Citi Research

Equities

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Quantitative
Asia

Searching for Alpha: Asia Earnings Surprise

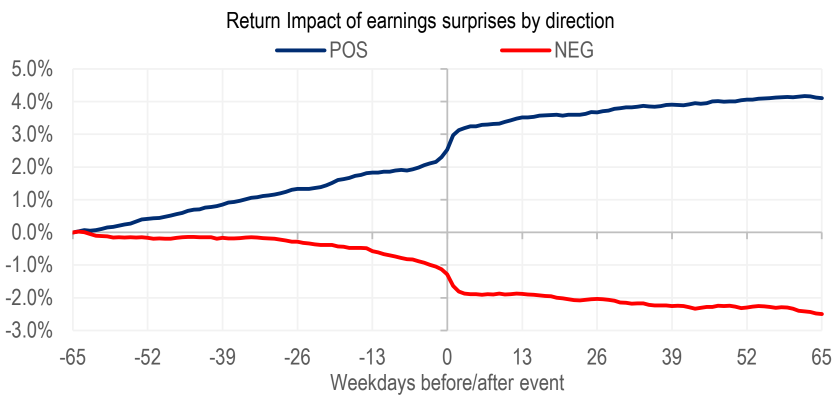
Predicting Asia Earnings Surprises

- **Earnings Surprises deliver moderate active returns** — Since 2001, earnings events delivered about 1% of active returns on announcement dates, despite the fact that the stock price moved in the same direction of surprises only 57% of the time. In our research, we build an earnings surprise model to predict the direction of surprise. Our model shows average active returns of ~0.4% during the month after rebalance in the out-of-sample test data from 2018 onwards (~7,000 observations), indicating out-of-the-box results substantially better than a coin flip. Combining with our fundamental analysts' views would likely improve results with a better understanding of company-specific catalysts around earnings results.

- **Predict earnings surprises using statistics and machine learning** — We applied a traditional statistical approach (logistic regression) and a machine learning approach (random forest) to IBES earnings surprise data for Asia ex Japan since 2001. Both models had an out-of-sample accuracy of about 60%. Narrowing down a list of predictive factors, we found the most significant factors for forecasting earnings surprise are: earnings revisions, previous surprises, peer beat-to-miss ratio, price momentum, analyst ratings, and market cap.

- **Current Earnings Season** — A rather positive earnings season is predicted given improving market momentum and earnings revisions. Tech stocks in Taiwan and India are among some of the high conviction stocks that are likely to have positive surprises. A companion Excel file (click here) is published with the stock level predictions for Asia ex Japan.

Figure 1. Average impact of earnings surprises since 2001 – MSCI Asia ex Japan



Source: Citi Research, IBES, Datastream, returns are measured relative to MSCI country index

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Predicting Asia Earnings Surprises

In this report we aim to formulate a quantitative model to predict earnings surprises. This has been done previously for US and Europe. The model has been applied in a recurring product to give insights during earnings season, with the latest edition for the US here. In Asia ex Japan, analyst coverage continues to improve as the markets become more dominant in global benchmarks, especially in China. This is important, as better coverage allows us to have a better idea of where consensus expectations stand, and thus whether an earnings print was a surprise relative to these expectations. A model to predict the direction of an upcoming earnings surprise would certainly be a useful tool during earnings season. The aim is to combine the output of this model with our analysts' fundamental view to help readers focus their energy on notable earnings events.

How important are earnings seasons?

Sell-side analysts are regularly pulling all-nighters during earnings season so investors can gain first-hand knowledge on earnings results and make wise decisions… but how much does that really matter? Should you stay up at night to listen to that earnings call and write/read that earnings summary? Or is the market already giving us hints as to the direction of a surprise?

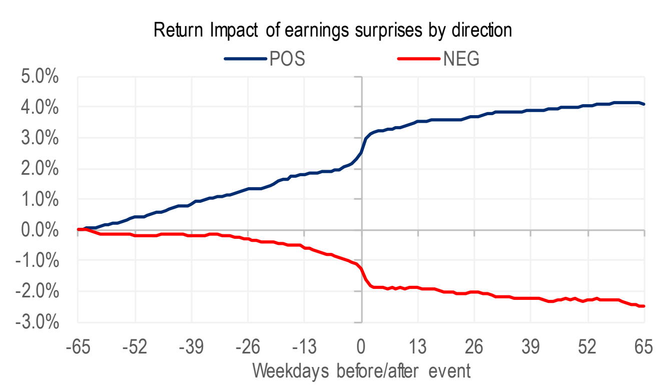
One way to quantify this is to examine historical earnings surprises and measure their:

1. Price Impact: How much excess return did an investor gain by buying/selling an earnings surprise event?

2. Hit Rate: How likely was a positive/negative earnings surprise followed by a positive/negative excess return?

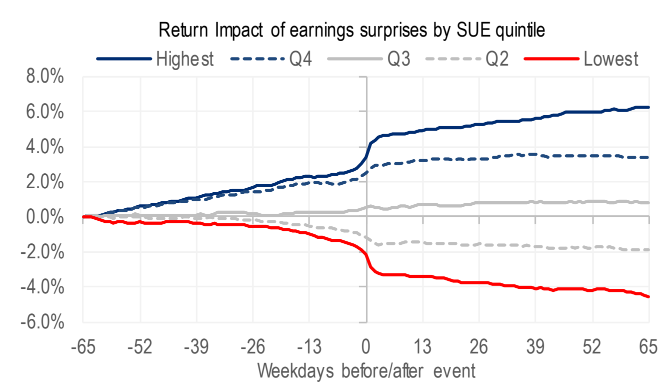
In Figure 2, we look at the average performance of MSCI Asia ex JP companies before and after earnings surprises. Performances are measured relative to each stock's respective MSCI country index. No surprise here, companies with better than expected earnings outperformed those on the other side that missed. The impact right on the event dates was about 1% of active return. After that, the effects quickly flattened out. What's interesting is that these out/under-performances happened even before the surprise dates. The companies with positive surprises on average outperformed by about 2% in the 3 months (13 weeks) before the announce dates. Those with negative surprises underperformed by about 1% in the same period, though mostly in the 1 month prior to announcement.

Figure 2. Average impact of earnings surprises since 2001



Source: Citi Research, IBES, Datastream

Figure 3. Impact of earnings surprises by SUE quintiles

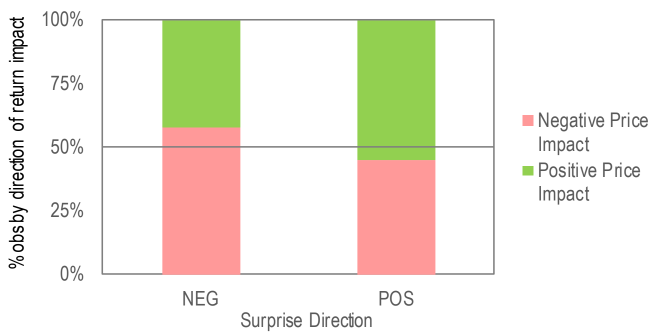


Source: Citi Research, IBES, Datastream

The magnitude of surprises also effects share price reaction. In Figure 3 we look at the price impact based on quintiles of SUE[1]. The higher the SUE, the higher the impact.

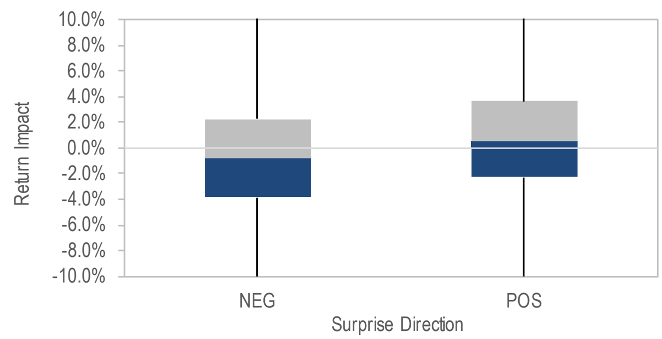
So on average, it appears that earnings surprises matter, but in Figure 4 and Figure 5 we look at the distribution of their price impacts. For this analysis we only look at the 1 week price impacts since event dates. Of all the positive surprises, the hit rate was about 55% to score a positive impact, and the hit rate was about 58% for negative surprises to have a negative price impact. The box plot also shows that median performances lie just above and below the zero line, with a fat distribution across the whole spectrum. So even if we managed to predict all the surprises correctly, the share price moved in the same direction (we made money) only about 57% of the time.

Figure 4. Hit Rates of surprises and 1 week price impacts



Source: Citi Research, IBES, Datastream

Figure 5. Distribution of 1 week price impacts by direction of surprises

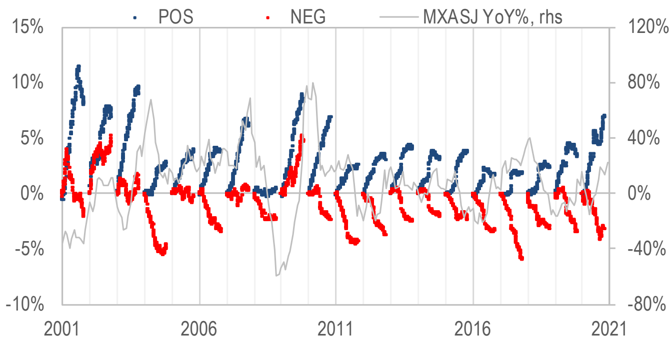


Source: Citi Research, IBES, Datastream

The payoff from buying/selling surprises also varied in both temporal and cross-sectional dimensions. In Figure 6 we grouped the surprises by year of announcement. In most years, positive surprises did end up with positive performance, and vice versa. However in the periods of extreme volatility, e.g. during the 2008/09 GFC crisis/recovery, the active returns were mostly disrupted as they were overshadowed by macro factors. Rolling 12 months hit rates are shown in Figure 7, with hit rates on both sides are generally higher since 2009/2010 – this could partly be due to improved analyst coverage in the region and more prudent investing since GFC. It's also interesting to see that most of the time, negative surprises are more likely to be impactful than positive surprises.

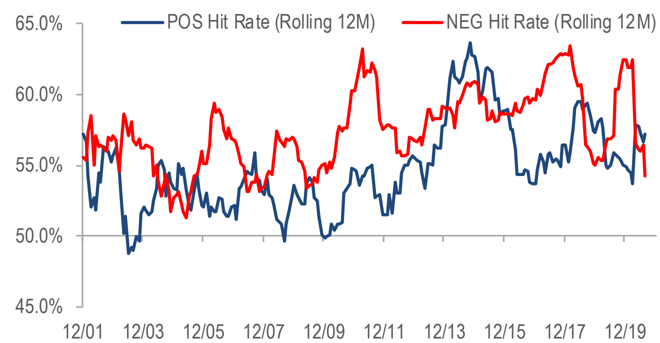
[1] SUE is standardized unexpected earnings, calculated as the amount of earnings surprise divided by the standard deviation of analyst estimates.

Figure 6. Return impacts of surprises by year



Source: Citi Research, IBES, Datastream

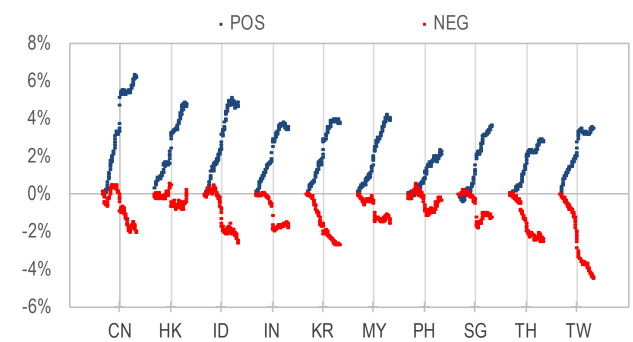
Figure 7. Rolling 12 month hit rates of surprises



Source: Citi Research, IBES, Datastream

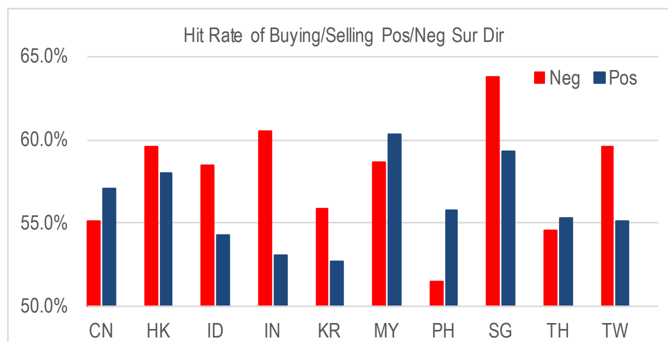
In terms of cross-sectional variation, Figure 8 and Figure 9 show that payoff is mostly normal for most markets, but hit rates are highest in Singapore but relatively low in Korea and Philippines.

Figure 8. Return impact of surprises by markets



Source: Citi Research, IBES, Datastream

Figure 9. Hit rates by market

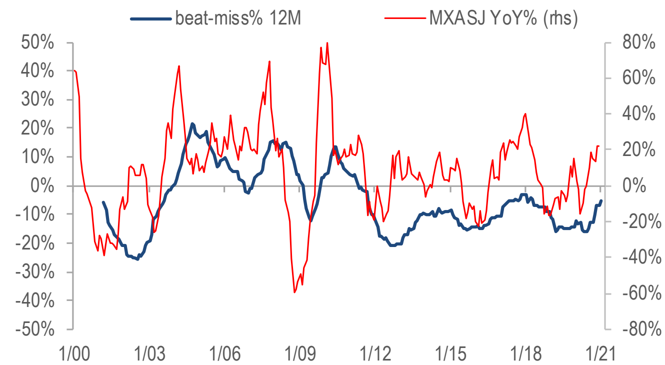


Source: Citi Research, IBES, Datastream

This is consistent with the analysis done in our US report and as mentioned in some academic papers such as "Contrarian share price reactions to earnings surprises" by Johnson and Zhao (2014) and in the broad survey paper "Stock prices and earnings: a history of research" by Dechow, Sloan and Zha (2013). The bottom line is that surprises matter only to a certain extent. With modest price impacts and an average hit rate of just 57%, it's not a be-all end-all event to monitor. Market environments and cross sectional variations could play more important at times.

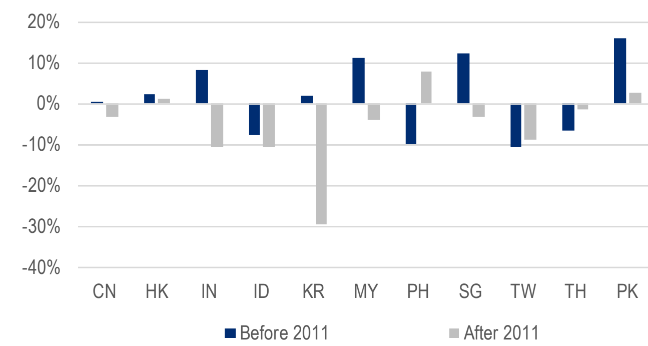
Another interesting statistic to look at is the aggregate beat-miss ratio, defined as the rolling 12 months number of positive surprises less negative surprises, divided by total number of events. In Figure 10, we look at this at the regional level. The fluctuation of the beat-miss ratio appears to roughly follow market cycles, but what's interesting is that since 2011 there was a structural shift leading to more misses than beats. In Figure 11 we can see that this increase in misses had happened in most markets, with Korea being the most pronounced.

Figure 10. Asia ex JP beat to miss ratio



Source: Citi Research, IBES

Figure 11. Average country beat to miss ratio before and after 2011



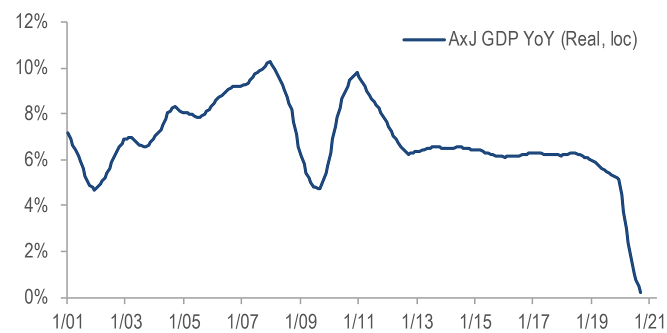
Source: Citi Research, IBES

The timing of this shift was in line with when we saw a generally lower and narrower valuation band in the Asia region, and also slower economic growth (Figure 12 and Figure 13). Analysts may have been unable to adapt to this period of lower risk tolerance and stagnant growth, and were still looking for a mean reversion to the pre-GFC "normal", thus resulting in more misses.

Figure 12. Asia ex JP PE ratio, pre- and post- 2011 average

Source: MSCI, Citi Research

Figure 13. Asia ex JP Real GDP Growth



Source: Haver, CEIC, Citi Research

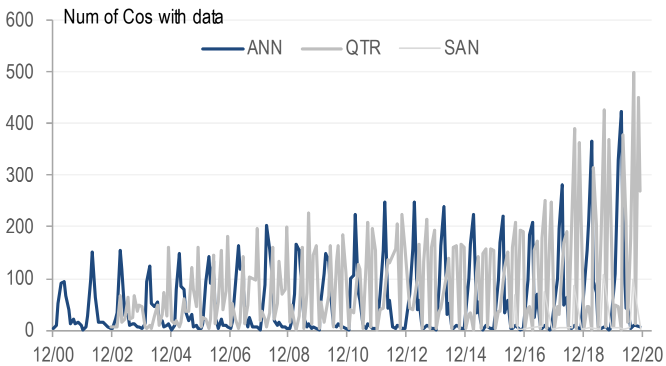
Data Collection and quality

In Asia, data quality is not always as good as developed markets like the United States, so let's address that first.

IBES consensus earnings surprise data was used throughout this report. The universe studied was quarterly constituents of MSCI AC Asia ex Japan. In Asia, not all companies report quarterly, with some being semi-annual or even only annual. In Figure 14 we can see that the number of annual surprises peaks every March, while quarterly data occurs in between. Semi-annual data also exists but mostly after 2015.

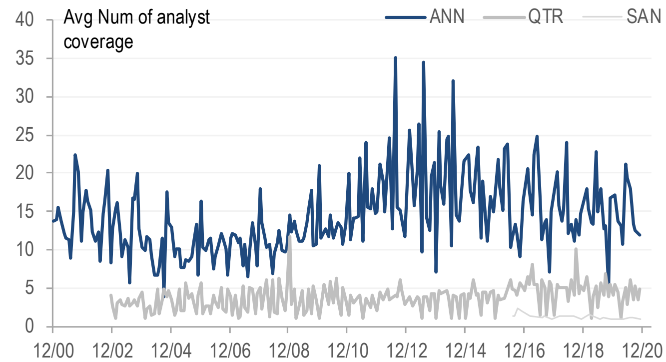
In terms of analyst coverage, sell-side analysts mostly supplied only their annual forecasts to vendors. So in Figure 15 we can see that on average, annual data consists of the highest number of analysts. Quarterly data on average was only made up of 3~5 analysts, while semi-annual data had an average of only 1~2 analysts coverage.

Figure 14. Number of companies reporting annual, semi-annual, and quarterly results – MSCI AC Asia ex Japan



Source: Citi Research, IBES

Figure 15. Average number of analysts coverage by reporting frequency – MSCI AC Asia ex Japan



Source: Citi Research, IBES

From Figure 16, we can see that Korea, Taiwan and India had the highest number of interim data available since 2010, and the number is considerably lower in the rest of Asia. It is however worth noticing that availability has greatly improved from less than 40% prior to 2010 to nearly 60% now.

Figure 16. Availability of interim surprises by market

% of interim surprises with at least 2 estimates in dataset			
	since 2000	Pre-2010	Post-2010
CN	26.8%	6.8%	32.7%
HK	7.9%	0.7%	14.7%
IN	60.9%	39.1%	70.8%
ID	28.2%	6.3%	41.1%
KR	70.2%	72.4%	68.3%
MY	14.2%	2.4%	27.6%
PH	29.9%	2.9%	44.2%
SG	32.1%	14.3%	47.7%
TW	64.3%	47.0%	73.8%
TH	44.0%	15.6%	60.7%
PK	21.4%	8.7%	45.8%
AxJ	**49.6%**	**38.6%**	**56.1%**

Source: Citi Research, IBES

Reporting frequency is also not always as regular as it is in the US. In Singapore, SGX recently adopted a risk-based approach to determine which companies are required to report quarterly[2]. So a lot of companies that used to report quarterly now only report semi-annually. In Korea and India, results are reported on either/both parent and consolidated basis. The IBES coverage on this can be sporadic as parent or consolidated level data is used for different time periods even within the same company.

The takeaway is that when looking at surprise data from whichever data vendor, it's important to keep in mind that factors like coverage and accounting standard would have an impact on how meaningful the data is.

[2] SGX RegCo adopts risk-based approach to quarterly reporting

Forecasting Earnings Surprises

The focus now is to examine whether we can forecast earnings surprises. We only aim to predict the direction of surprises, not the amount nor the share price impact, so an approach such as a multi-factor model that outputs a binary response is appropriate.

In the backtesting process, we collected surprises data from fiscal periods 12/2001 to 9/2020. For fiscal periods where multiple periodicity is available (e.g. FY2019 and 2019Q4 consensus are both available at the same time), we use the one with more analyst coverage, which is typically the full year number. We encode surprises as binary responses with 0 as a negative surprise and 1 as a positive surprise. We then grouped by their month of announcement date, and use factor data from the prior month-end to predict all surprises announced within that month. We use data on or before 12/2017 in the training set, with the rest used in testing.

The full list of factors we considered to predict the earnings surprise direction prior to narrowing down to the most significant factors are shown in Figure 17 below.

Figure 17. All factors considered to predict earnings surprise, prior to feature selection

Category	Rationale	Factor	Definition
Consensus Expectations	When analysts rush to upgrade a company, does that mean they have knowledge that the company is going to perform better than they had expected?	*ERR*	Earnings Revision Ratio: Defined as the monthly number of upward revisions less downward revisions, divided by to total number of estimates, for FY1 and FY2.
		Rating	Latest consensus rating (e.g. Buy, Sell, Hold)
		RatingChg	3 month change in consensus ratings
		RRR	Ratings Revision Ratio, defined similarly as Earnings Revision Ratio
Previous Surprise	Is a particular company likely to surprise consistently in the same direction because it implements an expectations management strategy?	*SurDirPrv*	Last fiscal period surprise direction
		SurSUEPrv	Standardized Unexpected Earnings (SUE), is calculated as the amount of earnings surprise divided by the standard deviation of analyst estimates, capped in the range of +/-3
Price Momentum	If a news event triggers a company to outperform peers, is that event and share price reaction related to better than expected earnings?	*PCHG_1M*	1 month price change relative to MSCI country index
		PCHG_3M	3 month price change relative to MSCI country index
Size / Coverage	Are larger companies, typically subjected to greater scrutiny from analysts, more transparent and thus less likely to surprise investors?	*MktCap*	Market capitalization
		NumEst_FY1	Number of analysts providing FY1 estimates
Value / Growth	Is healthy growth and cheap/fair valuations necessary for a positive surprises?	*EY_LTM*	Value is represented by trailing 12 months earnings yield
		EPS_Growth	Growth is represented by the EPS growth of the latest fiscal year with a log(1+x) transformation
Market Environment	If the overall market is positive, does that mean companies will fare better in this environment?	*MSCI_1MCHG*	1 month price performance of respective MSCI country index
		MSCI_3MCHG	3 month price performance of respective MSCI country index
		BeatMiss_12M	Beat to Miss ratio of respective MSCI country index, defined as the rolling 12 months number of positive surprises less negative surprises, divided by total number of events (see Figure 10 and Figure 11)

Source: Citi Research

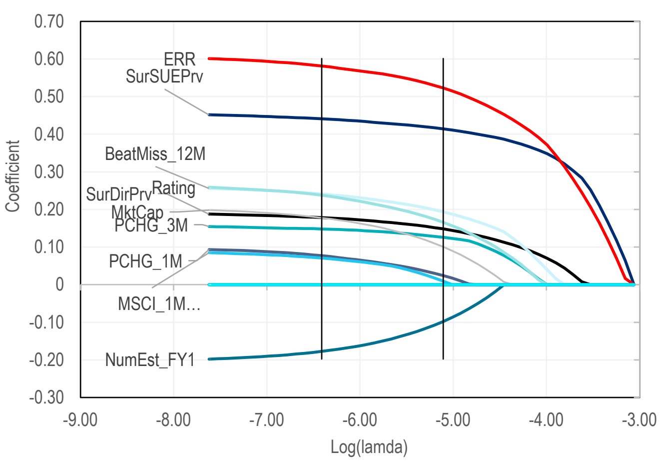
Estimates with less than 2 analysts were removed from the training set to reduce noises. Training data in each country was also balanced by random up-sampling of responses that had less observations.

Elastic net logistic regression and random forest were both used in feature selection process, which were run in R with the *glmnet* and *randomForest* packages.

As a brief introduction (with more in the Appendix), elastic net regression is a regularized regression where both linear and quadratic penalty are used, so it's essentially a combination of LASSO and ridge regression. Random forest on the other hand is to make predictions with an ensemble of decision trees, where each tree is trained with a random subset of features and data.

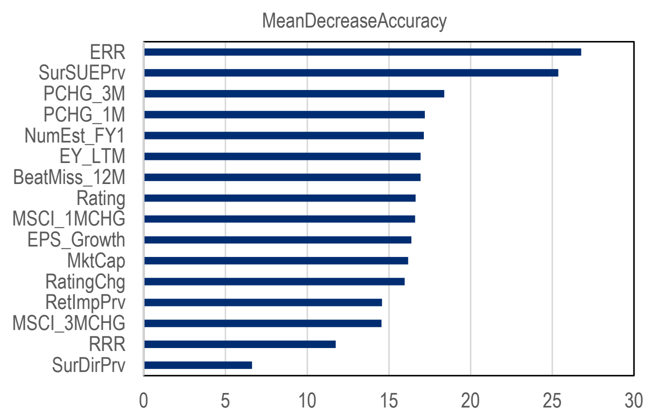
In Figure 18 we visualize a single run of the elastic net output by examining how the regression coefficients evolve with the regularization penalty lambda. As the regularization is relaxed, ERR and factors related to previous surprises are among the first to emerge. Ratings and surprise in country peers also show up early. Factors like value, growth, ratings change, and return impact however are suppressed throughout the tested range of regularization.

Figure 18. Feature selection in a single run of elastic net regression



Source: Citi Research, some factors are not labelled as they are suppressed to 0 by regularization

Figure 19. Mean decrease in accuracy in a single run of random forest



Source: Citi Research

When running a random forest fit, we also examined the importance of factors by ranking the decreases in accuracy when a factor is removed.

Give the random nature of these model fitting process, multiple runs of both elastic net and random forests were examined, and the set of factors that consistently appeared in top ranks of both methods are: **Earnings revisions, previous surprise SUE & direction, country's beat to miss ratio, 3 month price momentum, latest ratings, and market cap**.

While SUE showed up as one of the key factors, in practice this data is often missing for estimates with a single analyst, which occurs quite frequently for interim data. So in our final model we leave SUE out of our model and only keep surprise direction, which allows for better model coverage.

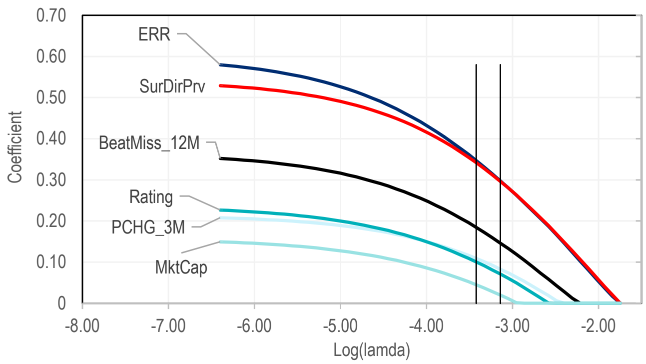
The selected factors were then fitted again using both elastic net logistic regression and random forest. All the factors are positively related to surprises in logistic regression. The final model of the logistic regression is:

$$\ln \frac{p}{1-p} = -0.17 + 0.35\,ERR + 0.34\,SurDirPrv + 0.18\,BeatMiss12M + 0.11\,Pchg3M + 0.10\,Rating$$

where *p* is the probability of a positive surprise, and each variable is scaled to the mean and 2 standard deviation of training set.

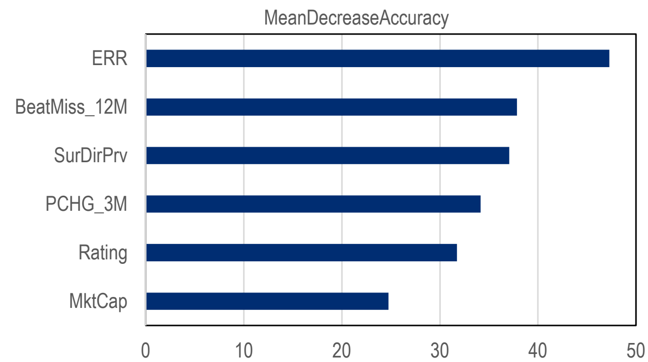
Figure 20 & Figure 21 show the elastic net path of this final model and also the significance of these factors in a random forest fit. From the elastic net model, it can be seen that the magnitude of the coefficients and their order of inclusion are pretty consistent. So it appears that earnings revisions, previous surprise direction and the beat to miss ratio of regional peers are the most significant indicators. We see very similar rankings in the random forest fit.

Figure 20. Elastic Net path of selected factors



Source: Citi Research

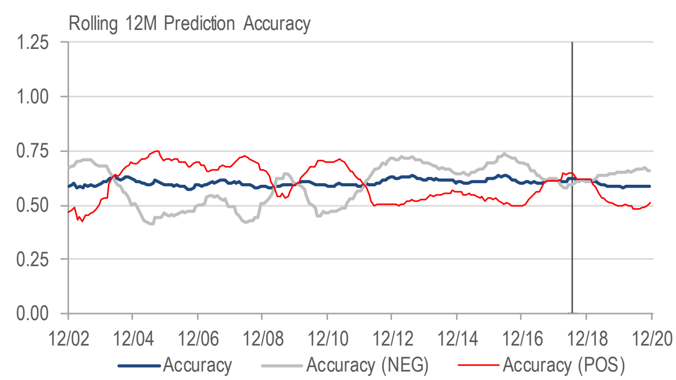
Figure 21. Importance of selected factors in random forest fit



Source: Citi Research

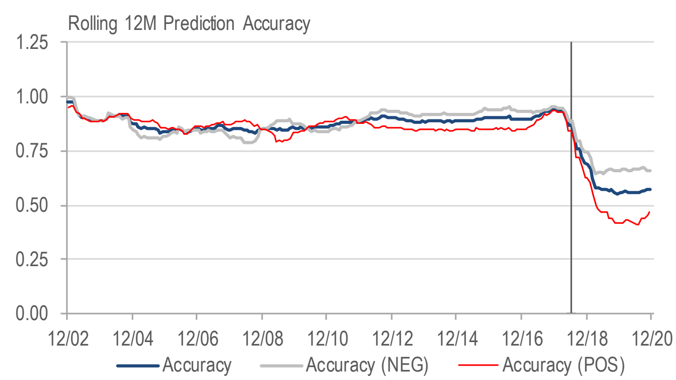
It can been seen that using either method achieves similar out-of-sample accuracies of about 60% (Figure 22 and Figure 23). Thus, we opt for the simpler logistic model which has better transparency and is easier to interpret.

Figure 22. Prediction accuracy of logistic model



Source: Citi Research (Vertical line is used to separate the test and training set)

Figure 23. Prediction accuracy of Random Forest model



Source: Citi Research (Vertical line is used to separate the test and training set)

It is worth pointing out that most of the accuracy came from getting the negative surprises right (66% accuracy), while positive surprises only had 52% accuracy. Analyzing the prediction accuracy by market (Figure 24), we can see that the accuracy is highest in Korea, but the bias in making better prediction for negative surprises exists in nearly all markets.

Figure 24. Prediction accuracy by market

Country	Accuracy	Accuracy (NEG)	Accuracy (POS)
China	58.5%	60.8%	55.7%
Hong Kong	58.8%	58.5%	59.1%
India	57.0%	64.1%	49.4%
Indonesia	55.3%	63.9%	46.0%
Korea	64.7%	77.3%	44.8%
Malaysia	62.1%	81.3%	33.3%
Philippines	64.4%	69.1%	58.6%
Singapore	59.8%	70.5%	45.4%
Taiwan	57.5%	58.7%	56.4%
Thailand	55.7%	65.9%	43.7%
Pakistan	54.3%	61.9%	42.9%
Overall	**59.2%**	**65.3%**	**51.9%**

Source: Citi Research

Figure 25. Prediction accuracy by reporting period

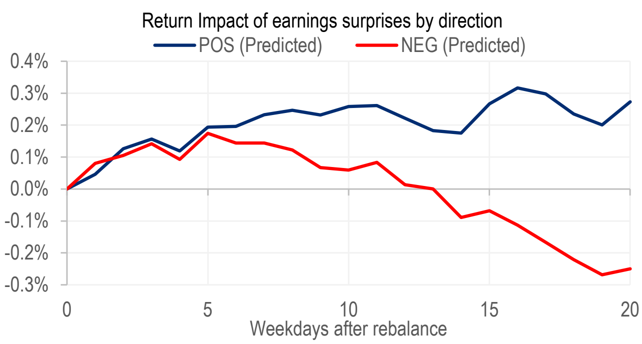
Period Type	Accuracy	Accuracy (NEG)	Accuracy (POS)
Annual	61.4%	62.6%	59.1%
Quarterly	58.8%	66.8%	50.4%
Semi-annual	51.6%	62.3%	44.1%
Overall	**59.2%**	**65.3%**	**51.9%**

Source: Citi Research

This can be understood better if we look at the prediction accuracies by reporting frequencies (Figure 25). The predictions made for annual results are close to 60% on both sides. However for interim results, the predictions are substantially biased to the negative side, and overall accuracies are also lower. While this is not ideal, it should not come as a surprise either given that interim consensus generally has lower data quality than full year numbers.

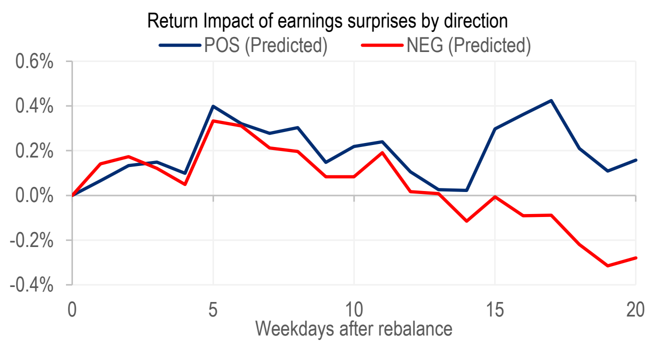
Based on the predicted surprises, we examined their performance during the month after each rebalance date. If you look at the full period including both training and testing set, which has ~29,000 data points (Figure 26), we see about 0.5% spread in performance between the predictions. Looking only at the testing period (~7,000 data points from 2018 onwards) (Figure 27), the spread is narrower. It should be noted that earnings events had only around 57% hit rate (Figure 4), combining this will around 60% accuracy in prediction, we do not expect a huge alpha relying on this model alone. It could however be combined with fundamental analysts' recommendation before earnings seasons to channel focus on specific events.

Figure 26. Active returns of predicted surprises (includes both training and testing data)



Source: Citi Research

Figure 27. Active returns of predicted surprises (includes only testing data)



Source: Citi Research

Current Earnings Season

The previous earnings seasons in 2020-Q3 offered a rarely seen positive beat to miss ratio on a rolling 3 months basis (Figure 28). This was because the earnings had been revised down sharply during the first half of 2020 due to COVID, and companies had more room to meet or surpass expectations. Only Hong Kong, Singapore, Indonesia and Philippines have more negative surprises than positive.

Figure 28. Earnings Beat-to-Miss in Asia ex JP

Source: IBES, MSCI, Citi Research

Figure 29. Number of beats and misses by market

	Number of Earnings Released (Rolling 3M)			
12/31/2020	Total	Beat	Miss	Ratio
PK	2	2	0	100.0
TW	82	61	19	51.2
IN	90	68	22	51.1
MY	22	15	6	40.9
TH	41	27	14	31.7
HK	5	3	2	20.0
KR	104	59	45	13.5
CN	342	191	146	13.2
SG	8	3	4	-12.5
ID	20	7	12	-25.0
PH	19	5	14	-47.4

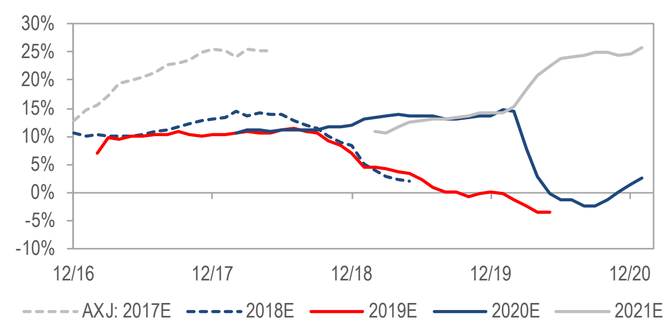
Source: IBES, MSCI, Citi Research

Turning our attention to the upcoming earnings season, at the aggregate level the earnings revision ratio in Asia has been recovering from the lows in early 2020 (Figure 30), while EPS growth estimates for 2020E and 2021E have also started to stabilize (Figure 31). The improving sentiment and improving macro conditions could be indicative of a positive earnings season, but given the recent trend of positive revisions, there will be less room for upcoming earnings results to surprise positively, relative to Q3.

Figure 30. Earnings Revision Ratio in Asia ex JP

Source: Factset, MSCI, Citi Research

Figure 31. Change in EPS growth estimates in Asia ex JP

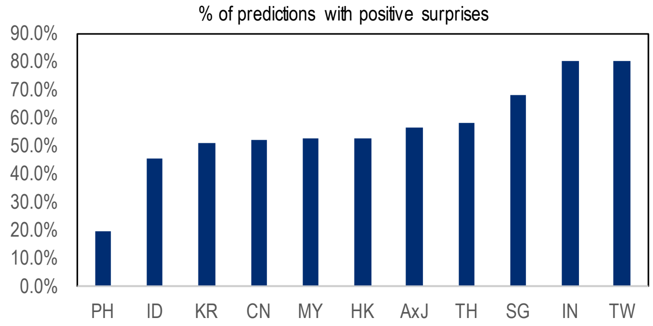


Source: Factset, MSCI, Citi Research

Applying our trained model, we took the current MSCI AC Asia ex JP constituents and use the factor data as of latest to compute their predicted earnings surprises.

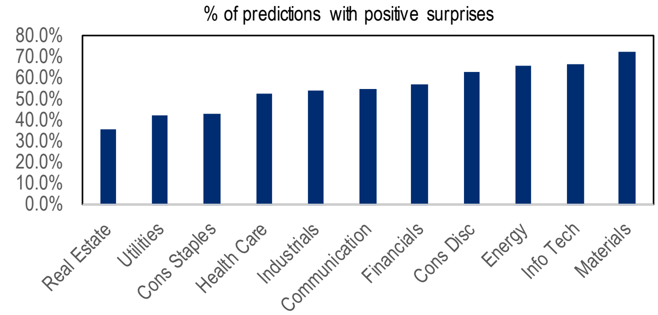
As shown in Figure 32, India and Taiwan are predicted to have the highest portion of positive earnings surprises. Sector-wise Tech and Materials are expected to perform best. At the aggregate level, the model predicts Asia ex JP to have about 56% of positive surprises.

Figure 32. Percentage of predicted positive surprises by market



Source: Citi Research

Figure 33. Percentage of predicted positive surprises by sector



Source: Citi Research

As of the day of writing, 73 earnings events have happened in Jan-2021. And based on factors as of 12/31/2020, 68% of these events were predicted correctly.

Figure 34. Earnings events in Jan-2021 related to MSCI Asia ex JP

	Earnings Surprises			
	Reported in 1/2021		Correctly Predicted on 12/2020	
Ctry	Positive	Negative	Positive	Negative
CN	18	16	14	9
IN	15	6	13	3
TW	7	2	7	1
TH	5	1	3	0
SG	3	0	0	0

Source: Citi Research

In Figure 35 we overlay the predicted earnings surprise direction and overlay that with our analysts' recommendations to get a list of top stocks to watch for in the upcoming earnings season.

Figure 35. Upcoming earnings releases to watch in Asia ex JP

Sedol	RIC	Name	CtryCode	sector	Price	Ratings	Mkt Cap (US$mn)	Event Date	Period
Largest Buy/Neutral rated stocks with upside catalyst watch and predicted to have positive surprise									
617190	HDFC.BO	Housing Development Finance	IN	Financials	2380	1	58,767	2/2/2021	Q3 21 (Cons)
644232	BRTI.BO	Bharti Airtel	IN	Communication	552	1	41,280	2/3/2021	Q3 21 (Cons)
BSQCB2	SBI.BO	State Bank Of India	IN	Financials	281.9	1	34,508	2/4/2021	Q3 21 (Cons)
B0JGGP	ITC.BO	ITC Ltd	IN	Cons Staples	203.35	2	34,322	2/11/2021	Q3 21 (Cons)
B17KC6	WLIL.SI	Wilmar Int'l	SG	Cons Staples	5.27	1	25,391	2/22/2021	Y 20
B0F9V2	OCBC.SI	Oversea-Chinese Banking Corp	SG	Financials	10.32	1	34,757	2/24/2021	Y 20
691678	UOBH.SI	United Overseas Bank	SG	Financials	23.38	1	29,623	2/25/2021	Y 20
646587	0027.HK	Galaxy Entertainment	HK	Cons Disc	58.8	1	32,946	3/1/2021	Y 20
BMM27D	JD.O	JD.com	CN	Cons Disc	88.69	1	137,925	3/2/2021	Q4 20
B0190C	0669.HK	Techtronic	HK	Industrials	116.8	1	27,609	3/4/2021	Y 20
B01B1L	2319.HK	Mengniu Dairy	CN	Cons Staples	46.25	1	23,552	3/12/2021	Y 20
B1YBT0	2382.HK	Sunny Optical Technology Group	CN	Info Tech	204.2	1	28,889	3/16/2021	Y 20
653182	0175.HK	Geely Automobile	CN	Cons Disc	28.35	1	35,904	3/23/2021	Y 20
674395	2338.HK	Weichai Power	CN	Industrials	22.9	1	23,434	3/26/2021	Y 20
653611	2388.HK	Bank of China (Hong Kong)	HK	Financials	23.2	2	31,638	3/29/2021	Y 20
629181	0386.HK	Sinopec	CN	Energy	3.71	1	57,936	3/29/2021	Y 20
B0MP1B	2313.HK	Shenzhou Int'l	CN	Cons Disc	152.1	1	29,491	3/29/2021	Y 20
BP3R3G	600690.SS	Haier Smart Home	CN	Cons Disc	31.85	1	44,734	3/30/2021	Y 20
B60LZR	1288.HK	Agricultural Bank of China	CN	Financials	2.8	1	126,397	3/30/2021	Y 20
671825	2333.HK	Great Wall Motor	CN	Cons Disc	24.3	1	28,760	3/31/2021	Y 20
Largest Sell/Neutral rated stocks with downside catalyst watch and predicted to have negative surprise									
BP3R5H	600315.SS	Shanghai Jahwa	CN	Cons Staples	39.62	2	4,179	2/2/2021	Y 20
B15SK5	090430.KS	Amorepacific	KR	Cons Staples	223000	2	11,655	2/3/2021	Y 20 (Cons)
B0166D	BH.BK	Bumrungrad Hospital	TH	Health Care	125.5	2	3,338	2/26/2021	Y 20
618666	2474.TW	Catcher Technology	TW	Info Tech	198	2	5,383	3/10/2021	Y 20 (Cons)
B85LKS	2018.HK	AAC Technologies Hldgs	CN	Info Tech	42.15	3	6,570	3/25/2021	Y 20
BFMFKK	HTHT.O	Huazhu	CN	Cons Disc	48.5	2	15,737	3/26/2021	Q4 20
607070	BRPT.JK	Barito Pacific	ID	Materials	885	2	5,891	3/30/2021	Y 20

Source: Bloomberg, Citi Research, Prices as of 1/29/2021 close

Appendix

Elastic Net Regression

Elastic Net regression was developed by Zou and Hastie in 2005, which is a form of regularized regression in the form of

$$\min_{\beta_0,\beta} \frac{1}{N} \sum_{i=1}^{N} w_i l(y_i, \beta_0 + \beta^T x_i) + \lambda \left[(1-\alpha) \|\beta\|_2^2 /2 + \alpha \|\beta\|_1 \right]$$

Where *l*(..) is a generic loss function of a regression problem. λ is the regularization strength and α controls the portion between linear and quadratic penalty. It becomes LASSO when α =1, and ridge regression when α = 0. In our case of a binary logistic regression, the loss function would be the negative log likelihood

$$l(y_i, \beta_0 + \beta^T x_i) = \log(1 + e^{\beta_0 + x_i^T \beta}) - y_i \left(\beta_0 + x_i^T \beta \right)$$

In R's *glmnet* package, this problem is solved by coordinate descent for a fixed value of α over a range of λ, and misclassification error can be used in cross-validation. A grid search is performed to find the optimal α and λ that give the lowest misclassification error.

Similar to LASSO and ridge regression, a regularization path like Figure 18 can be created for each fixed value of α, from which dominant features can be selected based on their order of inclusion, magnitude and cross-validation error.

Random Forest

Radom forest is a decision tree based model, where a decision tree is grown to fit the test data base on a random subset and features. These trees are then aggregated into a forest where outputs are averaged to make a final decision. In this study the *randomForest* package in R was used. More detail can be found in: [the package help manual]() and [its authors' website]().

Previously Published Research

Figure 36. Research Reports (since 2009)

Report	Date Published
Searching for Alpha: China A Alpha – Smoothing Price Momentum	30-Oct-2020
Under the Microscope: Overlapping Momentum	16-Oct-2020
Equity Markets Positioning Model – Introducing the EMP	14-Sep-2020
Searching for Alpha: Combining ESG and Risk Premia – A Double Screen Approach	11-Sep-2020
Searching for Alpha: Factoring Short Interest – Measuring and Profiting from Information in Shorts	8-Sep-2020
Searching for Alpha: Machine Learning – Attributing Higher-Order Interactions: SHAP Value as Factor Selection Criterion	28-May-2020
Searching for Alpha: Machine Learning – Leveraging Return Forecasts	28-Feb-2020
Searching for Alpha: China A Alpha - Sector-relative Value Is Powerful, Choose Sector Mappings Wisely	21-Feb-2020
Searching for Alpha: Machine Learning – Beyond Random Forests for Stock Selection	03-Oct-2019
Searching for Alpha: Earnings Surprise: Managing Expectations	23-Sep-2019
Searching for Alpha: Machine Learning – Interpreting Machine Learning Predictions	5-Mar-2019
Searching for Alpha: GAAP vs. Non-GAAP - Which Earnings does the Market Price?	7-Feb-2019
Searching for Alpha: Style Crowding in Asia - Getting Ahead of the Crowd	21-Nov-2018
Searching for Alpha: Earnings Surprise – Using Machine Learning to Forecast Earnings Surprises & Returns	17-Sep-2018
Searching for Alpha: The ESG Edge – A Step Forward	13-Sep-2018
Searching for Alpha: Machine Learning – Interacting Machine Learning and Factors	3-Sep-2018
Measuring the Crowded Trade: Introduction to our Crowding Composite for Individual Stocks	3-May-2018
Searching for Alpha: Profiting from Capex – Look to Capex Announcements	14-Mar-2018
Searching for Alpha: Tactical Style Rotation – Using Risk and Return to Manage Style Exposure	7-Sep-2017
Searching for Alpha: Big Data – Navigating New Alternative Datasets	10-Mar-2017
Searching for Alpha: Betting Against Accurate Beta	13-Feb-2017
Searching for Alpha: Competitive Advantage – Survival of the Fittest	19-Sep-2016
Searching for Alpha: Financial Strength Redux	9-Sep-2016
Searching for Alpha: Dynamic Style Weighting – Risk-Based Equity Style Allocation	14-Apr-2016
No Shorts Please: Long-Only Pure Style Portfolios	4-Mar-2016
Industry Alpha insights: Banks – One Size Does Not Fit All	18-Feb-2016
Under the Microscope: Stock Momentum Conflation	21 Sep-2015
Searching for Alpha: Macro Moves Markets	15-Sep-2015
Searching for Alpha: Style Performance, Trading Volumes and Investor Agreement	23-Mar-2015
World Radar Screen: Refining Our Global Search for Alpha	13-Mar-2015
Searching for Alpha: Networking with Analysts: Modelling Analyst Forecast Dependence	18-Feb-2015
The Rise of Low Risk Investing: Is it Getting Crowded Out There	01-Oct-2014
Under the Microscope: Five Innovations in Momentum Investing	27-Mar-2014
Searching for Alpha: Timing Price Momentum	07-Mar-2014
Equity Risk Premia Investing: A New Methodology For Monitoring Style Performance	27-Nov-2013
Stock Market Country Selection: Changes to a Well Established Model	23-Jul-2013
Searching for Alpha: Digging for Dividends – QUARI QUality with A Reliable Income	02-Jul-2013
Global Theme Machine: An Objective Way of Identifying Attractive Investment Themes	24-Jun-2013
Searching for Alpha: Purifying Analyst Recommendations – Removing Beta to get to the Alpha	25-Mar-2013
Searching for Alpha: Tangible Benefits of Intangibles – Brand, Respect & Intellectual Capital	06-Nov-2012
Low-Risk Portfolio Strategies: Sharpe Ratio Maximisation and Multi-Asset Applications	09-Mar-2012
Macro Risk and Style Rotation: A Guide Rather than a Prescription	28-Feb-2012
Searching for Alpha: Accruals Volatility – A New Approach to Quality Investing	14-Sep-2011
Industry Alpha Insights: Four Approaches to Tactical Industry Selection	24-Aug-2011
Industry Alpha Insights: Quantifying Industry Specific Fundamentals	17-Mar-2011
Low-Risk Equity Portfolios: More than just Minimum Variance	18-Nov-2010
Under the Microscope: Measuring Systemic Risk – The Absorption Ratio	15-Nov-2010
Under the Microscope: Optionality in Valuation	14-Jun-2010
Searching for Alpha: Earnings Surprise – Still Profiting from Surprises	31-Mar-2010
Searching for Alpha: Optimising Style Rotation Strategies	15-Oct-2009

Source: Citi Research

Citi Quant Research Team

Figure 37. Citi Quantitative Research Teams

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Appendix A-1

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Citi Research Quantitative World Radar Screen Model Coverage	30%	40%	30%			
% of companies in each rating category that are investment banking clients	39%	34%	31%			
Citi Research Quantitative Latam Radar Screen Model Coverage	20%	60%	20%			
% of companies in each rating category that are investment banking clients	75%	72%	38%			
Citi Research Quantitative Asia Radar Screen Model Coverage	20%	60%	20%			

% of companies in each rating category that are investment banking clients	33%	29%	24%
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