



Global Equity Country Allocation: An Application of Factor Investing

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- We create a global factor allocation strategy using country indices.
 - Small capitalization, Value, and Momentum.
- Combine single factor portfolios to create a global multifactor portfolio using alternative portfolio construction methodologies.
 - Equally weighted, inverse variance, minimum variance, maximum diversification.
- Examine the relationship between the stock based global factor portfolios (Fama and French (2012) and investable indices of factor portfolios) **and** the country based portfolios.



- **Question 1**
 - Can we create global factor portfolios using country indices which produce portfolios with similar performance and lower transaction costs than stock based factor portfolios?
- **Question 2**
 - Can we combine single factor portfolios to create a global multifactor portfolio using alternative portfolio construction methodologies?
- **Question 3**
 - Are global factors based on countries really a proxy for global factors based on individual stocks or do they represent rewards to independent global risks?



- Academic research based on individual stocks supports the view that exposure to small capitalization, value, high momentum and low risk factors is compensated with positive risk premia.
- The idea of building a globally diversified portfolio that combines the world market portfolio with “style” funds that capture the size, value, momentum and low risk premia is consistent with current interest in factor based asset allocation.
 - “**Smart beta**” products.
 - Institutional investors (**Norway’s Global Fund**).
- Implementing academic research on factor portfolio construction in practice is challenging.
 - Stock liquidity, transaction costs, turnover and risk constraints.



- Country based value, small capitalization, high momentum and low risk portfolios have **better Sharpe ratios** and in most cases statistically significant returns in excess of the world market portfolio.
 - Capitalization weighted factor portfolios have consistently “worst” performance (lower Sharpe and information ratios).
- Global multifactor portfolios created using alternative weighting schemes have higher and statistically significantly **higher** Sharpe ratios than the world market portfolio.
 - The weighting scheme used to combine **the four global factors makes little difference to performance**
- Factor portfolios based on countries have higher returns and volatility but very **similar return to risk** (Sharpe ratios) compared to the stock based factor portfolios of FF or the investable indices produced by MSCI.
 - Factor portfolios based on developed and emerging market stock indices **outperform** stock based factor portfolios but risk adjusted alphas although economically significant are not statistically significantly different from zero.



- Country dollar total return indices obtained from MSCI from July 1980 to December 2015 (426 monthly observations) from 23 developed markets and 21 emerging markets.
- Price to book (PB), price to cash flow (PCF), price to earnings (PE), dividend yield (DY) and market capitalization for the 23 developed and 21 emerging markets provided by Datastream.
- To construct the global value portfolios we rank at the end of June in year t all countries by a composite valuation indicator that combines the four ratios.
 - We form three portfolios containing one third of the 44 countries each and calculate the monthly returns over the next 12 months
- The small capitalization portfolio contains a third of all countries with the lowest capitalization and uses also a twelve-month rebalancing rule.
- We calculate every month the momentum for month t as the cumulative monthly returns for $t - 2$ to $t - 12$ and form three portfolios containing in equal numbers the highest, medium and lowest momentum countries.
- We estimate every month the country beta against the world index using a rolling sample of 60 monthly observations and create three portfolios that contain the highest, medium and lowest beta countries.



- We use a number of portfolio construction methodologies:

Portfolio Strategy	Country Weights
Capitalization Weighting (CW)	Proportional to market cap
Equal Weighting (EW)	$w_{ew} = \frac{1}{N}$
Inverse Variance (IV)	$w_{iv} = \frac{\left(1/\sigma_{it}^2\right)^h}{\sum_{i=1}^N \left(1/\sigma_{it}^2\right)^h}, i = 1, 2, \dots, N$
Minimum Variance (MinVar)	$\min w^T \Sigma w, s. t. \mathbf{1}^T w = 1 \text{ and } w_i \geq 0,$ w $i = 1, 2, \dots, N$
Maximum Diversified Portfolio (MDP)	$\frac{w^T \sigma}{\sqrt{w^T \Sigma w}}$ and $w_i \geq 0, i = 1, 2, \dots, N$



Global Single-Factor Portfolios

Weighting Scheme	Average	Volatility	Sharpe Ratio	TE	IR	Turnover	Break Even	Trading Cost	Raw Alpha [t-stat]
Value Portfolios									
CW	14.77%	19.46%	0.53	10.08%	0.41	82.48%	5.01%	0.03%	4.13% [2.40]
EW	16.91%	19.85%	0.63*	11.56%	0.54	117.38%	5.34%	0.12%	6.27% [2.63]
IV	14.93%	18.07%	0.58*	9.26%	0.46	113.34%	3.79%	0.10%	4.29% [2.29]
MinVar	16.05%	16.63%	0.70***	10.36%	0.52	196.76%	2.75%	0.18%	5.41% [2.78]
MDP	16.63%	19.25%	0.64*	11.97%	0.50	198.38%	3.02%	0.25%	5.99% [2.54]
Size Portfolios									
CW	15.09%	20.23%	0.53	12.78%	0.35	43.38%	10.25%	0.05%	4.45% [1.89]
EW	16.38%	20.04%	0.60	13.03%	0.44	83.50%	6.87%	0.13%	5.74% [2.20]
IV	14.32%	17.84%	0.56	10.23%	0.36	81.04%	4.54%	0.11%	3.68% [1.76]
MinVar	13.86%	17.38%	0.55	12.03%	0.27	154.34%	2.08%	0.22%	3.22% [1.39]
MDP	16.24%	18.74%	0.63*	12.28%	0.46	163.30%	3.43%	0.28%	5.60% [2.32]
Market Portfolio									
Market	10.64%	15.14%	0.41						



Weighting Scheme	Average	Volatility	Sharpe Ratio	TE	IR	Turnover	Break Even	Trading Cost	Raw Alpha [t-stat]
Momentum Portfolios									
CW	13.84%	19.61%	0.48	10.79%	0.30	150.25%	2.13%	0.05%	3.20% [1.69]
EW	18.14%	19.54%	0.70**	11.59%	0.65	496.22%	1.51%	0.39%	7.50% [3.45]
IV	17.50%	18.02%	0.73***	9.42%	0.73	570.76%	1.20%	0.36%	6.86% [3.91]
MinVar	19.06%	17.50%	0.84***	10.26%	0.82	778.82%	1.08%	0.46%	8.42% [4.47]
MDP	18.50%	19.28%	0.73**	12.55%	0.63	682.74%	1.15%	0.49%	7.87% [3.49]
Low Beta Portfolios									
CW	13.81%	16.27%	0.58*	9.76%	0.32	168.09%	1.88%	0.02%	3.17% [1.93]
EW	13.81%	16.74%	0.56	10.02%	0.32	170.43%	1.86%	0.12%	3.17% [1.69]
IV	13.46%	15.68%	0.58	8.82%	0.32	176.03%	1.60%	0.10%	2.82% [1.73]
MinVar	13.12%	15.33%	0.57	9.64%	0.26	182.11%	1.36%	0.12%	2.48% [1.38]
MDP	14.69%	17.09%	0.60	11.55%	0.35	203.66%	1.99%	0.15%	4.05% [1.87]
Market Portfolio									
Market	10.64%	15.14%	0.41						



- To study the benefits of factor combination, we create global factor portfolios using the four portfolio construction methodologies (EW, IV, MinVar, MDP).
- Each portfolio construction methodology combines the single-factor portfolios (value, small capitalization, high momentum and low beta portfolios) to deliver a multifactor portfolio.



Weighting Scheme	Average	Volatility	Sharpe Ratio	TE	IR	Turnover	Break Even	Trading Cost	Raw Alpha [t-stat]
Panel A. Capitalization Weighted Returns (CW)									
EW	14.37%	17.11%	0.58**	7.26%	0.51	242.61%	1.54%	0.09%	3.74% [2.87]
IV	13.96%	16.38%	0.58**	6.71%	0.50	231.66%	1.43%	0.09%	3.32% [2.75]
MinVar	13.17%	15.94%	0.55	7.06%	0.36	243.65%	1.04%	0.10%	2.53% [1.90]
MDP	13.90%	16.53%	0.58**	7.09%	0.46	245.39%	1.33%	0.10%	3.26% [2.63]
Panel B. Equally Weighted Returns (EW)									
EW	16.31%	18.03%	0.66**	9.75%	0.58	204.71%	2.77%	0.18%	5.67% [2.85]
IV	16.02%	17.73%	0.66**	9.59%	0.56	198.52%	2.71%	0.17%	5.38% [2.73]
MinVar	15.63%	17.42%	0.65**	9.73%	0.51	212.68%	2.34%	0.18%	4.99% [2.42]
MDP	16.06%	17.78%	0.66**	9.40%	0.58	246.99%	2.19%	0.21%	5.42% [2.78]
Market Portfolio									
Market	10.64%	15.14%	0.41						



Weighting Scheme	Average	Volatility	Sharpe Ratio	TE	IR	Turnover	Break Even	Trading Cost	Raw Alpha [t-stat]
Panel C. Inverse Variance Returns (IV)									
EW	15.05%	16.64%	0.64**	7.90%	0.56	213.31%	2.07%	0.15%	4.41% [2.78]
IV	14.84%	16.45%	0.64**	7.85%	0.54	199.75%	2.11%	0.15%	4.21% [2.65]
MinVar	13.77%	16.03%	0.59*	7.84%	0.40	204.53%	1.53%	0.14%	3.13% [1.97]
MDP	15.27%	16.83%	0.65**	7.81%	0.59	277.38%	1.67%	0.20%	4.64% [2.92]
Panel D. Minimum Variance Returns (MinVar)									
EW	15.52%	15.49%	0.72***	8.51%	0.57	305.23%	1.60%	0.15%	4.88% [2.97]
IV	15.28%	15.33%	0.71***	8.49%	0.55	283.55%	1.64%	0.15%	4.64% [2.81]
MinVar	14.54%	15.15%	0.67***	8.47%	0.46	287.96%	1.35%	0.14%	3.90% [2.38]
MDP	15.84%	15.57%	0.74***	8.60%	0.60	350.46%	1.48%	0.20%	5.20% [3.11]
Panel E. Maximum Diversified Portfolio Returns (MDP)									
EW	16.52%	17.44%	0.70**	10.20%	0.58	308.20%	1.91%	0.29%	5.88% [2.94]
IV	16.34%	17.25%	0.69**	10.13%	0.56	294.08%	1.94%	0.28%	5.70% [2.87]
MinVar	15.48%	16.96%	0.65**	10.07%	0.48	319.60%	1.52%	0.31%	4.84% [2.47]
MDP	16.65%	17.41%	0.70***	10.01%	0.60	382.36%	1.57%	0.36%	6.01% [3.05]
Panel F. Market Statistics									
Market	10.64%	15.14%	0.41						



- Country ETFs and stock index futures for developed markets are more liquid and can be dealt at large volumes compared to country ETFs or stock index futures for some of the emerging markets.
 - but the question is whether excluding emerging markets from the investor's menu will preserve the benefits of country based factor portfolio construction.



Global Multifactor Portfolios Based on All vs Developed Countries

	Average	Volatility	Sharpe Ratio	TE	IR	Turnover	Break Even	Trading cost	Raw Alpha [t-stat]
Panel A. Capitalization Weighted Returns (CW)									
Developed countries	12.55%	16.40%	0.50	6.46%	0.30	228.12%	0.84%	0.07%	
All countries	14.37%	17.11%	0.58**	7.26%	0.51	242.61%	1.54%	0.09%	1.82% [2.22]
Panel B. Equally Weighted Returns (EW)									
Developed countries	13.45%	16.73%	0.54	7.73%	0.36	189.65%	1.48%	0.12%	
All countries	16.31%	18.03%	0.66**	9.75%	0.58	204.71%	2.77%	0.18%	2.86% [2.27]
Panel C. Inverse Variance Returns (IV)									
Developed countries	13.86%	16.24%	0.58*	7.49%	0.43	202.41%	1.59%	0.12%	
All countries	15.05%	16.64%	0.64**	7.90%	0.56	213.31%	2.07%	0.15%	1.20% [1.62]
Panel D. Minimum Variance Returns (MinVaR)									
Developed countries	14.33%	15.52%	0.64**	8.04%	0.46	294.00%	1.25%	0.12%	
All countries	15.52%	15.49%	0.72***	8.51%	0.57	305.23%	1.60%	0.15%	1.19% [1.50]
Panel E. Maximum Diversified Portfolio Returns (MDP)									
Developed countries	14.25%	16.51%	0.60*	8.50%	0.42	285.92%	1.26%	0.20%	
All countries	16.52%	17.44%	0.70**	10.20%	0.58	308.20%	1.91%	0.29%	2.27% [1.62]
Panel F. Market Statistics									
Market	10.64%	15.14%	0.41						



	Average	Volatility	Sharpe	Raw Alpha [t-stat]
Panel A. Country-Based versus FF Factor Portfolios				
Value Portfolios				
Country based (EW)	14.56%	20.98%	0.56	<u>3.91% [1.51]</u>
FF	10.65%	15.23%	0.52	
Size Portfolios				
Country based (EW)	14.56%	21.04%	0.56	<u>5.21% [2.04]</u>
FF	9.35%	15.87%	0.42	
Momentum Portfolios				
Country based (EW)	15.15%	19.36%	0.64	<u>1.92% [0.74]</u>
FF	13.23%	16.07%	0.65	
Panel B. Country-Based versus FF Multifactor Portfolios				
Country based (EW)	14.76%	19.73%	0.61	<u>3.68% [1.63]</u>
FF	11.08%	15.19%	0.55	
Market	8.42%	14.98%	0.38	



	Average	Volatility	Sharpe	Raw Alpha [t-stat]
Panel A. Country-Based versus FF Factor Portfolios				
Value Portfolios				
Country based (EW)	11.50%	18.84%	0.46	
FF	10.65%	15.23%	0.52	0.85% [0.50]
Size Portfolios				
Country based (EW)	9.08%	18.06%	0.35	
FF	9.35%	15.87%	0.42	-0.27% [-0.13]
Momentum Portfolios				
Country based (EW)	12.61%	17.60%	0.56	
FF	13.23%	16.07%	0.65	-0.62% [-0.30]
Panel B. Country-Based versus FF Multifactor Portfolios				
Country based (EW)	11.06%	17.67%	0.47	
FF	11.08%	15.19%	0.55	-0.02% [-0.00]
Market	8.42%	14.98%	0.38	



Exposures of Country and Fama and French Factor Portfolios

		Alpha [t-stat]	$r_{mkt} - r_f$ [t-stat]	r_{hml} [t-stat]	r_{smb} [t-stat]	r_{wml} [t-stat]	R2
Panel A. Value	Country (EW)	3.06% [1.32]	1.24 [25.65]	0.37 [4.12]	0.69 [9.99]	-0.03 [-0.50]	78.43%
	FF	-0.12% [-0.31]	1.00 [125.88]	0.55 [28.46]	0.54 [47.23]	-0.02 [-2.18]	98.64%
Panel B. Small Capitalization	Country (EW) - FF	3.18% [1.29]	0.24 [4.70]	-0.18 [-2.08]	0.15 [2.19]	-0.01 [-0.13]	12.91%
	Country (EW)	3.48% [1.51]	1.19 [19.16]	0.32 [3.90]	0.65 [7.30]	-0.02 [-0.35]	71.30%
	FF	-0.11% [-0.29]	0.99 [158.94]	0.09 [6.90]	1.04 [88.15]	-0.01 [-1.54]	98.99%
Panel C. High Momentum	Country (EW) - FF	3.59% [1.42]	0.20 [3.07]	0.23 [2.71]	-0.38 [-4.30]	-0.01 [-0.12]	12.48%
	Country (EW)	3.38% [1.47]	1.15 [21.84]	0.14 [1.67]	0.39 [3.86]	0.21 [3.55]	73.76%
	FF	0.34% [0.72]	1.06 [1232.46]	0.03 [1.58]	0.63 [40.05]	0.45 [44.81]	98.21%
Panel D. Multifactor Portfolios	Country (EW) - FF	3.04% [1.21]	0.09 [1.69]	0.11 [1.29]	-0.24 [-2.55]	-0.24 [-4.02]	15.36%
	Country (EW)	2.57% [1.42]	1.14 [28.40]	0.27 [4.15]	0.53 [9.59]	0.06 [1.39]	81.68%
	FF	0.04% [0.09]	1.02 [153.33]	0.22 [14.74]	0.74 [62.66]	0.14 [19.40]	98.71%
	Country (EW) - FF	2.53% [1.25]	0.12 [2.89]	0.05 [0.70]	-0.21 [-3.61]	-0.08 [-1.78]	9.70%



Comparison of Country vs MSCI Based Global Factor and Multifactor Portfolios

	Average	Volatility	Sharpe	Raw Alpha [t-stat]	Risk adjusted alpha [t-stat]
Panel A. Country-Based versus MSCI Global Factor Portfolios					
Value Portfolios					
Country based (EW)	12.99%	23.36%	0.47	1.49% [0.60]	-0.02% [-0.01]
MSCI ACWI Enhanced Value	11.50%	20.12%	0.47		
Size Portfolios					
Country based (EW)	14.09%	22.82%	0.53	4.52% [1.97]	2.22% [1.04]
MSCI ACWI Equally Weighted	9.57%	18.73%	0.40		
Momentum Portfolios					
Country based (EW)	14.09%	20.93%	0.57	3.67% [1.34]	3.73% [1.50]
MSCI ACWI Momentum	10.42%	17.44%	0.48		
Low Volatility Portfolios					
Country based (EW)	10.07%	17.19%	0.47	1.72% [0.62]	-0.10% [-0.03]
MSCI ACWI Minimum Volatility	8.35%	10.86%	0.58		
Panel B. Country-Based versus MSCI-Based Multifactor Portfolios (December 1997 – June 2014)					
Country based (EW)	12.81%	20.36%	0.53	2.85% [1.30]	1.33% [0.68]
MSCI	9.96%	15.87%	0.50		
Market	6.78%	16.16%	0.29		



- **What do we do?**

- We create global factor portfolios based on country indices and implemented through country ETFs or stock index futures rather than individual stocks.
- We use alternative to market capitalization weighting schemes to target exposure to rewarded factors to create portfolios that are factor tilted and at the same time well diversified.
- We include emerging markets in the investor's opportunity set to increase the number of assets available and improve latitude in factor portfolio construction.
- We create global multifactor portfolios under different portfolio construction rules, with and without tracking error constraints and compare their performance to the world market portfolio.
- We investigate whether country based factor portfolios are proxies for stock based factor portfolios or whether they represent rewards to independent global risks.



- **What do we find?**

- We find that country based factor portfolios are a viable alternative implementation of factor investing in global equity management in the real world of illiquidity, transaction costs and capacity constraints.
- Multifactor portfolios created as a combination of country based factors achieve superior absolute risk adjusted performance, positive active returns, low tracking error and reasonable transaction costs.
- Country based multifactor portfolios perform well compared to the typical commercially available investable stock based factor indices used by investors as benchmarks to create factor portfolios.

- **What are the practical implications of our research?**

- Our empirical evidence suggests that country based factors are a linear combination of the well-known Fama and French factors
- Our paper applies the principles of factor investing to create an investable global factor portfolio using as alternative to individual stocks, country stock market indices.



Thank you!

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