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Abstract

Factor portfolios created by dynamically weighting country indices generated significant global market adjusted returns over the last thirty years. The comparison between stock and country based factor portfolios suggests that country based value, size and momentum factor portfolios implemented through index futures or country ETFs capture a large part of the return of stock based factor strategies. Given the complex issues and costs involved in implementing stock based factor strategies in practice, country based factor strategies offer a viable alternative. The behavior of the market and factor portfolios is dependent on the risk regime. A regime-dependent dynamic global factor portfolio outperforms the world equity market portfolio. The outperformance, in and out of sample, is robust to transaction costs and alternative portfolio construction methodologies.

JEL classification: G11, G15

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1. Introduction

There is now considerable evidence supporting the view that there are sources of return beyond traditional asset classes. Size, value and momentum risk premia are regarded as separate, independent sources of excess returns from the equity market premium. The existence of multiple risk premia means that the capitalization weighted portfolio of all stocks (the market portfolio) is no longer efficient. If factor returns are independent across countries, investing in a global portfolio of 'style' funds should provide considerable efficiency gains to a global equity portfolio. We examine the role of country indices in building a globally diversified portfolio of market, value, size and momentum premia.

Several studies have documented the profitability of investment strategies exposed to value, size and momentum[1]. In a recent paper, Fama and French (2012) examine international data for 23 developed equity markets and confirm the presence of significant value and momentum premia in international equity markets. Cakisi, Fabozzi and Tan (2012) also report consistent evidence of sizable factor premia in their study of 18 emerging markets. Most of the research on value, size and momentum premia use individual stock data. A number of papers have also looked whether the same tools used to create style portfolios based on individual stocks could be used to study the performance of investment strategies based on country or industry indices. The evidence reported in Richards (1997), Asness, Liew and Stevens (1997), Moskowitz and Giblatt (1999), Bhorjaj and Swaminathan (2006), Balvers and Wu (2006), Blitz and van Vliet (2008), Desrosiers, L'Her and Plante (2004) and Asness, Moskowitz and Pedersen (2013) suggest that valuation ratios like the PE ratio, market capitalization and past returns help explain the cross sectional variation of country or industry returns. Asness, Moskowitz and Pedersen (2013) report consistent value and momentum premia across different markets and asset classes.

The existence of value, size and momentum premia based on country indices is intriguing for two reasons. First, it raises the question on whether country based factor premia can be used to build a global portfolio of multiple premia that enhance the performance of the world market portfolio. Second, whether country based risk premia are similar to the risk premia documented using individual stocks. If country-based are similar to stock-based risk premia it is easier and less expensive to implement portfolio based investment passive strategies using futures or ETFs than constructing stock-based factor portfolios[2].

[1] A partial list of the most important papers includes for the size effect Banz (1981), Reinganum (1981), Brown, Kleidon and Marsh (1983), Lamourex and Sanger (1989), Fama and French (1992, 1993, 2012), Berk (1995), Heston, S.L., K.G. Rouwenhorst, and R.E. Wessels (1999), Horowitz, Loughran, and Savin (2000), Hawanini and Keim (2000) and Dimson, Marsh and Staunton (2002), for the value effect Basu (1977), Rosenberg, Reid and Lanstein (1985), Fama and French (1992) and Lakonishok, Shleifer and Vishny (1994) and for the momentum effect Jegadeesh and Titman (1993, 2001), Rouwenhorst (1998), Chui, Titman and Wei (2010), Griffin, Ji and Martin (2003), Grundy and Martin (2001).

[2] Building portfolios to capture factor premia using stocks is demanding. Even ignoring transaction costs and liquidity considerations, creating a portfolio that tracks factor returns requires a dynamic strategy as the portfolio of stocks held

Current research suggests that the distribution of asset returns is time varying characterized by periods of turbulence with high volatility and low returns followed by calmer periods with low volatility and above average returns[3]. In particular, in the high volatility regime equity market returns are negative while the Sharpe ratio for the value, small cap and momentum premia is close to zero. In the presence of regimes, portfolio managers should hold different portfolios depending on their forecasts of the future risk state[4]. Investors should scale down the volatility of their portfolios when volatility is high and increase the risk of their portfolios when volatility is below average. Regime based portfolio management is an attractive alternative to the traditional "one portfolio fits all" investment management practice.
The aim of this research is to:

1. compare the performance and risk characteristics of country versus stock based factor portfolios
2. examine the diversification benefits from investing in a portfolio of global factor premia constructed using country indices and
3. study whether a two-state regime driven portfolio of global style portfolios ads value compared to the static risk premia allocations studied both in and out of sample. We identify and predict regimes using a two-state regime-switching model of return dispersion[5].

The value, small cap and momentum country-based factor portfolios outperform the world market portfolio by 4.43%, 1.46% and 3.39%, per annum respectively. Our evidence suggests that country-based factor portfolios are good proxies of stock-based factor portfolios with similar average returns but higher volatilities. Country based factor portfolios can be constructed using liquid index futures and/or country ETFs avoiding the management and transaction costs required for the construction of factor portfolios using individual stocks. Global country based factor portfolios outperform the world market portfolio but the

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changes as risk attributes change. Academic papers usually ignore transaction costs, liquidity considerations, short-sale constraints and in general issues of investability confronted by investors in practice. Practitioners on the other hand have developed passive indices designed to capture factor premia that are investable but with controlled turnover. Despite long-standing evidence on the existence and profitability of non-market risk premia, individual investors have only very recently limited access to investment products that provide "passive" exposure to non-market risk premia.

[3] Evidence of regimes in the value, size and momentum premia are provided in the studies by Gulen, Xing, and Zhang (2011) and Stivers and Sun (2010).

[4] Studies that incorporate regimes in the portfolio construction process include Ang and Bekaert (2002, 2004), Guidolin and Ria (2010) and Tu (2010).

[5] Stock market return dispersion (RD) – defined as the cross sectional standard deviation of returns of a universe of securities – provides a timely, easy to calculate at any time frequency, model free measure of volatility. It measures the extent to which stocks move together or are diverging and has been used by both finance academics and practitioners to measure trends in aggregate idiosyncratic volatility, investors' herding behavior, micro-economic uncertainty, trends in global stock market correlations and as an indicator of potential alpha and a proxy for active risk. Research in Garcia, Mantilla-Garcia and Martellini (2012), Stivers and Sun(2010) and Angelidis, Sakkas and Tessaromatis (2013) suggests that RD is an effective proxy of the investment opportunity set with significant predictive power for stock returns, the value and momentum premia, market variance and the business cycle.

alpha generated can be fully explained by the exposure of these portfolios to the traditional stock-based market, value, size and momentum factors. Combining the country based factor portfolios with the world market portfolio improves the Sharpe ratio of the world market portfolio. The results are robust to various portfolio construction methodologies (mean-variance optimization, equal weights) used to create the global non-market factor portfolio.

The behavior of the market and factor premia is dependent on the risk regime. When we use return dispersion to identify future regimes we find that in the high-risk state (40% of the months in the sample) the average market and factor premia and the corresponding Sharpe ratios are close to zero. In contrast, in the low risk regime the excess return of the market and factor portfolios are statistically significantly different from zero with low volatilities. Incorporating regimes in the portfolio construction process improves the performance of the global portfolio further. The benefits of global factor portfolio investing and regime based portfolio construction are weaker but still significant in the out of sample 2000-2012 period.

In section 2, we describe the data and methodology used to create the country based portfolios and in section 3, we examine the performance of value, size and momentum portfolios and their exposure to stock based risk factors. Section 4 presents the performance of a global factor portfolio assuming a single state and in section 5 the performance of a regime dependent global factor portfolio strategy in and out of sample. Conclusions are in section 6.

2. Data and Methodology of Country Based Factor Construction

We use the 23 developed countries making up the MSCI World index. Data are provided by Datastream and cover the period July 1981 to December 2012. We use MSCI country total return indices to measure dollar country returns and the MSCI World index return to measure the performance of the world market portfolio. We have chosen this particular dataset because most of the developed markets indices have well established European domiciled country ETFs.

To construct the country based value portfolios we rank at the end of June in year t all countries by a composite[6] valuation indicator that combines a country's price to earnings ratio (PE), price to book ratio (PB), price to cash flow ratio (PC) and dividend yield. We form three portfolios containing one third of the

[6] The composite valuation indicator is calculated as the standardized sum of the standardized individual country valuation ratios and has a mean of one and a standard deviation of 1. Low values of the composite index indicate value and high values growth.

23 countries[7] each and calculate capitalization-weighted portfolio monthly returns over the next 6 months (countries remain in these portfolios from July of year t to December of the same year). We use a six-month rebalancing rule (June and December) to create three capitalization based country portfolios. The small capitalization portfolio contains a third of all countries with the lowest capitalization. We calculate the country based momentum portfolios by ranking monthly all countries according to their 6 month past performance. We form three portfolios containing in equal numbers the highest, medium and lowest momentum countries and calculate the portfolios capitalization weighted monthly returns over the next month.

We calculate stock based factor premia using data obtained from Thomson DataStream and covers all stocks (dead or alive) from July 30, 1981 to December 31, 2012 in the G7 markets: Canada, France, Germany, Italy, UK, and U.S.A. Returns are calculated in U.S.A. dollars. Following Ince and Porter (2006), Hou, Karolyi and Kho (2011), Guo and Savickas (2008), and Busse, Goyal and Wahal (2013) we impose various filters to minimize the risk of data errors and to account for potential peculiarities of the dataset. To calculate stock based factor returns we use a similar methodology to that used to create country based factor portfolios[8]. Global stock based factors are capitalization weighted portfolios of country factor portfolios.

Table 1 shows descriptive statistics for the 23 developed markets. Eighteen countries have a full history of monthly returns (1981:07-2012:12). Five countries have shorter return histories starting in 1988:01 (Finland, Greece, Ireland, New Zealand and Portugal). The world market portfolio has an average monthly return of 0.88% and a monthly standard deviation of 4.45%. During the 1981:07-2012:12 period stock markets in all 23 countries achieved positive returns. The Swedish stock market achieved the highest monthly average return (1.48%) and Ireland the lowest (0.49%).

Table 1 here

We show in table 1 the average composite value, capitalization and momentum measures per country. Based on the average composite value measure, the top three value countries are Belgium, Netherlands and

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[7] The dataset includes the following 23 countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Switzerland, Sweden, United Kingdom, and United States.

[8] At the end of June in year t we rank all stocks by the book to price ratio. We form three portfolios containing one third of all stocks each and calculate capitalization-weighted portfolio monthly returns over the next 6 months (stocks remain in these portfolios from July of year t to December of the same year). The small capitalization portfolio contains a third of all stocks with the lowest capitalization. To construct momentum portfolios we rank all stocks according to their 12 month past performance. We form three portfolios containing in equal numbers the highest, medium and lowest momentum stocks and calculate the portfolios capitalization weighted monthly returns over the next month. We use a six-month rebalancing rule (June and December) for the size and value factor portfolios and a monthly rebalancing rule for the momentum portfolios.

Spain. Japan, USA and Switzerland have the highest composite measure reading putting them in the category of growth countries. The average country momentum measure is 5.02% making Sweden, Denmark and Hong-Kong the highest momentum markets and Greece, Portugal and Japan the lowest momentum countries in the sample.

We also present the percentage of times a country entered one of the factor portfolios. The USA market entered the value portfolio 3% of the time and the growth portfolio 75% of the time, was always in the large capitalization portfolios and entered 32% of the time in the momentum portfolio. Japan, the second market by capitalization, entered the value portfolio 4% of the time and the growth portfolio 91% of the time a result of the high valuation measures for most of the period. The Japanese market was always in the large capitalization portfolio and 32% of the time in the high momentum portfolio. The UK market entered 25% of the time in the value portfolio, 100% of the time in the large capitalization portfolio and 25% in the high momentum portfolio. The value portfolio contains mainly European countries most of the time (Belgium 84%, Spain 57%, France 66%, Italy 61%, Netherlands 72% and Portugal 53%). Momentum on the other hand contains positions in all countries for about a third of the time. Countries entering the high momentum portfolio more than 40% of the time are Denmark, Finland, Hong-Kong, Norway, Sweden and Singapore, between 30%-40% Australia, Belgium, Canada, Spain, Greece, Ireland, Japan, Austria, Switzerland and USA. Germany, France, Italy, the Netherlands, New Zealand, Portugal and the UK enter the high momentum portfolio between 20%-30% of the time.

3. Global Factor Portfolios Using Equity Country Indices

3.1 The Performance of Global Value, Size and Momentum Factors

Panel A of table 2 presents the portfolio performance statistics for the world market portfolio and the value, size and momentum factor portfolios. In particular we show the annualized average, excess return, standard deviation and Sharpe ratios. The table also shows the return of the factor portfolios in excess of the world market portfolio (raw alpha), the tracking error and their information ratio.

During the 1981:07-2012:12 period the world market portfolio achieved an annualized return of 10.60% and a statistically significant excess return (market premium) of 6.04%. The annualized volatility of the market portfolio was 15.43%. The return to risk ratio as measured by the annualized Sharpe ratio was 0.39. A portfolio of countries tilted towards “inexpensive” (value) countries achieved an annualized return of 15.03% with 19.62% annualized volatility. The excess return of the value portfolio was 10.74% and the Sharpe ratio 0.53. The value portfolio outperformed the world portfolio by 4.43% with a tracking error of

9.81% and information ratio of 0.45. The portfolio consisting of countries with the smallest capitalization also outperformed the world market portfolio by 1.46 % with tracking error of 11.45% and information ratio of 0.13. The "small" capitalization portfolio is more volatile than the world market or value portfolios. The momentum portfolio achieved an annual return of 13.99%, volatility of 18.29% and a Sharpe ratio of 0.52.

Table 2 here

The performance measures presented in panel A of table 2 supports the following overall conclusions:

(a) the value, size and momentum portfolios outperformed the world market portfolio with significantly higher volatility. The Sharpe ratios of the factor portfolios are better than the Sharpe ratio of the market portfolio and (b) the raw alpha for all factor portfolios are positive and, with the exception of the size premium, statistically different from zero. The information ratios are positive but the high tracking errors suggests high active risk. The evidence suggests that adding the factor portfolios to the world market portfolio would enhance its performance and improve its Sharpe ratio.

How country based factor portfolio strategies compare with stock based portfolio strategies? Panel B of table 2 shows performance statistics for stock based investment strategies over the same period used to create the country-based strategies (1981:07-2012:12). Stock based value and size portfolios outperformed their country-based counterparts and the world market portfolio but with less risk (volatility) than country based portfolios[9]. Country based momentum portfolios in contrast outperformed stock based momentum portfolios and the world market portfolio. The combined effect of higher returns and lower volatility is that the Sharpe ratios of stock based portfolio strategies are higher[10] than country based strategies. Raw alphas, calculated as the difference between portfolio and benchmark return, are higher for value and small stock based strategies but have significantly lower volatilities than country-based factor portfolios. The active return to risk (information ratio) trade-off of all stock based strategies is significantly better than country-based strategies.

Panel C of table 2 shows the correlation matrix of the world market portfolio and the country and stock based value, size and momentum portfolios. The correlations between the factor portfolios are positive but less than perfect. Stock and country factor portfolios are long only portfolios and hence a large

[9] The hypothesis that average stock based factor portfolio returns are different from country based factor portfolio returns can be rejected at the 95% level of statistical significance.

[10] We use the approach of Jobson and Korkie (1981) and Memmel (2003) to test that hypothesis that the Sharpe ratios of stock versus country based factor portfolio are different. We find that the differences are statistically insignificant for size (z-statistic 0.97) and momentum (z-statistic 0.62) and statistically significant for the value portfolio (2.05).

part of their returns is due to the return of the market portfolio. The world market portfolio is highly but not perfectly correlated with the country factors (average correlation 0.84) while the average correlation between the factors is 0.79. Stock based portfolios are more correlated with the world market portfolio (average correlation 0.87), while the average correlation between the stock based factors is equal to 0.81. The average correlation between the country and stock based factor portfolios equals to 0.75. The correlations suggest that there are diversification benefits from combining the country factors in a global factor portfolio.

While average returns for both stock and country based factor portfolios are broadly similar, the main difference between the two methodologies lies in the risk of the portfolios. The lower volatility of stock-based factor portfolios reflects the better diversification of these portfolios compared with country-based portfolios. Better diversification might also explain the lower tracking error of stock based factor portfolios. The comparison between stock and country based factor portfolios suggests that country based value, size and momentum factors capture a large part of the return of stock based factor strategies. It also suggests that given the complex issues and costs involved in implementing stock based factor strategies in practice, country based factor strategies could offer a viable alternative.

3.2 The Factor Exposure of Global Value, Size and Momentum Portfolios

The evidence presented in table 2 suggests that all factor strategies outperform the capitalization weighted world market portfolio. The return difference between the factor strategies and the market index could be due to differences in exposures to systematic risk factors or could represent excess return due to market inefficiency.

We use the standard one factor market model and Carhart's (1997) four factor model to decompose factor portfolio returns in a systematic return component representing compensation for bearing factor risk and an alpha component representing compensation unexplained by systematic risk factors.

One factor model: $$r_p - r_f = \alpha + \beta_{mkt}\left(r_{mkt} - r_f\right) + \varepsilon_{p,i} \quad (1)$$

Four factor model: $$r_p - r_f = \alpha + \beta_{mkt}\left(r_{mkt} - r_f\right) + \beta_{size} r_{smb} + \beta_{hml} r_{hml} + \beta_{mom} r_{mom} + \varepsilon_{p,i}, \quad (2)$$

where $r_p - r_f$ is the excess return of the global factor (size or value or momentum) portfolio, $r_{mkt} - r_f$ is the excess market return, r_{smb} is the return of the size factor, r_{hml} is the return of the value factor, and r_{mom} is the return of the momentum factor[11].

[11] The stock based factors are calculated as the difference between the two extreme portfolios that are described in footnote 8.

The one factor model assumes that market risk represents the only systematic risk factor while the four-factor model assumes in addition risk factors due to size, value and momentum exposures. The estimated alpha is the abnormal return generated by the country based factor strategies. If the alpha of the strategies is zero, the payoff of the country based value strategies is spanned by the stock based factor strategies. Non-zero alphas will indicate that the country based factor strategies generate abnormal returns not explained by exposure to the four-factor model of Carhart (1997).

Table 3 here

For the global value factor, the one-factor model produces a positive and statistically significant alpha of 32 bps per month. The outperformance of the value portfolio remains after adjusting for the market risk of the portfolio. Using the four-factor model, the alpha of the value strategy is statistically insignificant. The evidence suggests that the outperformance of the value strategy is fully explained by the strategy's exposure to systematic factors.

The global size portfolio strategy produces a one-factor model monthly alpha of 10 bps but the estimate is insignificant. When we use the four-factor model to adjust for risk we find that the size portfolio has a market beta above 1 and positive exposures to the size, value and the momentum factors. Smaller capitalization countries tend to be value and momentum markets. The four-factor model alpha estimate is close to zero and statistically insignificant. The exposure of the size portfolio strategy to the factors accounts for the positive return difference between the portfolio and the world market index.

The momentum strategy has an alpha of 29 bps when the one-factor model is used to adjust for market risk. Using the four-factor model reduces the alpha to 15 bps. The momentum portfolio strategy has by construction a positive exposure to the momentum factor and insignificant exposures to the value and size factors.

The empirical evidence in table 2 suggests that country based value, size and momentum portfolio strategies outperform the world market portfolio by 4.43%, 1.46% and 3.39% annually respectively. When we adjust for risk using a four-factor model the outperformance is reduced drastically for the value and size portfolios (1.22% and -2.64%). For the momentum portfolio strategy the outperformance is reduced to 1.8%. We conclude that country based factor portfolio strategies are significantly exposed to the value, size and momentum factors derived from stocks. In that sense, country based factor portfolios might be thought as an alternative and cheaper way to access stock-based value, size and momentum premiums.

3.3 Global Factor Strategies: Turnover and Costs

Are country based factor portfolio strategies robust after transaction costs? Table 4 shows annual turnover rates and the break-even cost for each strategy. The break-even costs, defined as raw alpha divided by annual turnover, are the transaction costs that make the alpha of the factor portfolio zero and therefore make the strategy unprofitable.

Table 4 here

The value strategy has two-way turnover of 93.7% per annum. Assuming transaction costs of 20 bps (50 bps) reduces the alpha of the strategy by 19bps (47bps) respectively. The alpha becomes zero if the costs of trading exceed 473 bps. The size factor generates very modest annual turnover of 19.1% and remains profitable in the presence of transaction costs. For 20 bps (50bps) trading costs the outperformance of the size strategy is reduces by 4bps (10bps) respectively. The turnover of the momentum strategy is at 643.5% per annum, significantly higher than the other two factors. High turnover rates for country-based momentum strategies are reported by Descrosiers, L'Her and Plante (2004), Balvers and Wu (2005) and Blitz and van Vliet (2008). Round-trip transaction costs of 20 bps eliminate 1.29% of the strategy's outperformance. If trading costs are 50 bps, outperformance is almost eliminated (trading costs 3.22% versus alpha of 3.40%).

4. Globally Diversified Factor Portfolio – Single State

The evidence presented above suggest that country based factor strategies offer better return to risk trade-offs compared with the world market portfolio. A portfolio of factor strategies will further improve the return to risk trade off assuming the returns of the strategies are not perfectly correlated[12].

We use two different portfolio construction methodologies to create the global factor portfolio: mean-variance optimization and equally weighted. Mean–variance optimization is at the core of modern portfolio theory but in practical implementation estimation errors could lead to extreme portfolios. To assess the robustness of mean-variance optimization in creating a global factor portfolio we also create portfolios using equal weights.

The global factor portfolio is a combination of the long only factor portfolios with the world market portfolio using optimization to decide the appropriate mix of the global factor and world market portfolios. Formally, we maximize the Sharpe ratio: $\max(\frac{w'\mu - r_f}{\sqrt{w'\Sigma w}})$ where w is 1x4 matrix of the weights, μ is a4x1 mean matrix, and Σ is a 4x4 variance-covariance matrix. Optimal portfolios are

[12] To test statistically whether the factor portfolios are spanned by the world market portfolio we use the spanning test suggested by Huberman and Kandel (1987). The test suggests that the factor portfolios cannot be spanned by the market portfolio (p value = 0.007). Detailed results from the authors upon request.

created under the assumption of a) tracking error constraints of 2% (low active risk), and 5% (high active risk) against the world market portfolio.

Table 5 shows the performance characteristics of combinations of the world market portfolio with single global value, size and momentum portfolios. It also shows combinations of the world market portfolio with a portfolio of global factor portfolios constructed using mean-variance optimization, or equal weighting.

Tilting the world market portfolio[13] toward global value outperforms the world market portfolio by 0.91% in the low active risk case (tracking error less than 2%) and by 2.26% in the high active risk case (tracking error less than 5%). The outperformance is achieved with higher volatility. Despite the higher volatility, the Sharpe ratio of the global value factor portfolio combination (0.44 and 0.49 for low and high active risk respectively) is better than the Sharpe ratio of the world market portfolio (0.39). The active return to risk (information) ratio is 0.45, well above the median information ratios of a sample of mutual fund managers reported in Goodwin (1998). Tilting the world market portfolio towards the global size portfolios increases marginally the return of the world market portfolio. Blending the world market portfolio with the momentum factor increases the Sharpe ratio of the market portfolio and achieves an information ratio of 0.34.

Table 5 here

Combining the world market portfolio with a portfolio of global factors using mean-variance optimization outperforms the world market portfolio by 1.02% and 2.55% in the low and high active risk cases. The global portfolio offers an attractive active return to risk trade off (0.52) comparable with information ratios regarded as "good" in institutional investment management[14].

Table 5 also shows portfolio performance statistics for global factor portfolios constructed using equal weights. Using alternative weights to market capitalization allows an assessment of the robustness of the results to alternative portfolio construction methodologies. Equal portfolio weights is a simple and robust portfolio construction methodology that requires no estimates of risk and return and hence eliminates the effect of estimation error on portfolio construction. DeMiguel, Garlappi and Uppal (2009) argue that equally weighting should be a benchmark to assess the performance of other portfolio construction methodologies. With equal weighting we invest equally in the value, size and momentum portfolios and then use mean-variance optimization to decide the split between the world market portfolio

[13] The weight of the market portfolio for the 2% (5%) tracking error constraint is equal to 79.50% (48.87%).
[14] See Goodwin (1998) and Grinold and Kahn (1992).

and the combined factor portfolio. In this case, the weight of the market portfolio for the 2% (5%) tracking error constraint is equal to 73.72% (34.33%).

Using equal weights to construct the global factor portfolio produces similar performance in terms of return and risk to portfolios generated from mean-variance optimization. The Sharpe ratios are very similar while information ratios are slightly lower. The superiority of mean variance portfolio construction in sample is expected. We look at the out of sample evidence in section 5 of the paper.

5. Portfolio construction in a risk on - risk off framework

5.1 Identifying regimes in factor returns

We identify regimes by modeling return dispersion as a two-state regime-switching model described by the following equation:

$$\mathrm{RD_t} = \mu_{S_t} + \varepsilon_t, \varepsilon_t \sim N(0, \sigma_{S_t}), \tag{3}$$

where μ_{S_t} and σ_{S_t} are the mean and the standard deviation that are state dependent at time t. Following Hamilton (1989), we hypothesize that the process is first-order Markov and is described by a latent variable $S_t = 1,2$, while its transition matrix Π is characterized by constant probabilities (P,Q). Q (P) is the probability to stay in the low (high) risk regime. The RD regime model is a much simpler, more intuitive and easier to explain model of future volatility compared with a joint regime model describing the four states[15].

We calculate daily the cross-sectional variance at time t (CSV_t) using the following equation:

$$CSV_t = \sum_{i=1}^{N} w_{it} (r_{it} - r_{mt})^2, \tag{4}$$

where r_{it} is the return of index i in day t, r_{mt} is the return of the MSCI Developed stock index in day t, N is the number of indices and w_{it} is the market capitalization weight of index i in day $t-1$. We average daily CSVs to construct a monthly series. Return dispersion equals $\sqrt{CSV_t}$.

Table 6 presents the results from the estimation of equation 3. The Akaike, Schwarz, and Hannan-Quinn information criterion show that the state dependent specification describes better the behavior of

[15] In-sample results using a joint regime model for the factors are qualitatively similar to the return dispersion regime model and are available from the authors upon request. For the out-of-sample period, we obtain reliable estimates of the model only after 2004.

return dispersion than the single state process. A likelihood ratio test also shows that the test statistic is greater than the corresponding value of the chi-square distribution.

Return dispersion is 1.5 times greater than that of the low variance regime and the volatility of return dispersion is 2 times greater than that of the low risk regime. In state 1 (high risk environment) return dispersion (volatility) is equal to 0.0575 (0.0153) and in the state 2 is equal to 0.0385 (0.0075), a finding that implies that risk is not only higher during high periods of high volatility but it is also more volatile. Both states are persistent as the probability to stay in regime 1 (2) given that we are in regime 1 (2) equals 0.91 (0.94) and the market stays on the high (low) risk environment on average 11 (16) months.

Table 6 here

Table 7 shows the excess return, standard deviation, t-statistic testing the hypothesis that the excess return is zero and the Sharpe ratio of the world market portfolio and the global value, size and momentum portfolios in the high and low volatility regimes identified by the regime model. The regime model categorizes 145 months (38% of the sample) as high risk and 233 months (62% of the sample) as low risk. The excess returns of all portfolios are lower in the high-risk regime than the low-risk regime. In fact the market portfolio excess return is close to zero for the market, value portfolios and negative for the small capitalization portfolio. Portfolio volatility is markedly higher in the high-risk regime for all portfolios. As a result the hypothesis that in the high risk regime the excess returns for all factors is zero cannot be rejected. In contrast average excess returns are statistically different from zero in the low risk regime.

Table 7 here

The combination of low returns / high volatility in the high-risk regime and high returns/ low volatility in the low risk regime means that the return to risk is almost zero when risk is high. The Sharpe ratios are close to zero in the high risk environment and close to one in the low risk regime. If regimes can be predicted the investor would hold a less risky portfolio (cash if available) in the high-risk regime and a riskier portfolio when risk is low.

5.2. Regime-dependent factor allocation – in sample evidence

We construct the optimal global market and factor portfolio by maximizing the Sharpe ratio under the state dependent hypothesis. In the state dependent environment, we form the portfolio by maximizing the Sharpe ratio:

$$\frac{\pi_1 W_1 \mu_1 + \pi_2 W_2 \mu_2 - r_f}{\sqrt{\pi_1 \sigma_1^2 + \pi_2 \sigma_2^2}}, \tag{5}$$

where $\pi_1 (\pi_2)$ is the probability of dispersion to be in state 1(2), μ_1 (μ_2) is an 4x1 mean matrix of state 1 (2), $\sigma_1^2 = w_1 \Sigma_1 {w_1}^T$ is the variance of state 1, and $\sigma_2^2 = w_2 \Sigma_2 {w_2}^T$ is the variance of state 2. If the smoothed probability of dispersion is greater (lower) than 50%, we classify the month as a high (low) risk and we use the corresponding weights. The proposed modeling approach has a clear advantage over the single state as both the mean and the variance-covariance processes can change based on the current state and hence investors can alter the portfolio allocation accordingly.

Table 8 shows portfolio statistics for portfolios constructed dependent on the risk regime. We construct four global portfolios as combinations of the world market portfolio with (1) the global value portfolio (2) the global size portfolio, (3) the global momentum portfolio and (4) a combination of the global value, size and momentum portfolios. In each case, we construct a low and a high active risk portfolio using equation 5 and historical estimates of returns and the covariance matrix. The low active risk portfolio is designed to have maximum Sharpe ratio under the constraint that the tracking error of the portfolio against the optimal global static factor portfolio is up to 2% per annum. The high active risk portfolio has a tracking error limit of 5% annum.

During the July 1981-December 2012 period the world market portfolio achieved a total return of 10.60% with standard deviation of 15.43% and a Sharpe ratio of 0.39. The combination of the world market portfolio with the global factor portfolios produces better portfolios than the market portfolio. The combination of the world market portfolio with the global value portfolio[16] outperforms the market portfolio by 1.90% (TE 2%) and 3.66% (TE5%). The Sharpe ratio is improved from 0.39 for the world market portfolio to 0.49 in the low active risk case and to 0.55 in the high risk case. The active return to risk as measured by the information ratio (0.53 for the 2% TE) suggests a reasonably profitable active strategy by practical standards[17]. The turnover of the low active risk strategy is 51.91% per annum and in combination with the excess return suggests that the strategy will be profitable unless the investor faces transaction costs in excess of 3.67%. In the high risk case the global portfolio achieves higher return, Sharpe and information ratio. Turnover is also higher but the breakeven transaction costs are too high to make the portfolio strategy unprofitable. Similar results are obtained when we combine the world market portfolio with the momentum portfolios.

[16] For the 2% tracking error constraint the weight of the market portfolio during volatile (quiet) periods is equal to 85.78% (51.00%).
[17] See Goodwin (1998) and Grinold and Kahn (1992).

Table 8 here

Combining the world market portfolio with the size portfolio taking into account regimes improves the performance of the combines portfolio compared with the market portfolio. The global small cap portfolio achieves Sharpe ratios of 0.46 (low active risk) and 0.53 (high active risk) and information ratio of 0.46. The regime-dependent global small cap portfolio outperforms also the static, single state global small cap portfolio presented in table 5 and highlights the importance of regime-dependent portfolio construction.

The performance of the global market, value, size and momentum portfolio dominates all other global portfolio combinations. Using mean-variance optimization to find the weights allocated to the market portfolio[18] and the global factor portfolios improves the return, Sharpe and information ratios of all other portfolio strategies. The improvement in return is achieved with similar turnover to single global factor portfolio combinations. The high breakeven costs suggest that the portfolio strategy will be profitable even for retail investors who now have access to ETFs. The results are robust when we assume that the value, size and momentum portfolios are equally weighted rather than derived from mean-variance optimization, when combined with the world market portfolio. Comparing the single state case (table 5) with the two-state case (table 8) we find that regimes improve portfolio statistics in all cases and portfolio combinations. In the case of the global size portfolio combination that was unprofitable under single state static strategy, the dynamic portfolio strategy improves returns and the return to risk trade-off.

5.3. Regime-dependent factor allocation – out of sample evidence

At the end of each year, starting in December 1999, we construct a high risk and a low risk global portfolio based on historical returns up to the end of the year. We create dynamic forecasts of month t state probabilities using the regime model estimated using data until period t-1. Depending on next state's prediction we assume that the investor holds either the low or the high risk portfolio. To control turnover we keep the composition of these portfolios the same over next year. The dynamic generation of state forecasts and low/high risk portfolios using each time data available at the time of forecasting and portfolio construction produces the out-of-sample monthly portfolio returns.

Table 9 here

[18] In the low risk case the weight of the market portfolio during volatile (quiet) periods is equal to 67.55% (44.85%).

During the out of sample period, the world market portfolio achieved an annual arithmetic average return of 3.26% and excess return of 1.14%. The value, size and momentum portfolios had also significantly lower excess returns than the full sample (3.48% versus 10.51% for value, 3.73% versus 7.54% for size and 0.61% versus 9.47% for momentum, for the 2000-2012 and 1981:07-2012:12 samples respectively). Global factor portfolio returns had higher volatility compared with the volatility of the factors portfolios during the full sample. Lower returns and higher volatilities produced sharply low Sharpe ratio in the out of sample period. For example, the Sharpe ratio of the world market portfolio decreased from 0.39 to 0.07, of the value portfolio from 0.53 to 0.14, of the small cap portfolio from 0.38 to 0.16 and of the momentum portfolio from 0.52 to 0.04. In the out of sample period, equity investors got a smaller compensation for bearing risk.

Regime-dependent global factor portfolios outperformed the world market portfolio with the exception of the momentum portfolio. A dynamic combination of the world market portfolio with the value portfolio creates a portfolio with a Sharpe ratio of 0.12 (4.56% tracking error) and 0.16 (8.69% tracking error). Tilting towards the size portfolio performs even better, achieving an information ratio of 0.53.

A dynamic portfolio strategy combining the world market portfolio with a global portfolio of factors constructed using mean variance optimization improved the performance of the world portfolio. The Sharpe ratio of the global portfolio is 0.12 for the 3.93% tracking error portfolio and 0.15 for the 8.06% tracking error portfolio. An equally weighted portfolio of the factors dynamically combined with the world market portfolio improves performance further. The Sharpe ratio increases to 0.14 (tracking error 4.14%) and 0.17 (tracking error 6.36%).

The breakeven transaction costs estimates required to make the portfolios presented in table 10 (with the exception of the momentum combination) are unlikely to eliminate the outperformance generated by the regime dependent strategies. Even retail investors have today access to the low cost country ETFs needed to create the factor portfolios and implement the tactical moves suggested by the regimes.

6. Conclusion

Country based factor portfolios created by dynamically weighting country indices posted significant market risk-adjusted returns over the last thirty years. Long-only value, size and momentum portfolios outperform the world market portfolio achieving significantly higher Sharpe ratios. A diversified portfolio of factor portfolios and the world market portfolio improves the return to risk of the market portfolio. The return to risk offered by country based factor portfolios is comparable to the return of the traditional stock-based factor portfolios. Our evidence suggests that the outperformance of a globally diversified portfolio of factor funds is due to its exposure to the stock based market, value, size and momentum factors. Given that country-based factors are easier and less expensive to create and manage, we conclude that they represent a viable alternative to stock-based factor portfolios.

Regime based portfolio construction is an attractive alternative to static portfolios or continuously changing portfolios. Using return dispersion as a proxy for risk, we split the sample in high and low risk states. We find that in the high-risk environment the return to risk offered is close to zero. In contrast, the market, value, size and momentum premia are all positive and significant in the low risk regime. Regime dependent portfolios add value compared to single state static portfolios. The evidence, in and out of sample, is robust to transactions costs and alternative portfolio construction methodologies.

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Table 1. Descriptive Statistics for Countries and Percentage of Times a Country is Included in the Global Factor Portfolios.

This table shows the monthly average return and standard deviation for the 23 developed markets. It also presents the percentage of times a country is included in the global factor portfolios and the average values of the composite index, market capitalization and momentum for each country. For the value-premium portfolios, we rank at the end of June in year t all countries by a composite that combines the following country ratios: price to earnings, price to book, price to cash flow and dividend yield. Then we form three portfolios containing one third of the 23 countries. For the size premium portfolios, we rank at the end of June in year t all countries by market capitalization and then we form three portfolios containing one third of the 23 countries. For the momentum premium, we rank every month all countries according to their 6 month past performance and then we form three portfolios containing in equal numbers the highest, medium and lowest momentum countries. The sample period is from 1981M07 to 2012M12.

	Descriptive Statistics		Relative Inclusion			Relative Inclusion			Relative Inclusion			
Market	Average Return	Stand. Dev.	Average composite	Value	Growth	Average Capitalization	Small	Large	Average Momentum	Low	High	Sample from
Australia	1.09%	6.82%	-0.07	31%	24%	$381,165	0%	7%	5.99%	33%	39%	1981M07
Austria	0.98%	7.62%	-0.08	37%	45%	$44,953	100%	0%	5.06%	44%	31%	1981M07
Belgium	1.26%	6.22%	-0.94	84%	4%	$119,565	22%	0%	5.49%	30%	36%	1981M07
Canada	0.92%	5.79%	0.02	3%	33%	$574,123	0%	93%	5.45%	33%	31%	1981M07
Denmark	1.22%	5.94%	0.35	15%	49%	$76,416	100%	0%	6.44%	27%	40%	1981M07
Finland	1.08%	9.33%	0.13	29%	29%	$124,123	65%	0%	4.10%	40%	41%	1988M01
France	1.18%	6.25%	-0.58	66%	3%	$775,363	0%	76%	5.63%	29%	27%	1981M07
Germany	1.11%	6.77%	-0.37	30%	10%	$672,187	0%	100%	4.42%	34%	26%	1981M07
Greece	0.78%	11.00%	-0.11	47%	32%	$58,135	98%	0%	1.37%	49%	33%	1988M01
Hong-Kong	1.23%	8.51%	-0.11	22%	36%	$476,991	0%	37%	6.38%	33%	46%	1981M07
Ireland	0.49%	6.56%	0.06	30%	40%	$41,995	100%	0%	5.09%	31%	36%	1988M01
Italy	0.85%	7.38%	-0.50	61%	19%	$347,632	1%	34%	4.71%	46%	25%	1981M07
Japan	0.67%	6.44%	2.25	4%	91%	$2,620,723	0%	100%	3.14%	47%	32%	1981M07
Netherlands	1.22%	5.71%	-0.68	72%	3%	$320,573	0%	48%	5.68%	22%	25%	1981M07
New Zealand	0.74%	6.66%	0.10	24%	34%	$25,107	75%	0%	4.67%	27%	30%	1988M01
Norway	1.27%	7.85%	-0.53	55%	16%	$80,614	90%	0%	5.80%	26%	48%	1981M07
Portugal	0.47%	6.71%	-0.28	53%	19%	$53,124	98%	0%	2.47%	42%	30%	1988M01
Singapore	0.86%	7.59%	0.30	24%	55%	$141,361	46%	0%	5.37%	38%	42%	1981M07
Spain	1.20%	7.22%	-0.60	57%	6%	$368,501	0%	0%	4.26%	32%	30%	1981M07
Sweden	1.48%	7.54%	0.19	13%	49%	$196,151	19%	0%	6.89%	27%	44%	1981M07
Switzerland	1.14%	5.17%	0.55	13%	73%	$463,490	0%	46%	5.63%	30%	34%	1981M07
UK	1.00%	5.39%	-0.14	25%	25%	$1,532,287	0%	100%	5.79%	27%	25%	1981M07
USA	0.96%	4.47%	0.86	3%	75%	$7,231,845	0%	100%	5.63%	33%	32%	1981M07

Table 2. Factor Portfolios Based on Countries and Stocks: Return, Risk and Correlations

The table shows the annualized average, excess return, standard deviation, Sharpe ratios, the return of the portfolios in excess of the world market portfolio (raw alpha), tracking errors and the information ratios of the country based (panel A) and stock based (panel B) factor portfolios. The stock based portfolios use data from the G7 markets: Canada, France, Germany, Italy, UK, and USA. The global size, value and momentum portfolios are calculated as a value weighted average of individual country portfolios. T-statistics are based on HAC standard errors. Panel C presents the correlation coefficients between market, country based and stock based portfolios. The sample period is from 1981M07 to 2012M12.

		Panel A: Country Based			Panel B: Stock Based		
	Market	Value	Small	Hmom	Value	Small	Hmom
Average Return	10.60%	15.03%	12.06%	13.99%	16.68%	12.23%	13.35%
Standard Deviation	15.43%	19.62%	19.83%	18.29%	15.88%	15.26%	15.03%
Excess Return	6.04%	10.47%	7.50%	9.43%	12.12%	7.68%	8.79%
Sharpe Ratio	0.39	0.53	0.38	0.52	0.76	0.50	0.58
Raw alpha		4.43%	1.46%	3.39%	6.08%	1.63%	2.75%
t-statistic alpha ≠ 0		2.95	0.63	1.88	3.88	0.82	2.40
Tracking Error		9.81%	11.45%	9.88%	6.70%	10.08%	6.12%
Information Ratio		0.45	0.13	0.34	0.91	0.16	0.45

Panel C: Correlation Analysis

		Country Based			Stock Based		
	Market	Value	Small	Hmom	Value	Small	Hmom
Market	1.00						
Country Based Value	0.87	1.00					
Country Based Small	0.82	0.87	1.00				
Country Based Hmom	0.84	0.77	0.74	1.00			
Stock Based Value	0.91	0.81	0.78	0.74	1.00		
Stock Based Small	0.78	0.70	0.74	0.65	0.84	1.00	
Stock Based Hmom	0.92	0.76	0.74	0.81	0.80	0.78	1.00

Table 3. Factor Exposure of Country-based Global Factor Strategies

This table presents the estimated coefficients of the following regressions:

One factor model: $r_p - r_f = \alpha + \beta_{mkt}(r_{mkt} - r_f) + \varepsilon_{p,i}$ (1)

Four factor model: $r_p - r_f = \alpha + \beta_{mkt}(r_{mkt} - r_f) + \beta_{size} r_{smb} + \beta_{hml} r_{hml} + \beta_{mom} r_{mom} + \varepsilon_{p,i}$, (2)

where $r_p - r_f$ is the excess return of the global country based factor (size or value or momentum) portfolio, $r_{mkt} - r_f$ is the excess market return, r_{smb} is the return of the size factor, r_{hml} is the return of the value factor, and r_{mom} is the return of the momentum factor. T-statistics are based on HAC standard errors. The sample period is from 1981M07 to 2012M12.

	Value		Size		Momentum	
Exposure	1-factor	4-factor	1-factor	4-factor	1-factor	4-factor
alpha	0.003	0.001	0.001	-0.002	0.003	0.001
t-statistic	2.49	0.78	0.470	-1.26	1.833	0.83
β_{mkt}	1.10	1.13	1.05	1.13	0.99	1.02
t-statistic	23.84	28.27	15.38	20.19	22.60	22.12
β_{hml}		0.30		0.36		0.12
t-statistic		3.90		3.65		1.20
β_{smb}		0.11		0.42		-0.017
t-statistic		1.62		5.96		-0.28
β_{mom}		0.08		0.17		0.22
t-statistic		1.24		2.94		3.11
Adjusted R-Square	0.76	0.77	0.67	0.73	0.71	0.72

Table 4. Constructing Country Based Global Factors: Turnover and Costs

The table shows annual turnover rates and the break-even cost for each strategy. Break-even costs are defined as raw alpha divided by annual turnover.

Portfolios	Annual Turnover	Raw Alpha	Break-even Trading Costs
Value	93.70%	4.43%	4.73%
Small	19.10%	1.46%	7.64%
High Momentum	643.50%	3.39%	0.53%

Table 5. Combining the World Market Portfolio with Global Factors

The table shows the performance characteristics of combinations of the world market portfolio with single global value, size and momentum portfolios. It also shows combinations of the world market portfolio with a portfolio of global country based factor portfolios constructed using mean-variance optimization and equal weighting. Optimal portfolios are created under the assumption of a) tracking error constraints of 2% (low active risk) and 5% (high active risk) against the world market portfolio. It also shows the weight of the world market portfolio for each portfolio combination. The sample period is from 1981M07 to 2012M12.

		Average Return	Standard Deviation	Sharpe Ratio	Raw Alpha	Tracking Error	Information Ratio
World market portfolio		10.60%	15.43%	0.39			
World market portfolio combined with:							
1. Global value	TE 2%	11.51%	15.89%	0.44	0.91%	2.01%	0.45
	TE5%	12.87%	17.00%	0.49	2.26%	5.02%	0.45
2. Global small size	TE 2%	10.77%	15.57%	0.40	0.17%	1.30%	0.13
	TE5%	10.77%	15.57%	0.40	0.17%	1.30%	0.13
3. Global high momentum	TE 2%	11.26%	15.54%	0.43	0.66%	1.93%	0.34
	TE5%	12.26%	16.15%	0.48	1.66%	4.82%	0.34
4. Global value, small and high momentum							
- Mean variance optimization	TE 2%	11.63%	15.75%	0.45	1.02%	1.96%	0.52
	TE5%	13.16%	16.66%	0.52	2.55%	4.89%	0.52
- Equally weighted	TE 2%	11.41%	15.76%	0.43	0.81%	1.98%	0.41
	TE5%	12.63%	16.69%	0.48	2.03%	4.94%	0.41

	Weight of the world market portfolio	
World market portfolio combined with:	TE 2%	TE 5%
1. Global value	79.50%	48.87%
2. Global small size	88.64%	88.64%
3. Global high momentum	80.47%	51.19%
4. Global value, small and high momentum		
- Mean variance optimization	73.72%	34.33%
- Equally weighted	73.80%	34.50%

Table 6. Regime Switching and Return Dispersion.

This table presents the estimated coefficients of a regime-switching model for the return dispersion. The regime switching model is described as: $\begin{matrix} RD_t = \mu_1 + \varepsilon_{t1}, \varepsilon_{t1} \sim N(0, \sigma_1^2) \\ RD_t = \mu_2 + \varepsilon_{t2}, \varepsilon_{t2} \sim N(0, \sigma_2^2) \end{matrix}$ where μ_j and σ_j are the conditional mean and the standard deviation for state j=1, 2. The process is a first-order Markov which is described by latent variable $S_t = 1,2$, and by constant probabilities (P, Q). It also presents three information criterion (Akaike, Schwarz, and Hannan-Quinn), and the log likelihood values for the 2-state and single state specifications. The sample period is from 1981M07 to 2012M12.

	Coefficient	p value
μ_1	0.0575	0.00
μ_2	0.0385	0.00
σ_1	0.0153	0.00
σ_2	0.0075	0.00
P	0.91	0.00
Q	0.94	0.00
Log likelihood	2-state: 1224.15	Single State: 1126.49
Akaike info criterion	2-state: -6.06	Single State: -5.60
Schwartz criterion	2-state: -6.00	Single State-5.59
Hannan-Quin criterion	2-state: -6.04	Single State: -5.60

Table 7. Global Factors Performance in High/Low Risk Regimes.

The table shows the excess return, standard deviation, t-statistic testing the hypothesis that the excess return is zero and the Sharpe ratio of the world market portfolio and the global value, size and momentum portfolios in the high and low volatility regimes identified by the regime model. The sample period is from 1981M07 to 2012M12.

		Excess return (Er)	Volatility	t-stat Er≠0	Sharpe ratio
High Risk	Market	0.14%	19.84%	0.02	0.01
	Value	1.24%	23.39%	0.18	0.05
	Small Cap	-4.78%	24.12%	-0.69	-0.20
	Mom	4.00%	21.98%	0.63	0.18
Low Risk	Market	9.72%	11.84%	3.61	0.75
	Value	15.97%	15.29%	4.60	0.99
	Small Cap	17.81%	15.07%	5.21	1.12
	Mom	13.24%	15.16%	3.85	0.81

Number of months in high risk regime: 145. Number of month in low risk regime: 233

Table 8. State Dependent Global Factor Portfolios – In Sample

This table shows portfolio statistics for portfolios constructed dependent on the risk regime. We construct four global portfolios as combinations of the world market portfolio with (1) the global value portfolio (2) the global size portfolio, (3) the global momentum portfolio and (4) a combination of the global value, size and momentum portfolios. Regime-optimal portfolios are created under the assumption of a) tracking error constraints of 2% (low active risk) and 5% (high active risk) against the single state optimal portfolio. It also shows the weight of the world market portfolio for each portfolio combination. The sample period is from 1981M07 to 2012M12.

		Average Return	Standard Deviation	Sharpe Ratio	Raw Alpha	TE	Information Ratio	Turnover	Breakeven Tr. Costs
World market portfolio		10.60%	15.43%	0.39					
World market portfolio combined with:									
1. Global value portfolio	TE 2%	12.50%	16.29%	0.49	1.90%	3.56%	0.53	51.91%	3.66%
	TE5%	14.26%	17.55%	0.55	3.66%	6.98%	0.52	149.25%	2.45%
2. Global small size portfolio	TE 2%	11.83%	15.65%	0.46	1.23%	2.67%	0.46	51.55%	2.39%
	TE5%	13.31%	16.48%	0.53	2.71%	5.87%	0.46	113.25%	2.39%
3. Global high momentum portfolio	TE 2%	11.88%	15.84%	0.46	1.28%	3.80%	0.34	13.84%	9.26%
	TE5%	13.72%	17.86%	0.51	3.12%	9.17%	0.34	23.29%	13.38%
4. Global value, small size and high momentum									
- Mean variance optimization	TE 2%	12.79%	16.02%	0.51	2.18%	3.53%	0.62	49.71%	4.39%
	TE5%	15.18%	17.38%	0.61	4.58%	7.75%	0.59	134.06%	3.41%
- Equally weighted	TE 2%	12.52%	16.10%	0.49	1.92%	3.45%	0.56	64.84%	2.96%
	TE5%	13.60%	16.62%	0.54	3.00%	5.23%	0.57	149.25%	2.01%

	Weight of the world market portfolio	
World market portfolio combined with:	TE 2%	TE 5%
	High Risk (Low Risk)	High Risk (Low Risk)
1. Global value	85.78% (51.00%)	100% (0%)
2. Global small size	100% (65.46%)	100% (51.21%)
3. Global high momentum	57.36% (66.63%)	0% (15.60%)
4. Global value, small and high momentum		
- Mean variance optimization	67.55% (44.85%)	30.52% (0%)
- Equally weighted	82.54% (36.49%)	100% (0%)

Table 9. State Dependent Global Factor Portfolios – Out of Sample

This table shows out-of-sample statistics for portfolios constructed dependent on the risk regime. We construct four global portfolios as combinations of the world market portfolio with (1) the global value portfolio (2) the global size portfolio, (3) the global momentum portfolio and (4) a combination of the global value, size and momentum portfolios. Regime-optimal portfolios are created under the assumption of a) tracking error constraints of 2% (low active risk) and 5% (high active risk) against the single state optimal portfolio.
At the end of each year, starting in December 1999, we construct a high risk and a low risk portfolio based on historical returns up to the end of the year. We create dynamic forecasts of month t state probabilities using the regime model estimated using data until period t-1. Depending on next state's prediction we assume that the investor holds either the low or the high risk portfolio. To control turnover we keep the composition of these portfolios the same over next year. The dynamic generation of state forecasts and low/high risk portfolios using each time data available at the time of forecasting and portfolio construction produces the out-of-sample monthly portfolio returns. The sample period is from 2000M01 to 2012M12.

		Average Return	Standard Deviation	Sharpe Ratio	Raw Alpha	TE	Information Ratio	Turnover	Breakeven Tr. Costs
World market portfolio		3.26%	16.64%	0.07					
World market portfolio combined with:									
1. Global value portfolio	TE 2%	4.39%	18.74%	0.12	1.13%	4.56%	0.25	39.09%	2.88%
	TE5%	5.49%	21.33%	0.16	2.23%	8.69%	0.26	86.90%	2.56%
2. Global small size portfolio	TE 2%	4.90%	17.94%	0.16	1.64%	3.12%	0.53	41.52%	3.95%
	TE5%	6.59%	18.94%	0.24	3.33%	5.70%	0.58	79.40%	4.19%
3. Global high momentum portfolio	TE 2%	3.19%	17.01%	0.06	-0.07%	2.39%	-0.03	18.00%	-0.41%
	TE5%	2.96%	62.43%	0.01	-0.30%	5.61%	-0.05	43.60%	-0.68%
4. Global value, small size and high momentum									
- Mean variance optimization	TE 2%	4.35%	18.35%	0.12	1.09%	3.93%	0.28	41.80%	2.60%
	TE5%	5.25%	20.77%	0.15	1.99%	8.06%	0.25	106.99%	1.86%
- Equally weighted	TE 2%	4.63%	18.60%	0.14	1.37%	4.14%	0.33	46.69%	2.94%
	TE5%	5.58%	19.90%	0.17	2.32%	6.36%	0.37	56.25%	4.13%