**5. Anatomy of momentum risk**

In this part, we replicate the Part 5 of the original Paper.

Quote: “A well-documented result in the momentum literature is that momentum has time-varying market betas (Grundy and Martin, 2001). This is an intuitive finding because, after bear markets, winners are low-beta stocks and the losers have high betas. But Daniel and Moskowitz (2012) show that using betas to hedge risk in real time does not work. This contrasts with our finding that the risk of momentum is highly predictable and managing it offers strong gains. Why is scaling with forecasted variances so different from hedging with market betas? We show it is because time-varying betas are not the main source of predictability in momentum risk.

We use the market model to decompose the risk of momentum into market and specific risk:”

First, in Panel A, we replicate the distribution of WML and WML\* monthly returns. Next, we replicate the density fot the left-tail part for WML and WML\* monthly returns. (Here we still choose to use lower than −10 percentage points as left tail).

**Fig. 5. The density of plain momentum (WML) and risk-managed momentum (WMLn). The risk-managed momentum uses the realized variance in the previous six months to scale the exposure to momentum. The returns are from 1927:03 to 2011:12.**

图表, 折线图, 直方图

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**Fig. 6. The benefits of risk-management in the 1930s and the 2000s. The risk-managed momentum (WMLn) uses the realized variance in the previous six months to scale the exposure to momentum (WML).**

The realized variances and betas are estimated with six months of daily returns. On average, the market compo- nent β2t RVrmrf;t accounts for only **31%** of the total risk of momentum, which is different the the number given in the original paper, which is 23%. Almost **69%** of the momentum risk is specific to the strategy. Also, the different components do not have the same degree of predictability. Table 4 shows the results of an AR(1) on each component of risk.

**Table 4:Decomposition of the risk of momentum**

Each row shows the results of an AR(1) for six-month, non-overlapping periods. The first row is for the realized variance of the WML (winners minus losers); the second one, the realized variance of the market. The third row is squared beta, estimated as a simple regression of 126 daily returns of the WML on RMRF (market risk factor). The fourth row is the systematic component of momentum risk; the last row, the specific component. The out of sample R-squares use an expanding window of observations after an initial in-sample period of 20 years.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Variable | (t-statistics) | (t-statistics) |  |  |
|  | 0.0013 | 0.6271 | 10.98 | 46.33 |
|  | (4.153) | (10.451) |  |  |
|  | 0.0024 | 0.4808 | 38.34 | 0.09 |
|  | (5.737) | (7.555) |  |  |
|  | 0.1884 | 0.1125 | 1.60 | 4.16 |
|  | (9.822) | (1.552) |  |  |
|  | 0.0005 | 0.4368 | 2.55 | 34.10 |
|  | (4.025) | (6.685) |  |  |
|  | 0.0009 | 0.7144 | 23.00 | 44.03 |
|  | (3.353) | (11.513) |  |  |

Even thought Table 4 is not exactly the same with the one given in original paper, we find that the following points still hold in our replication.

* Either in-sample or out-of-sample, β2t is the least predictable component of momentum risk. Its OOS R-square is only **4.16%**. The realized variance of the market also has a small OOS R-square of **1.60%**.
* When combined, both elements form the market risk component and show more predictability with an OOS R-square of **34.10%**, but still less than the realized variance of momentum with an OOS R-square of **46.33%**.
* The most predictable component of momentum variance is the specific risk with an OOS R-square of **44.03%,** much more than predictability of the part due to the market.

**7. Robustness checks**

In this part, we conduct the robustness checks with our replicated model. We divide the sample into four subgroups (may have intersections), and for each subgroup, **we check the advantage of risk-managed WHL\* over WHL strategy**.

**Table 6 Performance of plain momentum (WML) and scaled momentum (WMLn) in different subsamples**

The first half of the sample is from 1927:03 to 1969:12. The second is from 1970:01 to 2011:12. The no-crash sample is from 1927:03 to 2011:12, excluding the years of 1932 and 2009. The post-war sample is from 1945:01 to 2005:12. The Sharpe ratio, standard deviation, information ratio, and the mean returns are all annualized. To obtain an information ratio that does not depend on the volatility target we divided previously both WML and WMLn by their respective standard deviations.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **First\_half** | | **Second\_half** | | **Non\_Crash** | | **Post\_War** | |
| **WML** | **WML\*** | **WML** | **WML\*** | **WML** | **WML\*** | **WML** | **WML\*** |
| **Maximum** | 15.75 | 61.05 | 18.36 | 74.40 | 18.36 | 74.40 | 18.36 | 74.40 |
| **Minimum** | -52.27 | -28.86 | -34.39 | -26.49 | -30.35 | -28.86 | -25.05 | -28.86 |
| **Mean** | 8.27 | 33.97 | 8.28 | 47.56 | 10.02 | 41.84 | 10.27 | 50.38 |
| **Standard Deviation** | 17.66 | 34.40 | 15.59 | 40.83 | 14.12 | 38.14 | 12.52 | 41.78 |
| **Kurtosis** | 37.48 | 7.14 | 10.33 | 6.48 | 8.47 | 6.79 | 6.39 | 5.57 |
| **Skewness** | -4.23 | 1.55 | -1.41 | 1.64 | -1.08 | 1.61 | -0.65 | 1.47 |
| **Sharpe Ratio** | **0.47** | **0.99** | **0.53** | **1.16** | **0.71** | **1.10** | **0.82** | **1.21** |

We can find the following results: In all cases, the risk-managed momentum strategy has higher sharpe ratio than standard momentum strategy.