13.24%
Information Ratio	0.60	-0.46	0.89	0.59
Sharpe Ratio	0.57	-0.50	0.87	0.54
Maximum Drawdown	-11.85%	-13.48%	-10.51%	-12.23%
Maximum Drawdown Date	Oct-08	Sep-08	Jan-09	Jan-00
Return to Drawdown Ratio	0.43	-0.29	0.84	0.58
Average Total Return in Up Market	3.6%	3.2%	0.4%	3.2%
Average Total Return in Down Market	-2.8%	-4.1%	1.3%	-3.2%
Market Beta	1.09	1.22	-0.12	0.67
Hit Rate	62%	42%	63.6%	60.7%

Source: Citi Investment Research and Analysis

The Core Portfolio in Detail

Benchmark is risk inefficient

It has long been recognized that the cap-weighted index is prone to some key inefficiencies. Chief amongst these is the susceptibility to risk concentration. Quantitative alternative benchmarks are well positioned to exploit these and other inefficiencies.

So far, alternative benchmarks outperform because cap weighted benchmarks are prone to becoming concentrated in unhedged (principally) macro risk concentration. The cap-weighted benchmark is biased in the long run towards Momentum names and against Value. This tilt towards the glamour quadrant (expensive with positive sentiment) tends to reflect market over-exuberance on common certain macro themes.

There are different ways of constructing portfolios to exploit this risk inefficiency. We examine and review risk parity and minimum variance in an Australian context.

In our view the fundamental indexing approach is naturally flawed, and too closely correlated to active stock selection. Ultimately its success depends solely on the value premium – this is best achieved not through active indexing but through active stock selection.

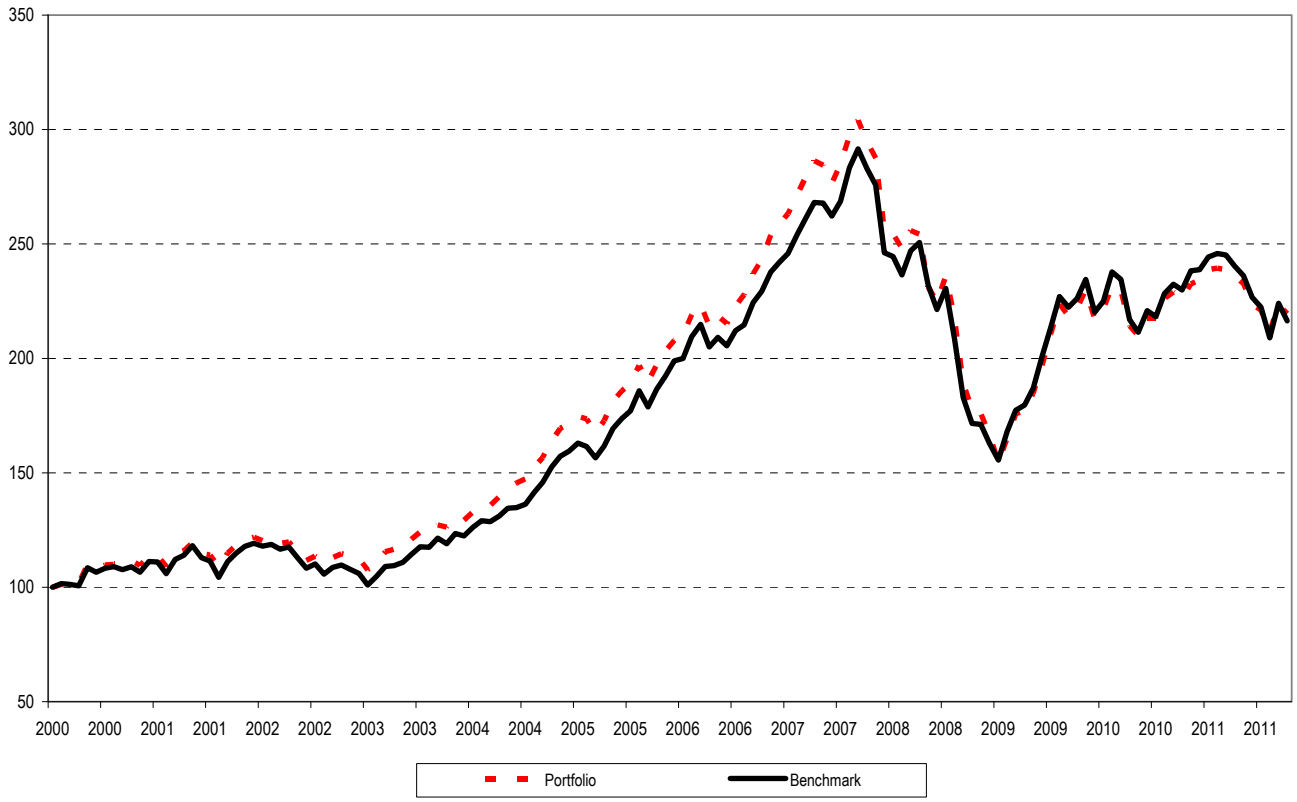
Risk Parity in Australian Equities

The annualized of our Risk Parity Index is essentially identical to the cap-weighted benchmark; however this is achieved with a slightly lower total risk (see Figure 11 below). The ex-post tracking error of the strategy relative to the cap-weighted benchmark S&P/ASX 200 was 2.8% annualized.

Stocks and sectors heavily represented in the cap-weighted benchmark and subject to global economic and credit cycles such as Banks and Metals and Mining tend to be underweighted aggressively, especially in the recent period. Their contribution to risk in the cap weighted benchmark far exceeds their contribution to market cap.

It is notable how poorly the strategy performed during the credit crunch between June 2007 and July 2008. This was a key period of underperformance and relates to the difficulty that multi-factor risk models experienced in reliably forecasting stock specific risk over this period. After all, this was a period in which balance sheet strength was the key factor, and while systematic, could not be effectively modeled either by observing balance sheet characteristics of stocks or through time series regressions of stock prices on macro variables. These risks could only be estimated through sound judgment.

Figure 10. Citi GQR Australia Risk Parity Portfolio (red, dotted) versus S&P/ASX 200 accumulation (full, black)



Source: Citi Investment Research and Analysis

Figure 11. Summary Statistics – Citi GQR Risk Parity Portfolio versus S&P/ASX 200 Accumulation

	Portfolio	Benchmark	Total Active	Common Factor[2]	Stock Specific
Annualised Total Return	6.76%	6.62%	0.14%	-0.22%	0.36%
Annualised Total Risk	12.36%	13.09%	2.57%	2.55%	2.25%
Information Ratio	0.59	0.56	0.02	-0.11	0.14
Sharpe Ratio	0.55	0.51	0.05	-0.09	0.16
Maximum Drawdown	-12.91%	-12.23%	-2.73%	-2.13%	-3.20%
Maximum Drawdown Date	Oct-08	Oct-08	Feb-09	May-08	Oct-08
Return to Drawdown Ratio	0.52	0.54	0.05	-0.10	0.11
Average Return in Up Market	2.9%	3.1%	-0.2%	-0.2%	0.0%
Average Return in Down Market	-2.8%	-3.1%	0.3%	0.0%	0.0%
Market Beta	0.93	1.00	-0.07	-0.07	-0.00
Hit Rate	62.7%	59.9%	47.2%	47.9%	53.5%

Source: Citi Investment Research and Analysis

[2] Common Factor as defined by the QuantIFI factor structure of asset returns. The breakdown is based on the fundamental characteristics and sectors of stocks as is laid out in detail in appendix VI

Minimum Variance

Our analysis on Minimum Variance highlighted the efficacy of the strategy even in this narrow market and the key sources of alpha. Contrary to popular misconception the outperformance does not relate to style exposure per se, but principally from active exposure to macro themes and sectors.

The Minimum Variance portfolio equalizes marginal contributions to risk for stocks with a weight greater than 0. In other words, a small weight increment on any existing position will result in an equal equivalent change in total risk on the portfolio.

As a result, the Minimum Variance portfolio will seek to hedge as much systematic risk as possible, and only take positions in assets with low stock specific risk. This can lead to some very concentrated portfolios.

The unsurprising finding against this backdrop from our original research from early last year was the prominent role played by the factor structure underpinning the covariance matrix forecast[3]. And our conclusions were that the macro time series models such as AURAM have tended to lead to higher information ratios than either statistical or fundamental oriented models. A summary of our findings is supplied in Appendix V.

For the purposes of this exercise, we have built on some of the findings of our earlier research, concentrating on using the RAM risk model only, and optimizing with only very loose constraints.

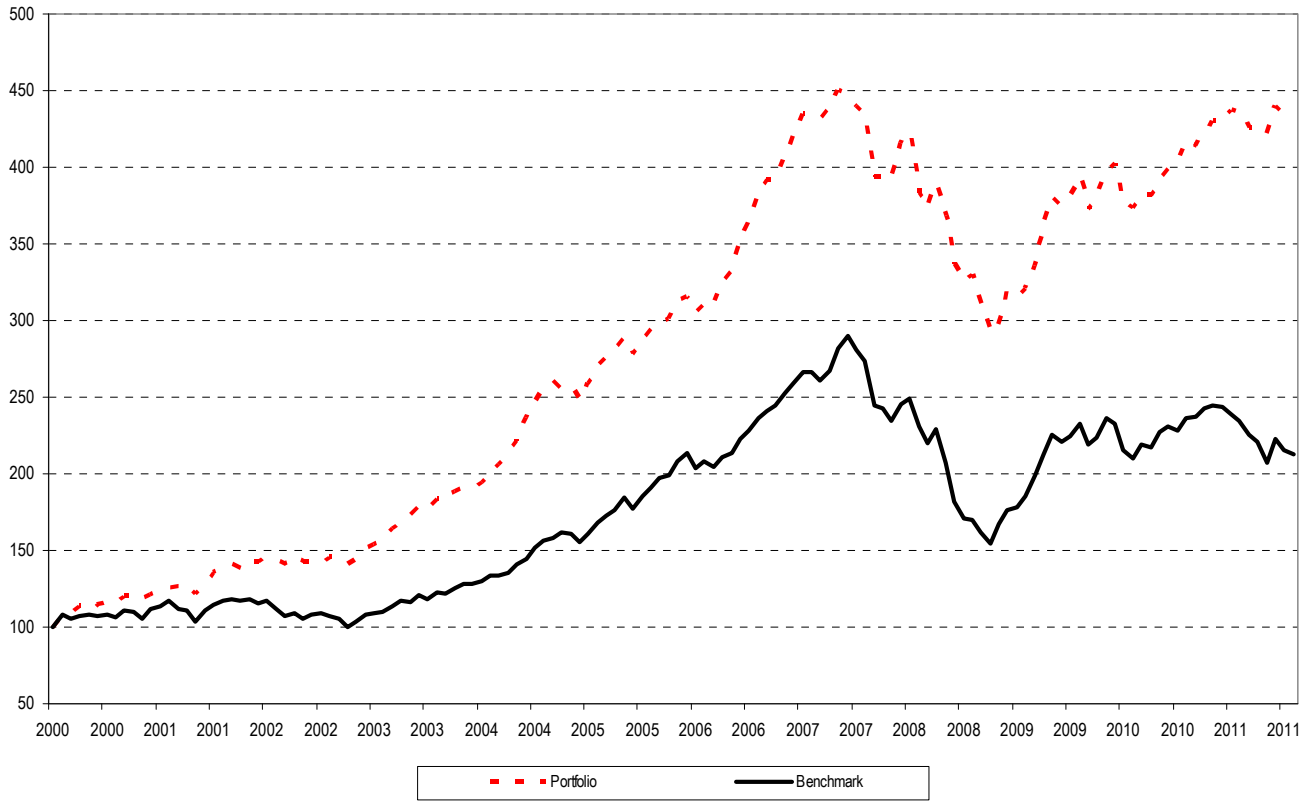
Figure 12. Optimisation Inputs, Settings and Constraints

Universe	S&P/ASX 200	Standard Cap weighted index
Objective Function	Minimum Variance	Minimise total risk
Benchmark	None	Benchmark Agnostic Optimisation
Alphas	None	No alphas required
Risk Model	Citi GQR AURAM Risk Model	Time Series Macro-Economic Risk Model
Max Super-Sector Underweight	greater of 7.5% or 50% of the sector weight in the S&P/ASX 200	To enable significant underweights in larger sectors
Max Super-Sector Overweight	lesser of 7.5% or 50% of the sector weight in the S&P/ASX 200	To prevent significant overweights in smaller sectors
Transaction Costs	None	
Min Weight Threshold	0.50%	To prevent formation of fragmented portfolio
Max Weight Threshold	None	

Source: Citi Investment Research and Analysis

[3] See "Minimum Variance in Australia: Consistent Lower Risk and Higher Returns than Cap-Weighted" by Citi Global Quantitative Research, 2 February 2011

Figure 13. Citi GQR Australia Minimum Variance Portfolio (Red, Dotted) versus S&P/ASX 200 Accumulation (Full, Black)



Source: Citi Investment Research and Analysis

Figure 14. Summary Statistics – Citi GQR Minimum Variance Portfolio versus S&P/ASX 200 Accumulation

	Portfolio	Benchmark	Total Active	Common Factor	Stock Specific
Annualised Total Return	13.64%	7.12%	6.52%	1.39%	5.13%
Annualised Total Risk	10.96%	13.24%	6.92%	5.84%	5.82%
Information Ratio	1.23	0.59	0.82	0.11	0.86
Sharpe Ratio	1.25	0.54	0.94	0.24	0.88
Maximum Drawdown	-9.51%	-12.23%	-6.30%	-3.59%	-5.31%
Maximum Drawdown Date	Jan-08	Oct-08	Mar-09	Jun-00	Oct-07
Return to Drawdown Ratio	1.43	0.58	1.04	0.39	0.97
Average Return in Up Market	2.8%	3.2%	-0.3%	-0.4%	0.0%
Average Return in Down Market	-1.5%	-3.2%	1.7%	1.0%	1.0%
Market Beta	0.71	1.00	-0.29	-0.14	-0.16
Hit Rate	67.9%	60.7%	62.9%	52.9%	64.3%

Source: Citi Investment Research and Analysis

Differences in Approach

Minimum Variance seeks to equalize the marginal contribution to risk of every position, while risk parity equalizes the contribution to risk. Unsurprisingly this leads to some very different looking portfolios: Minimum Variance is concentrated, finding a handful of stocks with offsetting characteristics to effectively hedge out as much systematic risk as possible. Risk parity on the other hand, takes greater notice of the stock specific risk of an asset, given it forms on average a greater proportion of an asset's total volatility.

While the performance of Minimum Variance is undoubtedly superior, due to its more aggressive hedging of the problematic risk exposure so prevalent in cap-weighted benchmarks, Risk Parity provides a useful and more diversified alternative. Risk Parity supplies index return with an overall reduction in volatility.

The best description of the feel of the portfolio is to imagine weights somewhere between Minimum Variance and Maximum Diversification (equal weighted) portfolios.

Risk Parity or Minimum Variance: Volatility Regimes

Given Minimum Variance's emphasis on the interaction of assets, and risk parity emphasis more on the stock specific, we examine how the relative volatility and return benefits of these approaches change through the cycle.

To measure the contemporaneous influence of both systematic and stock specific effects, we use the decomposition of cross-sectional volatility. We use this indicator to good effect in our Australia Radar Momentum model, to strip away the pro or anti cyclicality of the strategy in periods of risk concentration.

The charts below look at the spread in rolling risk between the Citi Risk Parity portfolio and the Citi Minimum Variance portfolio, and specifically how these vary with changes in the composition of cross-sectional volatility (see Figure 16).

For volatility benefit switch to minimum variance in periods of macro instability

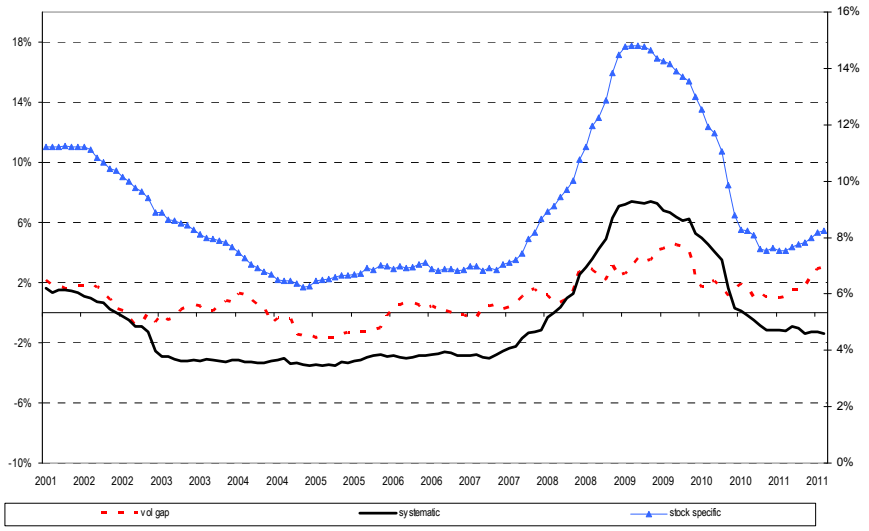
The relationship between these variables suggests that the risk benefit of risk parity relative to minimum variance is lesser in periods of high systematic volatility, and greater in periods of high stock specific volatility.

Figure 15. Regression of Volatility Gap versus Systematic and Stock Specific Components of Cross-Sectional Volatility

	Coefficients	Standard Error	t Stat	P-value
Systematic Volatility	136%	16.4%	8.31	0.00%
Stock Specific Volatility	-65%	9.5%	-6.91	0.00%

Source: Citi Investment Research and Analysis

Figure 16. 18 Month Rolling Standard Deviation of Returns Spread Risk Parity versus Minimum Variance (Red-Dotted, LHS) Plotted Against Systematic (Black, Lower, RHS) and Stock Specific Risk Concentration (Blue, Higher, RHS)



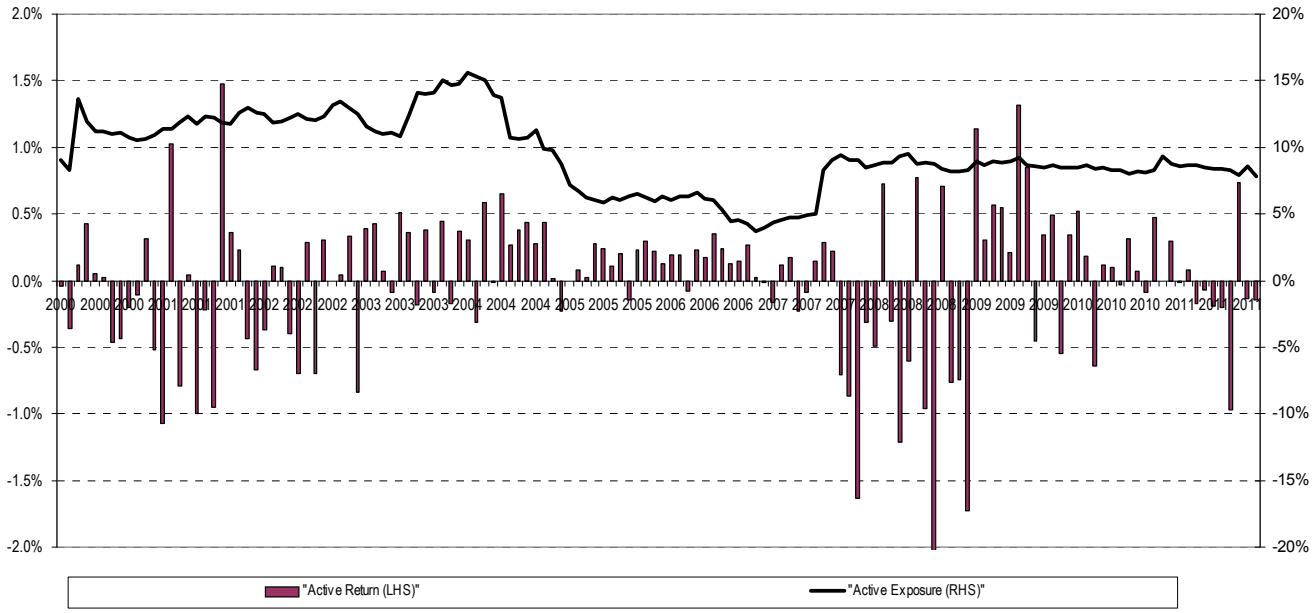
Source: Citi Investment Research and Analysis

The return relationship is more complex

In our data sample, and that qualifier is important, we find that the single biggest area of underperformance for risk parity was the credit crunch, between June 2007 and July 2008. In this period, the strategy was naturally far more aggressively overweight Real Estate and listed Infrastructure, both of which suffered huge losses over the period.

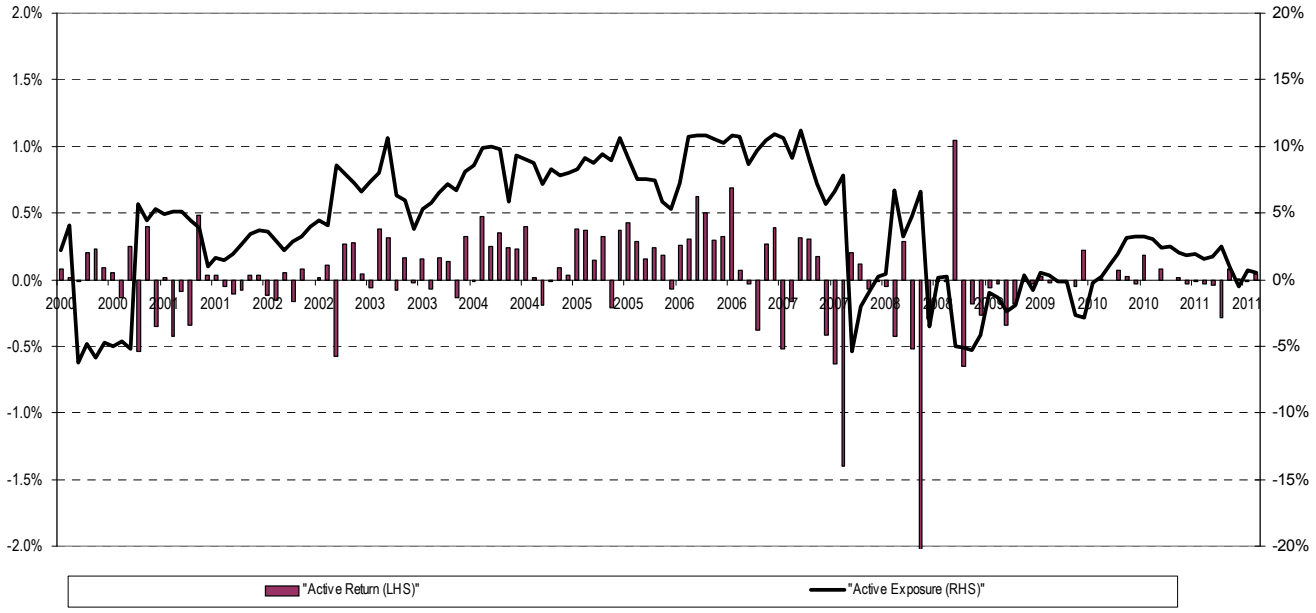
Figure 17 and Figure 18 show the exposure of both portfolios to real estate through time and associated factor payoffs. The negative return of Risk Parity over the credit crunch period is almost entirely explained by this overweight bias. Minimum Variance on the other hand, by placing a greater emphasis on how the sector fits into the global credit downturn, successfully neutralizes this exposure to good effect.

Figure 17. Risk Parity Exposure to Real Estate (Black line, RHS) versus Monthly Contribution to Return (Red Bars, LHS)



Source: Citi Investment Research and Analysis

Figure 18. Minimum Variance Exposure to Real Estate (Black line, RHS) versus Monthly Contribution to Return (Red Bars, LHS)



Source: Citi Investment Research and Analysis

Putting it All Together

Combining Core and Satellite into Final Portfolio

The final step in this approach is combining the portfolios: think of the whole process as being analogous to baking, and then icing a cake. Cake and icing are prepared independently, with different objectives in mind, and then combined together in quantities appropriate for the end consumer.

And generally speaking, the overlap in weights across our satellite and core portfolios is minimal. This is as intended given the very different objectives of the two legs of the final portfolio.

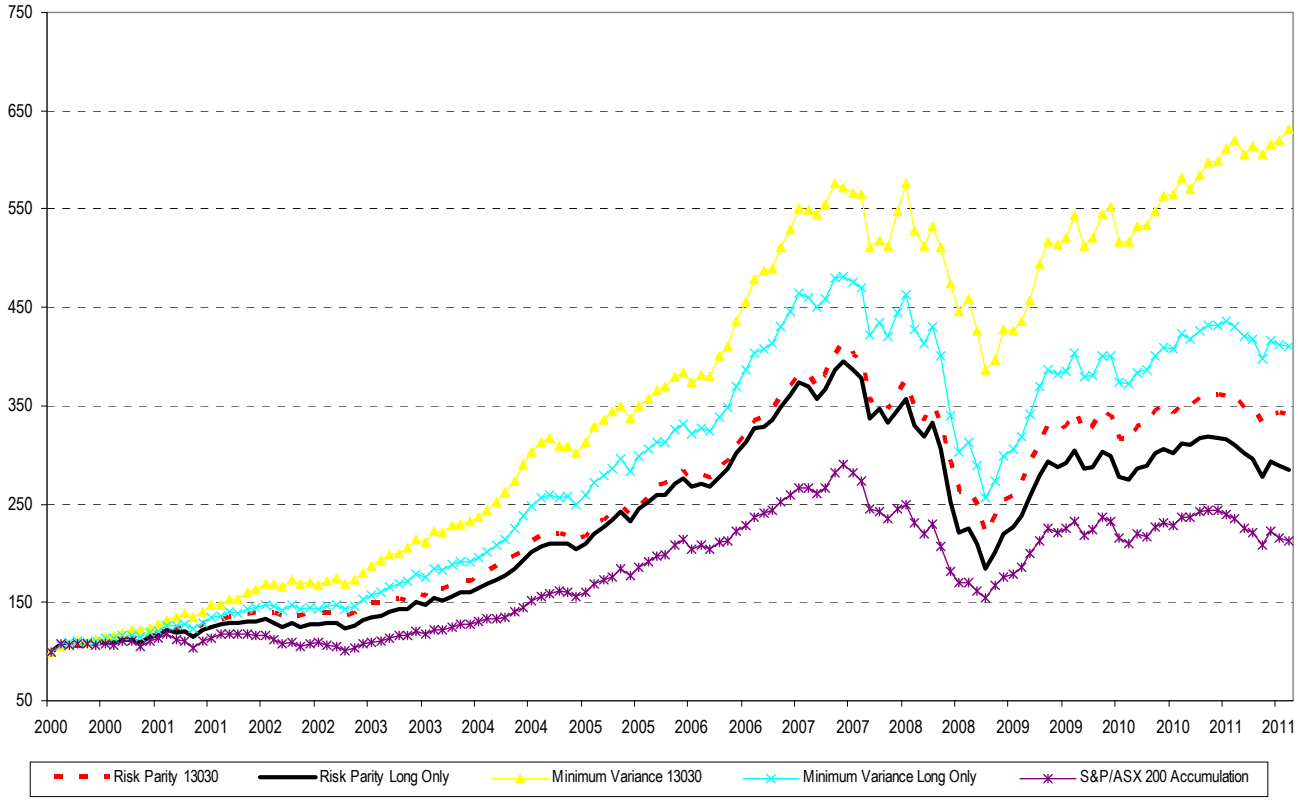
The allocation to both core and satellite in this example is fixed. The weight reflects two common product mandates in the industry: 130-30 and long-only. There is scope for a dynamic allocation that reflects amongst other things: wealth, expected return, drawdown tolerance, tax or liabilities, and this is a subject to which we will return.

130-30 corresponds to a weight of 75-25 core-satellite for risk parity-overlay, and 80-20 for minimum variance-overlay combinations. For the long only versions we bolt on 50% of the core portfolio to 50% of the long side of the satellite.

The holdings of the latest 130-30 Minimum Variance core-satellite portfolio are presented in Appendix III.

Performance Comparison

Figure 19. Wealth Curves of 5 Different Products: 13030 and Long Only Implementations Using Core of Minimum Variance and Risk Parity versus S&P/ASX 200



Source: Citi Investment Research and Analysis

Figure 20. Summary Statistics (S&P/ASX 200 Accumulation Index Relative)

	Risk Parity 13030	Risk Parity Long Only	Minimum Variance 13030	Minimum Variance Long Only
Annualised Total Return	4.24%	2.67%	9.98%	6.03%
Annualised Total Risk	5.41%	4.97%	8.27%	6.05%
Information Ratio	0.71	0.53	1.06	0.92
Sharpe Ratio	0.78	0.54	1.21	1.00
Maximum Drawdown	-7.31%	-7.25%	-5.59%	-6.58%
Maximum Drawdown Date	Feb-09	Feb-09	Oct-11	Feb-09
Return to Drawdown Ratio	0.58	0.37	1.79	0.92
Average Return in Up Market	0.0%	0.1%	-0.2%	0.1%
Average Return in Down Market	0.9%	0.4%	2.2%	1.1%
Market Beta	-0.13	0.01	-0.34	-0.10
Hit Rate	62.1%	59.3%	65.7%	66.4%

Source: Citi Investment Research and Analysis

Towards and Implementable Reality

These portfolios are close to but not necessarily completely practical in this form. In subsequent research we will show how to use optimization to transform a theoretical portfolio given transaction costs, turnover, sector, or leverage constraints.

Versus Traditional Methods of Portfolio Construction

In general investors have fallen in two main camps: those who favour the use of mean-variance optimizers, and those that do not. There are other approaches, but the vast majority sit in this space.

Mean variance optimization determines the optimal portfolio that maximizes a utility function that trades of expected return for risk, subject to constraints and other penalties.

Critics of the approach point to a particular dependency on the accuracy of risk and expected return inputs, and the difficulty in general of tying back an optimal solution to various parts of the investment process. This is especially true once constraints and transaction costs are factored into the problem.

Supporters of the approach tend to focus on its repeatability, discipline, and the ability to specify a plethora of parameters which otherwise would be hard to incorporate.

Academics and practitioners alike have debated the relative merits for years. In many ways we sympathize with the critics of mean-variance optimization, but also recognize the need as quantitative analysts to provide a systematic framework for portfolio construction.

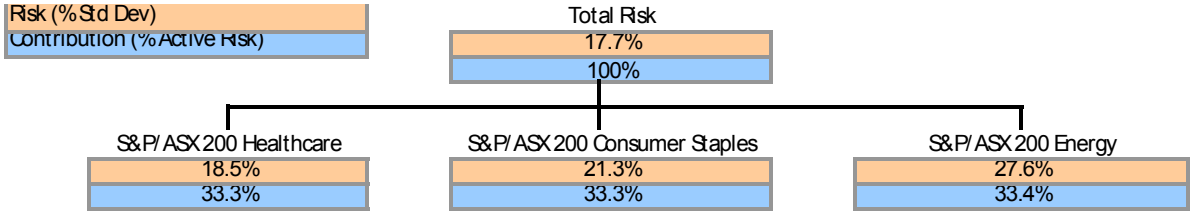
In subsequent work we will present a direct comparison of optimization versus our core-satellite approach.

Appendix I: On the Properties of Risk Parity Portfolios

Risk Contribution and Risk Parity

The basic tenet is to create a portfolio where the holdings of groups of holdings pretty much contribute to a pre-determined percentage to the overall total risk. A special case of the risk contribution portfolio is the risk parity portfolio, where every position contributes an equal percentage of the overall risk of the portfolio.

Figure 21. Example of Risk Parity Portfolio with Three Assets

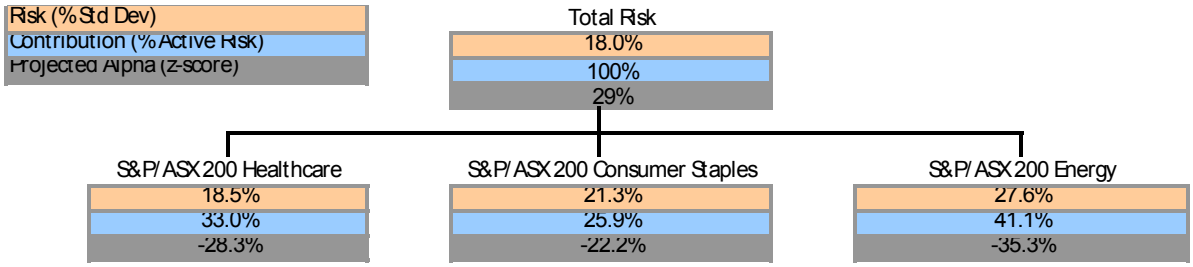


Source: Citi Investment Research and Analysis

The Intuitive Appeal of a risk budgeting approach

The process does lend itself more readily to intuition than other risk controlled strategies or portfolio construction approaches. It is consistent with the allocation of risk budget in proportion with ones conviction on a stock or sector.

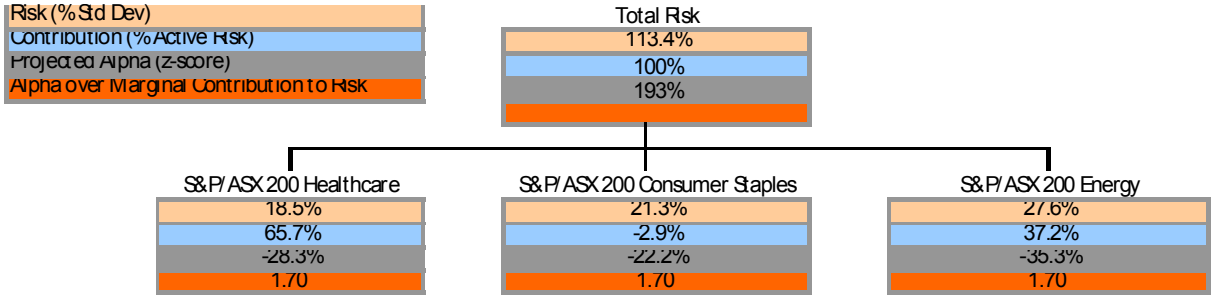
Figure 22. Risk Contribution Proportional to Alpha Score or Conviction Level



Source: Citi Investment Research and Analysis

Traditional quantitative approaches are different. Mean variance optimization approaches allocate positions such that the marginal contribution to risk of a stock or sector is in proportion to ones conviction, ie such that addition of weight increment to every position will lead to an increase in tracking error or total risk that is proportional to ones alpha. This leads to very different results.

Figure 23. Mean Variance Optimisation: Marginal Contribution to Risk Proportional to Alpha Score or Conviction Level



Source: Citi Investment Research and Analysis

Risk Parity in Academia

In his early paper on the topic in 2006, "On the Financial Interpretation of Risk Contribution: Risk Budgets Do Add Up", Qian showed that the contribution to total risk of a position or group of positions is proportional to its contribution to return in a loss event (see Appendix I). This observation holds true in the scenario where the portfolio is mean variance optimal. The more the weight of the security is greater than its mean-variance optimal weight, the more the loss contribution in percentage terms would exceed its percentage contribution to risk.

Qian also showed, however, how under the circumstances of a heavy drawdown, the arithmetic dictates that the extent of the departure from mean variance optimality is insignificant and that the relationship holds, eg **loss contributions are more or less proportional to risk contributions**.

This is an important property which will form the cornerstone of logic behind the formulation of our satellite construction methodology.

On the subject, Maillard, Roncalli and Teiletche also examined risk parity portfolios, called "On the properties of equally-weighted risk contributions portfolios", suggesting practical techniques for its formulation and examining performance characteristics in an asset allocation setting.

The first observation is that there is **nearly never an analytical solution to the risk parity portfolio – it must be solved numerically**. This can make its formulation computer intensive and complex.

In their work the authors compare minimum variance, risk parity and equal weighted portfolios and find some clear differences. Minimum variance is clearly the lowest volatility of the three, but also the highest turnover. Risk parity has a total volatility and sharpe ratio consistently in between the three approaches…

The final paper published only recently "Risk Based Allocation: A New Answer to an Old Question?" by Wai Lee examines the whole topic of portfolio construction and alternative benchmarking. Like many previous analyses it comments on the difficulty in uncovering the risk parity portfolio numerically, but find it of particular intuitive appeal to investment professionals and gaining increasing traction.

Appendix II: Practical Risk Budgeting Using Multi-Factor Risk Models

The framework that we focus on is the rho-sigma-x arithmetic proposed by Jose Menchero in his paper "Risk Contribution is Exposure times Volatility times Correlation". This is a useful and intuitive framework:

1. **rho**: the risk contribution of a position increases with its correlation to the overall portfolio
2. **sigma**: the risk contribution of a position increases with its overall volatility
3. **x**: the risk contribution of a position increases with its exposure

rho times sigma equals the Marginal Contribution to Risk of the Asset.

Note that one of the components of **rho** is the exposure of the asset itself. As the exposure increases, the correlation of that position and the portfolio changes, along with the overall balance in the portfolio.

This is the key reason why analytic solutions are hard to determine and the problem necessarily becomes a numeric one.

The Arithmetic of Risk Contributions

The x-sigma-rho framework specified by Menchero is as follows. For a complete treatise on this breakdown of Risk Contributions, see "Risk Contribution is Exposure times Volatility times Correlation" by Ben Davis and Jose Menchero, MSCI, January 2010.

Risk contributions are defined as:

$$\sigma(R) = \sum_m x_m \sigma(g_m) \rho(g_m, R)$$

Where x_m is the portfolio exposure to source m, $\sigma(g_m)$ is the volatility of source m, and $\rho(g_m, R)$ is the correlation of source m with the portfolio.

In our case, our sources m are the five super-sectors we have defined in Australian Equities: Resources, Financials, Industrial Cyclicals, Industrial Defensives and Asset Plays.

x_m becomes simply the portfolio weight in super-sector m, theta is its total risk estimate, and $\rho(g_m, R)$ is the forecast correlation between the total return of the super-sector and the total return of the portfolio.

To calculate the forecast correlation of the super-sector position and the overall portfolio we start with:

$$\rho(g_m, R) = \frac{\mathrm{cov}(g_m, R)}{\sigma(g_m)\sigma(R)}$$

Substituting in the fact that the total return of the portfolio is a weighted sum of super-sector weights

$$\rho(g_m, R) = \sum_n x_n \frac{\sigma(g_n)}{\sigma(R)} \frac{\mathrm{cov}(g_m, g_n)}{\sigma(g_m)\sigma(R)}$$

Reducing the last term further:

$$\rho(g_m, R) = \sum_n x_n \frac{\sigma(g_n)}{\sigma(R)} \rho(g_m, g_n)$$

This tells us that the correlation of the super-sector and the overall portfolio is a function of the weight in the sector itself, the correlation structure of super-sectors, and the ratio of its volatility to the portfolio volatility.

In addition the following also holds, given that marginal contribution to risk times exposure equals risk contribution.

$$MCR(m) = \sigma(g_m)\rho(g_m, R)$$

Setting up the Problem

There are two areas where we examine constructing a portfolio to a pre-determined risk budgeting framework.

We calculate our risk parity portfolio by pre-determining an equal risk budget across the five super-sectors. These super-sectors in our view, accurately capture the 5 different macro groups in the Australian market that are subject to different macro cycles. These are:

1. **Resources**: Global commodity cycle
2. **Financials**: Global credit cycle
3. **Industrial Cyclicals**: Domestic Interest Rates and Consumption
4. **Industrial Defensives**: Domestic and International GDP Growth
5. **Asset Plays**: Domestic credit conditions and asset prices

In our risk parity portfolio we seek to equal risk contributions across these 5 macro clusters, such that each contributes 20% of the overall risk.

In our satellite portfolio, we pre-determine a risk budget based on our conviction level or alpha associated with each macro cluster. We calculate risk budgets on the long and short side independently.

Portfolio Construction Objective

Our objective is to equalize the ratio across super-sectors of alpha over risk contribution, ie:

$$\frac{\alpha_m}{x_m \sigma(g_m)\rho(g_m, R)} = c$$

Where c is some constant. Mean variance is subtly different, maximum sharpe ratio objective equalising ratios of alpha over marginal contribution to risk, ie

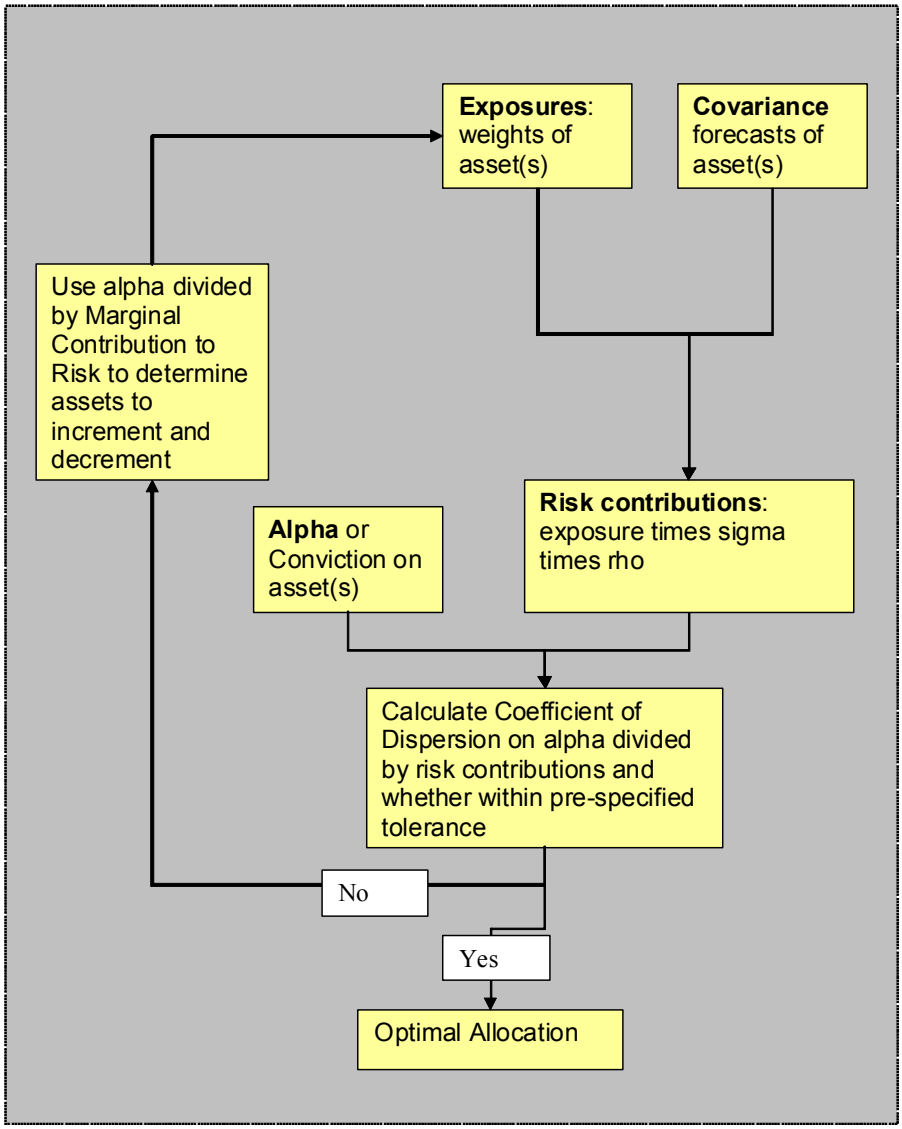
$$\frac{\alpha_m}{\sigma(g_m)\rho(g_m, R)} = c$$

Solving the Problem

Academics have proposed a number of ways of calculating the desired risk budgeted portfolio, our framework is much more simple.

At the heart of our approach is Menchero's **rho-sigma-x** decomposition (See The Arithmetic of Risk Contributions). We start with an equal weighted portfolio, and use an iterative approach to work out whether our solution sits within a certain pre-specified tolerance level. We increment and decrement assets we feel are most likely to drive us towards the optimal solution.

Figure 24. Calculating the Optimal Risk Contribution Portfolio



Source: Citi Investment Research and Analysis

Appendix III: Current 130-30 Portfolio

Figure 25. Current Portfolio: Minimum Variance plus Radar Overlay

ASX Code	Description	CIRA Rating	Last Price	Weight	Radar Quadrant
TLS	Telstra Corporation.	Buy	$ 3.38	20.3%	Attractive
ORG	Origin Energy	Buy	$ 13.27	10.9%	Attractive
AMC	Amcor Limited	Neutral	$ 6.98	9.2%	Glamour
IAG	Insurance Australia	Neutral	$ 2.90	8.9%	Unattractive
CPA	Commonwealth Prop	Neutral	$ 0.97	5.8%	Glamour
ASX	ASX Limited	Buy	$ 30.33	5.7%	Unattractive
IVC	InvoCare Limited	Neutral	$ 7.93	5.7%	Attractive
SKI	Spark Infrastructure	Neutral	$ 1.35	4.9%	Attractive
TTS	Tatts Group Ltd	Neutral	$ 2.47	4.6%	Glamour
CBA	Commonwealth Bank.	Sell	$ 50.84	3.6%	Attractive
SGT	Singapore Telecomm.	Buy	$ 2.36	3.1%	Attractive
TCL	Transurban Group	Neutral	$ 5.52	2.9%	Glamour
PTM	Platinum Asset	Not-Rated	$ 3.51	2.6%	Contrarian
CSL	CSL Limited	Buy	$ 30.00	2.4%	Attractive
RMD	ResMed Inc.	Buy	$ 2.76	2.3%	NA
WPL	Woodside Petroleum	Buy	$ 34.41	2.2%	Attractive
OSH	Oil Search Ltd	Neutral	$ 6.47	2.2%	Attractive
SIP	Sigma Pharmaceutical	Sell	$ 0.60	2.1%	Attractive
GNC	GrainCorp Limited	Neutral	$ 7.56	2.0%	Attractive
CTX	Caltex Australia	Neutral	$ 12.10	1.9%	Attractive
ANN	Ansell Limited	Neutral	$ 15.14	1.3%	Attractive
STO	Santos Ltd	Buy	$ 13.66	1.3%	Contrarian
NWS	News Corp	Not-Rated	$ 18.69	1.3%	Attractive
LEI	Leighton Holdings	Neutral	$ 24.25	1.3%	Attractive
QBE	QBE Insurance Group	Neutral	$ 12.13	1.2%	NA
MND	Monadelphous Group	Not-Rated	$ 22.66	1.1%	Glamour
EXT	Extract Resources	Not-Rated	$ 8.60	0.9%	NA
SGP	Stockland	Buy	$ 3.36	0.9%	Attractive
WDC	Westfield Group	Buy	$ 8.79	0.9%	Attractive
SBM	St Barbara Limited	Neutral/High Risk	$ 2.34	0.8%	Glamour
ILU	Iluka Resources	Buy	$ 18.15	0.8%	Contrarian
CQO	Charter Hall Office	Neutral	$ 3.55	0.8%	Attractive
GMG	Goodman Group	Buy	$ 0.67	0.8%	Attractive
SWM	Seven West Media Ltd	Buy	$ 3.54	0.7%	Attractive
FLT	Flight Centre	Buy	$ 19.70	0.7%	Attractive
NVT	Navitas Limited	Neutral	$ 3.02	0.7%	Contrarian
CRZ	Carsales.Com Ltd	Not-Rated	$ 4.90	0.7%	Attractive
NCM	Newcrest Mining	Buy	$ 33.92	0.6%	Unattractive
SUN	Suncorp Group Ltd	Buy	$ 8.23	0.6%	Unattractive
WSA	Western Areas NL	Neutral	$ 5.84	0.6%	Attractive
Other Longs <0.5%				5.9%	
Other Shorts <-0.5%				-2.8%	
KCN	Kingsgate Consolid.	Neutral	$ 7.91	-0.6%	Unattractive
MGX	Mount Gibson Iron	Neutral/High Risk	$ 1.43	-0.6%	Unattractive
MML	Medusa Mining Ltd	Buy/High Risk	$ 6.01	-0.6%	Unattractive
CSR	CSR Limited	Neutral	$ 2.04	-0.9%	Unattractive
TEN	Ten Network Holdings	Neutral	$ 0.88	-0.9%	Unattractive
MIN	Mineral Resources.	Not-Rated	$ 12.20	-0.9%	Unattractive
SGM	Sims Metal Mgmt Ltd	Not-Rated	$ 15.32	-0.9%	Unattractive
BSL	BlueScope Steel Ltd	Not-Rated	$ 0.41	-0.9%	Unattractive
AGO	Atlas Iron Limited	Buy	$ 3.31	-0.9%	Unattractive
AZT	Aston Res Ltd	Not-Rated	$ 9.30	-0.9%	Unattractive
DJS	David Jones Limited	Neutral	$ 2.56	-1.3%	Unattractive
TOL	Toll Holdings Ltd	Not-Rated	$ 5.21	-1.3%	Unattractive
AIO	Asciano Limited	Not-Rated	$ 4.69	-1.3%	Unattractive
BLY	Boart Longyear	Buy	$ 3.77	-1.3%	Unattractive
MQG	Macquarie Group Ltd	Buy	$ 26.10	-1.7%	Unattractive
AMP	AMP Limited	Buy	$ 4.27	-1.7%	Unattractive
WOW	Woolworths Limited	Neutral	$ 24.34	-2.2%	Unattractive
CCL	Coca-Cola Amatil	Neutral	$ 11.58	-2.7%	Unattractive
WES	Wesfarmers Limited	Neutral	$ 29.46	-2.7%	Unattractive

Source: Citi Investment Research and Analysis

Appendix IV: Citi AURAM Risk Model

The Citi AURAM risk model is a time series macro-economic risk model, rolled out in a desktop application called GRAM-X. Investors can estimate portfolio risk and sources of risk of their current holdings, run scenarios, and perform optimizations relative to a benchmark.

Calculation of AURAM is based on up to ten years of monthly data over the All Ordinaries universe. The sensitivities are re-estimated monthly using a rolling window approach, where the most recent month of data is added and the oldest month of data is dropped. Stocks that have less than 18 months of data are assigned the appropriate sector index betas as a proxy.

Figure 26. Factors in the AURAM Model

Macro Factor	Description
Economic Growth	The monthly change in 12 month forward consensus mean Australian Gross Domestic Product % growth forecasts (source: Consensus Economics)
China Industrial Production	The monthly change in 12 month forward consensus mean China Industrial Production % growth forecasts (source: Consensus Economics)
Credit	The monthly percentage change in composite spread of the iTraxx Australia IG 5 Year Index (source: Markit, Thomson Datastream)
Bond Yields	The monthly percentage change of the mid rate of Inflation Protected Commonwealth Government Bonds (source: RBA)
$AUD/$USD Exchange Rate	The monthly percentage change in the 12 month forward consensus forecast for the $AUD/$USD cross rate return (source: Consensus Economics)
Inflation	The monthly change in 12 month forward consensus percentage change in Australian Consumer Prices forecast (source: Consensus Economics)

Source: Citi Investment Research and Analysis, Markit, Consensus Economics, RBA, Thomson Datastream, S&P/ASX

For more details on the Australian Risk Attribute Model, refer to our report dated 11th May 2011: 'Australian RAM Version 2.0 – Wholesale Changes to Our Flagship Macroeconomic Risk Model'.

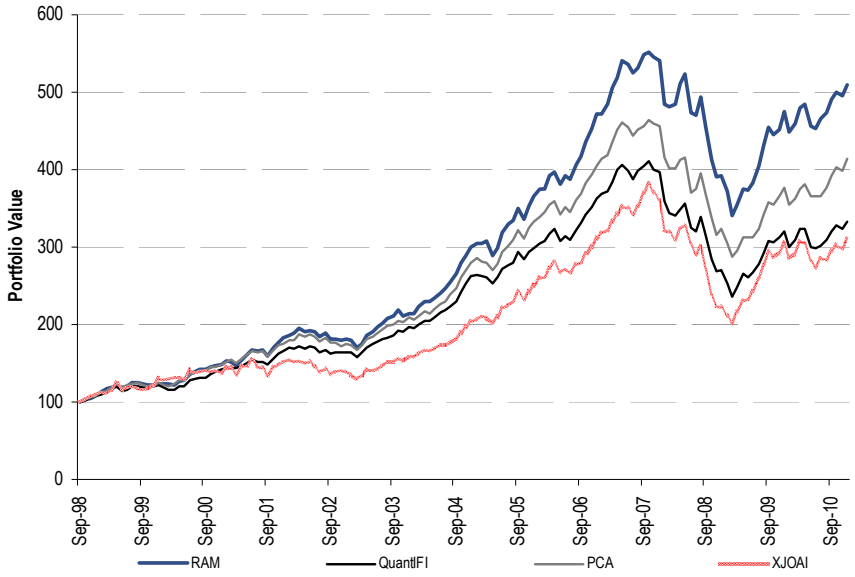
Appendix V: Minimum Variance in Australia

In February 2011, we looked in detail at practical Minimum Variance portfolio construction and performance decomposition.

Our research suggests that far from a passive strategy, Minimum Variance is most definitely an active strategy, with the key linchpin being the forecast covariance matrix of asset returns. In the analysis, we varied the factor structure of the risk model:

- (**RAM**) Our core Macro-oriented Australia Risk Attribute Model approach
- (**PCA**) A simple Principal Components based statistical approach: We use a principal components model until 85% of the market cap weighted index variance could be explained or a maximum of 10 components, whichever is reached earlier
- (**QFI**) A "fundamental" approach based on our QuantIFI style indices[4] (this is in essence a simplified cross-sectional fundamental model)

Figure 27. Risk Model Wealth Curves

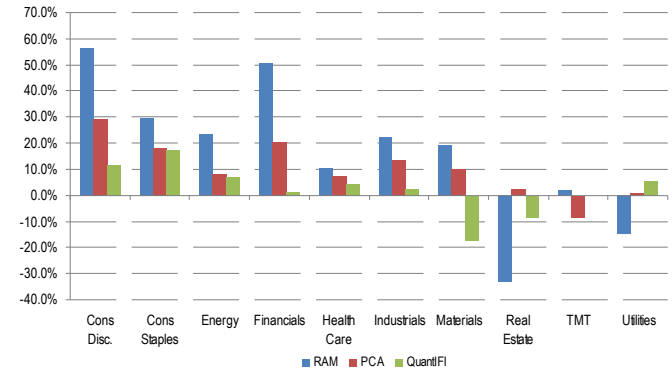


Source: Citi Investment Research and Analysis

The results in Figure 23 highlight the importance of factor structure on the performance and risk benefit of Minimum Variance. And **our analysis suggests the highest Sharpe ratio was achieved using the RAM model**.

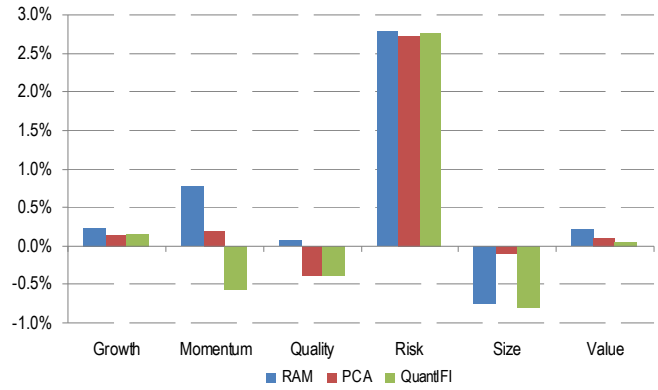
[4] For a description of the QuantIFI indicies (which are published daily on Bloomberg) see "**Introducing Citi QuantIIF Indices for Australian Equities**" January 2010

Figure 28. Sector Contributions



Source: Citi Investment Research and Analysis

Figure 29. Style Contributions

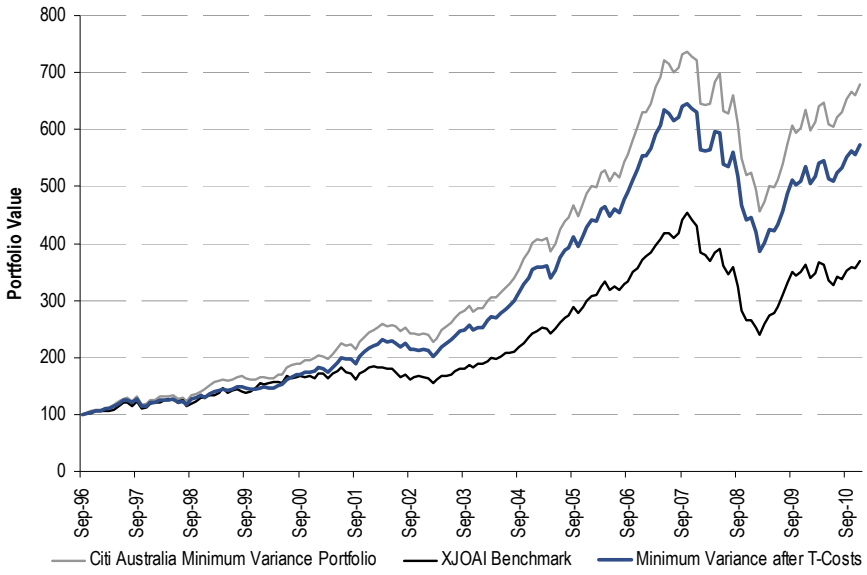


Source: Citi Investment Research and Analysis

Figure 28 and Figure 29 highlight sector and style contributors to performance. In particular we note the importance of the sector contributions to overall returns.

Overall, our Minimum Variance strategy backtested since 1996 achieved an information ratio of 0.76.

Figure 30. Relative Wealth Curve



Source: Citi Investment Research and Analysis

Appendix VI: QuantIFI Australia

The first step of QuantIFI Index construction process involves the identification of the most important systematic drivers of risk and return in the Australian Equity market over the long term. Using results from the extensive style performance research published by the Citi Global Quantitative Research team, together with client feedback and stylized facts documented within the Academic literature we arrive at the following styles: Size, Value, Growth, Risk, Momentum and Quality.

For each style factor, we then select a list of descriptors that best represent that specific attribute. For instance, we use the total market capitalization and the last reported total assets to represent a company's size attribute. These descriptors are then winsorized and weighted to arrive at a style factor loading or style factor beta for each stock in the ASX200 universe to each style. We also center the market cap weighted mean loading of the ASX 200 estimation universe around zero for each style factor which ensures that the market has zero exposures to all of the above style factors.

We next employ a weighted regression technique to compute a set of orthogonal style factor portfolios using the monthly total excess returns of all stocks in the estimation universe and their a priori style factor loadings constructed as described above.

The table below lists the Citi Australia QuantIFI Style Indices together with the descriptors used in the construction of each index.

Figure 31. Citi Australia QuantIFI Indices – Style Factors and Descriptors

Style Index	Descriptors	Description
Value	FY1 Earnings Yield	Forecast IBES FY1 Consensus Earnings Yield
	Trailing Valuation Measures	Trailing Yields (Earnings, Cash Flow, Divs) and Book/Price
Growth	S&P Growth Score	5 Yr Trailing Growth Measures (Earnings, Sales, Int. Growth)
	Trend Growth in Earnings	Trend in Historical (3 Years) + Forecast (2 Years) EPS
	Long Term Growth Forecasts	Forecast IBES Consensus Long Term Growth Rates
Size	Market Capitalisation	Natural log of Market Capitalization
	Balance Sheet Size	Last Reported Total Assets
Risk	Beta	Historical Beta to the ASX 200 (1 Year)
	Volatility	Share Price Volatility (6 Months)
Momentum	Price Momentum - Long Term	One year volatility adjusted price trend
	Price Momentum - Short Term	60 days volatility adjusted price trend
	Earnings Momentum	Earnings Revision Ratio (IBES Consensus - 3 Months)
Quality	Profitability	IBES Consensus FY1 Return on Equity
	Earnings Quality	Earnings Stability
	Leverage	Debt/Assets Ratio
	Balance Sheet Liquidity	Quick Ratio

Source: Citi Investment Research and Analysis

The last step involves a simple linear combination of the monthly style factor portfolios with the forward returns of each constituent stock measured over a monthly or daily periodicity to generate an index of style returns. By construction, each index has a unit exposure to any one style and zero exposure to all other styles, at the time of the monthly rebalance.

For more details on QuantIFI Style Indices, refer to our report dated 8th January 2010: 'Introducing Citi QuantIFI Indices for Australian Equities'.

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.

IMPORTANT DISCLOSURES

Zee Yusuf, Associate, holds a long position in the securities of Insurance Australia Group Ltd,CSL Ltd,News Corp,AMP Ltd.

Nigel Pittaway, Analyst, holds a long position in the securities of AMP Ltd.

A member of the household of Trevor Huynh, Associate, holds a long position in the securities of Leighton Holdings Ltd.

Citigroup Global Markets Inc. or its affiliates beneficially owns 1% or more of any class of common equity securities of Atlas Iron Ltd, Amcor Limited, AMP Ltd, Australian Securities Exchange, BlueScope Steel, Commonwealth Bank of Australia, Coca-Cola Amatil Ltd, CSL Ltd, CSR Ltd, Caltex Australia, David Jones Ltd, Insurance Australia Group Ltd, Iluka Resources Ltd, Kingsgate Consolidated Limited, Leighton Holdings Ltd, Mount Gibson Iron, Macquarie Group Limited, Newcrest Mining Ltd, News Corp, Origin Energy Ltd, Oil Search Ltd, QBE Insurance Group Ltd, ResMed Inc, Sims Metal Management, Stockland, Sigma Pharmaceuticals Ltd, Santos Ltd, Suncorp Group Ltd, Transurban, Ten Network Holdings Ltd, Telstra Corp Ltd, Toll Holdings Ltd, Tatts Group Ltd, Westfield Group, Wesfarmers Ltd, Woolworths Ltd, Woodside Petroleum Ltd, Western Areas NL. This position reflects information available as of the prior business day.

Within the past 12 months, Citigroup Global Markets Inc. or its affiliates has acted as manager or co-manager of an offering of securities of Commonwealth Bank of Australia, CSL Ltd, Macquarie Group Limited, SingTel, Santos Ltd, Telstra Corp Ltd, Westfield Group, Woolworths Ltd, Woodside Petroleum Ltd.

Citigroup Global Markets Inc. or its affiliates has received compensation for investment banking services provided within the past 12 months from AMP Ltd, Commonwealth Bank of Australia, Commonwealth Property Office Fund, CSL Ltd, Caltex Australia, Leighton Holdings Ltd, Macquarie Group Limited, News Corp, Platinum Asset Management Ltd, QBE Insurance Group Ltd, SingTel, Telstra Corp Ltd, Westfield Group, Woolworths Ltd, Woodside Petroleum Ltd.

Citigroup Global Markets Inc. or its affiliates expects to receive or intends to seek, within the next three months, compensation for investment banking services from Amcor Limited, Commonwealth Bank of Australia, Caltex Australia, Macquarie Group Limited, SingTel, Woolworths Ltd.

Citigroup Global Markets Inc. or an affiliate received compensation for products and services other than investment banking services from AMP Ltd, QBE Insurance Group Ltd, Suncorp Group Ltd, Asciano Limited, Amcor Limited, Ansell Ltd, Australian Securities Exchange, Boart Longyear Ltd, BlueScope Steel, Commonwealth Bank of Australia, Coca-Cola Amatil Ltd, Commonwealth Property Office Fund, CSL Ltd, CSR Ltd, Caltex Australia, Flight Centre Ltd, Goodman Group, Insurance Australia Group Ltd, InvoCare Ltd, Leighton Holdings Ltd, Macquarie Group Limited, Newcrest Mining Ltd, Navitas Limited, News Corp, Origin Energy Ltd, Oil Search Ltd, Platinum Asset Management Ltd, Stockland, Spark Infrastructure Group, SingTel, Santos Ltd, Seven West Media Ltd., Transurban, Ten Network Holdings Ltd, Telstra Corp Ltd, Toll Holdings Ltd, Westfield Group, Wesfarmers Ltd, Woolworths Ltd, Woodside Petroleum Ltd in the past 12 months.

Citigroup Global Markets Inc. currently has, or had within the past 12 months, the following as investment banking client(s): Commonwealth Bank of Australia, Westfield Group, Amcor Limited, AMP Ltd, Commonwealth Property Office Fund, CSL Ltd, Caltex Australia, Leighton Holdings Ltd, Macquarie Group Limited, News Corp, Platinum Asset Management Ltd, QBE Insurance Group Ltd, SingTel, Telstra Corp Ltd, Woolworths Ltd, Woodside Petroleum Ltd.

Citigroup Global Markets Inc. currently has, or had within the past 12 months, the following as clients, and the services provided were non-investment-banking, securities-related: AMP Ltd, Insurance Australia Group Ltd, Suncorp Group Ltd, QBE Insurance Group Ltd, Asciano Limited, Amcor Limited, Ansell Ltd, Australian Securities Exchange, Boart Longyear Ltd, BlueScope Steel, Commonwealth Bank of Australia, Coca-Cola Amatil Ltd, Commonwealth Property Office Fund, CSL Ltd, CSR Ltd, Caltex Australia, Flight Centre Ltd, Goodman Group, Iluka Resources Ltd, InvoCare Ltd, Leighton Holdings Ltd, Macquarie Group Limited, Newcrest Mining Ltd, Navitas Limited, News Corp, Origin Energy Ltd, Oil Search Ltd, Platinum Asset Management Ltd, St Barbara Limited, Sims Metal Management, Stockland, Spark Infrastructure Group, SingTel, Santos Ltd, Seven West Media Ltd., Transurban, Telstra Corp Ltd, Toll Holdings Ltd, Westfield Group, Wesfarmers Ltd, Woolworths Ltd, Woodside Petroleum Ltd, Western Areas NL.

Citigroup Global Markets Inc. currently has, or had within the past 12 months, the following as clients, and the services provided were non-investment-banking, non-securities-related: Asciano Limited, Amcor Limited, AMP Ltd, Ansell Ltd, Australian Securities Exchange, Boart Longyear Ltd, BlueScope Steel, Commonwealth Bank of Australia, Coca-Cola Amatil Ltd, CSL Ltd, CSR Ltd, Caltex Australia, Flight Centre Ltd, Goodman Group, Insurance Australia Group Ltd, InvoCare Ltd, Leighton Holdings Ltd, Macquarie Group Limited, Newcrest Mining Ltd, Navitas Limited, News Corp, Origin Energy Ltd, Oil Search Ltd, QBE Insurance Group Ltd, Stockland, Spark Infrastructure Group, SingTel, Santos Ltd, Suncorp Group Ltd, Seven West Media Ltd., Transurban, Ten Network Holdings Ltd, Telstra Corp Ltd, Toll Holdings Ltd, Westfield Group, Wesfarmers Ltd, Woolworths Ltd, Woodside Petroleum Ltd.

Citigroup Global Markets Inc. or an affiliate received compensation in the past 12 months from Commonwealth Bank of Australia, AMP Ltd, QBE Insurance Group Ltd, Suncorp Group Ltd.

Analysts' compensation is determined based upon activities and services intended to benefit the investor clients of Citigroup Global Markets Inc. and its affiliates ("the Firm"). Like all Firm employees, analysts receive compensation that is impacted by overall firm profitability which includes investment banking revenues.

The Firm is a market maker in the publicly traded equity securities of Amcor Limited, Coca-Cola Amatil Ltd, CSL Ltd, Macquarie Group Limited, Newcrest Mining Ltd, News Corp, SingTel, Telstra Corp Ltd, Westfield Group, Woodside Petroleum Ltd.

For important disclosures (including copies of historical disclosures) regarding the companies that are the subject of this Citi Investment Research & Analysis product ("the Product"), please contact Citi Investment Research & Analysis, 388 Greenwich Street, 28th Floor, New York, NY, 10013, Attention: Legal/Compliance [E6WYB6412478]. In addition, the same important disclosures, with the exception of the Valuation and Risk assessments and historical disclosures, are contained on the Firm's disclosure website at www.citigroupgeo.com. Valuation and Risk assessments can be found in the text of the most recent research note/report regarding the subject company. Historical disclosures (for up to the past three years) will be provided upon request.

Citi Investment Research & Analysis Ratings Distribution

	12 Month Rating			*Relative Rating*		
Data current as of 31 Dec 2011	**Buy**	**Hold**	**Sell**	**Buy**	**Hold**	**Sell**
Citi Investment Research & Analysis Global Fundamental Coverage	57%	34%	9%	10%	79%	10%
% of companies in each rating category that are investment banking clients	45%	41%	40%	49%	43%	41%
Citi Investment Research & Analysis Quantitative World Radar Screen Model Coverage	30%	40%	30%			
% of companies in each rating category that are investment banking clients	22%	24%	21%			
Citi Investment Research & Analysis Quantitative Decision Tree Model Coverage	52%	0%	48%			
% of companies in each rating category that are investment banking clients	54%	0%	44%			
Citi Investment Research & Analysis Asia Quantitative Radar Screen Model Coverage	20%	60%	20%			
% of companies in each rating category that are investment banking clients	21%	22%	20%			
Citi Investment Research & Analysis Australia Radar Model Coverage	41%	0%	59%			
% of companies in each rating category that are investment banking clients	22%	0%	17%			

Guide to Citi Investment Research & Analysis (CIRA) Fundamental Research Investment Ratings:
CIRA's stock recommendations include an investment rating and an optional risk rating to highlight high risk stocks.
Risk rating takes into account both price volatility and fundamental criteria. Stocks will either have no risk rating or a High risk rating assigned.
Investment Ratings: CIRA's investment ratings are Buy, Neutral and Sell. Our ratings are a function of analyst expectations of expected total return ("ETR") and risk. ETR is the sum of the forecast price appreciation (or depreciation) plus the dividend yield for a stock within the next 12 months. The Investment rating definitions are: Buy (1) ETR of 15% or more or 25% or more for High risk stocks; and Sell (3) for negative ETR. Any covered stock not assigned a Buy or a Sell is a Neutral (2). For stocks rated Neutral (2), if an analyst believes that there are insufficient valuation drivers and/or investment catalysts to derive a positive or negative investment view, they may elect with the approval of CIRA management not to assign a target price and, thus, not derive an ETR. Analysts may place covered stocks "Under Review" in response to exceptional circumstances (e.g. lack of information critical to the analyst's thesis) affecting the company and / or trading in the company's securities (e.g. trading suspension). As soon as practically possible, the analyst will publish a note re-establishing a rating and investment thesis. To satisfy regulatory requirements, we correspond Under Review and Neutral to Hold in our ratings distribution table for our 12-month fundamental rating system. However, we reiterate that we do not consider Under Review to be a recommendation.
Relative three-month ratings: CIRA may also assign a three-month relative call (or rating) to a stock to highlight expected out-performance (most preferred) or under-performance (least preferred) versus the geographic and industry sector over a 3 month period. The relative call may highlight a specific near-term catalyst or event impacting the company or the market that is anticipated to have a short-term price impact on the equity securities of the company. Absent any specific catalyst the analyst(s) will indicate the most and least preferred stocks in the universe of stocks under consideration, explaining the basis for this short-term view. This three-month view may be different from and does not affect a stock's fundamental equity rating, which reflects a longer-term total absolute return expectation. For purposes of NASD/NYSE ratings-distribution-disclosure rules, most preferred calls correspond to a buy recommendation and least preferred calls correspond to a sell recommendation. Any stock not assigned to a most preferred or least preferred call is considered non-relative-rated (NRR). For purposes of NASD/NYSE ratings-distribution-disclosure rules we correspond NRR to Hold in our ratings distribution table for our 3-month relative rating system. However, we reiterate that we do not consider NRR to be a recommendation.

Prior to October 8, 2011, the firm's stock recommendation system included a risk rating and an investment rating. **Risk ratings,** which took into account both price volatility and fundamental criteria, were: Low (L), Medium (M), High (H), and Speculative (S). **Investment Ratings** of Buy, Hold and Sell were a function of CIRA's expectation of total return (forecast price appreciation and dividend yield within the next 12 months) and risk rating. Additionally, analysts could have placed covered stocks "Under Review" in response to exceptional circumstances (e.g. lack of information critical to the analyst's thesis) affecting the company and/or trading in the company's securities (e.g. trading suspension). Stocks placed "Under Review" were monitored daily by management and as practically possible, the analyst published a note re-establishing a rating and investment thesis. For securities in developed markets (US, UK, Europe, Japan, and Australia/New Zealand), investment ratings were:Buy (1) (expected total return of 10% or more for Low-Risk stocks, 15% or more for Medium-Risk stocks, 20% or more for High-Risk stocks, and 35% or more for Speculative stocks); Hold (2) (0%-10% for Low-Risk stocks, 0%-15% for Medium-Risk stocks, 0%-20% for High-Risk stocks, and 0%-35% for Speculative stocks); and Sell (3) (negative total return). For securities in emerging markets (Asia Pacific, Emerging Europe/Middle East/Africa, and Latin America), investment ratings were:Buy (1) (expected total return of 15% or more for Low-Risk stocks, 20% or more for Medium-Risk stocks, 30% or more for High-Risk stocks, and 40% or more for Speculative stocks); Hold (2) (5%-15% for Low-Risk stocks, 10%-20% for Medium-Risk stocks, 15%-30% for High-Risk stocks, and 20%-40% for Speculative stocks); and Sell (3) (5% or less for Low-Risk stocks, 10% or less for Medium-Risk stocks, 15% or less for High-Risk stocks, and 20% or less for Speculative stocks).

Investment ratings are determined by the ranges described above at the time of initiation of coverage, a change in investment and/or risk rating, or a change in target price (subject to limited management discretion). At other times, the expected total returns may fall outside of these ranges because of market price movements and/or other short-term volatility or trading patterns. Such interim deviations from specified ranges will be permitted but will become subject to review by Research Management. Your decision to buy or sell a security should be based upon your personal investment objectives and should be made only after evaluating the stock's expected performance and risk.

Guide to Citi Investment Research & Analysis (CIRA) Quantitative Research Investment Ratings:
CIRA Quantitative Research World Radar Screen recommendations are based on a globally consistent framework to measure relative value and momentum for a large number of stocks across global developed and emerging markets. Relative value and momentum rankings are equally weighted to produce a

global attractiveness score for each stock. The scores are then ranked and put into deciles. A stock with a decile rating of 1 denotes an attractiveness score in the top 10% of the universe (most attractive). A stock with a decile rating of 10 denotes an attractiveness score in the bottom 10% of the universe (least attractive).
CIRA Asia Quantitative Radar Screen model recommendations are based on a regionally consistent framework to measure relative value and momentum for a large number of stocks across regional developed and emerging markets. Relative value and momentum rankings are equally weighted to produce a global attractiveness score for each stock. The scores are then ranked and put into quintiles. A stock with a quintile rating of 1 denotes an attractiveness score in the top 20% of the universe (most attractive). A stock with a quintile rating of 5 denotes an attractiveness score in the bottom 20% of the universe (least attractive).
CIRA Australia Quantitative Radar Screen model recommendations are based on a robust framework to measure relative value and momentum for a large number of stocks across the Australian market. Stocks with a ranking of 1 denotes a stock that is above average in terms of both value and momentum relative to the stocks in the Australian market. A ranking of 10 denotes a stock that is below average in terms of both value and momentum relative to the stocks in the Australian market.
CIRA Quantitative Decision Tree model recommendations are based on a predetermined set of factors to rate the relative attractiveness of stocks. These factors are detailed in the text of the report. The Decision Tree model forecasts whether stocks are attractive or unattractive relative to other stocks in the same sector (based on the Russell 1000 sector classifications).

For purposes of NASD/NYSE ratings-distribution-disclosure rules, a Citi Investment Research & Analysis (CIRA) Quantitative World Radar Screen recommendation of (1), (2) or (3) most closely corresponds to a buy recommendation; a recommendation from this product group of (4), (5), (6) or (7) most closely corresponds to a hold recommendation; and a recommendation of (8), (9) or (10) most closely corresponds to a sell recommendation. An (NR) recommendation indicates that the stock is no longer in the screen.
For purposes of NASD/NYSE ratings distribution disclosure rules, a CIRA Asia Quantitative Radar Screen recommendation of (1) most closely corresponds to a buy recommendation; a CIRA Asia Quantitative Radar Screen recommendation of (2), (3), (4) most closely corresponds to a hold recommendation; and a recommendation of (5) most closely corresponds to a sell recommendation. An (NR) recommendation indicates that the stock is no longer in the screen.
For purposes of NASD/NYSE ratings-distribution-disclosure rules, a CIRA Quantitative Research Decision Tree model or Quantitative Research Australia Radar Screen recommendation of "attractive" (1) most closely corresponds to a buy recommendation. All other stocks in the sector are considered to be "unattractive" (10) which most closely corresponds to a sell recommendation. An (NR)/(0) recommendation indicates that the stock is no longer in the screen.
Recommendations are based on the relative attractiveness of a stock, thus can not be directly equated to buy, hold and sell categories. Accordingly, your decision to buy or sell a security should be based on your personal investment objectives and only after evaluating the stock's expected relative performance.

NON-US RESEARCH ANALYST DISCLOSURES
Non-US research analysts who have prepared this report (i.e., all research analysts listed below other than those identified as employed by Citigroup Global Markets Inc.) are not registered/qualified as research analysts with FINRA. Such research analysts may not be associated persons of the member organization and therefore may not be subject to the NYSE Rule 472 and NASD Rule 2711 restrictions on communications with a subject company, public appearances and trading securities held by a research analyst account. The legal entities employing the authors of this report are listed below:

Citigroup Global Markets Singapore PTE LIMITED	Paul R Chanin; Puneet Singh; Anmol Sethy; Tushar Subhra Mandal; Si An Tan; Arthur Pineda
Citicorp Pty Ltd	Nick Morton; Zee Yusuf; Craig Woolford; Nigel Pittaway; Clarke Wilkins; Marie Miyashiro, CFA; Laurence Parisi; Guy Robinson; Alex Smith; Craig Williams; Mark Greenwood; Justin Diddams; David Haddad; Wes Nason; Jackie Tin, CFA; Craig Sainsbury; Tim Mitchell, CFA; Trevor Huynh; Ben Dalling; Jenny Owen
Citigroup Global Markets Japan Inc.	Nachiket R Garde, CFA; Masayoshi Yoshihara
Citigroup Global Markets Inc	Jason B Bazinet
Citibank N.A. New Zealand Branch	Andy Bowley

OTHER DISCLOSURES

Citigroup Global Markets Inc. and/or its affiliates has a significant financial interest in relation to AMP Ltd, Commonwealth Bank of Australia, Caltex Australia, Macquarie Group Limited, News Corp, Suncorp Group Ltd, Telstra Corp Ltd, Woolworths Ltd, Woodside Petroleum Ltd. (For an explanation of the determination of significant financial interest, please refer to the policy for managing conflicts of interest which can be found at www.citigroupgeo.com.)

Citigroup Global Markets Inc. or its affiliates beneficially owns 2% or more of any class of common equity securities of Atlas Iron Ltd, Amcor Limited, BlueScope Steel, Coca-Cola Amatil Ltd, CSR Ltd, David Jones Ltd, Insurance Australia Group Ltd, News Corp, Origin Energy Ltd, ResMed Inc, Suncorp Group Ltd, Transurban, Tatts Group Ltd, Westfield Group.

Citigroup Global Markets Inc. or its affiliates beneficially owns 10% or more of any class of common equity securities of Australian Securities Exchange, CSL Ltd, Leighton Holdings Ltd, Macquarie Group Limited, Sims Metal Management, Toll Holdings Ltd, Woodside Petroleum Ltd.

Citigroup Global Markets Inc. or its affiliates beneficially owns 5% or more of any class of common equity securities of AMP Ltd, Commonwealth Bank of Australia, Caltex Australia, Iluka Resources Ltd, Newcrest Mining Ltd, QBE Insurance Group Ltd, Santos Ltd, Wesfarmers Ltd, Woolworths Ltd, Western Areas NL.

For securities recommended in the Product in which the Firm is not a market maker, the Firm is a liquidity provider in the issuers' financial instruments and may act as principal in connection with such transactions. The Firm is a regular issuer of traded financial instruments linked to securities that may have been recommended in the Product. The Firm regularly trades in the securities of the issuer(s) discussed in the Product. The Firm may engage in securities transactions in a manner inconsistent with the Product and, with respect to securities covered by the Product, will buy or sell from customers on a principal basis.

Securities recommended, offered, or sold by the Firm: (i) are not insured by the Federal Deposit Insurance Corporation; (ii) are not deposits or other obligations of any insured depository institution (including Citibank); and (iii) are subject to investment risks, including the possible loss of the principal amount invested. Although information has been obtained from and is based upon sources that the Firm believes to be reliable, we do not guarantee its accuracy and it may be incomplete and condensed. Note, however, that the Firm has taken all reasonable steps to determine the accuracy and completeness of the disclosures made in the Important Disclosures section of the Product. The Firm's research department has received assistance from the subject company(ies) referred to in this Product including, but not limited to, discussions with management of the subject company(ies). Firm policy prohibits research analysts from sending draft research to subject companies. However, it should be presumed that the author of the Product has had discussions with the subject company to ensure factual accuracy prior to publication. All opinions, projections and estimates constitute the judgment of the author as of the date of the Product and these, plus any other information contained in the Product, are subject to change without notice. Prices and availability of financial instruments also are subject to change without notice. Notwithstanding other departments within the Firm advising the companies discussed in this Product, information obtained in such role is not used in the preparation of the Product. Although Citi Investment Research & Analysis (CIRA) does not set a predetermined frequency for publication, if the Product is a fundamental research report, it is the intention of CIRA to provide research coverage of the/those issuer(s) mentioned therein, including in response to news affecting this issuer, subject to applicable quiet periods and capacity constraints. The Product is for informational purposes only and is not intended as an offer or solicitation for the purchase or sale of a security. Any decision to purchase securities mentioned in the Product must take into account existing public information on such security or any registered prospectus.

Investing in non-U.S. securities, including ADRs, may entail certain risks. The securities of non-U.S. issuers may not be registered with, nor be subject to the reporting requirements of the U.S. Securities and Exchange Commission. There may be limited information available on foreign securities. Foreign companies are generally not subject to uniform audit and reporting standards, practices and requirements comparable to those in the U.S. Securities of some foreign companies may be less liquid and their prices more volatile than securities of comparable U.S. companies. In addition, exchange rate movements may have an adverse effect on the value of an investment in a foreign stock and its corresponding dividend payment for U.S. investors. Net dividends to ADR investors are estimated, using withholding tax rates conventions, deemed accurate, but investors are urged to consult their tax advisor for exact dividend computations. Investors who have received the Product from the Firm may be prohibited in certain states or other jurisdictions from purchasing securities mentioned in the Product from the Firm. Please ask your Financial Consultant for additional details. Citigroup Global Markets Inc. takes responsibility for the Product in the United States. Any orders by US investors resulting from the information contained in the Product may be placed only through Citigroup Global Markets Inc.

Important Disclosures for Morgan Stanley Smith Barney LLC Customers: Morgan Stanley & Co. LLC (Morgan Stanley) research reports may be available about the companies that are the subject of this Citi Investment Research & Analysis (CIRA) research report. Ask your Financial Advisor or use smithbarney.com to view any available Morgan Stanley research reports in addition to CIRA research reports.
Important disclosure regarding the relationship between the companies that are the subject of this CIRA research report and Morgan Stanley Smith Barney LLC and its affiliates are available at the Morgan Stanley Smith Barney disclosure website at www.morganstanleysmithbarney.com/researchdisclosures.
For Morgan Stanley and Citigroup Global Markets, Inc. specific disclosures, you may refer to www.morganstanley.com/researchdisclosures and https://www.citigroupgeo.com/geopublic/Disclosures/index_a.html.
This CIRA research report has been reviewed and approved on behalf of Morgan Stanley Smith Barney LLC. This review and approval was conducted by the same person who reviewed this research report on behalf of CIRA. This could create a conflict of interest.

The Citigroup legal entity that takes responsibility for the production of the Product is the legal entity which the first named author is employed by. The Product is made available in **Australia** through Citigroup Global Markets Australia Pty Ltd. (ABN 64 003 114 832 and AFSL No. 240992), participant of the ASX Group and regulated by the Australian Securities & Investments Commission. Citigroup Centre, 2 Park Street, Sydney, NSW 2000. The Product is made available in Australia to Private Banking wholesale clients through Citigroup Pty Limited (ABN 88 004 325 080 and AFSL 238098). Citigroup Pty Limited provides all financial product advice to Australian Private Banking wholesale clients through bankers and relationship managers. If there is any doubt about the suitability of investments held in Citigroup Private Bank accounts, investors should contact the Citigroup Private Bank in Australia. Citigroup companies may compensate affiliates and their representatives for providing products and services to clients. The Product is made available in **Brazil** by Citigroup Global Markets Brasil - CCTVM SA, which is regulated by CVM - Comissão de Valores Mobiliários, BACEN - Brazilian Central Bank, APIMEC - Associação dos Analistas e Profissionais de Investimento do Mercado de Capitais and ANBID - Associação Nacional dos Bancos de Investimento. Av. Paulista, 1111 - 11º andar - CEP. 01311920 - São Paulo - SP. If the Product is being made available in certain provinces of **Canada** by Citigroup Global Markets (Canada) Inc. ("CGM Canada"), CGM Canada has approved the Product. Citigroup Place, 123 Front Street West, Suite 1100, Toronto, Ontario M5J 2M3. This product is available in **Chile** through Banchile Corredores de Bolsa S.A., an indirect subsidiary of Citigroup Inc., which is regulated by the Superintendencia de Valores y Seguros. Agustinas 975, piso 2, Santiago, Chile. The Product is made available in **France** by Citigroup Global Markets Limited, which is authorised and regulated by Financial Services Authority. 1-5 Rue Paul Cézanne, 8ème, Paris, France. The Product is distributed in **Germany** by Citigroup Global Markets Deutschland AG ("CGMD"), which is regulated by Bundesanstalt fuer Finanzdienstleistungsaufsicht (BaFin). CGMD, Reuterweg 16, 60323 Frankfurt am Main. Research which relates to "securities" (as defined in the Securities and Futures Ordinance (Cap. 571 of the Laws of Hong Kong)) is issued in **Hong Kong** by, or on behalf of, Citigroup Global Markets Asia Limited which takes full responsibility for its content. Citigroup Global Markets Asia Ltd. is regulated by Hong Kong Securities and Futures Commission. If the Research is made available through Citibank, N.A., Hong Kong Branch, for its clients in Citi Private Bank, it is made available by Citibank N.A., Citibank Tower, Citibank Plaza, 3 Garden Road, Hong Kong. Citibank N.A. is regulated by the Hong Kong Monetary Authority. Please contact your Private Banker in Citibank N.A., Hong Kong, Branch if you have any queries on or any matters arising from or in connection with this document. The Product is made available in **India** by Citigroup Global Markets India Private Limited, which is regulated by Securities and Exchange Board of India. Bakhtawar, Nariman Point, Mumbai 400-021. The Product is made available in **Indonesia** through PT Citigroup Securities Indonesia. 5/F, Citibank Tower, Bapindo Plaza, Jl. Jend. Sudirman Kav. 54-55, Jakarta 12190. Neither this Product nor any copy hereof may be distributed in Indonesia or to any Indonesian citizens wherever they are domiciled or to Indonesian residents except in compliance with applicable capital market laws and regulations. This Product is not an offer of securities in Indonesia. The securities referred to in this Product have not been registered with the Capital Market and Financial Institutions Supervisory Agency (BAPEPAM-LK) pursuant to relevant capital market laws and regulations, and may not be offered or sold within the territory of the Republic of Indonesia or to Indonesian citizens through a public offering or in circumstances which constitute an offer within the meaning of the Indonesian capital market laws and regulations. The Product is made available in **Israel** through Citibank NA, regulated by the Bank of Israel and the Israeli Securities Authority. Citibank, N.A, Platinum Building, 21 Ha'arba'ah St, Tel Aviv, Israel. The Product is made

available in **Italy** by Citigroup Global Markets Limited, which is authorised and regulated by Financial Services Authority. Via dei Mercanti, 12, Milan, 20121, Italy. The Product is made available in **Japan** by Citigroup Global Markets Japan Inc. ("CGMJ"), which is regulated by Financial Services Agency, Securities and Exchange Surveillance Commission, Japan Securities Dealers Association, Tokyo Stock Exchange and Osaka Securities Exchange. Shin-Marunouchi Building, 1-5-1 Marunouchi, Chiyoda-ku, Tokyo 100-6520 Japan. If the Product was distributed by SMBC Nikko Securities Inc. it is being so distributed under license. In the event that an error is found in an CGMJ research report, a revised version will be posted on the Firm's Global Equities Online (GEO) website. If you have questions regarding GEO, please call (81 3) 6270-3019 for help. The Product is made available in **Korea** by Citigroup Global Markets Korea Securities Ltd., which is regulated by the Financial Services Commission, the Financial Supervisory Service and the Korea Financial Investment Association (KOFIA). Citibank Building, 39 Da-dong, Jung-gu, Seoul 110-180, Korea. KOFIA makes available registration information of research analysts on its website. Please visit the following website if you wish to find KOFIA registration information on research analysts of Citigroup Global Markets Korea Securities Ltd. http://dis.kofia.or.kr/fs/dis2/fundMgr/DISFundMgrAnalystPop.jsp?companyCd2=A03030&pageDiv=02. The Product is made available in **Malaysia** by Citigroup Global Markets Malaysia Sdn Bhd (Company No. 460819-D) ("CGMM") to its clients and CGMM takes responsibility for its contents. CGMM is regulated by the Securities Commission of Malaysia. Please contact CGMM at Level 43 Menara Citibank, 165 Jalan Ampang, 50450 Kuala Lumpur, Malaysia in respect of any matters arising from, or in connection with, the Product. The Product is made available in **Mexico** by Acciones y Valores Banamex, S.A. De C. V., Casa de Bolsa, Integrante del Grupo Financiero Banamex ("Accival") which is a wholly owned subsidiary of Citigroup Inc. and is regulated by Comision Nacional Bancaria y de Valores. Reforma 398, Col. Juarez, 06600 Mexico, D.F. In **New Zealand** the Product is made available to 'wholesale clients' only as defined by s5C(1) of the Financial Advisers Act 2008 ('FAA') through Citigroup Global Markets Australia Pty Ltd (ABN 64 003 114 832 and AFSL No. 240992), an overseas financial adviser as defined by the FAA, participant of the ASX Group and regulated by the Australian Securities & Investments Commission. Citigroup Centre, 2 Park Street, Sydney, NSW 2000. The Product is made available in **Pakistan** by Citibank N.A. Pakistan branch, which is regulated by the State Bank of Pakistan and Securities Exchange Commission, Pakistan. AWT Plaza, 1.1. Chundrigar Road, P.O. Box 4889, Karachi-74200. The Product is made available in the **Philippines** through Citicorp Financial Services and Insurance Brokerage Philippines, Inc., which is regulated by the Philippines Securities and Exchange Commission. 20th Floor Citibank Square Bldg. The Product is made available in the Philippines through Citibank NA Philippines branch, Citibank Tower, 8741 Paseo De Roxas, Makati City, Manila. Citibank NA Philippines NA is regulated by The Bangko Sentral ng Pilipinas. The Product is made available in **Poland** by Dom Maklerski Banku Handlowego SA an indirect subsidiary of Citigroup Inc., which is regulated by Komisja Nadzoru Finansowego. Dom Maklerski Banku Handlowego S.A. ul.Senatorska 16, 00-923 Warszawa. The Product is made available in the **Russian Federation** through ZAO Citibank, which is licensed to carry out banking activities in the Russian Federation in accordance with the general banking license issued by the Central Bank of the Russian Federation and brokerage activities in accordance with the license issued by the Federal Service for Financial Markets. Neither the Product nor any information contained in the Product shall be considered as advertising the securities mentioned in this report within the territory of the Russian Federation or outside the Russian Federation. The Product does not constitute an appraisal within the meaning of the Federal Law of the Russian Federation of 29 July 1998 No. 135-FZ (as amended) On Appraisal Activities in the Russian Federation. 8-10 Gasheka Street, 125047 Moscow. The Product is made available in **Singapore** through Citigroup Global Markets Singapore Pte. Ltd. ("CGMSPL"), a capital markets services license holder, and regulated by Monetary Authority of Singapore. Please contact CGMSPL at 1 Temasek Avenue, #39-02 Millenia Tower, Singapore 039192, in respect of any matters arising from, or in connection with, the analysis of this document. This report is intended for recipients who are accredited, expert and institutional investors as defined under the Securities and Futures Act (Cap. 289). The Product is made available by The Citigroup Private Bank in Singapore through Citibank, N.A., Singapore Branch, a licensed bank in Singapore that is regulated by Monetary Authority of Singapore. Please contact your Private Banker in Citibank N.A., Singapore Branch if you have any queries on or any matters arising from or in connection with this document. This report is intended for recipients who are accredited, expert and institutional investors as defined under the Securities and Futures Act (Cap. 289). This report is distributed in Singapore by Citibank Singapore Ltd ("CSL") to selected Citigold/Citigold Private Clients. CSL provides no independent research or analysis of the substance or in preparation of this report. Please contact your Citigold//Citigold Private Client Relationship Manager in CSL if you have any queries on or any matters arising from or in connection with this report. This report is intended for recipients who are accredited investors as defined under the Securities and Futures Act (Cap. 289). Citigroup Global Markets (Pty) Ltd. is incorporated in the **Republic of South Africa** (company registration number 2000/025866/07) and its registered office is at 145 West Street, Sandton, 2196, Saxonwold. Citigroup Global Markets (Pty) Ltd. is regulated by JSE Securities Exchange South Africa, South African Reserve Bank and the Financial Services Board. The investments and services contained herein are not available to private customers in South Africa. The Product is made available in **Spain** by Citigroup Global Markets Limited, which is authorised and regulated by Financial Services Authority. 29 Jose Ortega Y Gassef, 4th Floor, Madrid, 28006, Spain. The Product is made available in the **Republic of China** through Citigroup Global Markets Taiwan Securities Company Ltd. ("CGMTS"), 14 and 15F, No. 1, Songzhi Road, Taipei 110, Taiwan and/or through Citibank Securities (Taiwan) Company Limited ("CSTL"), 14 and 15F, No. 1, Songzhi Road, Taipei 110, Taiwan, subject to the respective license scope of each entity and the applicable laws and regulations in the Republic of China. CGMTS and CSTL are both regulated by the Securities and Futures Bureau of the Financial Supervisory Commission of Taiwan, the Republic of China. No portion of the Product may be reproduced or quoted in the Republic of China by the press or any third parties [without the written authorization of CGMTS and CSTL]. If the Product covers securities which are not allowed to be offered or traded in the Republic of China, neither the Product nor any information contained in the Product shall be considered as advertising the securities or making recommendation of the securities in the Republic of China. The Product is for informational purposes only and is not intended as an offer or solicitation for the purchase or sale of a security or financial products. Any decision to purchase securities or financial products mentioned in the Product must take into account existing public information on such security or the financial products or any registered prospectus. The Product is made available in **Thailand** through Citicorp Securities (Thailand) Ltd., which is regulated by the Securities and Exchange Commission of Thailand. 18/F, 22/F and 29/F, 82 North Sathorn Road, Silom, Bangrak, Bangkok 10500, Thailand. The Product is made available in **Turkey** through Citibank AS which is regulated by Capital Markets Board. Tekfen Tower, Eski Buyukdere Caddesi # 209 Kat 2B, 23294 Levent, Istanbul, Turkey. In the **U.A.E**, these materials (the "Materials") are communicated by Citigroup Global Markets Limited, DIFC branch ("CGML"), an entity registered in the Dubai International Financial Center ("DIFC") and licensed and regulated by the Dubai Financial Services Authority ("DFSA") to Professional Clients and Market Counterparties only and should not be relied upon or distributed to Retail Clients. A distribution of the different CIRA ratings distribution, in percentage terms for Investments in each sector covered is made available on request. Financial products and/or services to which the Materials relate will only be made available to Professional Clients and Market Counterparties. The Product is made available in **United Kingdom** by Citigroup Global Markets Limited, which is authorised and regulated by Financial Services Authority. This material may relate to investments or services of a person outside of the UK or to other matters which are not regulated by the FSA and further details as to where this may be the case are available upon request in respect of this material. Citigroup Centre, Canada Square, Canary Wharf, London, E14 5LB. The Product is made available in **United States** by Citigroup Global Markets Inc, which is a member of FINRA and

registered with the US Securities and Exchange Commission. 388 Greenwich Street, New York, NY 10013. Unless specified to the contrary, within EU Member States, the Product is made available by Citigroup Global Markets Limited, which is regulated by Financial Services Authority.
Pursuant to Comissão de Valores Mobiliários Rule 483, Citi is required to disclose whether a Citi related company or business has a commercial relationship with the subject company. Considering that Citi operates multiple businesses in more than 100 countries around the world, it is likely that Citi has a commercial relationship with the subject company.
Many European regulators require that a firm must establish, implement and make available a policy for managing conflicts of interest arising as a result of publication or distribution of investment research. The policy applicable to CIRA's Products can be found at www.citigroupgeo.com.
Compensation of equity research analysts is determined by equity research management and Citigroup's senior management and is not linked to specific transactions or recommendations.
The Product may have been distributed simultaneously, in multiple formats, to the Firm's worldwide institutional and retail customers. The Product is not to be construed as providing investment services in any jurisdiction where the provision of such services would not be permitted.
Subject to the nature and contents of the Product, the investments described therein are subject to fluctuations in price and/or value and investors may get back less than originally invested. Certain high-volatility investments can be subject to sudden and large falls in value that could equal or exceed the amount invested. Certain investments contained in the Product may have tax implications for private customers whereby levels and basis of taxation may be subject to change. If in doubt, investors should seek advice from a tax adviser. The Product does not purport to identify the nature of the specific market or other risks associated with a particular transaction. Advice in the Product is general and should not be construed as personal advice given it has been prepared without taking account of the objectives, financial situation or needs of any particular investor. Accordingly, investors should, before acting on the advice, consider the appropriateness of the advice, having regard to their objectives, financial situation and needs. Prior to acquiring any financial product, it is the client's responsibility to obtain the relevant offer document for the product and consider it before making a decision as to whether to purchase the product.
With the exception of our product that is made available only to Qualified Institutional Buyers (QIBs), CIRA concurrently disseminates its research via proprietary and non-proprietary electronic distribution platforms. Periodically, individual CIRA analysts may also opt to circulate research posted on such platforms to one or more clients by email. Such email distribution is discretionary and is done only after the research has been disseminated via the aforementioned distribution channels. CIRA simultaneously distributes product that is limited to QIBs only through email distribution.
The level and types of services provided by CIRA analysts to clients may vary depending on various factors such as the client's individual preferences as to the frequency and manner of receiving communications from analysts, the client's risk profile and investment focus and perspective (e.g. market-wide, sector specific, long term, short-term etc.), the size and scope of the overall client relationship with Citi and legal and regulatory constraints.

ADDITIONAL INFORMATION IS AVAILABLE UPON REQUEST