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Why have emerging markets become less risky than developed markets?

The great risk conundrum of 2022 – 2023

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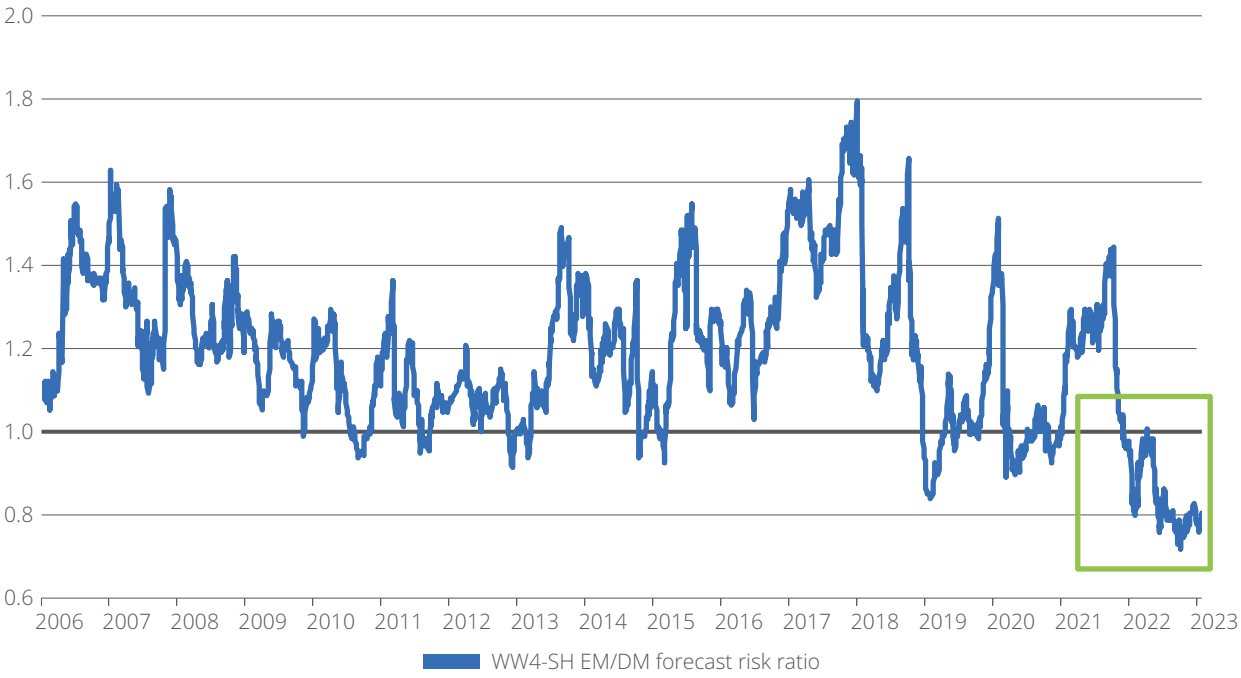
1. Introduction

Qontigo's Applied Research team has tracked the ratio of the STOXX® Emerging Markets 1500 Index (also "Emerging Markets 1500", "EM 1500", or "EM") versus the STOXX® Global 1800 Index (also "Global 1800", "Developed Markets" or "DM") risk for many years as part of our Quarterly Risk Review series. Throughout 2022 and into 2023, the Emerging Markets 1500 has shown lower forecast and realized volatility versus the Global 1800. Although the ratio has inverted for a few days or weeks from time to time, this is the longest sustained inversion we have seen in our data extending back to 2006. The key findings of our analysis are as follows:

- EM risk has been lower than DM risk for all of 2022 and into 2023.
- This phenomenon only exists at the index level: On average, EM countries exhibit higher volatility than DM countries.
- The inversion of the risk ratio is therefore driven by the relative diversification properties of the two indices.
- We used the Axioma Worldwide Equity model and *x-sigma-rho* risk decomposition to disentangle the effects of factor covariance on each of the indices and pinpoint the systematic risk factors that are driving the inversion.
- The concentration in the Developed Markets index is unprecedented and its largest constituents have been the most volatile of late, upending normal expectations of market beta for both DM and EM stocks.

From 2006 to the end of 2021, the median EM to DM risk ratio was 1.19; for the period since January 2022, it has been 0.82.

Figure 1: Ratio of Emerging Markets 1500 to Global 1800 short horizon risk.



Source: Qontigo.

This is somewhat counterintuitive given the recent tumult on the global equity markets, particularly as the US dollar has strengthened considerably against most other currencies. Dollar strength usually leads to stress in developing country economies, primarily as a result of their external financing, and in such situations emerging market risk spreads typically widen in the same way as high-yield bonds do in comparison to investment grade ones. This can be seen in the chart above in 2008–2009, 2011, 2013, 2015, 2018 and 2020. One explanation for the current conundrum is that most emerging markets are commodity exporters; as a result, the inflation-driven volatility increases currently affecting developed economies are not impacting these emerging economies as much. Since inflation already runs higher in EM economies, the shock to equity valuations is less pronounced. However, while this theory may be intuitively compelling, it does not fit the data on individual country volatilities, which are higher across the board for emerging markets. **This relative volatility conundrum only exists at the index level, which implies that there is a significant difference in the diversification of the two indices**.

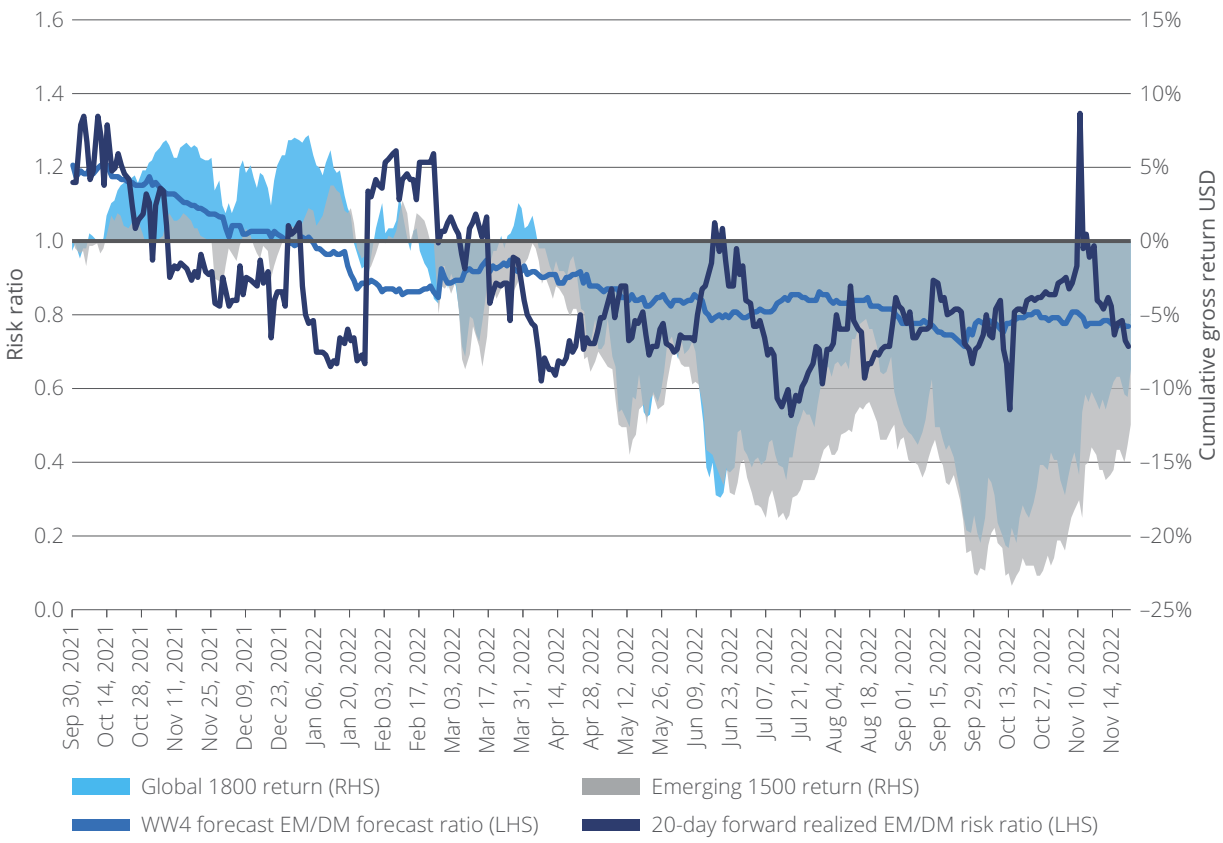
We used the Axioma Worldwide Equity Factor Short-Horizon Risk Model (WW4-SH) to examine the risk decomposition of the Emerging Markets 1500 and Global 1800. In the process, we discovered that the unprecedented concentration of US-based mega-cap technology and consumer discretionary companies in the DM index is causing a lack of diversification relative to the Emerging Markets 1500. The drawdowns in these companies have generally been larger than overall global market drawdowns, forcing their beta exposures to flip from low beta to high beta. This has extremely interesting implications for risk analysis worldwide.

We used WW4-SH – a generalized model over all global equity markets – for simplicity, since it enabled us to compare the analytics on both indices using the same set of factors. However, the EM/DM inversion persists even if we use the more granular Axioma Worldwide Equity Linked Factor Risk Model (WWLM4), which uses separate submodels for the United States, Developed Markets ex-US and Emerging Markets, and then links their factors together in the covariance matrix.

2. EM/DM risk ratio since September 2021

We started with a "close-up" of a relatively recent period for the EM/DM risk ratio and compared this with the realized 20-day forward ratios of EM to DM volatility for the same dates. We also plotted the index returns on the right-hand axis.

Figure 2: Forecast EM/DM ratio vs. 20-day forward realized EM/DM volatility and index returns.



Source: Qontigo.

This chart shows that the WW4-SH risk forecasts are fairly accurate at the one-month horizon and that the EM index drawdown was more severe overall in this period, despite having lower forecast and realized volatility. This confounds the typical understanding of EM/DM risk even more.

We used three dates in our comparative analysis of the index risk decompositions:

– The starting point of September 30, 2021, when the ratio was "normal" at ~1.2:1
– November 30, 2021, when it was almost exactly 1:1, and
– November 30, 2022 – the most recent measurement – when it was 0.8:1

Figure 3: WWH-SH risk forecasts and EM/DM ratio.

Source: Qontigo.

3. A bit of risk model math

A risk model is a very useful tool for understanding common sources of risk in different portfolios. Generally, there are four components of concern in such models:

1) The *exposures* or loadings of assets on factors
2) The *return variance* of the factors
3) The *covariance* of the factors with one another and
4) The *stock-specific variances*

We will not concern ourselves with the fourth component here since we are dealing with broad-based index portfolios in this analysis. Instead, we will concentrate on components 1–3, and particularly on the combination of 2 and 3 – the factor covariance matrix.

The factor covariance matrix for the WW4 model is a 249 × 249 square matrix containing 6 blocks of factors: Global Market Intercept (M), Style factors (S), Industry factors (Ind), Domestic China (DC), Country factors (Co), and Currency factors (FX):

Figure 4: WW4-SH factor block covariance matrix.

M	M,S	M,Ind	M,DC	M,Co	M,FX
S,M	**S**	S,Ind	S,DC	S,Co	S,FX
Ind,M	Ind,S	**Ind**	Ind,DC	Ind,Co	Ind,FX
DC,M	DC,S	DC,Ind	**DC**	DC,Co	DC,FX
Co,M	Co,S	Co,Ind	Co,DC	**Co**	Co,FX
FX,M	FX,S	FX,Ind	FX,DC	FX,Co	**FX**

Source: Qontigo.

In Axioma's models, Industry and Country factor returns are net of the Global Market Intercept return. In other words, these factors capture the active return and risk of industries and countries relative to the Global Market.

The non-colored, off-diagonal blocks contain the covariances of the factor group in the column and the factor group in the row, and are labeled using a combination of the row and column names in the block.

Each of the green factor blocks along the diagonal of the matrix represents a subcomponent of the matrix, with the subcomponent diagonals containing the variances of the individual factors in the group and the covariances of each factor in the group in the off-diagonal. For example, the "S" block contains a 13×13 submatrix of the Style factors in the model – the variances of the individual factors such as Size and Value plus the covariance between Size and Value in the off-diagonal elements.

Portfolio exposures to risk factors by themselves aren't informative: One needs to understand the risk impact of the exposures. Exposures of similar magnitude may have very different risk contributions if the factors themselves exhibit dissimilar volatilities. Multiplying the vector **X** of portfolio exposures to factors by the factor covariance matrix produces a single number representing the total factor risk for the portfolio:

Equation 1: Total factor risk.

$$\sigma_{factor} = \sqrt{X'\Omega X}$$

Where:
X = vector of portfolio exposures to factors
Ω = Factor covariance matrix
X' = transpose vector X

Adding the vector of constituent weights multiplied by the stock-specific variance matrix to the quantity under the radical above produces the **total risk**.

Figure 5: Total risk and factor risk as of Nov 30, 2022.

Nov 30, 2022	Total risk	Total factor
Global 1800	24.07	24.01
Emerging 1500	19.09	18.96

Source: Qontigo.

The "Total factor" column in Figure 5 uses Equation 1 to compute the factor risk. As one would expect in broad indices with well over 1,000 stocks, the factors account for nearly all of the risk.

The most basic way of understanding factor contributions to risk is to multiply the squared exposure of the portfolio and the factor variance, and then take the square root:

Equation 2: Standalone factor contribution.

$$Factor\ contribution\ = \sqrt{\left(x^2\sigma_f^2\right)}$$

This is equivalent to replacing all the off-diagonal elements of the covariance matrix with zeros, as if the factors were unrelated.

This formulation of the contribution can help us understand the standalone risk impact of each factor by taking its volatility and our linear sensitivity (exposure) to that volatility. However, it doesn't consider the covariance of the factors with the other factors acting on our portfolio. For example, on November 30, 2022, both the EM and the DM indices had 100% (unit) exposure to the Global Market factor, by far the most important factor in the WW4 risk model. From the formula above, we get the following:

Figure 6: he Global Market factor's contribution to risk (factor volatility = 20.18).

Nov 30, 2022	Global 1800	Emerging 1500
Exposure	1	1
Contribution	20.18	20.18

Source: Qontigo.

Same factor, same exposure, same risk contribution. Intuitively, this makes sense but it should be noted that the contribution of 20.18% of the Global Market factor for the EM index is higher than the total risk of 19.09%. This means that some other factor has a negative risk contribution. However, a look back at Equation 2 above makes it clear that, since both the exposures and factor volatilities are squared, all risk contributions will be positive. Therefore, the risk reduction must be attributable to diversification amongst the 249 factors in the model. This is the key to understanding why Emerging Markets 1500 risk has been lower than Developed Markets risk all this time.

Factor block decomposition

We can use Equation 1 on each of the factor blocks separately to compute the risk from each group of factors and then sum them up. However, the sum of the parts will not be equal to the total factor risk in the portfolio, because computing the risk from each block separately takes into account only the covariance between the factors in the block, not the inter-block covariance. The difference between the total factor risk and the sum of the blocks represents the **inter-block covariance** contribution.

Figure 7: Factor block risk decomposition.

September 30, 2021			November 30, 2021			November 30, 2022		
Factor block	Global 1800	Emerging 1500	Factor block	Global 1800	Emerging 1500	Factor block	Global 1800	Emerging 1500
Global Market	9.60	9.60	Global Market	11.42	11.42	Global Market	20.18	20.18
Style risk	1.35	1.19	Style risk	1.29	1.22	Style risk	1.01	4.25
Industry risk	0.42	2.28	Industry risk	0.63	2.13	Industry risk	0.49	2.08
Country risk	1.86	7.66	Country risk	2.10	7.55	Country risk	2.53	10.38
Currency risk	1.67	3.64	Currency risk	1.54	3.06	Currency risk	3.19	5.53
Domestic China	0.00	0.02	Domestic China	0.00	0.02	Domestic China	0.00	0.03
Sum of blocks	**10.02**	**13.07**	**Sum of blocks**	**11.80**	**14.24**	**Sum of blocks**	**20.61**	**23.83**
Total factor (X'ΩX)^0.5	**10.60**	**12.24**	**Total factor (X'ΩX)^0.5**	**12.36**	**12.65**	**Total factor (X'ΩX)^0.5**	**24.01**	**18.96**
Covariance contribution	**0.58**	**–0.83**	**Covariance contribution**	**0.56**	**–1.59**	**Covariance contribution**	**3.40**	**–4.87**
Total risk	**10.68**	**12.51**	**Total risk**	**12.48**	**12.92**	**Total risk**	**24.07**	**19.09**

Source: Qontigo.

From these tables, a few patterns are immediately apparent:

1) The covariance contribution for the Global 1800 is always additive, while for the Emerging Markets 1500 it is always diversifying
2) The degree of concentration (diversification) from the interaction of factors increases over the period, particularly from November 2021 to November 2022
3) EM risk in each of the factor blocks is roughly equal to or greater than that for the corresponding DM block in every period, in most cases by orders of magnitude

The factor block level analytics confirm most investors' intuition about emerging markets risk relative to that for developed markets: the countries are riskier, there is less industry diversification in emerging markets and their currencies are more volatile (even though developed market currencies are more volatile now than they have been in decades). So how is it that the Emerging Markets 1500 is less volatile than its Developed Markets counterpart?

4. A few empirical notes on concentration

While both indices have well over 1,000 constituents, they are not necessarily that "diversified" in their allocations. We can get a sense of this by looking at the effective number of industries and countries in each index. This is arrived at using the inverse of the Herfindahl index[1] for the sum of the country and industry allocations involved.

Figure 8: Inverse Herfindahl index for the sum of the country and industry allocations.

Index	Actual number of countries	Effective number of countries	Actual number of industries	Effective number of industries
EM 1500	22[2]	6	65	**17**
DM 1800	28	**2**	68	32

Source: Qontigo.

With respect to industries, the top five allocations as a percentage of market capitalization are 44.6% for the Emerging Markets 1500 and 28.2% for the Developed Markets. With respect to country allocations, the top five allocations are 77.5% for the Emerging Markets 1500 and 84.3% for the Developed Markets. Within that 84% at the top of the Global 1800, almost 66% is allocated to the United States, driving down the effective number of countries to just two.

5. Analyzing covariance

To comprehend how the Emerging Markets 1500 – an index allocated to riskier countries and currencies, concentrated in riskier industries and with more extreme style exposures – could have lower total risk than its "safer" Developed Markets counterpart, we needed to dive into both the portfolio exposures and the covariance of the factor returns. We did this using another method of risk decomposition, sometimes known as *x-sigma-rho* because it breaks down factor risk contributions into three parts:

- The exposure (*x*)
- The factor volatility (*sigma*) and
- The factor correlation to the portfolio (*rho*)

X-sigma-rho utilizes marginal contribution to total risk (MCTR) as a building block in a bottom-up decomposition of risk along the dimensions of the linear factor model. MCTR has two key properties that can enhance risk decomposition:

1) When weighted by exposure or allocation, the sum of the MCTRs over all the factors equals the total factor risk of the portfolio and

2) MCTR is the covariance of each risk factor with the rest of the portfolio, and has two components:
   a) The factor's volatility and
   b) The factor's correlation with the portfolio

[1] The inverse of the Herfindahl index is computed as 1/(sum of squared market cap allocation percentages).

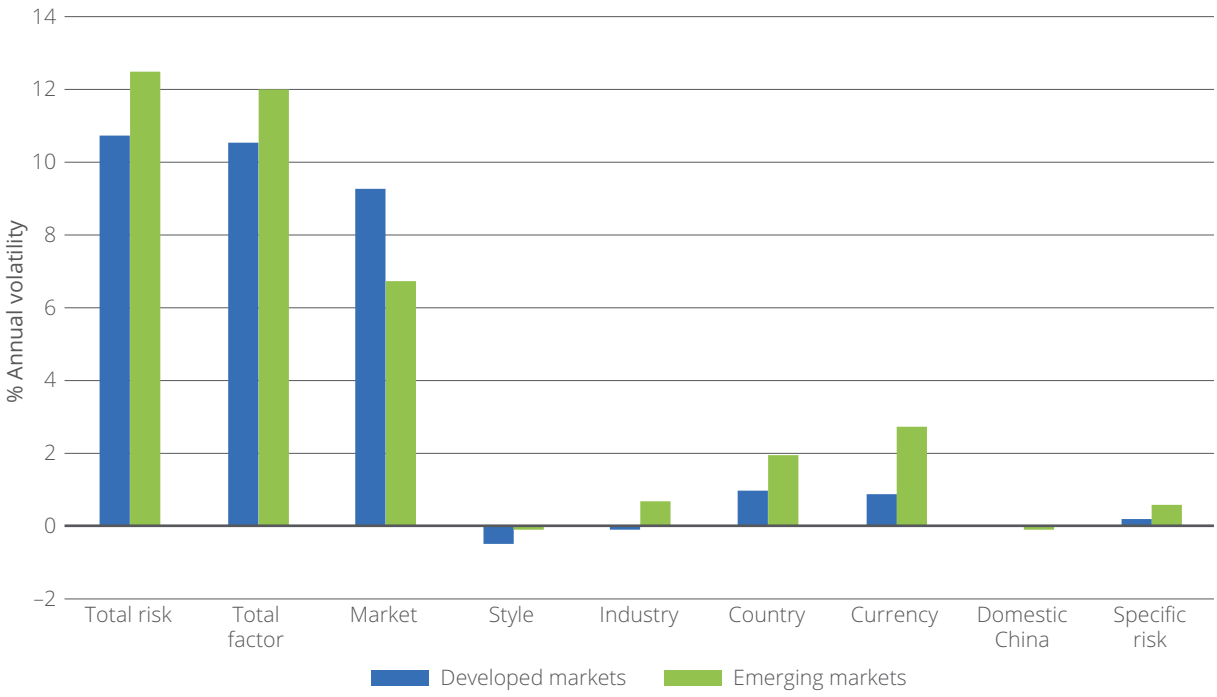
[2] The EM 1500 originally contained 23 countries, but Russia was removed on March 18, 2022.

When combined with the exposure (*x*), we arrive at an additive risk contribution from each factor that explains not only how sensitive the portfolio is to the factor volatility (*sigma*), but also how this is mitigated by the factor's correlation (*rho*) with the portfolio. In this framework, risk contributions can be positive or negative, and we can see how the factor interactions reduce, or in some cases increase, risk in each of these indices. For a more complete derivation of MCTR and *x-sigma-rho*, please see the appendix.

6. "Normal" EM/DM ratio as of September 30, 2021

Using the *x-sigma-rho* framework at the factor group level, we arrived at the following risk decompositions for September 30, 2021:

Figure 9: The *x-sigma-rho* framework at the factor group level as of Sep 30, 2021.



Source: Qontigo.

On this date, we can see how things "normally" look when comparing the EM and DM indices. The EM total risk is higher, and the components coming from the Style, Industry, Country, Currency, and even specific risk are higher. However, Global Market risk is lower. As mentioned earlier, both portfolios have 100% exposure to the Global Market factor (i.e., they are both fully invested at all times). Since this is the case, how can the Global Market factor risk contribution be so much lower for the EM index?

Figure 10: Global Market factor risk contribution as of Sep 30, 2021.

Factor	Factor vol	Global 1800 MTCR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Global Market	9.60	9.29	1	**0.97**	**9.29**	6.73	1	**0.70**	**6.73**

Source: Qontigo.

The Global Market factor is the return of the WW4 model's estimation universe; this contains both developed and emerging markets stocks but is dominated by developed markets constituents, particularly from the United States. It is understandable that the correlation of the DM index would be nearly 1. It is also understandable that the correlation of the EM index would be high, but not nearly as high as the DM index. Due to the significantly lower correlation with the Global Market factor, the contribution to EM risk is 257 basis points (bps) lower. However, the EM index more than makes up for the shortfall here with incremental risk from Countries, Industries, Currencies and Styles.

Three key Style factors that differentiate these indices at this point in time are Market Sensitivity, which measures the relative beta exposures to the global market portfolio; Volatility, which measures relative levels of residual risk; and Size, which is the natural log of company market capitalization.

Figure 11: Partial Style exposure comparison as of Sep 30, 2021.

Factor	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Market Sensitivity	4.26	0.64	2.40	**–0.05**	0.56	**–0.11**	1.93	**0.04**	0.45	**0.08**
Volatility	5.31	0.62	2.76	**–0.20**	0.52	**–0.55**	2.25	**0.10**	0.42	**0.22**
Size	3.38	0.22	0.77	**0.18**	0.23	**0.14**	0.61	**–0.17**	0.18	**–0.10**

Source: Qontigo.

For Market Sensitivity and Volatility, we see the DM index has negative exposures while the EM index has positive exposures, which is what would be expected. EM stocks are usually considered "high beta" and generally have higher volatility than DM stocks. The Size exposure of the DM index gives some indication of how top-heavy it is in mega-cap US tech names, which at that point in time were less risky than the overall market. Conversely the EM index, despite a few mega-cap names, has negative exposure to Size and is composed of much smaller stocks. Note that in the case of Market Sensitivity, both indices have an exposure that is very close to zero, although in one case it is positive and in one negative. This indicates that neither index is heavily influenced by betas very different from 1. With all three factors, the difference in risk contribution is driven mainly driven by exposure; the factor correlations to the respective indices are relatively similar, although they are lower in all cases for the EM index.

In the aggregate, the Market Sensitivity and Volatility exposures explain a difference in total risk of almost 100 basis points (out of a total difference of 183 bps). The Size factor is additive in DM and diversifying in EM at this point, and the factor correlation with both portfolios is comparatively low. In addition to the factor correlations with the indices, we can derive the correlation of each factor with the main source of risk in each index – the Global Market factor itself. Factors with high correlations to the Market factor such as Market Sensitivity and Volatility, will provide substantial levels of diversification when the portfolio in question has negative exposures, but far less when the exposures are positive.

Comparative country factor risk: A "normal" EM/DM ratio

As shown in the comparative risk decomposition chart above, much of the incremental risk of the EM index comes from countries and currencies. Looking at Country factor risk contributions side by side for September 30, 2021 gives us some insight into how the allocations in each index contribute to risk.

Figure 12: Country factor risk contributions as of Sep 30, 2021.

Factor	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution
United States	4.04	0.38	1.86	64.52%	0.46	1.20
Japan	10.04	–0.12	–1.35	8.52%	–0.13	–0.12
United Kingdom	5.60	–0.16	–0.70	4.52%	–0.13	–0.03
France	5.17	0.01	0.04	3.34%	0.01	0.00
Germany	6.26	–0.05	–0.27	2.89%	–0.04	–0.01
Canada	4.46	–0.18	–0.81	2.83%	–0.18	–0.02
Switzerland	5.76	–0.01	–0.20	2.81%	–0.03	–0.01
Australia	8.15	–0.35	–2.92	2.30%	–0.36	–0.07
Netherlands	5.47	0.03	0.09	1.61%	0.02	0.00
Sweden	9.18	–0.06	–0.30	1.25%	–0.03	0.00
Hong Kong	11.85	–0.16	–2.70	0.85%	–0.23	–0.02
Denmark	8.78	0.04	0.39	0.77%	0.04	0.00
Spain	7.64	–0.09	–0.56	0.73%	–0.07	0.00
Italy	7.17	–0.01	0.03	0.70%	0.00	0.00
Finland	9.64	0.06	0.57	0.35%	0.06	0.00
Singapore	8.75	–0.03	–0.97	0.35%	–0.11	0.00
China	19.00	–0.11	–4.02	0.33%	–0.21	–0.01
Belgium	6.09	–0.08	–0.51	0.28%	–0.08	0.00
Ireland	8.77	–0.03	–0.01	0.24%	0.00	0.00
Norway	8.07	–0.21	–1.87	0.24%	–0.23	0.00
New Zealand	8.26	–0.27	–2.60	0.11%	–0.31	0.00
				Total country risk		**0.90**

Factor	Factor vol	Correlation to Global Market factor	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
India	13.12	–0.31	1.94	22.98%	0.15	0.45
Taiwan	15.43	–0.16	4.32	20.45%	0.28	0.88
Korea, Republic of	12.25	–0.23	2.36	17.39%	0.19	0.41
China	19.00	–0.11	3.21	10.27%	0.17	0.33
Brazil	15.21	–0.17	0.36	5.89%	0.02	0.02
Russian Federation	7.39	–0.33	–1.35	5.31%	–0.18	–0.07
South Africa	13.30	–0.28	–0.62	3.41%	–0.05	–0.02
Thailand	12.41	–0.30	–0.12	3.32%	–0.01	0.00
Mexico	7.80	–0.43	–0.98	2.34%	–0.13	–0.02
Indonesia	16.44	–0.32	–0.02	1.79%	0.00	0.00
Malaysia	8.91	–0.34	–0.96	1.75%	–0.11	–0.02
Philippines	16.66	–0.22	1.40	1.36%	0.08	0.02
Vietnam	19.50	–0.19	–0.09	1.13%	0.00	0.00
Chile	19.14	–0.18	–1.01	0.63%	–0.05	–0.01
Turkey	16.99	–0.30	–3.14	0.44%	–0.18	–0.01
Hungary	9.89	–0.31	–1.44	0.33%	–0.15	0.00
Greece	13.20	–0.07	–0.10	0.32%	–0.01	0.00
Colombia	15.37	–0.26	–1.64	0.30%	–0.11	0.00
Hong Kong	11.85	–0.16	2.54	0.22%	0.21	0.01
Czech Republic	9.84	0.03	1.61	0.15%	0.16	0.00
Egypt	16.38	–0.22	–1.24	0.10%	–0.08	0.00
				Total country risk		**1.95**

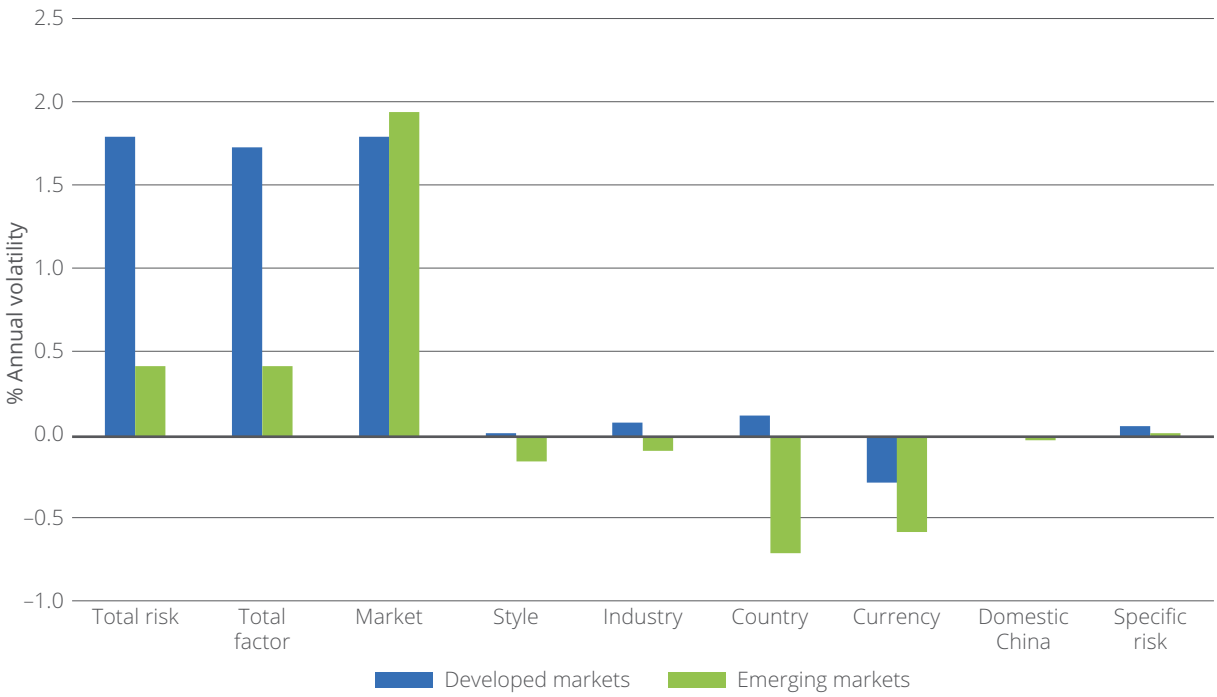
Source: Qontigo.

When comparing the two tables, two features immediately become clear. First, the Country factor volatilities for EM countries, especially in the top five allocations, are much higher than the corresponding top five for the DM index. Next, 134% of the total country risk for the Global 1800 comes from the United States, which accounts for 65% of the index market cap. In fact, the second-largest allocation – to Japan – *reduces* portfolio risk by 12 basis points, and all other countries beneath that also reduce risk. The MCTRs of all countries other than the USA are negative, meaning that increasing exposure to any other country would actually *reduce* the risk of the index. This suggests that there is lots of diversification available, but the passive market cap weighting of the index disallows it. The concentration of the Global 1800 in the USA has an outsize impact on the subsequent increase in risk, and the lack of diversification is the main reason why DM risk has remained elevated relative to the inherently riskier EM index.

7. EM/DM ratio of 1:1 as of November 30, 2021

The two months from the end of September to the beginning of December 2021 saw a substantial increase in global equity market risk. Global Market factor volatility increased by 19% – from 9.60% to 11.42% – during that period. Overall, the changes in risk in the two indices can be broken down as follows:

Figure 13: Changes in risk composition, Sep 30, 2021 – Nov 30, 2021.



Source: Qontigo.

As expected, the Global Market factor drove the majority of the increase for both indices, but not in the same way. While the correlation of the DM index remained constant at ~0.97, the EM index correlation increased by 7 bps to 0.77.

Figure 14: Global Market factor risk contribution as of Nov 30, 2021.

Factor	Factor vol	Global 1800 MTCR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Global Market	11.42	11.10	1	**0.97**	**11.10**	8.67	1	**0.77**	**8.67**
	+182			**Unchanged**	**+180**	**+200**		**+0.07**	**+194**

Source: Qontigo.

At the same time, the risk contributions from EM countries declined, whereas they rose from DM countries:

Figure 15: EM Country factor risk contributions as of Nov 30, 2021

Factor	Factor vol	Correlation to Global Market factor	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution	Change in exposure	Change in volatility	Change in correlation to EM 1500	Change in risk contribution
Taiwan	**12.14**	**–0.22**	**1.89**	**21.78%**	**0.16**	**0.41**	**1.33%**	**–3.29**	**–0.13**	**–0.47**
China	**16.85**	**–0.15**	**2.20**	**10.29%**	**0.13**	**0.23**	**0.03%**	**–2.14**	**–0.04**	**–0.10**
India	**14.06**	**–0.27**	**1.63**	**22.85%**	**0.12**	**0.37**	**–0.13%**	**0.95**	**–0.03**	**–0.07**
Brazil	**18.64**	**–0.21**	**–0.28**	**5.24%**	**–0.01**	**–0.01**	**–0.64%**	**3.44**	**–0.04**	**–0.04**
South Africa	12.34	–0.35	–1.50	3.39%	–0.12	–0.05	–0.02%	–0.97	–0.07	–0.03
Philippines	12.96	–0.28	–0.06	1.48%	0.00	0.00	0.11%	–3.70	–0.09	–0.02
Mexico	8.32	–0.50	–1.90	2.26%	–0.23	–0.04	–0.08%	0.52	–0.10	–0.02
Chile	32.48	–0.25	–4.28	0.61%	–0.13	–0.03	–0.02%	13.34	–0.08	–0.02
Vietnam	16.96	–0.26	–1.59	1.26%	–0.09	–0.02	0.13%	–2.54	–0.09	–0.02
Turkey	24.12	–0.43	–6.84	0.39%	–0.28	–0.03	–0.04%	7.13	–0.10	–0.01
Thailand	12.64	–0.30	–0.44	3.37%	–0.04	–0.01	0.05%	0.23	–0.03	–0.01
Indonesia	14.94	–0.31	–0.37	1.92%	–0.02	–0.01	0.13%	–1.49	–0.02	–0.01
Hungary	12.26	–0.45	–3.34	0.32%	–0.27	–0.01	–0.01%	2.37	–0.13	–0.01
Malaysia	11.02	–0.36	–1.23	1.79%	–0.11	–0.02	0.04%	2.10	0.00	–0.01
Colombia	16.43	–0.37	–3.30	0.30%	–0.20	–0.01	0.00%	1.06	–0.09	–0.01
Egypt	21.45	–0.37	–3.99	0.12%	–0.19	0.00	0.02%	5.07	–0.11	0.00
Czech Republic	11.23	–0.14	–0.04	0.15%	0.00	0.00	0.00%	1.38	–0.17	0.00
Hong Kong	10.31	–0.14	1.83	0.23%	0.18	0.00	0.01%	–1.54	–0.04	0.00
Greece	12.71	–0.08	0.22	0.34%	0.02	0.00	0.01%	–0.49	0.02	0.00
Russian Federation	10.66	–0.25	–1.25	5.04%	–0.12	–0.06	–0.27%	3.27	0.07	0.01
Korea, Republic of	**15.27**	**–0.15**	**3.28**	**16.76%**	**0.21**	**0.55**	**–0.63%**	**3.03**	**0.02**	**0.14**
			Total country factor contribution: 1.25				**Change in contribution:**			**–0.70**

Source: Qontigo.

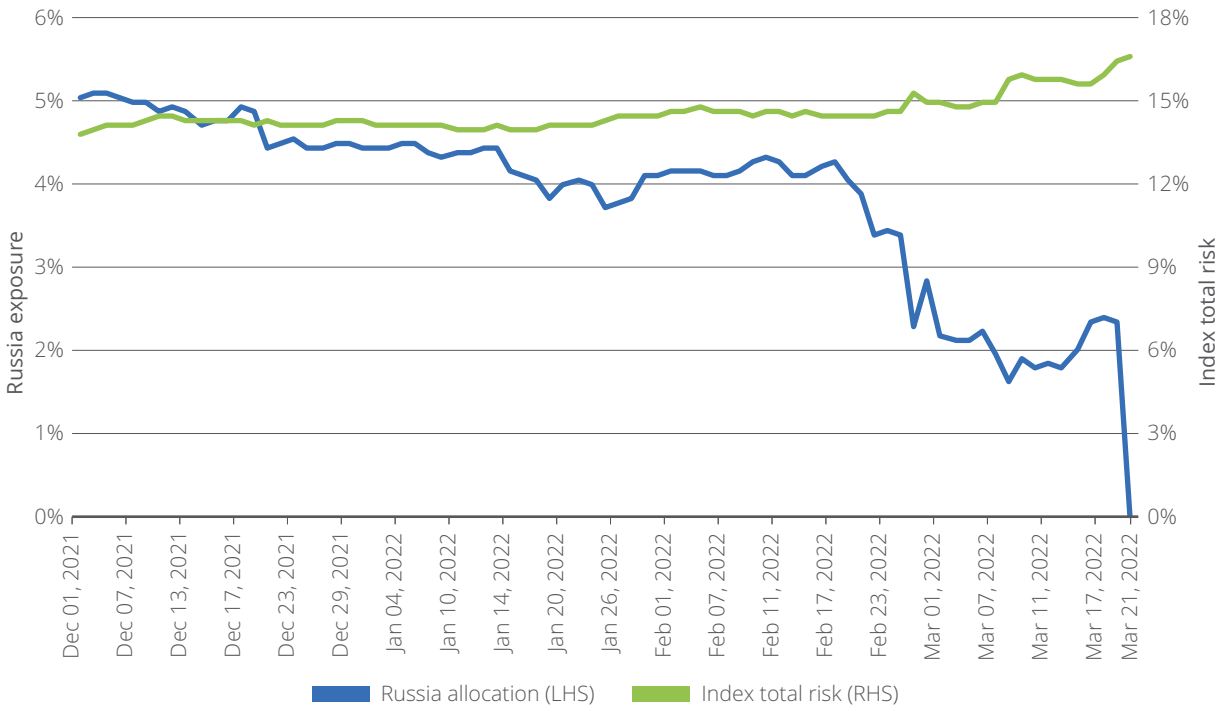
All of the major country allocations in the EM index (except Korea) saw their correlations to both the Global Market factor and the EM index itself decrease. This increased the amount of diversification they provide, offsetting the overall increase in risk by 70 bps. In the Global 1800 index, a 183 bps increase in allocation to the United States due to strong relative performance and a concomitant 37 bps increase in the US Country factor risk contributed 8 bps out of a total 12 bps increase in Country factor risk.

Over the two-month span examined, the EM 1500 also went from an exposure of +0.1 to the Volatility factor to an exposure of –0.05. The corresponding change in the contribution to total risk went from +21.5 bps to –9 bps, resulting in a swing in the risk contribution of –30 bps. As the EM index became more correlated overall with the Global Market factor, the residual returns of its constituents, and hence the exposure to Volatility, decreased. The exact opposite occurred in the Global 1800: The exposure to Volatility increased, although it was still negative at –0.13.

8. 2022: The year of inversion

The trend that began between October and December of 2021 continued into 2022 as inflation concerns spread worldwide, central banks increased their overnight rates, Russia invaded Ukraine and supply chain issues persisted even though the global pandemic largely receded. Russia was formally removed from most global indices, including the Emerging Markets 1500 on March 21, 2022. Its weight on its last day of inclusion in the index was down 50% from its average of about 5% to less than 2.5%. Even though the volatility of Russian stocks was extreme in February – March of 2022, their exclusion did not affect the index risk forecast much – this continued to increase despite the index losing some of its most volatile constituents.

Figure 16: EM 1500 Russia allocation and index volatility, Dec 01, 2021 – Mar 21, 2022.



Source: Qontigo.

Risk in both DM and EM indices was much higher in November 2022.

Figure 17: *X-sigma-rho* risk decomposition for the DM vs. EM indices as of Nov 30, 2022.

Source: Qontigo.

Figure 18: Change in risk from Dec 2021 to Nov 2022.

Source: Qontigo.

From November 2021 to November 2022, DM risk increased by 93%, while EM risk rose by 48% and the EM/DM ratio decreased by 23%.

For both indices, the increase was entirely attributable to factor risk. However, Emerging Markets Index benefited from

1) Lower correlation to the Global Market
2) Greater diversification amongst its Country allocations, and
3) A sea change in its Style risk profile

Figure 19: Risk decomposition comparison as of Nov 30, 2022.

	Global 1800	Emerging 1500	Difference	% of difference in total risk (negative % = additive)
Total risk	**24.07**	**19.09**	**–4.98**	
Total factor	23.96	18.82	–5.13	
Global Market	**19.89**	**15.93**	**–3.96**	**79.51%**
Style	**0.57**	**–2.49**	**–3.06**	**61.53%**
Industry	**–0.03**	**0.57**	**0.60**	**–11.96%**
Country	**1.48**	**0.48**	**–1.01**	**20.20%**
Currency	**2.04**	**4.35**	**2.31**	**–46.41%**
Domestic China	**0.00**	**–0.01**	**–0.01**	**0.19%**
Specific risk	0.11	0.27	**0.15**	–3.07%

Source: Qontigo.

Correlation to Global Market

The EM 1500's market risk increased considerably from November 2021 to November 2022, and its correlation to the Global Market factor increased as well. Nevertheless, the correlation was still 20% lower than that for the DM index and therefore the increase in the market risk contribution was almost 400 bps lower.

Figure 20: Global Market factor risk contributions as of Nov 30, 2022.

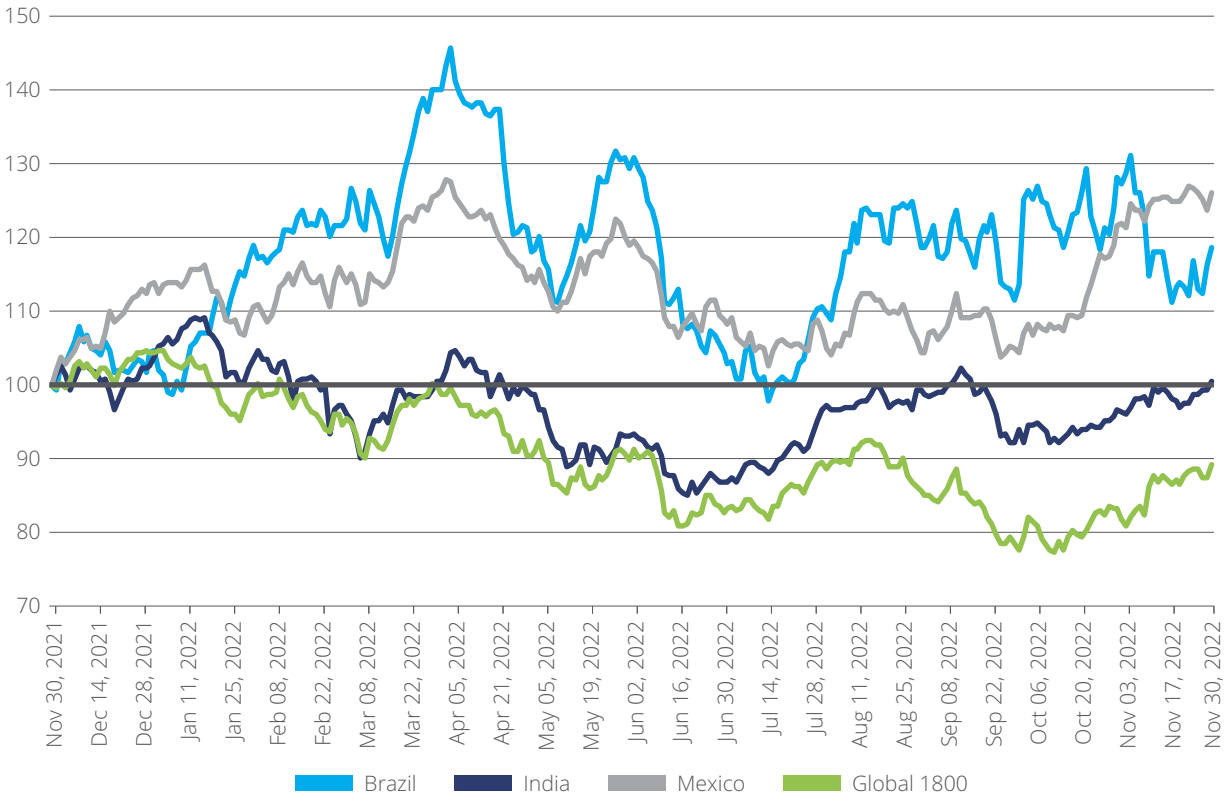
Factor	Factor vol	Global 1800 MTCR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Global Market	20.18	19.89	1	**0.99**	**19.89**	15.93	1	**0.79**	**15.93**
1y change:	**+182**	**+879**		**+0.02**	**+879**	**+7.26**		**+0.02**	**+584**

Source: Qontigo.

EM: Low beta?

As developed markets equities sold off but experienced brief rallies through much of 2022, many emerging markets zagged while the developed markets zigged.

Figure 21: STOXX Global 1800 Index vs. selected STOXX emerging country indices, Nov 2021 – Nov 2022.



Source: Qontigo.

As the general direction of the global market was down and these outlier countries rose, they went from being high beta to low beta. By contrast, the largest constituents of the DM index (which are also the largest constituents of the total global market) declined even more than the index on average, and thus became high beta stocks. Of the 498bp difference in risk between the EM and DM indices, 306 points are attributable to Style factors. Nearly 60% of that figure comes from the difference in Market Sensitivity exposure.

Figure 22: Style factor risk contributions as of Nov 30, 2022

Factor	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Market Sensitivity	**7.06**	**0.77**	**5.52**	**0.10**	**0.78**	**0.53**	**3.83**	**–0.47**	**0.54**	**–1.79**
Volatility	5.49	0.76	4.06	–0.10	0.74	**–0.41**	3.41	0.02	0.62	**0.08**
Medium-Term Momentum	4.58	–0.39	–1.97	–0.04	–0.43	**0.08**	–1.15	0.11	–0.25	**–0.13**
Size	**4.19**	**0.46**	**1.96**	**0.17**	**0.47**	**0.34**	**1.74**	**–0.19**	**0.42**	**–0.32**
Short-Term Momentum	2.82	–0.57	–1.60	–0.01	–0.57	0.02	–1.28	0.12	–0.45	–0.15
Earnings Yield	1.74	0.05	0.12	0.01	0.07	0.00	0.12	0.10	0.07	0.01
Liquidity	1.69	0.19	0.27	0.14	0.16	0.04	0.64	–'0.28	0.38	–0.18
Profitability	1.53	0.00	0.07	0.05	0.04	0.00	–0.03	0.04	–0.02	0.00
Value	1.43	0.03	0.07	–0.05	0.05	0.00	0.07	0.05	0.05	0.00
Exchange Rate Sensitivity	1.12	–0.13	–0.14	0.06	–0.12	–0.01	–0.02	–0.03	–0.02	0.00
Dividend Yield	1.06	–0.08	–0.06	0.04	–0.06	0.00	–0.04	0.09	–0.04	0.00
Growth	1.03	0.16	0.15	–0.01	0.14	0.00	0.11	–0.12	0.11	–0.01
Leverage	0.89	0.04	0.03	0.01	0.03	0.00	0.16	0.06	0.19	0.01
				Total Style risk contribution:		**0.57**		**Total Style risk contribution:**		**–2.49**

Source: Qontigo.

The “low beta” tag generally does not apply to stocks from countries such as India, China or Taiwan, nor should we expect the current relative risk level to persist. The country-by-country breakdown of the index exposure shows that most of the major countries in the index had negative contributions to Market Sensitivity exposure.

Figure 23: Country-by-country contributions to Market Sensitivity exposure as of Nov 30, 2022.

Country	EM 1500 allocation	Average Market Sensitivity exposure	Market Sensitivity exposure contribution	Country factor risk contribution
India	27.13%	–0.64	**–0.132**	–0.18
China	10.00%	–0.78	**–0.086**	0.20
Taiwan	19.48%	–0.70	**–0.082**	0.60
Indonesia	2.76%	–1.05	**–0.030**	–0.10
Korea, Republic of	15.54%	–0.09	**–0.028**	0.42
Thailand	3.99%	–0.66	**–0.026**	–0.05
Brazil	6.41%	–0.37	**–0.025**	–0.17
Malaysia	1.89%	–0.82	**–0.016**	–0.01
Vietnam	1.07%	–1.24	**–0.014**	–0.06
Philippines	1.46%	–0.82	**–0.011**	–0.01
Mexico	3.08%	–0.11	**–0.006**	–0.08
Hong Kong	0.28%	–0.86	**–0.003**	0.01
Turkey	0.89%	–0.41	**–0.003**	–0.04
Chile	0.71%	–0.32	**–0.002**	–0.01
Colombia	0.21%	–0.72	**–0.001**	0.00
Egypt	0.09%	–1.33	**–0.001**	0.00
Hungary	0.23%	–0.32	**–0.001**	0.00
			–0.47	

Source: Qontigo.

While the Market Sensitivity factor makes the second-largest contribution to the difference in risk forecasts after the Global Market factor, this may be a temporary phenomenon. The DM drawdown in mega-cap technology and consumer discretionary stocks that had led the index for so long and resulted in unprecedented concentrations in those markets (particularly the USA) may not be over, but global betas will reset to a new baseline as the window of returns for estimating beta exposures starts to move away from the worst of those negative returns. The EM stocks that now appear to be low beta will most likely revert to high beta as volatility in developed mega-caps recedes, even if price levels remain lower.

Another 66 basis points in differential Style factor risk is attributable to the Size factor. In this case it is not the relative exposures that have changed, but the factor volatility plus the correlations of the factor with both indices and with the Global Market factor.

Figure 24: Change in Size factor risk contributions, Sep 30, 2021 – Nov 30, 2022

Date	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Sep 30, 2021	3.38	0.22	0.77	0.18	0.14	**0.14**	0.61	–0.17	0.18	**–0.10**
Nov 30, 2022	**4.19**	0.46	1.96	0.17	**0.47**	**0.34**	1.74	–0.19	**0.42**	**–0.32**
	+0.81	**+0.24**	**+1.19**	**–0.01**	**+0.33**	**+0.20**	**+1.13**	**–0.02**	**+0.23**	**–0.22**

Source: Qontigo.

Size became much more correlated with both the index returns and the Global Market factor, since the market drawdown and the increase in market volatility were largely driven by the largest companies (mainly in the USA). The negative Size exposure, coupled with the more than doubled correlation to both the index and the Global Market factor, resulted in an enormous diversification benefit for the EM index.

The country conundrum

According to the comparative risk decomposition table above, the Country factors contribute an aggregate 148 bps of the Global 1800's total risk and just 48 bps of the Emerging Markets 1500's total risk. This stands in stark contrast to the factor block decomposition shown earlier (figure 7, for November 30, 2022), where country risk in the EM index was four times the magnitude of country risk in the Global 1800 (10.38 vs. 2.53). That block decomposition includes the covariance amongst the Country factors themselves, so the substantial difference in the block decomposition vs. the *x-sigma-rho* decomposition comes from covariance with the other non-country factors. When we drill down to the Country factor contributions to risk, we get a better understanding of how this occurs.

Figure 25: Global 1800 country factor risk contributions as of Nov 30, 2022.

Factor	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contri–bution	Change from Sep. 30, 2021
United States	**5.50**	**0.51**	**3.07**	**66.27%**	**0.56**	**2.04**	**0.83**
Japan	**8.45**	**–0.28**	**–2.55**	**7.35%**	**–0.30**	**–0.19**	**–0.07**
United Kingdom	**9.65**	**–0.18**	**–1.67**	**4.57%**	**–0.17**	**–0.08**	**–0.04**
France	**9.08**	**–0.05**	**–0.27**	**3.33%**	**–0.03**	**–0.01**	**–0.01**
Canada	**6.08**	**–0.13**	**–0.65**	**3.26%**	**–0.11**	**–0.02**	**0.00**
Switzerland	8.95	–0.03	–0.10	2.80%	–0.01	0.00	0.00
Germany	**10.58**	**0.01**	**0.35**	**2.55%**	**0.03**	**0.01**	**0.02**
Australia	10.22	–0.38	–4.11	2.55%	–0.40	–0.10	–0.04
Netherlands	7.37	–0.01	–0.04	1.31%	–0.01	0.00	0.00
Sweden	12.30	–0.14	–1.51	0.98%	–0.12	–0.01	–0.01
Denmark	11.56	–0.02	–0.34	0.79%	–0.03	0.00	–0.01
Hong Kong	23.47	–0.19	–5.66	0.75%	–0.24	–0.04	–0.02
Spain	8.66	–0.16	–1.31	0.68%	–0.15	–0.01	0.00
Italy	10.41	–0.08	–0.62	0.63%	–0.06	0.00	0.00
Singapore	14.33	–0.14	–2.66	0.43%	–0.19	–0.01	–0.01
Finland	11.45	–0.18	–1.99	0.32%	–0.17	–0.01	–0.01
Belgium	8.69	–0.16	–1.36	0.25%	–0.16	0.00	0.00
Norway	12.22	–0.41	–5.28	0.25%	–0.43	–0.01	–0.01
Ireland	11.21	–0.03	–0.33	0.21%	–0.03	0.00	0.00
New Zealand	11.94	–0.45	–5.81	0.10%	–0.49	–0.01	0.00
				Total country risk		**1.48**	**0.61**

Source: Qontigo.

This table is similar to the one we looked at from September 30, 2021, when the EM/DM risk ratio was 1.2. However, the numbers in this case are larger as factor volatilities have increased, as has the magnitude of factor/portfolio correlations in both directions. In the DM index, the United States accounts for 137%

of the country risk and all the other countries with the exception of Germany have a diversifying or neutral effect. The proportion of country risk from the USA is about the same as it was 14 months earlier, but the factor volatility is much higher, as are the correlations with both the rest of the index and the Global Market factor.

Figure 26: Change in United States country factor risk contributions, Sep 30, 2021 – Nov 30, 2022.

Date	Factor vol	Correlation to Global Market factor	Global 1800 MCTR	Global 1800 exposure	Factor/ Global 1800 correlation	Global 1800 risk contribution
Sep 30, 2021	4.04	0.38	1.86	64.52%	0.46	**1.20**
Nov 30, 2022	**5.50**	0.51	3.07	66.27%	**0.56**	**2.04**
	+1.46	**+0.13**	**+1.21**	**+1.75%**	**+0.10**	**+0.83**

Source: Qontigo.

All of the *x, sigma* and *rho* components of the risk contribution increased in the case of the United States, leading to an 83 bps change in its risk contribution to the index over this time span.

The Emerging Markets 1500's country allocations tell a different story:

Figure 27: Emerging Markets 1500 Country factor risk contributions, as of Nov 30, 2022.

Factor	Factor vol	Correlation to Global Market factor	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contri-bution	Change from Sep. 30, 2021
India	**13.22**	**–0.36**	**–0.65**	**27.13%**	**–0.05**	**–0.18**	**–0.62**
Taiwan	**16.52**	**–0.24**	**3.07**	**19.48%**	**0.19**	**0.60**	**–0.29**
Korea, Republic of	**15.38**	**–0.26**	**2.73**	**15.54%**	**0.18**	**0.42**	**0.01**
China	**30.24**	**–0.30**	**1.98**	**10.00%**	**0.07**	**0.20**	**–0.13**
Brazil	**25.22**	**–0.34**	**–2.66**	**6.41%**	**–0.11**	**–0.17**	**–0.19**
South Africa	**11.06**	**–0.31**	**–1.04**	**4.15%**	**–0.09**	**–0.04**	**–0.02**
Thailand	**16.19**	**–0.39**	**–1.17**	**3.99%**	**–0.07**	**–0.05**	**–0.04**
Mexico	**11.58**	**–0.50**	**–2.71**	**3.08%**	**–0.23**	**–0.08**	**–0.06**
Indonesia	**15.35**	**–0.48**	**–3.54**	**2.76%**	**–0.23**	**–0.10**	**–0.10**
Malaysia	12.07	–0.24	–0.31	1.89%	–0.03	–0.01	0.01
Philippines	14.17	–0.33	–0.91	1.46%	–0.06	–0.01	–0.03
Vietnam	**43.02**	**–0.30**	**–5.85**	**1.07%**	**–0.14**	**–0.06**	**–0.06**
Turkey	29.20	–0.25	–4.19	0.89%	–0.14	–0.04	–0.02
Chile	15.25	–0.33	–1.87	0.71%	–0.12	–0.01	–0.01
Greece	11.96	–0.21	–0.55	0.39%	–0.05	0.00	0.00
Hong Kong	23.47	–0.19	4.83	0.28%	0.21	0.01	0.01
Hungary	18.08	–0.27	–1.04	0.23%	–0.06	0.00	0.00
Colombia	20.20	–0.20	–0.55	0.21%	–0.03	0.00	0.00
Czech Republic	15.40	–0.07	2.05	0.15%	0.13	0.00	0.00
Egypt	23.03	–0.22	–2.63	0.09%	–0.11	0.00	0.00
				Total country risk		**0.48**	**–1.54**

Source: Qontigo.

While India has an allocation of more than one quarter of index market cap, it is negatively correlated with the EM index and with the Global Market factor. All of the major allocations except Korea, Taiwan, and China have the same diversifying properties. How can this be when the index is composed of them? Within the framework of the WW4 risk model, the explanation lies with the Global Market factor, which constitutes 84% of the overall risk. These countries' active returns often counteracted the Global Market factor and are therefore negatively correlated with it. Since the Global Market factor accounts for 84% of the total risk, they appear as negative risk contributions due to the diversification they add. Zooming in on India gives us a clearer picture of how things have changed compared to before the inversion.

Figure 28: Change in India's Country factor risk contribution, Sep 30, 2021 – Nov 30, 2022.

Date	Factor vol	Correlation to Global Market factor	EM 1500 MCTR	EM 1500 exposure	Factor/ EM 1500 correlation	EM 1500 risk contribution
Sep 30, 2021	13.12	–0.31	1.94	22.98%	0.15	**0.45**
Nov 30, 2022	**13.22**	–0.36	–0.65	27.13%	**–0.05**	**–0.18**
	+0.11	**–0.06**	**–2.59**	**+4.15%**	**–0.20**	**–0.62**

Source: Qontigo.

This means that even though factor volatility rose slightly and the allocation to India increased considerably, the correlation of the Country factor (i.e., its active return vs. the Global Market) decreased so much that the risk contribution from India went from +0.45 to –0.18, a swing of –62 bps. Other countries such as Taiwan, Brazil, and China showed similar changes in correlation.

9. Linked model confirmation

As described earlier, the Axioma WWLM4-SH model uses the United States equity model for US stocks, the Developed Markets ex-US equity model for non-US developed markets stocks, and the Emerging Markets equity model for emerging markets stocks, then estimates the cross-market covariances of the factors in each model. The model has three different intercepts, one for each of the sub-models. Consequently, the Emerging Markets intercept factor should be considerably less volatile than either the US or DM ex-US intercepts, because the return dispersion of individual emerging markets has resulted in diversification that has not been available in developed markets or in the United States, which is generally considered to be the broadest and deepest equity market on Earth.

Figure 29: Axioma WWLM4-SH risk forecast as of Nov 30, 2022.

	STOXX Global 1800	STOXX Emerging Markets 1500	EM/DM ratio
Total risk	23.68%	19.29%	0.81

Source: Qontigo.

Without going into too much detail, we can simply use Equation 2 (standalone risk contribution) to get a sense of how this much more detailed model essentially tells us the same thing as WW4.

Figure 30: Axioma WWLM4-SH market intercepts risk contributions as of Nov 30, 2022.

Market intercepts	Factor volatility	Global 1800 exposure	Global 1800 standalone risk contribution	EM 1500 exposure	EM 1500 standalone risk contribution
United States market intercept	25.40	66.22%	16.82	0.00%	0
Developed Ex-US market intercept	16.67	33.33%	5.55	0.30%	0.05
Emerging markets intercept	15.75	0.46%	0.07	99.70%	15.70
	Sum of contributions (no covariance)		**22.45**		**15.75**

Source: Qontigo.

The United States factor has a factor volatility that is almost 1,000 basis points higher than the Emerging Markets factor, and even the Developed ex-US factor is more than 100 basis points higher. While this is not the whole story within the framework of the linked model, it confirms what WW4 is saying about the difference in risk between these two indices in a very direct way: aggregate EM market risk is lower than US market risk, and US market risk is the dominant force in the DM index risk forecast.

10. Conclusion

The persistent conundrum of an emerging markets index that is composed of riskier countries, is concentrated in more volatile industries and currencies, and has more extreme Style factor exposures with lower forecast and realized volatility than the "safer" developed markets equities asset class appears to be mainly due to the unprecedented concentration in the United States market, and the recent high volatility in the largest companies in that country. In the last 16 months, the market sensitivity, or beta, of what are typically considered to be a high-risk class of equities has changed dramatically, but this is relative to a global market that is dominated by mega-cap US technology/consumer discretionary companies that have been severely repriced. Even if these global market leaders do not recover their former valuations any time soon, it is unlikely that their high level of return volatility will persist much longer. As it fades, we would expect the relative riskiness of emerging markets to increase once again, showing up in the volatility-related style exposures for the index as well as in non-negative correlations between EM country factors and the Global Market factor. However, this reversion has not yet taken place in 2023, as US markets continue to battle conflicting narratives regarding the persistence of inflation and a looming recession.

11. Appendix

MCTR and *x-sigma-rho*

The marginal contribution to risk (MCTR) is a key component of risk analytics when a linear factor model such as WW4-SH is used. MCTR is the partial derivative of portfolio risk with respect to factor (or asset) exposure:

Equation 3: MCTR

$$MCTR_{factor} = \frac{\partial \sigma_p}{\partial x_p}$$

Where:
∂x_p = change in portfolio exposure
$\partial \sigma_p$ = change in portfolio risk

The marginal contribution of a factor is derived by taking the factor's covariance with the portfolio as a fraction of the total portfolio risk:

Equation 4: MCTR derivation

$$MCTR_{factor} = \frac{COV(f,p)}{\sigma_p}$$

Since the MCTR is a fraction of the total portfolio risk, the weighted sum of all factor MCTRs will be the total factor risk for the portfolio.

Factor/portfolio covariance is defined as:

Equation 5: Factor/portfolio covariance

$$COV(f,p) = \sigma_f \sigma_p \rho_{f,p}$$

Where:
$\rho_{f,p}$ = correlation of factor and portfolio

Putting it all together, we have:

Equation 6: MCTR expanded

$$MCTR_{factor} = \frac{\sigma_f \sigma_p \rho_{f,p}}{\sigma_p}$$

The MCTR factor has two parts – the factor volatility and the factor correlation to the portfolio. When we "weight" this by the factor exposure, we get *x* × *sigma* × *rho*, which is an additive risk contribution that will sum to the total factor risk. Since the exposures and correlations can be negative or positive in this framework, we will now be able to tell which factor exposures and correlations reduce or add risk and why.

12. Contacts & Information

Learn more about how Qontigo can help you better manage risk and enhance your investment process.
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