Deutsche Bank
Research

Global

Quantitative Strategy

Signal Processing

Date
13 May 2019

Macro-Driven Country Rotation (MDCR) Model

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Country Selection: An Alternative Venue for Security Selection

In this report, we develop a model to explain country return variation. In our view, the growth of investment vehicles that track equities at the country-level in conjunction with considerable differences in monthly country returns has given rise to new opportunities for quantitative-minded investors. As we show, combining our country model with a standard equity quantitative stock selection model may result in a substantial increase in the risk-adjusted return.

Macroeconomic Fundamentals: The Key to Country Timing

We explore using a wide range of novel macroeconomic data to explain country returns. This data captures the economic fundamentals of an individual country including information related to business and professional (economist) surveys, various economic activity indicators, C DS spreads, oil prices, yield curves and FX rates. Our results are consistent with the idea that investors underreact to information related to future economic growth and require a premium for holding risky countries.

Harnessing Country Alpha

The models we present in this report generates Sharpe Ratio of 1.2 to 1.4 using a variety of developed and emerging market countries. The main advantage of the country rotation strategy is the low costs associated with implementation – the model can be implemented using country futures or ETFs that are extremely liquid when compared to the single-stock equities.

Distributed on: 13/05/2019 22:42:09 GMT

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A Letter to Our Readers

Our approach to country selection is different from most conventional academic researches in that we focus on a wide range of country-specific data. The new country model that we present in this report tends to derive influence from macroeconomic characteristic differences between countries rather than aggregated stock-level differences across countries. As we show, including different types of signals in the model provides diversification benefits, reduces historical drawdown and creates more stable returns.

Consistent with previous research, we use commercially available capitalization-weighted benchmarks denominated in local currency as our proxy for country equity returns. Our use of local returns over USD- or EURO-denominated returns enables us to focus specifically on the drivers of individual country returns, rather than trying to simultaneously predict foreign exchange movements.

Based on economic intuition and empirical correlations, we group factors in the new country rotation model into six distinct different themes: *Value, Growth, Technical, Risk, Macro Environment and Global Drivers*. Our approach mitigates multicollinearity while making it easier to understand the behavior of model components. The themes capture two main elements that affect the pricing of country equities: (i) growth expectations and (ii) risk. As we show, our results are consistent with the idea that investors underreact to information that is correlated with future economic growth and require a premium for investing in risky countries.

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We deploy these models on three universes: MSCI Developed Markets, MSCI Emerging Markets and MSCI Global Markets (which is the combination of developed market and emerging market countries). To avoid forward-looking bias, our analysis leverages point-in-time data. Our examination indicates that investors who follow this approach can potentially generate reliable out-performance after consideration of transaction costs. The analysis that we present can be used to enhance global stock selection models and more explicit country-timing models.

The returns from the monthly-rebalanced country rotation model that we develop has lower correlations with the returns associated with traditional quantitative equity strategies. The main advantage of country rotation model involves the low costs associated with implementation: most country models can be implemented using country futures or ETFs that are extremely liquid when compared to the single-stock equities. The main disadvantage of these models relative to quantitative equity involves having much lower breadth, instead of stock selection with over 5000+ stocks we are instead picking among 40+ country indices.

We are happy to speak at length about our empirical findings and opinions – for those that want more details or clarity on our analysis, please do not hesitate to reach out to setup a meeting in-person, over the phone or attend one of our many webinars. You can reach a member of the team by contacting DBEQS.AMERICAS@DB.com or reaching out to your Deutsche Bank sales contact.

Regards,

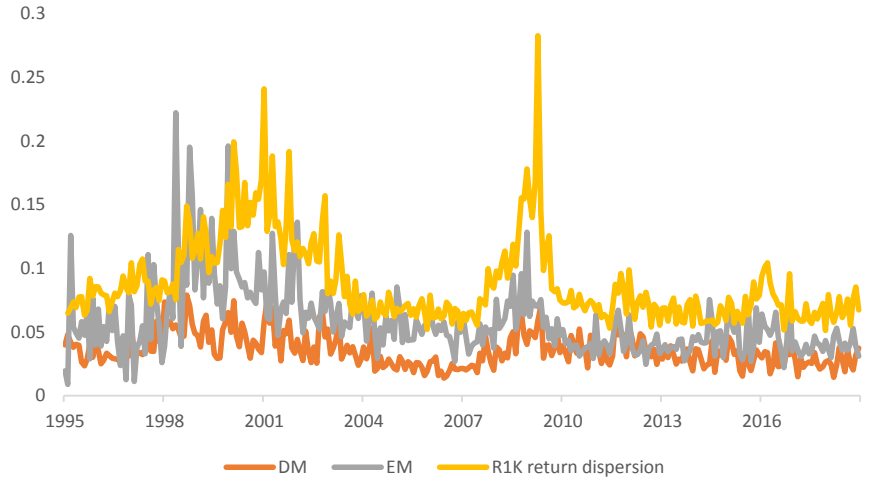
Ronnie, Shuan, Jessica, Alex and the Deutsche Bank US Quantitative Strategy team.

1. Introduction

1.1 Opportunity Set

We start our analysis with a discussion of the opportunity set associated with country selection. Figure 1 displays the time series of cross-sectional return dispersion for (i) Russell 1000 stocks and (ii) MSCI Developed Markets and Emerging Markets countries from January 1995 to December 2018. We show dispersion for Russell 1000 stocks as many managers use the constituents of this index to define their eligible US stock selection universe.

Figure 1: Return Dispersion from January 1995 to December 2018.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell

The average cross-sectional monthly return dispersion for stocks in Russell 1000 is about 8.8%, compared to 5.8% cross countries in Emerging Markets and 3.6% in Developed Markets. Although the cross-country dispersions are somewhat lower than that among Russell 1000 stocks, the opportunity set is still on the same order of magnitude. The higher dispersion in Emerging Markets relative to Developed Markets potentially indicates greater opportunity for country selection in the former group of countries.

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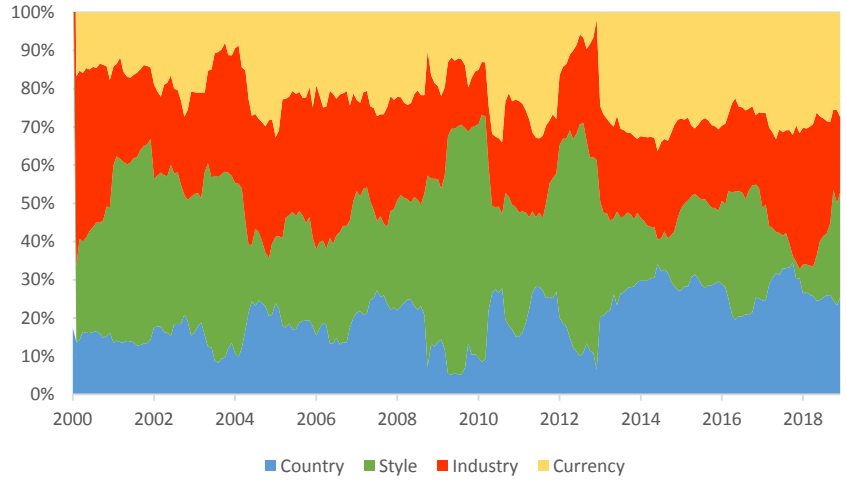
Following the approach examined in Alvarez et al (2012), we examine the amount of return variation explained by global (market), style (size, value, momentum, growth, liquidity, and volatility), country, industry, currency and stock-specific factors which reflect the potential opportunity set available for alpha associated with these different segments. Stock-specific or the residual variation un-explained by systematic exposures and global (market beta) accounts for the majority or approximately 70-80% of the return variation. Figure 2 decomposes the remaining systematic variation into country, style, industry and currency components to display the relative importance of these different sources of return variation.

Figure 2: Global Opportunity Set Excluding Global (Market) and Stock-Specific.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell

The average exposures to countries and style is 12% and 15%, respectively. As we show, the variation explained by country has been steadily increasing over time while the proportion of the return variation driven by style has been declining. Thus, country effects have increasingly become a main driver of the global stock returns in recent years.

Country effects have increasingly become a main driver of the global stock returns in recent years.

1.2 Country Universes

We examine country return variation using three different country universes: MSCI Developed Markets (MSCI World Index), MSCI Emerging Markets and MSCI Global Markets (MSCI ACWI Index) which is a combination of developed markets and emerging markets. To avoid forward-looking bias, we use point-in-time universes. We exclude Venezuela from the universe due to lack of data coverage for most of the variables we examine.

Our sample starts in January of 1995 for developed markets and 1999 for emerging markets. The later start date is due to lack of data availability for emerging market countries prior to 1999. Among the 51 countries that have appeared in the global universe during the sample period, 11 of them have experienced at least one upgrade or downgrade event. Israel and Portugal were upgraded from emerging markets to developed markets in 2010 and 1997, respectively. Greece entered developed markets in 2001 but was downgraded to emerging markets in 2013. Pakistan was downgraded to frontier markets in 2009 but came back to emerging markets in 2017. Egypt, Qatar and UAE moved from frontier markets to emerging markets in 2001, 2014 and 2014, respectively. Countries that have been downgraded to frontier markets include Argentina, Jordan, Sri Lanka and Morocco.

1.3 Summary Statistics by Country

Figure 3 and 4 display the annualized local return, USD return, local volatility and USD volatility for developed market and emerging market countries, respectively.

Figure 3: Developed Market Country Statistics from 1995 to 2018.

	Local Return (%)	USD Return (%)	Local Vol(%)	USD Vol(%)
Japan	2.9	2.5	17.9	17.4
Ireland	4	4	20.4	21.4
Portugal	5.2	5.4	19.1	22
Austria	5.8	6.2	21.7	25.2
Italy	6.2	6.6	21	23.6
UK	7.4	6.9	13.2	15.4
Singapore	6.3	7.3	21.3	24.4
Israel	8.7	7.8	20.8	22.8
Belgium	7.9	8	18.4	20.7
Canada	8.5	8.5	14.2	14.2
New Zealand	7.5	8.9	15	21.4
France	8.8	9	17.5	19.8
Germany	9	9.1	20.5	22.2
Netherlands	9.4	9.3	18	19.7
Switzerland	8.4	9.8	14.9	16.2
United States	10.1	10.1	14.6	14.6
Australia	9.2	10.1	12.6	20.3
Hong Kong	10.3	10.3	23.8	23.9
Norway	10.2	10.4	20.5	25.4
Spain	10.8	11	20.8	23.8
Sweden	12.4	12.5	21.1	24.5
Denmark	12.9	12.9	18	19.4
Finland	13.8	13.7	29.5	30.6
DM EW Avg.	8.5	8.7	18.9	21.3
DM VW Avg.	9.5	9.6	18.8	20.5

Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell

Figure 4: Emerging Market Country Statistics from 1998 to 2018.

	Local Return (%)	USD Return (%)	Local Vol(%)	USD Vol(%)
Greece	-8	-6.5	33.8	37.3
UAE	-2	3.5	32	33.6
Jordan	5.1	5.1	18.9	19
Morocco	6	6.2	16.3	18.4
Qatar	2.9	7.2	26.6	26.4
Taiwan	7.2	8	22.8	25.1
Philippines	9.4	8.6	21.3	24.3
Chile	11.3	10.5	15.7	21.7
Poland	9	10.9	24.3	32.3
China	11.1	11	29	29
Malaysia	9.8	11.7	18.3	21
Mexico	14.3	12.1	18.5	24
Hungary	11.4	12.4	25.7	33.1
South Africa	15.4	12.6	17.3	25.3
Argentina	19.2	12.9	40.8	41
Sri Lanka	17.3	13.8	30.1	31.7
Korea	12.5	14.4	24.4	30
Egypt	23.3	15.1	33.3	33.6
Czech Republic	12.7	15.3	22.5	27.2
Pakistan	13.3	15.4	31.1	32.4
India	16.9	15.5	24.7	28.8
Thailand	13.9	15.5	26.7	30.4
Turkey	27.7	16.7	42	48
Brazil	19	17	23.7	36.7
Colombia	19.5	17.4	25.2	30.9
Indonesia	19.3	18.9	26.2	35
Peru	19.2	19.2	27.4	27.7
Russia	22.8	20.9	35.1	38.4
EM EW Avg.	12.8	12.2	26.2	30.1
EM VW Avg.	14.9	13.1	25.1	30.3

Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell

In developed markets, Japan had the lowest local return of 2.9% while Finland generated the highest return of about 13.8%; In emerging markets, the biggest loser was Greece with -8.0% local return and the biggest winner was Russia with 22.8% local return. Greece had a negative return that can be attributed to stock market underperformance due to the sovereign debt crisis which occurred after 2011. The larger return range in emerging markets indicates a potentially bigger opportunity set for quantitative selection for emerging markets relative to developed markets. The USD return volatility is generally higher than local return volatility, especially in emerging markets. Thus, exchange rate movements introduce more noise into the return process, making it harder to predict future returns. For this reason, we choose to focus on local returns instead of USD returns when modeling countries.

2. Data Sources

Figure 5 lists the different data sources used in the model explained in the next section. We explore a wide range of macroeconomic data sources, including various financial markets, different surveys of future economic activities and the realized values of macroeconomic indicators.

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Figure 5: Data Sources.

Top Down Macroeconomic Data	Description	Source
Local Yield Curve	Daily local bond yields for different maturities	Bloomberg
MSCI Country Index Return	Monthly MSCI Country Index Local and USD Return	Bloomberg
Local Currency to USD FX Rate	Daily local currency to USD exchange rate	Bloomberg
Bloomberg Macro Survey	Quarterly economist survey on next quarter country GDP growth rate	Bloomberg
Sovereign CDS	Sovereign Bond Daily credit default swap price	Bloomberg
Oil Price	Daily crude spot price	Bloomberg
Oil Production and Consumption	Country-level annual oil production and consumption	BP Statistics
Chicago Fed National Activity Index	Monthly weighted-average of 85 national economic activity indicators	Chicago Fed
European Central Bank Professional Forecasters Survey	Quarterly professional forecasters survey of EU GDP growth	ECB
Global Economic Policy Uncertainty Index	Monthly GDP-weighted country-specific economic policy uncertainty index	EPU Website
Global Manufacturing PMI	Monthly country-specific purchasing manager index aggregated by manufacturing value-add	Haver Financial
OECD Business Condition Survey	Organization for Economic Cooperation and Development monthly future business conditions survey	OECD Website
Philadelphia Fed Professional Forecasters Survey	Quarterly professional forecasters survey on US GDP growth	Philadelphia Fed
MSCI Index Country Constituents	Monthly Point-In-Time MSCI World, Emerging and ACWI Index Country Constituents	Thomson Reuters
Bottoms Up Stock Aggregated Data	**Description**	**Source**
Stock Market Data	Daily stock price, return and volume	Compustat & Tomson Reuters
Company Fundamental Data	Monthly Company Financial Statements Items	Compustat & WorldScope
Analyst Estimates	Monthly Analysts EPS and Sales Estimates	IBES

Source : Deutsche Bank Quantitative Equity Strategy

3. Country Alpha Building Blocks

We organize the factors in the model into various investment themes: *Macro Environment, Global Driver, Risk, Technical, Growth and Value*. The factors in one theme tend to either (i) rely on similar data sets and/or (ii) have higher correlations with each other. By grouping factors into different baskets, we mitigate the issue of multi-collinearity and provide greater transparency in understanding model performance. In this section, we describe in more detail the economic rationale and factor construction for each quantitative insight used to explain country returns. Specifically, we include in our analysis top down factors that rely on information at the country level and bottom up factors that generally derive value from stock-level information.

By grouping factors into different baskets, we mitigate the issue of multi-collinearity and provide greater transparency in understanding model performance.

3.1 Macro Environment (Top Down)

Factors included in the macroeconomic environment theme are related to **changes in** underlying economic conditions at the country-level. While these changes are historical, we conjecture that market participants underreact to new information about a country's growth prospects which leads to return predictability.

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Business Conditions

OECD conducts a monthly business tendency survey (also called business opinion or business climate survey) that asks managers about their businesses' current situation and near future expectations. The survey covers broad sectors of the economy, including consumer, manufacturing, service, retail and construction and collects information on prices, orders, employment, exports and production. OECD provides point-in-time monthly survey results starting in 1995 for most countries.

We focus specifically on the surveys in future prices and confidence in consumer, manufacturing and service sectors, whose goods and services are potentially more direct measures of the business conditions. For example, if more respondents indicate the prices of their products will increase in the future – this information may either indicate higher demand or improving overall consumer consumption.

In each month except December, OECD releases the survey results on the last business day of the month. The December results are delayed for about two weeks due to year end processing. To be conservative in back-testing, we add a one month lag. From the survey we extract information on whether respondents have indicated that conditions are improving or deteriorating. This information is recorded in a similar way to how earnings consensus from sell-side analysts are collected for earnings up vs. down ratios commonly used in quantitative finance models.

Macro Surprise

This signal is analogous to a country-version of post-earnings announcement drift (PEAD), which predicts that investors tend to underreact to company earnings surprises. In the same way, we measure the difference between the macroeconomic quantity relative to an estimate or benchmark.

One challenge in constructing a macro surprise measure involves the choice of macroeconomic indicators. We choose to focus on GDP, which is an aggregate measure that captures many different elements of country-level economic conditions including industrial production, import and export activity and consumer spending. Additionally, this variable has the widest coverage as nearly every country reports GDP.

To construct the macro surprise measure, we rely on two main data sources: reported GDP growth and consensus GDP growth. One month before the GDP is released, Bloomberg surveys a panel of (mostly sell-side) economists to understand their GDP forecasts for the next period. The variable definition for macro surprise is listed below.

$$ms_{t,i} = \frac{rGDP_{t,i} - cGDP_{t,i}}{\left|rGDP_{t,i} + cGDP_{t,i}\right|}$$

Where rGDP(t,i) is realized GDP growth at quarter t for country i, cGDP(t,i) is the most recent consensus of GDP growth before its announcement at quarter t for country i.

The second step is to standardize this measure by its time-series historical mean and standard deviation using past 20 quarters data for each country similar to earnings surprise signals constructed for quantitative equity portfolios. We calculate this time series z-score to capture how extreme the latest surprise is on a historical basis.

$$sms_{t,i} = \frac{ms_{t,i} - m_{t,i}}{std_{t,i}}$$

Local Yield Curve Shift

Using the daily yield curve for each country we estimate "parallel shifts" as the combination of changes in short-term and long-term yields. We hypothesize that rising interest rates (relative to other countries) reflect an increase in the opportunity cost of equity investments and lead to negative future expected country returns. Higher interest rates crowd out business investment and discourage consumer spending.

Local Yield Curve Twist

We also examine yield curve slope changes. Yield curve flattening compresses financial firm profit margins (banks borrow at the short term rate while lending at the long term rate), potentially leading to lower future economic growth and lower future country equity prices. Twist and Shift are similar to the factors explored by Chen et al (2016).

Currency Strength

We use the change in foreign exchange rate (local currency to USD) to provide insight on whether a country's currency is appreciating or depreciating. A depreciating local currency will make a country's goods more competitive in international markets, potentially increasing the stock price of exporters leading to higher country equity prices.

3.2 Global Drivers (Top Down)

We now turn our attention to factors that explain country stock returns that are driven by a global macroeconomic time series but whose influence varies across countries. We speculate that either (i) country-level sensitivities are not well understood by financial market participants or (ii) investors systematically underreact to the changes in the global macro indicators.

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Oil Price Changes

To capture a country's sensitivity to oil price we use the difference between oil production and consumption scaled by GDP. Then we multiply this sensitivity by the impulse or the past oil price change. We conjecture that increasing oil prices will be positive for a country with high production relative to consumption and negative for a country with high consumption relative to production.

Macro Sensitivities

We estimate the sensitivity of a country's future return to various global drivers. These drivers are listed in Figure 6.

Figure 6: List of Global Drivers

Global Driver	Description
$\Delta POil_t$	The change in oil price at month t, we use 1 month moving average of daily oil price returns.
ΔInt_t	The change in US interest rate at month t, we use the difference between short term moving average of daily interest rate and long term moving average of daily interest rate.
ΔMU_t	The change in macro uncertainty index at month t. We use global economic policy uncertainty index developed by Baker and Bloom (2016).
$\Delta USTW_t$	The change in US exchange rate vs trade weighted basket of foreign currencies at month t.
ΔPMI_t	The change in global manufacturing PMI at month t, we use the ratio of PMI at month t to the 6m moving average.
$\Delta CFNAI_t$	The change in Chicago Fed National Activity Index (CFNAI) at month t. The change is calculated as the difference between 1 month and 6 month moving average of the index.
$\Delta SPFUS_t$	The change in real US GDP growth forecasts from Philadelphia Fed's Survey of Professional Forecasters (SPF) at month t. We use the ratio of current month forecast to the 6m moving average.
$\Delta SPFEU_t$	The change in real euro area GDP growth forecasts from ECB Survey of Professional Forecasters. The change is calculated as the ratio of current month forecast to the 6m moving average.

Source : Deutsche Bank Quantitative Equity Strategy

To mitigate the multi-collinearity among the global drivers, we take principle component analysis (PCA) approach. Every month we extract the first principle component among these eight variables using rolling 36 months data. Then, we regress one month forward return on the first principle component as specified by the following formula:

$$r_{i,t+1} = \beta_0 + \beta_1 FPC_t + \varepsilon_t$$

Where

r(i,t+1): The return of country i in month t+1

FPC(t): First principle component at the end of month t of global drivers

The metrics used in this section differ in the estimation of the country-level sensitivity. The first is more fundamentally-based (oil production and consumption), while the second is based on regression analysis to estimate sensitivities.

3.3 Risk

In a country selection model, we propose country equity returns underreact to shocks in volatility.

The low volatility anomaly explains that stocks with low volatility outperforms the stocks with high volatility. In a country selection model, we propose country equity returns underreact to shocks in volatility. Volatility is potentially a proxy for perceived country risk. An alternative explanation for our factors involves investors requiring a higher risk premium for investing in risky assets.

Local equity market volatility changes

We capture the change in stock market volatility by calculating the difference between historical short-term volatility and long-term volatility. The volatility is based on each country's daily MSCI country index returns.

Local interest rate volatility changes

We calculate the interest rate volatility change by taking the average volatility change using the 1-year yield and 10-year yield. The volatility is calculated using daily yield changes over the past year. The change is calculated as the difference between short term volatility and long term volatility.

FX volatility changes

We first calculate daily returns of local currency to USD exchange rate. Then, following the same methodology used for equity market volatility, we calculate the change in FX volatility by computing the difference between short term and long term volatility.

Sovereign CDS

Credit Default Swaps (CDS) is a contract between two market participants. When a credit event occurs, such as the reference entity fails to pay a coupon or a debt restructuring, the seller of the CDS is obligated to pay the buyer an amount equivalent to the face value of the contract minus any recovery on the bond. Similar to insurance policy, the buyer pays the seller a premium which represents the default likelihood of the reference entity.

Investors use sovereign CDS to hedge against the default risk of a country or sovereign debt. The CDS spread they pay reflects the amount of risk they are taking. We find that countries with higher CDS spread offer higher forward returns. This relationship is more pronounced in emerging markets countries as default risk is generally higher and has more cross-sectional dispersion than among developed markets countries.

Our measure is to use six-month moving average of the sovereign CDS spread to capture the default risk of a country. We only include this factor for emerging markets as the developed markets CDS market is not as liquid since developed markets investors are not concerned about the default risk of developed markets countries.

Sovereign CDS change
The sovereign CDS change is calculated as the six-month moving average of daily percentage changes in sovereign CDS spread. We find that equity investors underreact to the innovations in the country default risk, thus an increase in the CDS spread leads to lower future equity returns.

3.4 Technicals

The explanations for technical factors explaining variation in country returns are similar to the underreaction or risk premium explanations motivating quantitative stock-selection models.

Technical themes includes signals based on market data, such as changes in price, volume or shares outstanding. The explanations for these factors explaining variation in country returns are similar to the underreaction or risk premium explanations motivating quantitative stock-selection models.

Return Momentum

Jegadeesh and Titman (1993) document that stocks with higher past returns tend to outperform those with lower past returns. We use past 12-month MSCI country index return, skipping the latest month scaled by the past twelve-month volatility.

Liquidity

Our measure of liquidity is calculated as the ratio of absolute return to the trading volume of a country index. This measure captures market impact as higher ratios indicate lower liquidity. We aggregate the daily ratio of absolute return to trading volume for single stocks (See for example Amihud (2015)) to the country-level over the past month.

Liquidity Changes

To capture country-level changes in liquidity, we examine the difference between one-month turnover and three-month turnover. Turnover is defined as the ratio of the number of shares traded to total number of flow shares. We aggregate stock-level turnover to country level.

3.5 Growth

Investors tend to underreact to earnings revisions at the country level. Countries with increasing earnings estimates will outperform those with decreasing estimates.

Investors tend to underreact to the analysts' earnings revisions on the single-stock level. A company's stock will go up following a positive analyst earning revision and go down following a negative revision. We observe a similar phenomenon at the country level. Countries with increasing earnings estimates will outperform those with decreasing estimates.

To capture the earnings revisions at the country level, we aggregate stock-level earnings revisions to the country level. One signal we explored is a measure of breadth and it is defined as the difference between the number of upward and downward estimate revisions for the upcoming 12 months scaled by the total number of estimates. Another factor we used involves examining the magnitude of the revisions and it is calculated as the percentage of changes in sales per share for the current fiscal year. The look-back window for both factors is 3 months.

3.6 Value

Typical value metrics scale a variety of fundamental such as book equity, earnings, sales and cash flow by price. There are various explanations provided by academic literature why price-scaled strategies explain differences in average returns. Fama and French (1992, 1993) suggest value stocks are riskier and therefore have higher expected returns. Lakonishok, Shleifer and Vishny (1994) in contrast hold the view that investors make mistakes when assigning earnings and sales expectations for growth stocks, which lead to under-performance relative to value stocks.

We observe that the country valuation measures also explain the country return variation. To form the valuation metrics at country level, we aggregate stock-specific cash flow-based valuation measures to the country level. Cash flow-based valuation accounts for low quality non-cash earnings and is a better indicator for the sustainable future profitability.

We observe that the country valuation measures also explain the country return variation. To form the valuation metrics at country level, we aggregate stock-specific cash flow-based valuation measures to the country level.

Figure 7 summarizes the different factors used in this paper.

Figure 7: Factors used in this paper.

Theme	Factor	Description	Direction
Macro Environment	Macro Surprise	Standardized percentage difference between consensus GDP growth and reported GDP growth	Positive
	OECD Business Survey	Change in OECD business survey of future prices and confidence in consumer, manufacturing and service sectors	Positive
	Yield Curve Slope	Level of local yield curve slope defined as the difference between long term yield (10y) and short term yield (1y).	Positive
	Yield Curve Slope (Δ)	Change in slope of local yield curve, 1m daily ma vs 12m daily ma	Positive
	Long Term Yield (Δ)	Change in local long term yield (10y), 1m daily ma vs 12m daily ma	Negative
	short Term Yield (Δ)	Change in local short term yield (1y), 1m daily ma vs 12m daily ma	Negative
	Currency Strength	Change in local currency to USD exchange rate, 6m average daily exchange rate return	Negative
Global Driver	Oil Sensitivity	Difference between oil production and consumption scaled by GDP multiplied by oil price change	Positive
	Macro Sensitivity	Predicted return from a country's beta to various global drivers	Positive
Risk	Sovereign CDS	Level of a country's sovereign CDS spread	Positive
	Sovereign CDS (Δ)	Change in a country's sovereign CDS spread, 6m average daily CDS spread change	Negative
	Local Equity Vol (Δ)	Change in volatility of the local stock market, 1m vol. vs 12m vol.	Negative
	FX Vol (Δ)	Change in volatility of local currency to USD exchange rate, 1m vol. vs 12m vol.	Negative
	Short Term Int. Vol (Δ)	Change in volatility of local short term yield, 1m vol. vs 12m vol.	Negative
	Long Term Int. Vol (Δ)	Change in volatility of local long term yield, 1m vol. vs 12m vol.	Negative
Technical	Return Momentum	12m return momentum (skip latest month) scaled by volatility of the return	Positive
	Illiquidity	Stock level Amihud measure aggregated to country level	Positive
	Liquidity (Δ)	Difference between 1 month turnover and 3 month turnover	Positive
Value	Cash Flow to EV	Cash flow divided by enterprise value, aggregate to country level	Positive
	Cash Flow Yield	Cash flow divided by price, aggregated to country	Positive
	EBIT to EV	EBIT divided by enterprise value, aggregated to country	Positive
	Free Cash Flow to EV	Free cash flow divided by enterprise value, aggregated to country	Positive
	Free Cash Flow Yield	Free cash flow divided by price, aggregated to country	Positive
Growth	Earning Rev. Breadth	No. of upward revision minus no. of downward revision scale by total no. of estimates, aggregated to country	Positive
	Earning Rev. Magnitude	Percentage of changes in estimated sales per share, aggregated to country	Positive

Source : Deutsche Bank Quantitative Equity Strategy

4. Performance Analysis

4.1 Back-testing Methodology

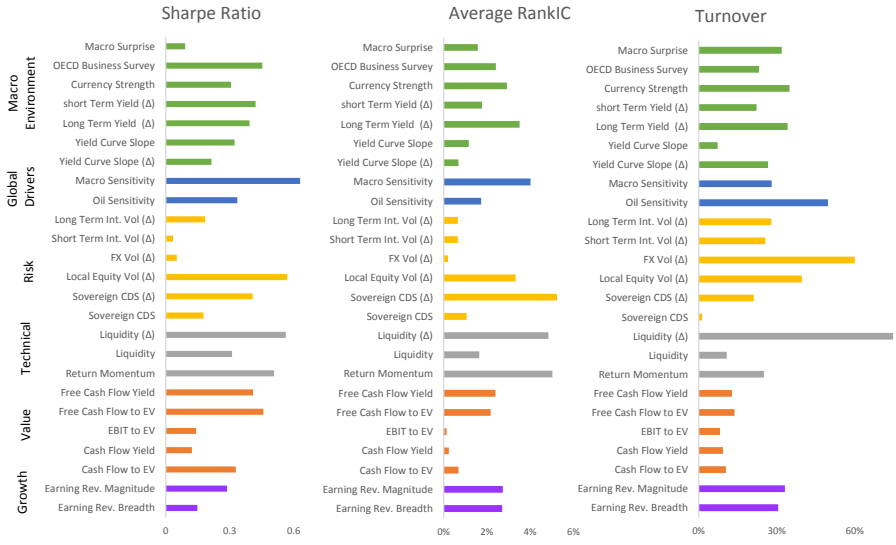
To examine the efficacy of our factors, we sort countries into five (quintiles) equal groups by factor score, go long those countries in the group with the highest scores, and short the countries in the group with the lowest scores. Country returns within the long and short portfolio are equally-weighted. The portfolios are dollar-neutral after each rebalance, and have 100% leverage in the long and short legs. The portfolios are rebalanced at the end of each month. Average IC refers to the Spearman rank correlation coefficient between factor scores and next month returns.

To examine the efficacy of our factors, we sort countries into five (quintiles) equal groups by factor score, go long those countries in the group with the highest scores, and short the countries in the group with the lowest scores.

4.2 Developed Market Factor Performance

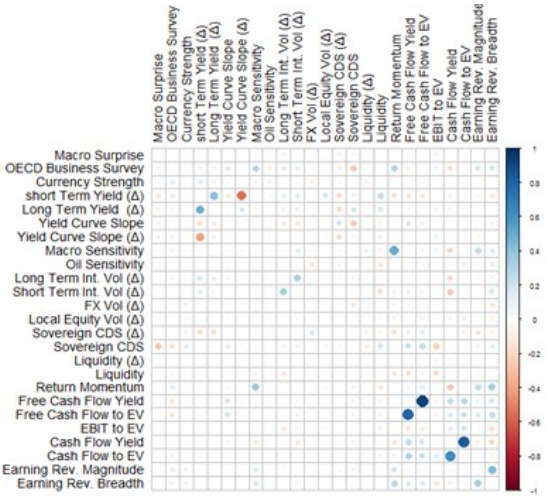
Figure 8 shows the factor quintile performance in developed markets. For each factor, we show Sharpe Ratio, average rank IC and turnover. Figure 9 shows the correlation among the factors in developed markets. This table is organized as follows: the lower-left triangle contains the spearman rank correlation among the different factor scores; the upper-right triangle contains the spearman rank correlation of returns among different long/short quintile portfolios for the sample period from January 1995 to December 2018.

Figure 8: Developed Markets Factor Quintile Performance (Sharpe Ratio, Average IC and Turnover).



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 9: Developed Markets Factor Correlation.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

For the Macro Environment theme, OECD Business Survey and Interest Rates Change (short term and long term) have high risk-adjusted performance as measured by Sharpe Ratio or Rank IC. Macro Sensitivity has stronger efficacy and lower turnover when compared to Oil Sensitivity in Global Drivers themes. Local Equity Volatility Change and Sovereign CDS Change outperform other factors in the Risk theme. We also see that Value and Growth factors that are aggregated from stock-level information have relatively weaker performance when compared to other factors. Change in Liquidity has the highest turnover while Value factors tend to be very persistent.

The factor correlation within theme is generally higher than the factor correlations across themes. For example, Changes in Long Term and Short Term Yield have a score correlation of 42%. One exception is that Return Momentum in Technical theme is correlated with Macro Sensitivity in Macro Environment theme, they have a score correlation of 38%.

The factor correlation within theme is generally higher than the factor correlations across themes.

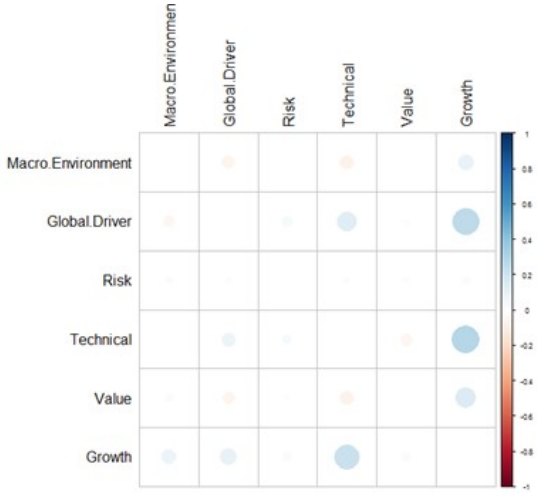
Figure 10 shows the quintile performance, Sharpe Ratio and average IC for each theme in developed markets and Figure 11 shows the correlation among the themes. The upper-triangle shows return correlation while lower-triangle shows theme score correlation.

Figure 10: Developed Markets Theme Performance.

	1(Low)	2	3	4	5(High)	High - Low Annual Return	Sharpe Ratio	Average IC
Macro Environment	4.00%	7.00%	9.60%	10.40%	10.10%	6.00%	0.61	4.30%
Global Driver	4.40%	6.50%	8.80%	10.60%	11.30%	7.00%	0.73	6.20%
Risk	7.00%	7.60%	7.20%	8.50%	10.90%	3.80%	0.4	2.50%
Technical	4.20%	7.60%	8.40%	9.10%	11.90%	7.70%	0.79	5.80%
Growth	5.50%	8.60%	8.90%	8.20%	10.20%	4.70%	0.46	3.20%
Value	5.40%	7.30%	11.60%	8.60%	8.90%	3.50%	0.4	1.60%

Source :Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 11: Theme Correlation in Developed Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

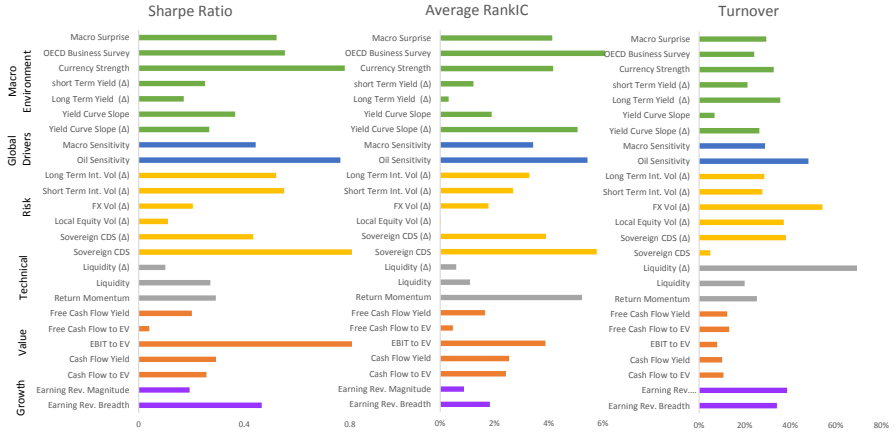
The payoff of each theme tends to be linear and monotonic except in Value where the middle-quintile has the highest annualized return. Technical and Global Driver have the highest Sharpe Ratio and IC closely followed by Macro Environment. Value has the lowest Sharpe Ratio and IC than other themes. As we show, the correlations among themes are quite low. The highest one is between Growth and Technical which has a return correlation of 28% and score correlation of 22%.

In the developed markets, the payoff of each theme tends to be linear and monotonic except in Value where the middle-quintile has the highest annualized return.

4.3 Emerging Market Factor Performance

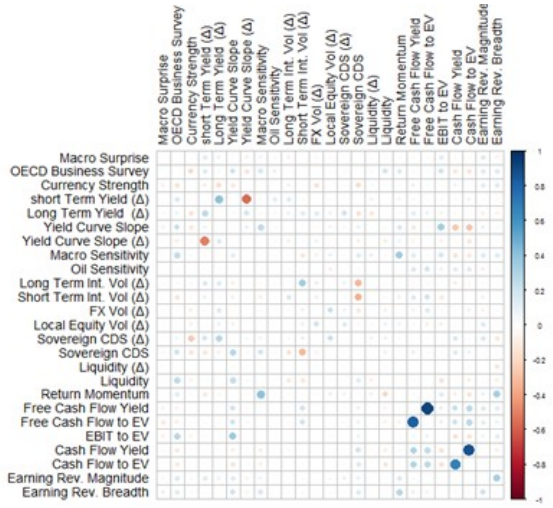
Figure 12 displays the factor quintile performance in emerging markets. For each factor, we show Sharpe ratio, average rank IC and turnover. Figure 13 shows the correlation among the factors in emerging markets. The upper-triangle shows the return correlation and the lower-triangle reports the score correlation.

Figure 12: Emerging Markets Factor Quintile Performance.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 13: Emerging Markets factor correlation.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

In emerging markets, OECD Business Survey performs the best in terms of IC but moderately well when measured using the Sharpe Ratio. Currency Strength and Oil Sensitivity are among the top performers in both Sharpe Ratio and IC possibly because as international trade is the main economic driver for emerging market countries. In addition, the wider dispersion in default risk of the sovereign debt among emerging markets countries may explain the strong performance of Sovereign CDS spread. Similar to what we see in developed markets, Change in Liquidity has the highest turnover and the Value factors are the most persistent.

Correlation within the theme is generally higher than that across different themes. For example, Changes in Long Term and Short Term Yield have a score correlation of 41%. Return Momentum in Technical theme and Macro Sensitivity in Macro Environment theme are the exception across the themes, they have a score correlation of 41%.

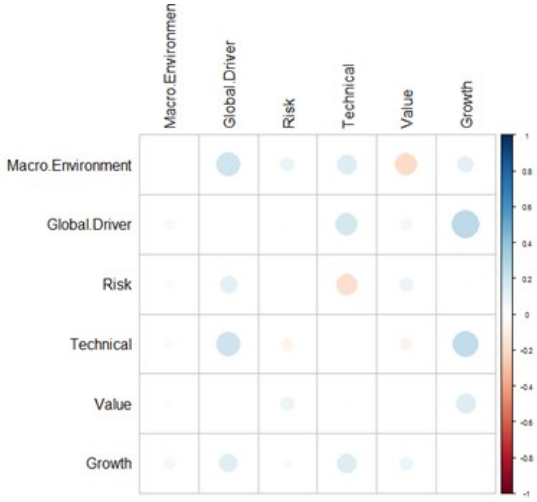
Figure 14 shows the quintile performance, Sharpe Ratio and average IC for each theme in emerging markets and Figure 15 shows the correlation among the themes. The upper triangle shows return correlation while lower triangle shows score correlation.

Figure 14: Emerging Markets Theme Performance.

	1(Low)	2	3	4	5(High)	High - Low Annual Return	Sharpe Ratio	Average IC
Macro Environment	7.20%	12.70%	12.40%	14.20%	22.80%	15.60%	1.04	5.80%
Global Driver	7.30%	12.90%	13.00%	18.60%	19.10%	11.80%	0.81	4.30%
Risk	11.50%	13.10%	13.10%	13.30%	18.10%	6.60%	0.41	2.70%
Technical	12.00%	13.50%	14.90%	14.20%	15.70%	3.70%	0.25	2.70%
Growth	12.90%	12.50%	12.60%	11.00%	19.30%	6.40%	0.47	1.50%
Value	10.90%	13.80%	12.00%	15.70%	16.60%	5.60%	0.4	3.10%

Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 15: Correlation in Emerging Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

In the emerging markets, most of the themes except Technical have higher quintile return spreads than those in the developed markets. Macro Environment has the highest Sharpe Ratio and IC followed by Global Drivers theme. Contrary to what we see in the developed markets, Technical theme has the lowest Sharpe Ratio and IC than other themes. The correlation among themes are quite low. The highest one is between Growth and Technical, they have a return correlation of 25% and score correlation of 13%.

In the emerging markets, most of the themes except Technical have higher quintile return spreads than those in the developed markets. Macro Environment has the highest Sharpe Ratio and IC followed by Global Drivers theme.

5. Portfolio Construction: Combining Theme Scores

We consider three approaches to combine different themes: (i) equal-weight, (ii) alpha-weight and (iii) risk-parity.

In this section, we discuss how to combine different themes to derive the country-level forecasts. We consider three different approaches: (i) equal-weight, (ii) alpha-weight (Luo et al (2011)) and (iii) risk-parity (Osiol et al (2017)).

For alpha-weight approach, we follow steps illustrated below:

- Every month, regress the one month forward return on the six theme scores following Fama-Macbeth regression framework, where R(t+1) is a vector of country returns from month t to month t+1, F(i,t) is a vector of theme scores at month t.

$$R_{t+1} = \beta_{0,t} + \sum_{i=1}^{6} \beta_{i,t} F_{i,t}$$

- Following a Fama-Macbeth regression framework, for each theme calculate the exponentially-weighted average (60 month half-life) of βs obtained from the above regression using an expanding window starting at the beginning of the sample ending at the current month[1] .
- The weight of the theme is the maximum of the exponentially-weighted β and zero. This process avoids taking positions against a theme.

For the risk-parity approach, the weight of each theme is determined as the following:

- Similar to alpha-weight approach, run the multivariate Fama-Macbeth regression on six themes to obtain time series of coefficients.
- At each month, estimate the variance/covariance matrix of the six theme basket returns using expansion window.
- The weight is determined in such a way that the risk contribution of each theme is equal, or:

$$w_i \frac{\partial \sigma}{\partial w_i} = w_j \frac{\partial \sigma}{\partial w_j}$$

- where i≠j, w(i) is the weight assigned to the theme i.

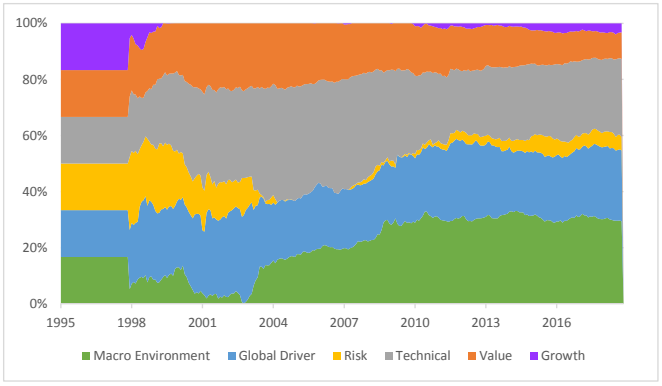
For both the alpha-weight and risk parity approaches we require a sufficient number of observations to estimate different components. For the first 36 months of the backtest period, we equally weight the insights.

1 We also explore other decay rate and find economically similar results.

Figure 16 and Figure 17 display different theme weights over time in developed markets (1995 to 2018) and emerging markets (1999 to 2018) for alpha-weight approach. As we show, top-down Macro Environment and Global Driver are over-weight relative to an equal-weight approach in both developed and emerging markets. Bottom-up Value and Growth, the two themes aggregated from stock level information receive much less weight. In developed markets, Technical theme is also over-weight while Risk theme receives very little weight. On the other hand, Risk theme accounts for much more weight in emerging markets than in developed markets.

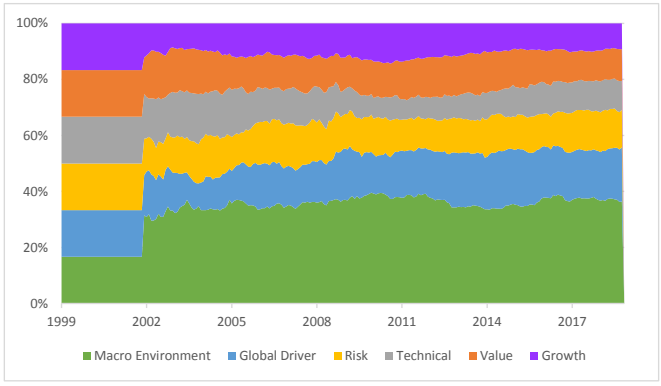
As we show, top-down Macro Environment and Global Driver are over-weight relative to an equal-weight approach in both developed and emerging markets. Bottom-up Value and Growth, the two themes aggregated from stock level information receive much less weight.

Figure 16: Theme Weights in Developed Markets Using Alpha-Weight Approach.



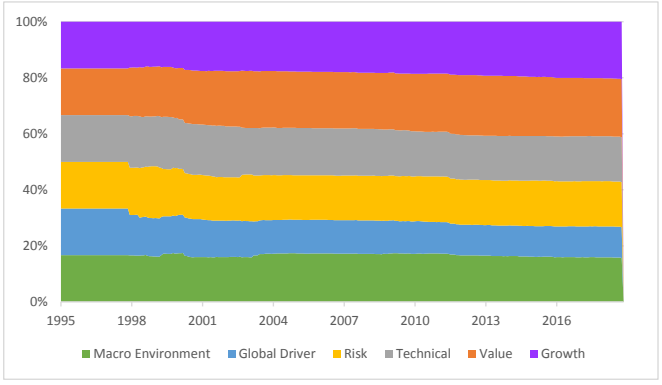
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 17: Theme Weights in Emerging Markets Using Alpha-Weight Approach.



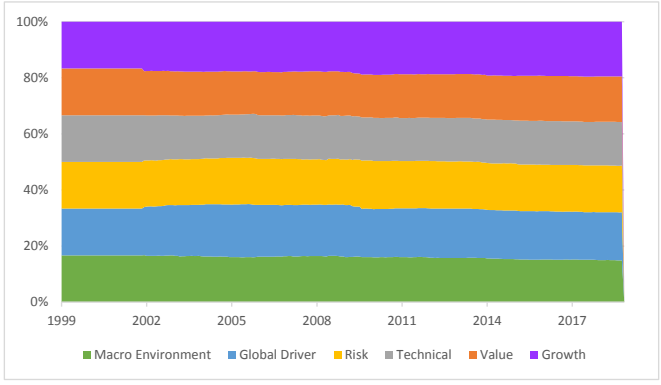
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 18: Theme Weights in Developed Markets using Risk-Parity Approach.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 19: Theme Weights in Emerging Markets using Risk-Parity Approach.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 18 and Figure 19 show the risk parity theme weight for developed markets and emerging markets. As we show, the reported weights are very similar to equal weight, indicating that each theme has the similar marginal risk contribution.

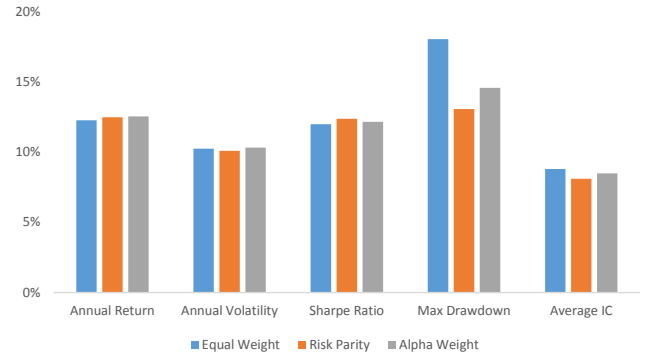
Figure 20, 21 and 22 report performance statistics for the country rotation model formed using three weighting schemes in developed markets, emerging markets

In the developed markets, risk parity approach has the lowest max drawdown.

and Global. In the developed markets, risk parity approach has the lowest max drawdown (13%) compared to equal-weight (18%) and alpha-weight (15%). All three weighting schemes generate similar results in annualized return, volatility, Sharpe Ratio and average IC. In the emerging markets, the risk parity approach yields highest return (21.6%) and Sharpe Ratio (1.4) while alpha-weight approach generates the highest average IC (8.3%). In Global, all three weighting approaches have similar results in annualized return, volatility and Sharpe Ratio while alpha-weight generates the lowest drawdown (9%).

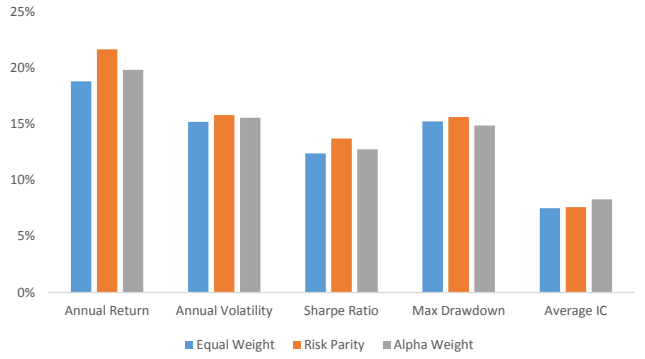
In the emerging markets, the risk parity approach yields highest return and Sharpe Ratio.

Figure 20: Comparison of Performance Using Different Weighting Schemes in Developed Markets (1995 to 2018).



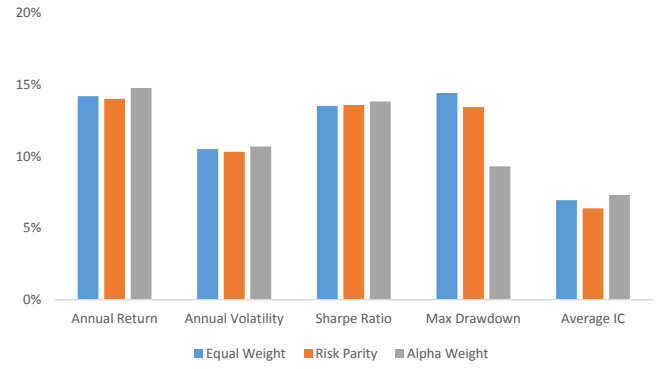
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 21: Comparison of Performance Using Different Weighting Schemes in Emerging Markets (1999 to 2018).



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 22: Comparison of Performance Using Different Weighting Schemes in Global (1999 to 2018).

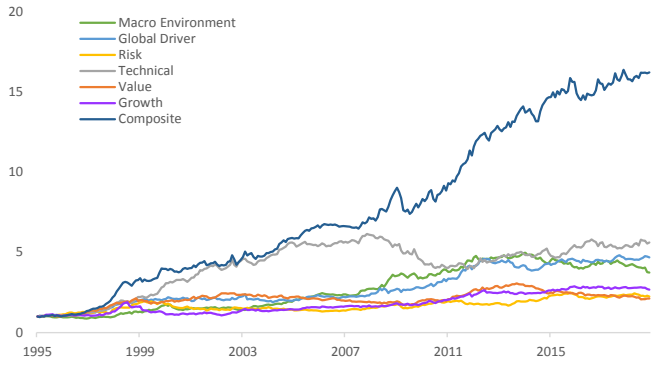


Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 23, 24 and 25 show the growth in wealth for $1 invested in each individual theme and the composite model using risk parity approach for developed markets, emerging markets and Global, respectively. In all markets, Macro Environment and Global Drivers provide greater contribution to total returns; in developed markets technical factors also provide robust performance.

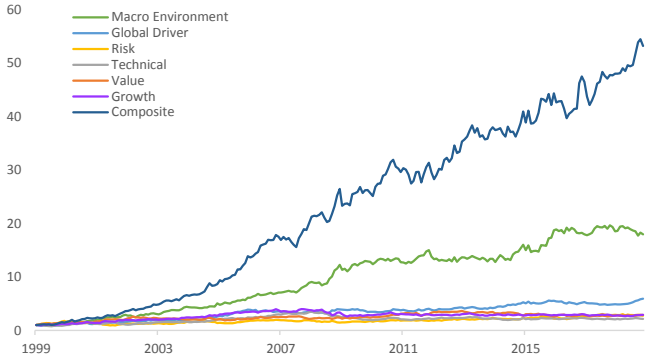
In all markets, Macro Environment and Global Drivers provide greater contribution to total returns; in developed markets technical factors also provide robust performance.

Figure 23: Wealth Curve of Themes and Composite Score in Developed Markets.



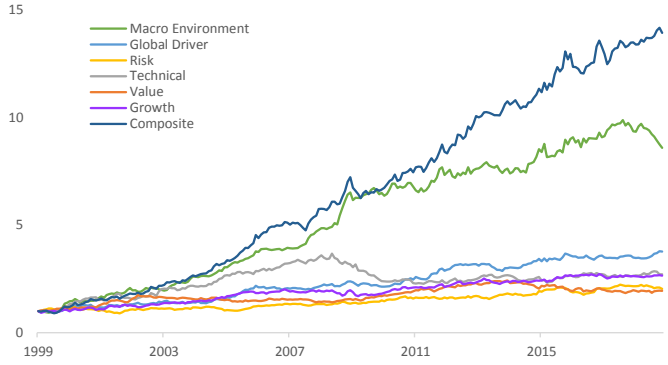
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 24: Wealth Curve of Themes and Composite Score in Emerging Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 25: Wealth Curve of Themes and Composite Score in Global.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

6. Where Do Country Alphas Come From?

The performance of a quantitative strategy is traditionally measured by its Sharpe Ratio or Information Ratio and costs are related to volatility, tracking error, draw-down or turnover. Although these measures are useful in comparing different strategies, they may obscure the true skill of the strategy by not distinguishing between static and dynamic components of the alpha. Take country rotation model as an example – if the model has a static position on a certain country by always taking a short position in a country which has under-performed over the entire sample, we may observe a high risk-adjusted return that is not robust when we remove that country from the universe and re-estimate the strategy.

Figure 26 and 27 attempts to understand the contribution to permanent positions for the country rotation model by displaying the percentage of months a country is placed in each quintile. The last column is the difference between high and low quintiles which indicates the static positions. We take an average of the absolute value of the difference as the overall measure of the static positions in each market. We see that overall, the static positions of the model in both developed markets and emerging markets are mild. In average, developed markets has a static positions of 14% while emerging markets has 23%.

We see that overall, the static positions of the model in both developed markets and emerging markets are mild.

Figure 26: Persistent Positions in Developed Markets.

	Low	Mid Low	Mid	Mid High	High	High – Low
Finland	40%	27%	14%	11%	7%	-33%
Singapore	41%	20%	13%	14%	13%	-29%
Portugal	38%	17%	16%	14%	15%	-24%
Japan	33%	20%	21%	12%	13%	-20%
Canada	36%	18%	13%	14%	18%	-17%
Israel	18%	8%	8%	3%	6%	-13%
Sweden	28%	22%	19%	14%	17%	-10%
Germany	17%	23%	34%	19%	7%	-10%
Norway	30%	18%	17%	13%	22%	-8%
US	21%	21%	20%	25%	14%	-7%
Greece	14%	18%	14%	9%	8%	-5%
Australia	20%	22%	20%	24%	15%	-5%
France	12%	22%	32%	22%	12%	0%
Spain	23%	19%	22%	13%	23%	0%
UK	22%	15%	20%	17%	26%	5%
New Zealand	23%	15%	16%	18%	29%	6%
Belgium	15%	18%	28%	19%	21%	6%
Netherlands	16%	21%	21%	20%	23%	7%
Switzerland	15%	14%	23%	25%	22%	7%
Hong Kong	20%	17%	13%	17%	34%	14%
Italy	4%	18%	24%	30%	24%	20%
Denmark	7%	10%	24%	26%	32%	25%
Austria	13%	12%	17%	18%	40%	27%
Ireland	3%	7%	17%	22%	51%	47%
Avg. of Static Positions						14%

Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 27: Persistent Positions in Emerging Markets.

	Low	Mid Low	Mid	Mid High	High	High – Low
Morocco	64%	17%	13%	5%	1%	-64%
Qatar	64%	16%	11%	9%	0%	-64%
Poland	46%	26%	21%	7%	1%	-45%
Jordan	48%	15%	17%	15%	5%	-43%
Malaysia	41%	19%	21%	15%	4%	-37%
Chile	43%	28%	14%	9%	6%	-37%
Israel	30%	15%	9%	3%	1%	-29%
Taiwan	26%	34%	22%	12%	5%	-21%
India	23%	34%	21%	18%	3%	-20%
Czech Republic	25%	21%	21%	24%	9%	-16%
Thailand	19%	18%	25%	26%	12%	-7%
Korea	12%	19%	31%	27%	11%	-1%
Greece	6%	11%	9%	5%	6%	0%
Portugal	0%	0%	0%	0%	0%	0%
China	12%	28%	18%	26%	15%	3%
UAE	18%	24%	25%	11%	22%	4%
Philippines	11%	29%	22%	20%	17%	6%
Brazil	9%	18%	29%	29%	15%	6%
Peru	18%	13%	20%	20%	30%	12%
Mexico	10%	19%	17%	29%	25%	15%
Egypt	20%	9%	14%	20%	37%	17%
Colombia	9%	15%	21%	28%	26%	17%
Hungary	17%	17%	15%	17%	34%	17%
Sri Lanka	4%	18%	32%	25%	21%	18%
South Africa	7%	15%	25%	27%	26%	20%
Argentina	20%	10%	15%	13%	43%	23%
Pakistan	20%	11%	11%	14%	44%	25%
Indonesia	8%	16%	15%	24%	37%	28%
Russia	5%	5%	20%	18%	53%	48%
Turkey	3%	9%	12%	24%	53%	50%
Avg. of Static Positions						23%

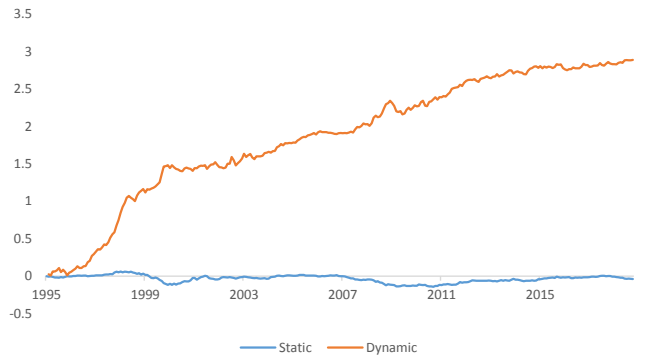
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Following Andrew Lo (2008), we decompose the alphas into static and dynamic components. Specifically, the weight in static portfolio is calculated as the average weight of each country in the monthly long/short portfolio for the whole sample period. The dynamic portfolio is just the difference between the monthly portfolio and the static portfolio.

Figure 28, 29 and 30 show the wealth curve of the dynamic vs static portfolios in developed markets, emerging markets and global. We see that in each market, vast majority of the alphas come from dynamic components.

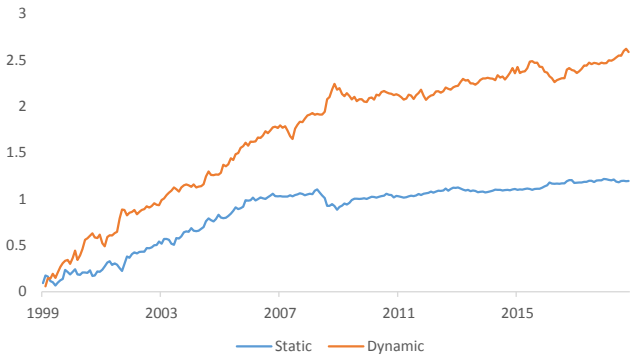
In each market, vast majority of the alphas come from dynamic components.

Figure 28: Dynamic vs Static Return in Developed Markets.



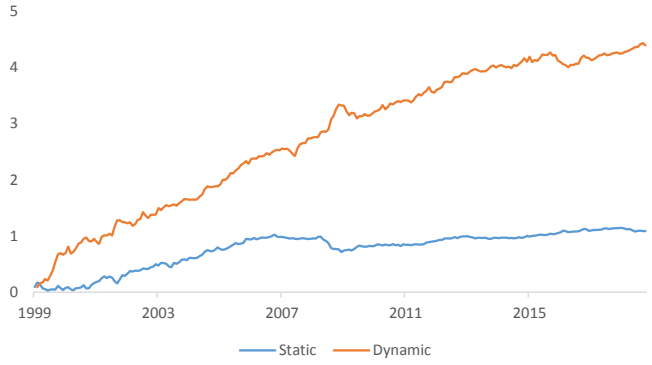
Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 29: Dynamic vs Static Return in Emerging Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 30: Dynamic vs Static Return in Global.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

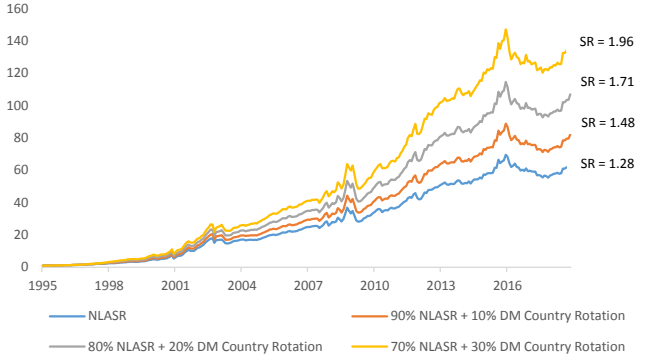
7. Additive of the Country Rotation Model

We examine the diversification benefits associated with adding a country rotation model to our static NLASR stock selection model which uses machine learning algorithm AdaBoost to select factors and instead of assigning dynamic weights takes the average factor weights over the entire sample. We use this model as our proxy for a representative stock selection model.

Figure 31 and 32 show the cumulative return for NLASR and strategies that combine NLASR with country rotation model using different weights in developed markets and emerging markets, respectively. All strategies are levered to have the same ex-post volatility for ease of comparison. In developed markets, the Sharpe ratio increases from 1.28 to 1.96 once we allocate 30% of weight to country rotation strategy and 70% of weight to NLASR. We see the similar performance improvements in emerging markets as well.

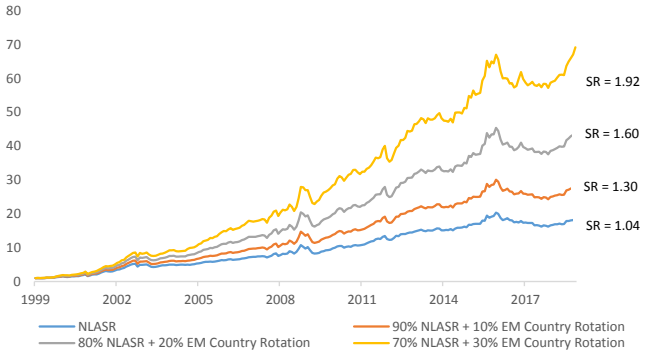
Combining country rotation model and stock selection model may significantly improve the risk-adjusted return.

Figure 31: Combining Country Rotation Model with NLASR in Developed Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

Figure 32: Combining Country Rotation Model with NLASR in Emerging Markets.



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

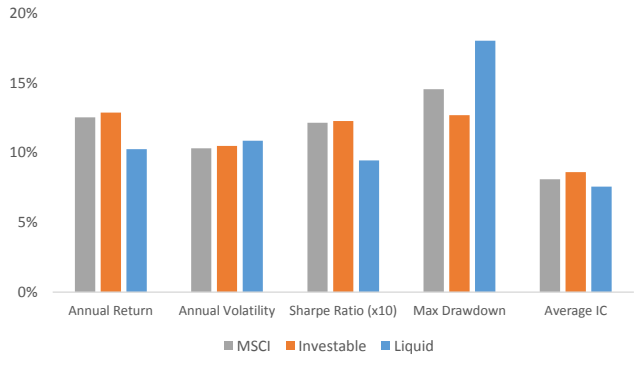
8. Country Rotation Model Implementation

For a global equity portfolio manager, he or she can follow a two-stage process when constructing portfolios. First, our country rotation model can be used to come up with the country allocation, and then a stock selection model can be applied to pick the stocks within each country.

A potentially more cost effective way to implement country rotation involves obtaining long and short exposures using country index futures. All the results we show thus far are based on country universes defined by MSCI. To investigate the practicality of using country index futures, we further define two universes. One is investible universe where we remove countries without tradeable country index futures, another is a liquid universe where we only include countries with liquid country index futures which are defined as those with ADV higher than $150m.[2]

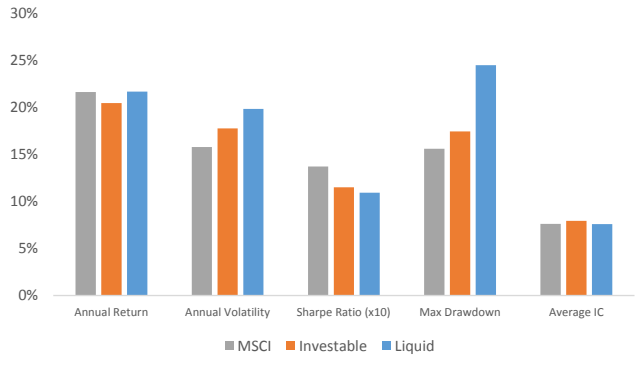
For the first universe consisting of available country index futures, this restriction causes the removal of Ireland and Israel from developed markets and Colombia, Peru, Czech Republic, Egypt, Qatar, UAE, Pakistan, Philippines, Argentina, Jordan, Sri Lanka and Morocco from emerging markets. For the second universe that considers liquidity, the more stringent restriction causes us to remove Austria, Belgium, Denmark, Finland and Portugal from the investible developed markets universe and Mexico, Greece, Hungary and Indonesia from investible emerging markets universe. Figure 33, 34 and 35 show the annualized return, volatility, Sharpe Ratio and average IC for the investible and liquid universes using developed markets, emerging markets and Global country indices.

Figure 33: Comparison of Performance Using Different Universes in Developed Markets (1995 to 2018).



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

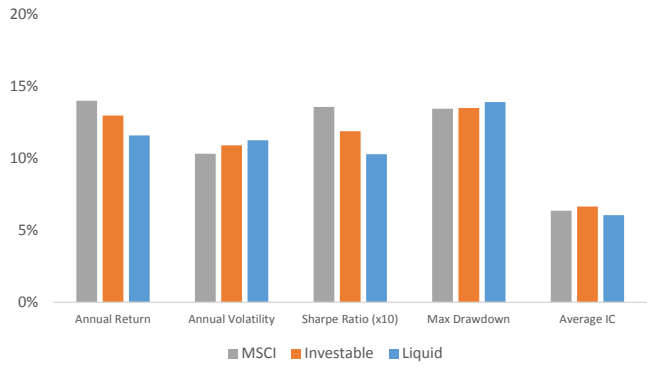
Figure 34: Comparison of Performance Using Different Universes in Emerging Markets (1999 to 2018).



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

2 This number is based on assuming $1b AUM gross exposure ($500m in each side), less than 15% participation in daily ADV and 25% one-way turnover when rebalancing.

Figure 35: Comparison of Performance Using Different Universes in Global (1999 to 2018).



Source : Deutsche Bank Quantitative Equity Strategy, Thomson Reuters, Compustat, S&P, Russell, Bloomberg, Haver Financial

After we restrict the universe to investible and liquid countries, the risk-adjusted performance of the strategy in different markets is generally weaker, but still remain attractive with Sharpe Ratio ranging from 0.9 to 1.2. In developed markets, the investible universe actually has higher annualized return and Sharpe Ratio than larger MSCI universe. Notably, the average IC which is a better comparison measure across different universes remains stable in both developed markets and emerging markets. On the other hand, we see that the drawdown increases for liquid countries since there are fewer countries in long and short baskets and we are taking more concentrated positions.

After we restrict the universe to investible and liquid countries, the average IC which is a better comparison measure across different universes remains stable in both developed markets and emerging markets.

9. Conclusion

In this report, we examine how macro-related data can be used with efficient portfolio construction to create a country rotation strategy capable of generating high, uncorrelated risk-adjusted returns. Investors tend to underreact to the new information that is correlated with the future economic growth expectations and have a preference against investing in riskier countries. We find that signals that capture the innovation or surprises in the macro-economic environment or reflect the level of various country risks are effective in explaining country equity returns.

We present a new country rotation model that mainly captures the differences in country-specific macroeconomic characteristics instead of simple aggregating stock level information that are used by conventional country timing models. Our model generates high risk-adjusted performance (Sharpe Ratio of 1.2, 1.4 and 1.4 for developed markets, emerging markets and Global, respectively) that is fairly robust to investible and liquid country index future constraints. Among a global universe of about 20 liquid countries, the model generates a Sharpe Ratio of about 1.0 with 12% annualized return.

Our model generates high risk-adjusted performance which is fairly robust to investible and liquid country index future constraints.

Bibliography

Forbes, William, Huijgen, Carel and Plantinga, Auke, Using Analysts' Earnings Forecasts for Country/Industry-Based Asset Allocation (June 2004). Available at SSRN: https://ssrn.com/abstract=567121

Zaremba, Adam, Combining Equity Country Selection Strategies (July 10, 2015). Available at SSRN: https://ssrn.com/abstract=2616056 or http://dx.doi.org/10.2139/ssrn.2616056

Zaremba, Adam, Country Selection Strategies Based on Value, Size and Momentum (December 12, 2014). Investment Analyst Journal, 44(3), 171-198

Gregg Fisher, Ronnie Shah and Sheridan Titman, Should You Tilt Your Equity Portfolio to Smaller Countries? The Journal of Portfolio Management Fall 2017, 44(1) 127-141

Desrosiers, Stéphanie and Lemaire, Natacha and L'Her, Jean-Francois, Residual Income Approach to Equity Country Selection. Financial Analysts Journal, Vol. 63, No. 2, pp. 76-89, 2007.

Zaremba, Adam and Szczygielski, Jan, And the Winner Is…A Comparison of Valuation Measures for Country Asset Allocation (January 31, 2018). Journal of Portfolio Management, Forthcoming. Available at SSRN: https://ssrn.com/abstract=3114803

Blitz, David and van Vliet, Pim, Global Tactical Cross-Asset Allocation: Applying Value and Momentum Across Asset Classes (2008). Journal of Portfolio Management, pp. 23-28, Fall 2008

Rizova, Savina, Predictable Trade Flows and Returns of Trade-Linked Countries (March 2, 2010). AFA 2011 Denver Meetings Paper. Available at SSRN: https://ssrn.com/abstract=1562697

Huijgen, Carel A. and Plantinga, Auke, Analysts' Earnings Forecasts and International Asset Allocation (August 1999). Available at SSRN: https://ssrn.com/abstract=174168

Bali, Turan G. and Peng, Lin and Shen, Yannan and Tang, Yi, Liquidity Shocks and Stock Market Reactions (August 23, 2013). Fordham University Schools of Business Research Paper No. 2020476

Eiling, Esther and Gerard, Bruno, Emerging Equity Market Comovements: Trends and Macro-Economic Fundamentals (July 10, 2014). Forthcoming in the Review of Finance

Tavares da Luz Soares, João Vasco and Cardoso, David, Inefficiency in Macroeconomic News Forecasts: Effects on Asset Prices and Asset Allocation Rules (December 1, 2011). Available at SSRN: https://ssrn.com/abstract=2076074

Jiang, Christine X. and Jordan, Steven J. and Parikh, Bhavik, Macroeconomic Uncertainty, Risk, and Country Index Returns: International Evidence (January 14,

2013). Midwest Finance Association 2013 Annual Meeting Paper. Available at SSRN: https://ssrn.com/abstract=2140026

Davis, Joseph H. and Aliaga-Diaz, Roger A, Oil, the Economy, and the Stock Market (April 2008). Available at SSRN: https://ssrn.com/abstract=1136524

Flannery, Mark Jeffrey and Protopapadakis, Aris, Macroeconomic Factors Do Influence Aggregate Stock Returns. Available at SSRN: https://ssrn.com/abstract=314261

Lucey, Brian M. and Nejadmalayeri, Ali and Singh, Manohar, Impact of US Macroeconomic Surprises on Stock Market Returns in Developed Economies (January 2008). Available at SSRN: https://ssrn.com/abstract=1083656

Miguel-A Alvarez, Yin Luo, Rochester Cahan, Javed Jussa, Zongye Chend and Sheng Wang, Correlation & Consequences, Deutsche Bank Quantitative Strategy (2012)

Osiok, James, Spyros Mesomeric, Paul Ward, Andy Moniz, Jacopo Capra, Aris Tentes, Caio Natividade, Vivek Anand. "Linear Signal Blending", Deutsche Bank Quantitative Strategy (2017)

Yin Luo, Rochester Cahan, Miguel Alvarez, Javed Jussa and Zongye Chen. "Tail Risk in Optimal Signal Weighting", Deutsche Bank Quantitative Strategy (2011)

Shomesh Chaudhuri and Andrew Lo. Dynamic Alpha: A spectral Decomposition of Investment Performance Across Time Horizons. Management Science (October 2018). Available at https://doi.org/10.1287/mnsc.2018.3102

Steve Chen, Ronnie Shah, George Zhao, David Elledge, Alex Chao "Navigating Through Rising Interest Rates: Impact for Quant Strategies", Deutsche Bank Quantitative Strategy (2018)

Scott Baker, Nicholas Bloom, Steven David, Measuring Economic Policy Uncertainty. The Quarterly Journal Economics, Volume 131, Issue 4, November 2016, Pages 1593- 1636

Narasimhan Jegadeesh, Sheridan Titman Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. The Journal of Finance, March 1993

Amihud, Hameed, Kang, Zhang. The Illiquidity Premium: International Evidence. Journal of Financial Economics Vol. 117, Issue 2, August 2015, Pages 350-368

Fama, Eugene F. and Kenneth R. French. "Common Risk Factors in the Returns on Stocks and Bonds" The Journal of Financial Economics 33.1 (1993): 3-56

Lakonishok, Josef, Andrei Shleifer and Robert W. Vishny. "Contrarian Investment, Extrapolation, and Risk" The Journal of Finance 49.5 (1994): 1541-1578

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