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Quantitative Analysis (Citi)
Japan

Pan-Asian Quants

Quantitative Investable Factor Indices methodology update

- **What's New** — In this update to the index construction methodology, we investigate the impact of two changes. Firstly, we make the indices exhibit constant leverage from month to month. Secondly, we allow the weights of the stocks in each index to change on a daily basis instead of maintaining a constant proportion in each stock.

- **First change: Constant leverage** — The current process of style portfolio generation is dollar-neutral, but there is no constraint on the total portfolio size. Going forward we propose to make both the long and short side of each style portfolio sum to unity every month, thereby controlling the numbers of units being held by the investor during monthly rebalancing. In effect, the indices are now orthonormal in addition to being orthogonal.

- **Second Change: Drifting weights** — Currently we rebalance the weights daily to start-of-period weight to maintain constant exposure for each stock. This introduces turnover on a daily basis thereby increasing the trading costs. To reduce these we move to a buy-and-hold mechanism where we let the weights of the stock in the portfolio change based on the daily performance.

- **Implications** — Buy-and-hold strategies are static (passive) in terms of assets but allow changing characteristics over time. The assumption of constant risk premia associated with the factor may be inappropriate and the updated methodology reflects this while having the advantage of controlling the leverage and turnover of each style.

- **Style Performance** — Value has trounced all other equity styles in Japan. At a 9.3% per annum return on an 8.9% annualized volatility basis, a passive Value trade tracking our Japan QuantIFI Value index has shown an impressive 1.04 Information Ratio. It is also the best performing style during the last 3 years.

- **Investment Opportunities** — With these changes, we are now able to offer tracking products on these indices priced on a daily basis. These are available in both swap and fully funded form. Please contact any of the authors or your Citi Salesperson for details on the pricing.

Figure 1. Bloomberg codes

BB Code	CITQJPSZ	CITQJPVA	CITQJPGR	CITQJPRI	CITQJPMO	CITQJPQU
Annualized Returns	-3.01	9.3	0.66	-1.37	0.3	2.94
Annualized Volatility	9.03	8.96	7.67	16.22	9.8	8.74
Information Ratio	-0.33	1.04	0.09	-0.08	0.03	0.34

Source: Citi Research.

- Quantitative Analysis

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Executive Summary

In this report we update the methodology underlying the construction of our style factor indices for Japanese equities. These indices have two key differentiating characteristics. Firstly, they provide "pure" factor exposure (i.e., a Value index has a unit exposure to the Value factor and a Zero exposure to all other style factors). Secondly, the indices are investible as each stock's weight in the index is a function of its recent liquidity in the market—attributes which give the indices potential applicability within the investment process in multiple areas such as asset allocation, portfolio construction and risk management. We enhance these indices by making two changes that reduce turnover and control for leverage.

Index construction philosophy

The philosophy underlying factor indices is an extension of the financial theory of capital asset pricing. Essentially there is one key difference: the beta itself is expressed as a combination of "factor betas" to several individual and independent factors instead of just the one factor Capital Asset Pricing Model (CAPM) which provides a beta against the market. Thus, it stays true to the philosophy of efficient separation of alpha and beta in portfolio construction, a topic of much interest within the investment community.

In a nutshell, working with factor indices helps us to accomplish the following:

1. Attribute equity market returns between systematic market wide factors and an unsystematic, stock specific component;
2. Create orthogonal factor (or style) indices as benchmarks of linearly independent payoffs to each systematic factor;
3. Apply tilts to (or hedge) the individual factor exposures as a way of effectively managing the portfolio's systematic risk exposures.

Clients will recognize this as simply a multifactor extension to the processes commonly employed to measure and manage a portfolio's market beta. The main value-add comes from the additional level of granularity they provide in portfolio construction and risk management.

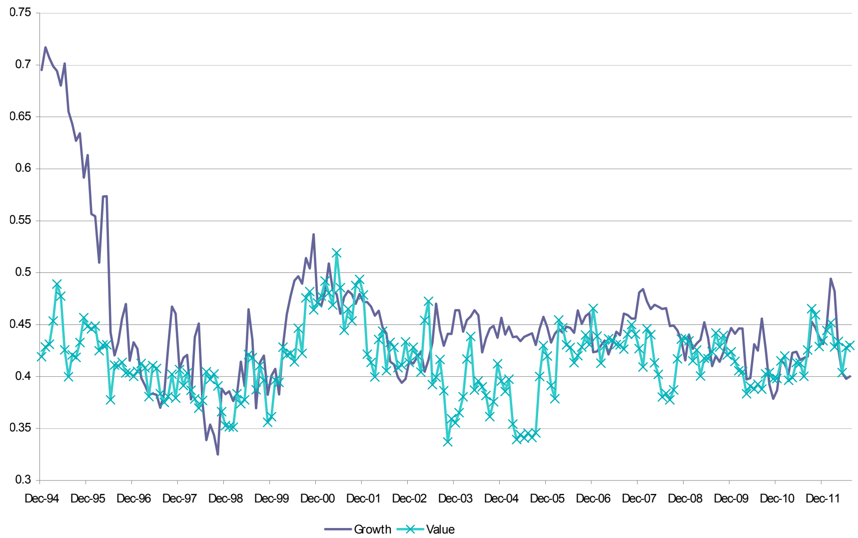
We now make two changes to the way these indices are rebalanced every month and priced every day

First change: Constant leverage

The current process of style portfolio generation doesn't have any explicit constraint in terms of sum of weight on the long or short side. The weight for the long side for any style is same as the short side, making the portfolios dollar-neutral. However, this weight (long side or short side of any style) can vary month to month. It may sum to 0.5 on one month, to 0.6 the next month, and then to 0.4 the following. This affects overall volatility characteristics of the portfolio. It also implies that for a constant dollar invested the numbers of units being held by the investor are changing on rebalance day.

For example, the chart below is showing how this leverage level has changed historically for Value and Growth styles. As can be seen, the leverage level is quite volatile especially for the Growth style.

Figure 2. Leverage ratio for Growth (CITQJPGR) and Value (CITQJPVA)



Source: Citi Research.

Hence going forward we propose to make these indices constant leverage. What this means that we will make sure each side of each style portfolio sums to unity every month. An implication of this would be that the portfolios will no longer be unit beta to a particular style (they will remain 0 beta to other styles). This beta will change from month to month. For example, in July 2012 the beta of CITQASRI to Risk is 1.65 and the beta of CITQASQU to Quality is 2.1. Figure 3 below shows the latest values in August.

Figure 3. Beta to style/market Indices

Style/market index	Size	Value	Growth	Risk	Momentum	Quality	S&P Beta
Size	2.55	0	0	0	0	0	0.13
Value	0	2.33	0	0	0	0	0.07
Growth	0	0	2.50	0	0	0	0.05
Risk	0	0	0	1.95	0	0	0.70
Momentum	0	0	0	0	1.94	0	0
Quality	0	0	0	0	0	2.25	-0.08
S&P Index	0	0	0	0	0	0	1

Source: Citi Research.

This, however, stays true in spirit to the purpose of the indices, which is to gain exposure to different styles. In effect it is just a scaling—in mathematical terms, the indices are now orthonormal in addition to being orthogonal.

Second Change: Drifting weights

Currently the daily returns in any month are calculated based on the weights as calculated at the start of the month on rebalance day. These weights are derived from the fundamental attributes that go into the make-up of each style. In practice this means we rebalance the weights daily to start of period weight. This, however, introduces turnover on a daily basis, thereby increasing the trading costs. We propose to let the weights of the stock in the portfolio change based on the daily returns of all the stocks in the style portfolio. This is congruent with a buy-and-hold

mechanism and how these portfolios are envisaged to be invested into on a passive basis.

Many asset characteristics change gradually over time. Asset required returns (discount rates) evolve over time in line with these changing characteristics, even if the underlying factor risk premia are stable over time. Even many characteristics or factor exposures exhibit time-varying *ex ante* rewards.

Buy-and-hold strategies are static (passive) in terms of assets, but they allow changing characteristics over time. Conversely, to maintain a portfolio with stable characteristics, whether it is the TOPIX Index, a small-cap value stock portfolio, or a constant-duration Treasury portfolio, a certain amount of portfolio rebalancing or trading is required. Whether we study asset classes, strategy styles, or risk factors, then, the assumption of constant premia may be inappropriate.

Therefore, in our new methodology, we move away from the daily rebalancing and this will be done only once at end of each month.

In the next section, we review the characteristics of each index and implications of these two changes on a historical basis.

Index characteristics

The first step in the index construction process involves the identification of the most important systematic drivers of risk and return in the Japanese 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, Quality and Sector risks.

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 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 S&P Primary Market Index (S&P PMI Japan) to each style. We also center the market cap weighted-mean loading of the estimation universe around zero for each style factor, which ensures that the market has zero exposure to all of the above style factors.

We next employ weighted regression techniques 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. Please see Appendix A for further details.

Figure 4 below is a list of the Citi Japanese Equity Style Factor Indices together with the descriptors used in the construction of each index.

Figure 4. Citi Japanese equity style factor indices—Factors & descriptors

Style Index	Descriptors	Description
Size	Market Capitalization	Natural log of Market Capitalization
	Balance Sheet Size	Last Reported Total Assets
Value	FY1 Earnings Yield	Forecast IBES FY1 Consensus Earnings Yield
	Trailing Valuation Measures	Combination of Trailing Yields (Earnings, Book, Cash Flow, Dividends)
Growth	S&P Growth Score	5 Year Trailing Growth measures (Earnings, Sales, Internal Growth)
	Long Term Growth Forecasts	Forecast IBES Consensus Long Term Growth Rate
Risk	Volatility	Share Price Volatility (6 Months)
	Beta	Historical Beta (1 Year) to the S&P Japan Primary Market Index
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 Research.

Index factor & market betas

By construction each style index has a beta of zero to all other styles. While no specific constraint is applied on the market beta of each index, this too is close to zero given the dollar neutral weights of each index. The style and market betas of each index as of August 2012 are shown in Figure 5 below.

Figure 5. Beta to Style/Market Indices

Style/Market Index	Size	Value	Growth	Risk	Momentum	Quality	S&P Beta
Size	2.55	0	0	0	0	0	0.13
Value	0	2.33	0	0	0	0	0.07
Growth	0	0	2.50	0	0	0	0.05
Risk	0	0	0	1.95	0	0	0.70
Momentum	0	0	0	0	1.94	0	0
Quality	0	0	0	0	0	2.25	-0.08
S&P Index	0	0	0	0	0	0	1

Source: Citi Research.

Index Returns – Long/short

In Figure 6 below we present summary risk and return characteristics since 1995 for each style index. These returns are “pure” returns to a specific style, i.e., the returns to Growth are the actual payoff to Growth characteristics in the Japanese equity market after neutralizing for beta and other systematic effects represented by the other style indices.

Figure 6. Risk & return Characteristics of Citi Japan style factor indices

Year	Size	Value	Growth	Risk	Momentum	Quality
1995	-3.9	19.39	5.21	4.33	-2.54	-5.23
1996	3.89	11.76	6.67	-2.05	6.19	3.97
1997	13.56	16.58	18.72	-20.95	43.92	9.47
1998	-17.55	23.34	-3.98	-7.83	-23.63	0.53
1999	9.1	-25.35	28.76	49.38	23.79	-4.4
2000	-6.79	3.42	-13.37	-50.57	-2.68	8.24
2001	-5.44	1.82	-0.88	-7.59	-11.38	-11.87
2002	-4.01	31	-3.04	8.91	7.36	4.87
2003	-18.56	23.74	-9.63	47.79	5.18	-5.72
2004	-2.15	15.75	-0.36	10.87	-10.96	11.16
2005	5.32	2.71	1.84	7.29	3.08	-0.58
2006	10.3	12.94	-5.67	-13.2	4.79	13.04
2007	2.54	4.89	-2.31	-0.82	5.13	-0.21
2008	-5.77	7.01	-2.08	-20.39	-4.28	11.12
2009	-15.5	0.83	1.4	48.02	-20.97	-1.77
2010	-2.35	11.39	-4.73	1.67	-4.44	1.52
2011	-14.01	8.28	-6.61	-15.75	3.63	16.92
2012	4.64	12.59	10.16	-8.05	1.56	7.27
Annualized Returns	-3.01	9.3	0.66	-1.37	0.3	2.94
Annualized Volatility	9.03	8.96	7.67	16.22	9.8	8.74
IR	-0.33	1.04	0.09	-0.08	0.03	0.34
% with Positive Returns	51.47	56.16	53.32	52.08	54.98	54.52
Best Monthly Return	2.56	3.35	3.64	4.96	3.28	4.03
Worst Monthly Return	-3.95	-3.27	-3.22	-6.41	-5.35	-3.27
Maximum Drawdown	-52.19	-33.29	-38.73	-56.63	-41.91	-23.42
Low Date	12/30/2011	11/8/2000	11/11/2011	10/1/2001	2/20/2012	8/23/2001
Level of Highwater	1.15	2	1.65	1.12	1.66	1.19
High Date	1/19/1998	3/3/1999	1/4/2000	2/7/2000	3/2/2000	10/17/1997

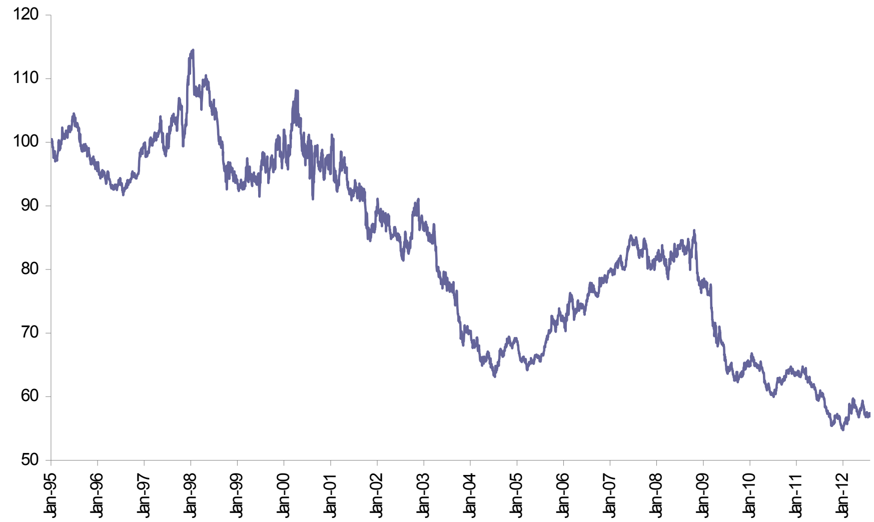
Source: Citi Research.

Historical QuantIFI style performance

In this section, we present the historical wealth curves for each of the six styles along with brief commentary on their performance.

The Size index measures the return to large caps versus small caps in Japan. Except for the period of the TMT bubble in 1999 and the run-up during 2005-2007, small caps have been good investments. Year-to-date this year, however, large-cap stocks have been outperforming

Figure 7. Japan Size QuantIFI Index - CITQJPSZ

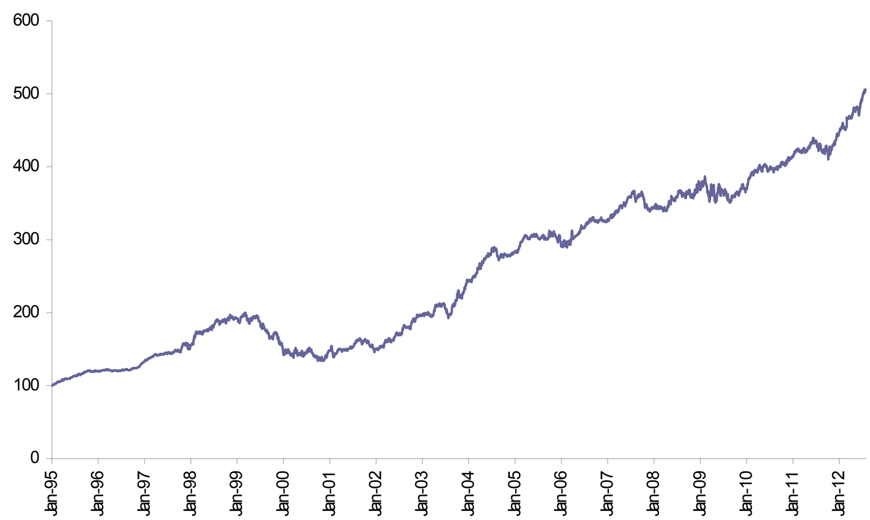


Source: Citi Research.

Value style investing has beaten all other styles in Japan. What is also notable is the consistency of the return profile. It has delivered returns over all periods, barring the late 1999 period of the TMT bubble

Even in the recent GFC period, Value has continued to outperform and is as of now the best-performing style year to date

Figure 8. Japan Value QuantIFI Index - CITQJPVA



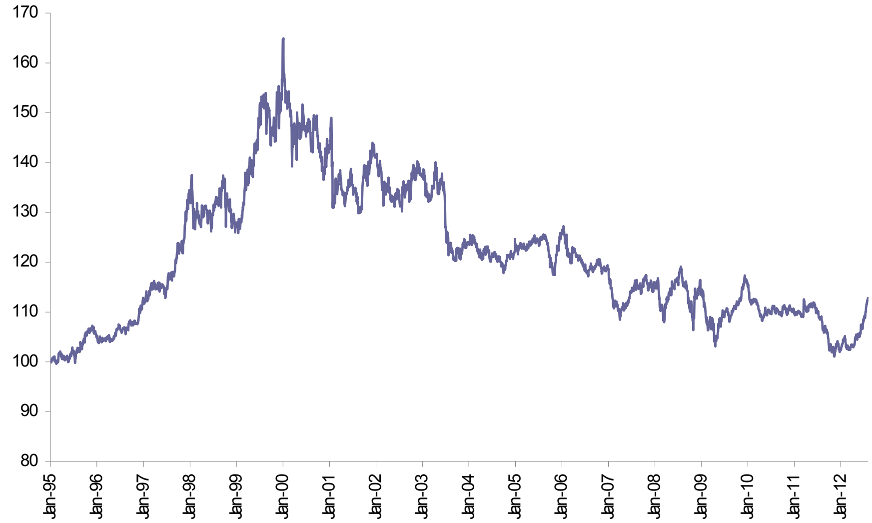
Source: Citi Research.

As can been seen in Figure 9, Growth investing as a style has not worked in Japan since the turn of the century. Its best year was in 1999 during the TMT bubble

Even during the 2004-2007 bull market, this style did not deliver

Year-to-date, however, Growth has been the second-best style to follow behind Value

Figure 9. Japan Growth QuantIFI Index – CITQJPGR

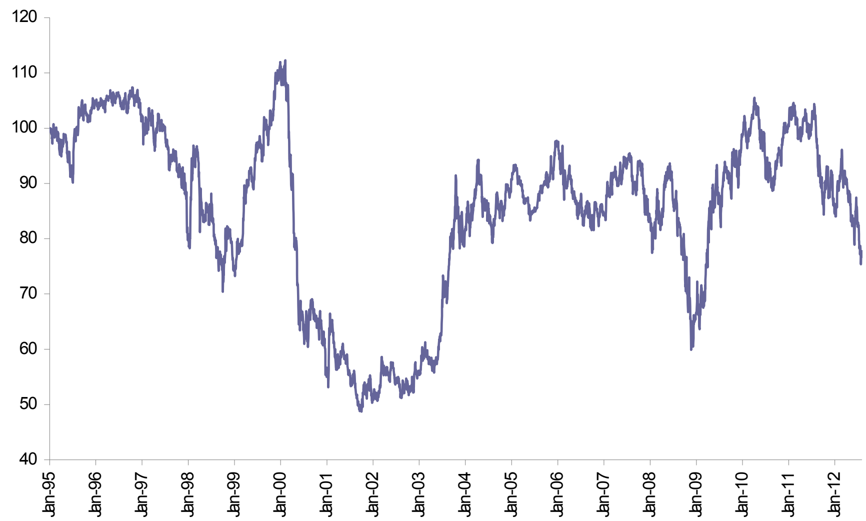


Source: Citi Research.

The risk style has had a negative information ratio over the long term, indicating that investors in Japanese equities have not been compensated for holding riskier stocks. The best years for this style were 1999, 2003 and 2009

The return-to-risk year to date has been negative, indicating that risk aversion is has paid off

Figure 10. Japan Risk QuantIFI Index - CITQJPRI

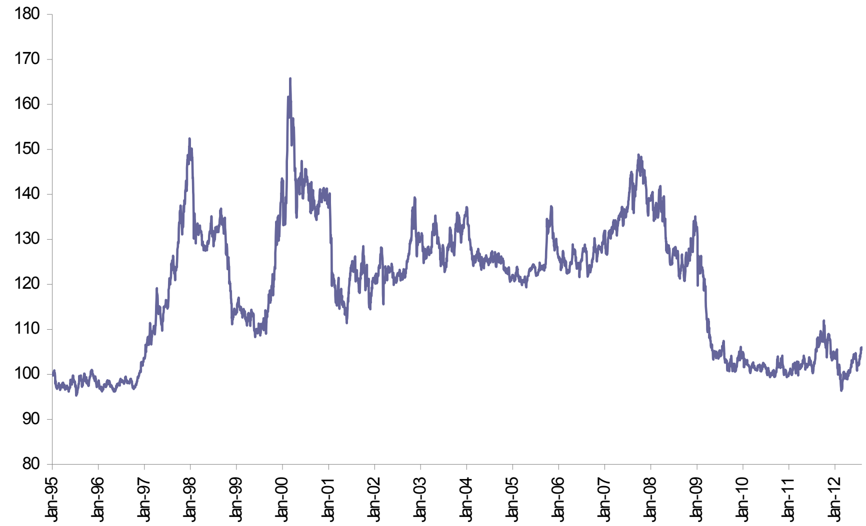


Source: Citi Research.

Momentum as a style has not really delivered in Japan, and this is especially true when considered on a relative basis to other markets. Apart from 1997, 2002, and the 2005-2007 bull market, buying high-momentum stocks has generally been a losing proposition

Japan exhibits strong reversal effects, and we look to exploit these effects in our stock-selection models, but for the 'pure' momentum style measure shown here these effects are excluded

Figure 11. Japan Momentum QuantIFI Index - CITQJPMO

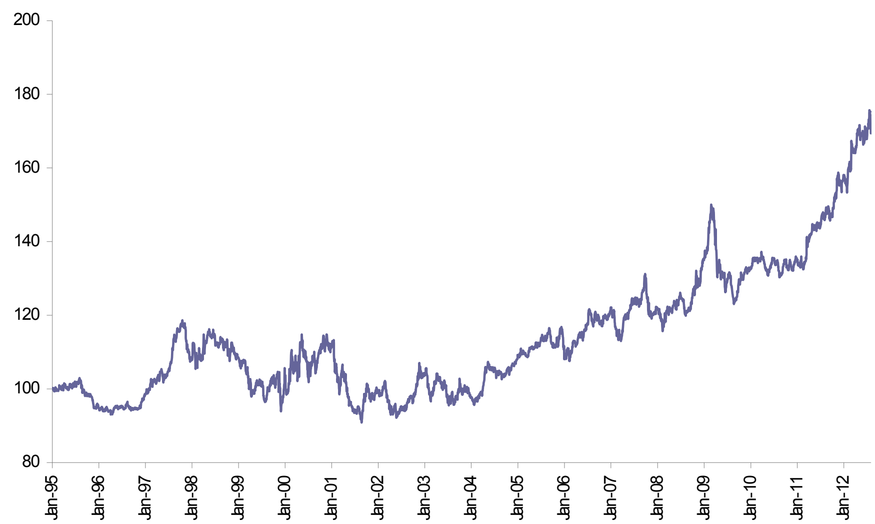


Source: Citi Research.

The Quality style factor has demonstrated a positive return in the Japanese equity market second only to value. However, relative to the value style, it performed comparatively worse during the global financial crisis although its defensive attributes were still apparent especially in 2008

Overall, it was the best-performing style in 2011 as its defensive characteristics were rewarded by the market

Figure 12. Japan Quality QuantIFI Index - CITQJPQU



Source: Citi Research.

Appendix A

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

$$Y = XR + \delta$$

Where Y – Stock returns in excess of the T-Bill rate

X – Matrix of the betas of stocks to the different Style factors and dummy loadings indicating their Sector membership

R – Returns of the pure Style factors

δ – Stock specific returns

Pure factor portfolios are then computed as

$$fp = (x^T wx)^{-1} \cdot (x^T w)$$

Where w is a matrix of regression weights computed as a function of each stock's recent liquidity

These are then scaled to 1.

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

$$R = fp \cdot Y$$

Where Y may be of monthly or daily or any other periodically

Residual portfolio returns are then derived as follows

$$K = P - \beta_{mkt} \cdot R_{mkt} - \beta_{style} \cdot R_{style} - \beta_{\sec tor} \cdot R_{\sec tor}$$

Where Portfolio returns, $P = \sum h_i Y_i$

Appendix A-1

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	12 Month Rating			*Relative Rating*		
Data current as of 30 Jun 2012	**Buy**	**Hold**	**Sell**	**Buy**	**Hold**	**Sell**
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% of companies in each rating category that are investment banking clients	27%	22%	18%			
Citi Research Quantitative Decision Tree Model Coverage	50%	0%	50%			
% of companies in each rating category that are investment banking clients	52%	0%	45%			
Citi Research Asia Quantitative Radar Screen Model Coverage	20%	60%	20%			
% of companies in each rating category that are investment banking clients	25%	23%	20%			
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