Active Portfolios: Dynamic Diversification Across Trading Strategies

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Several characteristics of a firm and its past return have been shown to be useful in predicting future returns, leading to long-short trading strategies with positive expected return using no invested capital. I develop the idea of active portfolios, which treat these long-short strategies as investable zero-cost assets. I show that, since the returns from these long-short strategies are largely uncorrelated, active portfolios which make simultaneous bets on several long-short strategies have Sharpe ratios several times that of the market and extremely attractive return characteristics. I argue that this is because the diversification achievable in active portfolios far exceeds that attainable through international, industry, or other traditional sources of diversification.

Researchers have found a large number of long-short trading strategies that earn significant return with no invested capital. These strategies can be roughly categorized as momentum (Jegadeesh and Titman [1993], Moskowitz and Grinblatt [1999], Asness, Liew, and Stevens [1997]), value (Lakonishok, Shleifer, and Vishny [1994], Fama and French [1992,1996]), firm size (Banz [1981], Fama and French [1992]) and reversal on a long (De Bondt and Thaler [1985], Asness [1994]) and short (Lehmann [1990] , Jegadeesh [1990]) time scale. These strategies basically sort stocks by one of the above criteria every month, then go long a portfolio of stocks that strongly exhibit that criteria and short a portfolio that weakly exhibit it, and earn a return that is the spread between the two portfolios. Different studies have used different samples, methodologies, and time periods to find different return spreads from these trading strategies, but a large amount of research supports the view that the above strategies have positive expected return.

I look at the performance of "active" portfolios, which treat long-short trading strategies as investable assets and which follow several strategies at once. They are "active" because the trading strategies turn over some of their capital every month, even if the portfolio doesn't adjust how much capital is allocated to each strategy. Just as holding many uncorrelated assets in a traditional portfolio can reduce the portfolio's variance, an active portfolio will benefit by following multiple trading strategies if their returns are uncorrelated. If all the trading strategies earn a return via exposure to one or two common underlying factors (such as a market factor or firm distress factor), then the diversification achievable in an active portfolio will not be significant. However, if the

returns to the strategies are not driven by common factor exposures, an active portfolio may achieve a higher risk-adjusted return than any single strategy.

This paper's goal is to see how trading strategies interact in an active portfolio.[1] It's contributions are two-fold

1. I find that, due to their low correlations, extremely high Sharpe ratios are achievable with active portfolios, and active portfolios don't have any alternative risk characteristics that would justify their high return.
2. Most of the trading strategies I use can be thought of as sources of hedge fund beta. Thus active portfolios can be viewed simply as positive loadings on various sources of hedge fund beta. I won't address the issue of replicating the returns of a specific hedge fund or hedge fund index through loadings on these betas, but I do show that levels of return often associated with successful hedge funds can be achieved using leveraged active portfolios. Using only five trading strategies (sources of hedge fund beta), I show how to achieve returns around 20% per year with market-like levels of volatility. Since I confine myself to the US equity market, certainly many more sources of hedge fund beta exist in other markets, and one could improve the achievable set of risk-return profiles by including these in an active portfolio.[2]

[1]Other researchers such as Asness [1997] have looked at how trading strategies such as these interact in a different manner, finding that jointly conditioning on a stock's value and momentum properties allows better prediction of future returns. This paper considers a different form of interaction, looking at variance reduction in active portfolios.

[2] Pursuing value and momentum trading strategies internationally may provide other uncorrelated sources of long-short return. Asness [1997] finds very low correlation between returns on size, value, and momentum bets for country indexes and those for US stocks. Rouwenhorst [1998] finds returns to stock momentum strategies in other countries correlate with stock momentum returns in the U.S. Arshanapalli, Coggin, and Doukas [1998] report low positive correlations for returns to long-short value strategies across developed countries.

Data and Methodology

The data for zero-cost trading strategies are monthly returns from January 1956 through December 2005. All data are taken from Professor Kenneth French's Data Library[3], which has monthly returns for decile portfolios sorted on various criteria. I use monthly return series for equal-weight decile portfolios sorted on firm size, book-to-market, past return over the last 12 months, excluding last month (PAST(12,2)), and past return over the last 60 months, excluding the most recent year (PAST(60,13)). From this I create five zero-cost trading strategy return series that will be the components of active portfolios.

1. **MKT** is the return of the CRSP value-weighted market portfolio minus the one month treasury rate.

2. **HML** is the return of a strategy that goes long the highest decile book-to-market portfolio and short the lowest decile book-to-market portfolio.

3. **SMB** is the return achieved going long the smallest market capitalization decile and short the largest market capitalization decile.

4. **MOM** is long the decile with the highest PAST(12,2) and short the decile with the lowest PAST(12,2).

5. **REV** is long the decile with the lowest value of PAST(60,13) and short the decile highest value.[4]

[3] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

[4] I originally considered a short-term reversal strategy based on one-month reversals. This strategy had very high returns around 2% per month, but the returns dwindled to about 0.5% per month for value-weight deciles, suggesting that extremely small stocks were driving the returns. Also, the required turnover of a one-month reversal strategy suggests it may be too costly to implement. Results for active portfolios that include this strategy are even more striking and are available from the author upon request.

Though few would consider borrowing to buy the market a trading strategy, it will be one of the sources of return I use to construct active portfolios.[5]

Trading Strategies and Active Portfolios

Summary statistics for the five trading strategies are shown in Exhibit I. Note that all the returns shown are zero-cost returns: they are return spreads from a long minus a short position (or in the case of the market, the return of the market minus the T-bill rate). The long-short trading strategies have monthly volatilities generally of the same magnitude of the long-short market return, but the trading strategies tend to have higher returns and Sharpe ratios. More importantly, Exhibit I shows that the return series from the trading strategies are largely uncorrelated, with an average correlation of 0.00 to two significant digits. This is what will offer the great diversification benefits in an active portfolio. Exhibit II looks at higher order risk characteristics of the trading strategies (again based on monthly returns). This indicates that mean-variance analysis may understate the trading strategy risk relative to the market for two reasons. One is that the trading strategies tend to have higher kurtosis, indicating a larger probability of extreme movements, which is undesirable. The momentum strategy has high negative skewness, indicating a higher than normal probability of a large negative movement. More importantly, the trading strategies (except for momentum) all have high first-order autocorrelation. This indicates return continuation, which has two bad properties. First, it leads annual variance to be higher than we'd expect by naively annualizing monthly

[5] The monthly return data I use for the four long-short strategies are based on reforming a portfolio every month, holding it a month, and reforming it. The momentum, value, size, and long-term reversal strategies all have positive return with holding periods of a year or longer, so the data I use are a proxy for the actual returns an investor would receive following these strategies.

variance. Second, it increases the chance that that an institution executing the trading strategy will run out of money (or run into a margin limit) and have to close shop, since bad months tend to follow each other. Autocorrelation is especially high for the SMB and HML strategies. It's well known that value strategies can have long periods of low returns (Asness Friedman Krail [2000]), and the returns to the SMB strategy have been lower in the later part of the sample period than in the earlier part, leading to autocorrelation.[6] The *adjusted Sharpe ratio* calculated in Exhibit I recalculates the annualized variance to take account of this return continuation.[7] The trading strategies' adjusted Sharpe ratios are slightly lower than their raw Sharpe ratios, but still generally higher than that of the market. Individually, the four active trading strategies (HML,SMB,MOM, and REV) seem to perform better than the market, but combining trading strategies can provide even better returns.

To see how trading strategies interact, I construct four kinds of active portfolios, each of which invests some of its capital in all of the trading strategies.

1. An ***equal-weight active portfolio*** invests an equal amount in all trading strategies and rebalances annually. Specifically, given some initial amount of capital, a long-short bet is made on each trading strategy, with the long and short position equal to one-fifth of the initial capital. At the end of every year the magnitude of the bet on each strategy is adjusted so they are all equal again.
2. A ***leveraged active portfolio*** is the same as the equal-weight active portfolio, but it uses leverage so that the monthly volatility of the active portfolio is the same as

[6] The mean monthly return to the SMB strategy for the first 300 months of my sample was 0.84% per month. The mean monthly return during the second 300 months was 0.28%.
[7] Specifically, I model returns as a first-order autoregressive model, with an autoregressive coefficient equal to the sample autocorrelation. Then I annualize the variance to take account of this return continuation. Details are available from the author upon request.

the average monthly volatility of the individual strategies (4.67% per month). The intuition is that an investor willing to engage in long-short strategies is willing to accept trading-strategy levels of volatility, so this portfolio delivers as much return as it can for that level of volatility, while maintaining equal bets in all the strategies.

3. An annually-rebalanced mean-variance ***optimized active portfolio*** that uses foreknowledge of the trading strategies' variance-covariance structure and returns to select optimal portfolio weights.
4. An annually-rebalanced optimized ***minimum-variance active portfolio*** that uses foreknowledge of the variance-covariance structure but not of the strategies' returns. This portfolio is optimized to minimize variance while investing as much as possible in the trading strategies.

The two optimized portfolios are simply for demonstration: an investor without foreknowledge of the strategies' future return and covariance structure could not have constructed these portfolios, and any investor who does have foreknowledge needn't read journals to be successful! The return properties of these active portfolios are shown in Exhibit III. The non-leveraged portfolios all have similar returns of just less than 1% per month. But the diversification in active portfolios drives the volatility below half the average volatility of the individual trading strategies! This reduction in volatility gives the active portfolios their extremely high Sharpe ratios. Even the equal-weight active portfolio has superb performance, with a Sharpe ratio (1.45) and adjusted Sharpe ratio

(1.24) roughly four times that of the market.[8] The optimized portfolio is a little better than the equal weight one: its return is a little higher, with a little less volatility and a little less autocorrelation, giving it a higher adjusted Sharpe ratio. But it's clear that even the equal weight portfolio achieves tremendous variance reduction without using any foreknowledge of the trading strategy return properties.

Exhibit III also shows returns from a leveraged portfolio, which uses sufficient leverage to give the same monthly volatility as the average trading strategy. This portfolio has returns of nearly 2% per month with market-like levels of volatility. Since all returns shown are zero-cost returns, the active portfolios short some subset of stocks, use the proceeds of the short sale to buy a long position, and then deposit the original capital in an interest-bearing account (some of which will be put up as margin). All returns shown ignore transaction and margin costs (which would reduce reported returns) but they also ignore the cash return from the interest bearing account, which would add roughly 5% per year over the sample period. Also, because all returns shown are zero-cost, a two-to-one leveraged portfolio earns twice the zero-cost return with twice the volatility. We don't need to borrow more cash to fund it, since it simply shorts twice as much and uses the proceeds to go long twice a much.

Measures of Diversification

The high Sharpe ratios reported in the previous section come almost entirely from the fact that huge volatility reduction is achievable by investing in several trading strategies at once. Spreading an investment across just five trading strategies resulted in volatility 53% below that of the average trading strategy and 49% below the market's

[8] The adjusted Sharpe ratio accounts for autocorrelation when it annualized volatility.

volatility. Since international diversification is often held up as an example of how spreading an investment in different places can benefit investors, I compare the volatility reduction in active portfolios to that in portfolios of MSCI developed country and regional indexes. All country and regional index returns are gross US dollar returns minus the US risk-free rate.[9] Exhibit IV shows the basic properties of the index returns, the correlation across regional indexes, and each index's correlation with the MSCI world index. Comparing Exhibit I with Exhibit IV, it's clear that the regional indices' ***individual*** return properties aren't that different from the trading strategy returns: the regional indexes have slightly lower mean returns than the trading strategies with similar levels of volatility. However, the regional returns are far more correlated than the trading strategy returns, and all are tremendously correlated with the world index. The regional indexes have an average correlation of 55% with each other and almost 80% with the MSCI world index. Exhibit V shows that the huge reduction in volatility reaped by building active portfolios of trading strategies doesn't come about when building portfolios of regional indexes. The equal-weight regional index portfolio only achieves a volatility reduction of 19% (versus the average regional index volatility), and even the optimized portfolios don't achieve a substantial increase in return or decrease in variance versus the individual regional indexes themselves. Because of this, the portfolios of regional strategies don't achieve substantially higher Sharpe ratios than the individual regional indexes, and the benefits of diversification are limited.

[9] The regional index and country returns are from Feb. 1970 to Dec. 2005. Index performance data is from http://www.mscibarra.com/products/indices/stdindex/performance.jsp. The four regional indexes are the Nordic countries, North America, the Pacific, and Europe. The fourteen country indexes are Japan, Singapore, the USA, Australia, the U.K., Honk Kong, Switzerland, Germany, Canada, Norway, Denmark, Belgium, Sweden, and Spain.

Exhibit VI looks at excess returns on portfolios of MSCI country indexes for 14 developed countries. The average monthly return among the 14 countries over the sample period was 0.71% per year, with average monthly volatility of 6.62% and an average annualized Sharpe ratio of 0.265. Exhibit VI shows returns to portfolios of country indexes. Diversifying across all 14 countries in an equal-weight portfolio gives a slightly higher Sharpe ratio (0.5) than diversifying across regional indexes, but not by much. The biggest difference between the active portfolios and the portfolio of country indexes is in volatility reduction. Even investing across 14 countries only reduces volatility by 32% (versus the average country's volatility of 6.62% per month) , while an active portfolio with just 5 trading strategies reduces the volatility by 53% (versus the average trading strategy volatility of 4.67%). Because of this, the active portfolio has less than half the monthly volatility of the country index portfolio, and this drives the large difference in Sharpe ratios. The optimized country portfolio is a little better but still can't match the volatility reduction of the equal-weight active portfolio. The levels of diversification achieved in active portfolios simply cannot be matched with traditional diversification.

Consistency of Active Portfolio Returns

Exhibit VIII examines the consistency of returns from the equal-weight active portfolio over every five-year sub-period beginning in 1956. The dotted red line is the capital market line determined using the mean return and volatility of the market over the entire 1956-2005 sample. The capital market line begins at the origin because all returns plotted are zero-cost returns, so the capital market line represents borrowing some

fraction of ones capital and investing the proceeds in the CRSP value-weighted market index. The circles and X's are the returns and volatilities achieved by the equal weight unleveraged active portfolio over each sub-period. Sub-periods in the beginning of the sample are marked with circles and those in the second half are marked with X's. It's clear that the active portfolio return was not only positive over every five-year sub-period, but also had a consistently better return – volatility tradeoff than the market average over every sub-period. Also, Exhibit VIII shows that the equal-weight active portfolio had higher mean monthly return and lower monthly volatility over the second half of the sample than over the first half, despite the falling returns to the small-cap minus large-cap strategy.

Next I look at consistency with regards to methodology. All results presented so far are based on equal-weight trading strategies. That is, each *individual* trading strategy (except for MKT) goes long and short equal-weight deciles of stocks. If, instead, the trading strategies are long-short value-weight deciles, the influence of small stocks will be reduced. Keeping the MKT strategy the same, if the other four long-short strategies use value-weight rather than equal-weight deciles, then the five value-weight strategies have an average correlation of 0.08. This is slightly higher than the average correlation for the equal-weight strategies, but is still quite low (the regional indexes and country indexes have average correlations above 0.4). Exhibit IX shows the mean returns of an active portfolio that uses the value-weight trading strategies. The mean returns are about 25% lower and the volatilities about 15% higher than the active portfolio following equal-weight trading strategies, but the Sharpe ratio is still nearly three times that of the market. Clearly the extreme returns of active portfolios depend to some extent on the

influence of smaller stocks, but remain positive and economically significant after reducing that influence.

Conclusions

I showed that diversification, one of the most basic tenants of investing, is extremely effective for non-traditional sources of return. Active portfolios which combine multiple long-short trading strategies achieve significant variance reduction, much more so than portfolios which spread an equity investment across countries or regions. This reduction in variance leads to extremely high Sharpe ratios for active portfolios. If we consider the trading strategies identified here to be sources of hedge fund beta, it's clear that we can achieve returns on a par with all but the best hedge funds using leverage and positive loadings on the five sources of hedge fund beta identified here.

Though I looked at portfolios following five simple long-short trading strategies (one of which was just to buy the market), there are many other sources of positive return that could be examined, both from long-short strategies (like value and momentum bets) in international markets, and long-only returns from real estate, bond, and credit markets. Adding these sources of return should allow us to construct even better active portfolios.

This research also calls into question whether return-spreads to long-short value, size, and momentum bets can exist in equilibrium in the market. On an individual basis, it seems plausible that the returns to value, size, momentum, or long-term reversal bets could be compensation for some risk that most investors are unwilling to bear without compensation. However, this research shows that investors who choose not to bear this

risk (that is, who choose not to seek the extra return achievable by adding a long-short value, momentum, size, etc. bet to their portfolio) are not only leaving positive returns on the table but are also giving up a huge source of potential diversification. I hope further research can look at this in more detail.

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Exhibit I
Returns to trading strategies, 1956-2005

	MKT	SMB	HML	MOM	REV
Monthly Mean	0.50%	0.56%	1.10%	1.22%	1.01%
Geometric Mean	0.40%	0.44%	1.02%	1.03%	0.90%
Monthly Volatility	4.33%	5.09%	4.11%	5.75%	4.08%
Sharpe Ratio	0.33	0.30	0.91	0.66	0.81
Adjusted Sharpe Ratio	0.31	0.26	0.81	0.72	0.71

Correlations	MKT	SMB	HML	MOM	REV
MKT	1.00	0.05	-0.41	-0.09	-0.09
SMB		1.00	0.18	-0.41	0.68
HML			1.00	-0.04	0.50
MOM				1.00	-0.36
REV					1.00

Exhibit II
Higher order moments and time series properties of trading strategies

	MKT	SMB	HML	MOM	REV
Skewness	-0.50	0.99	0.26	-2.79	2.14
Kurtosis	4.94	6.33	6.21	27.49	15.32
ACF(1)	0.07	0.16	0.12	-0.10	0.14
% negative	41%	50%	38%	32%	44%

Adjusted annualized volatility and Sharpe Ratio

	MKT	SMB	HML	MOM	REV
Annualized IID Vol	14.98%	17.63%	14.24%	19.92%	14.13%
Annualized AR(1) Vol	15.92%	20.32%	15.87%	18.11%	16.02%
Annualized Mean	4.91%	5.35%	12.90%	13.08%	11.38%
Adjusted Sharpe Ratio	0.308	0.263	0.813	0.723	0.710

Exhibit III

Returns to annually rebalanced active portfolios

Portfolio	Equal Weight	Equal Weight Levered	Optimized	Min. Var.
Leverage	1	2.005	1	1
Monthly Mean	0.91%	1.88%	0.95%	0.87%
Geometric Mean	0.88%	1.77%	0.93%	0.85%
Monthly Volatility	2.21%	4.67%	2.04%	1.93%
Volatility Reduction	53%	0%	56%	59%
Annualized Sharpe Ratio:	1.45	1.45	1.66	1.60
Adjusted Sharpe Ratio	0.00	0.00	0.00	0.00
Higher order moments and time series properties of active portfolios				
Skewness	0.69	0.37	-0.81	-0.53
Kurtosis	7.98	8.01	13.22	9.36
ACF(1)	0.17	0.15	0.06	0.12
% Negative	28%	28%	24%	26%

Exhibit IV

Regional index return properties

	Nordic	Europe	N. America	Pacific
Monthly Mean	0.82%	0.56%	0.50%	0.58%
Geometric Mean	0.65%	0.44%	0.40%	0.40%
Monthly Volatility	5.86%	4.83%	4.39%	6.01%
Sharpe Ratio	0.40	0.32	0.32	0.24
ACF(1)	0.07	0.04	0.02	0.12

Regional Index Retrun Correlations

	Nordic	Europe	N. America	Pacific
Nordic	1.00	0.73	0.57	0.47
Europe		1.00	0.64	0.55
N. America			1.00	0.39
Pacific				1.00
World Index Correlation	0.70	0.83	0.87	0.73

Exhibit V
Returns to Annually Rebalanced Regional Index Portfolios

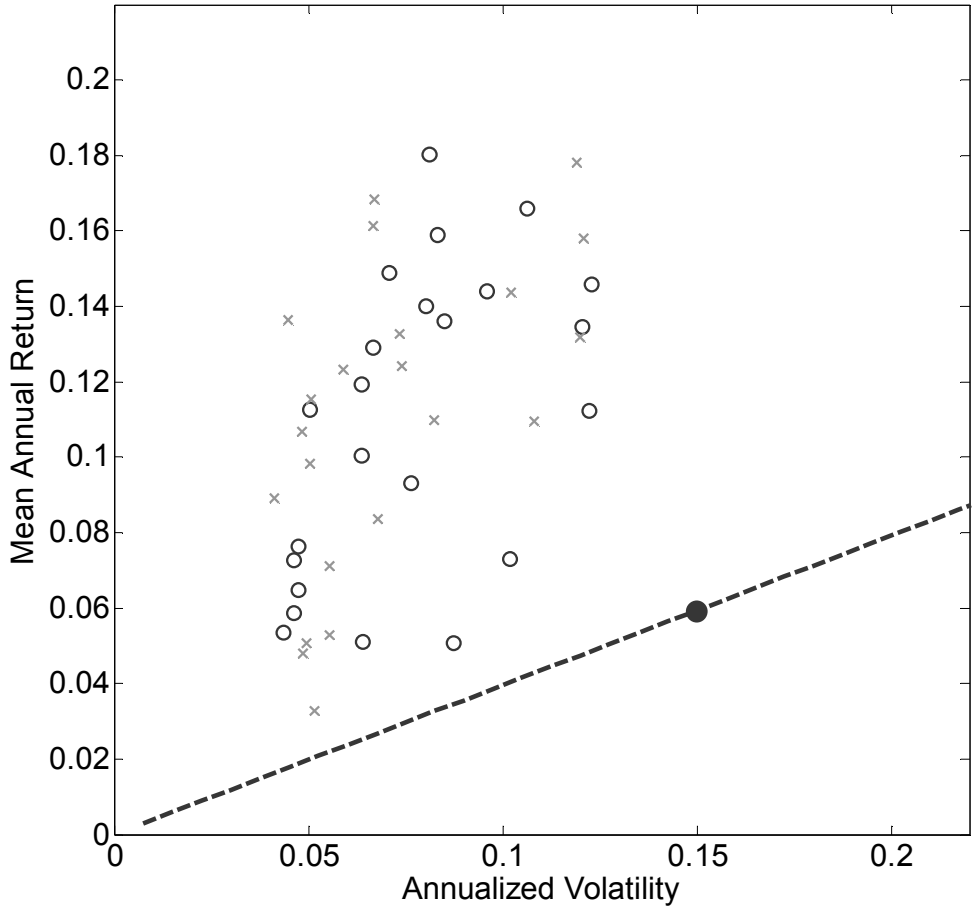
Portfolio	Equal Weight	Equal Weight Levered	Optimized	Min. Var.
Leverage	1.00	1.23	1.00	1.00
Monthly Mean	0.63%	0.77%	0.69%	0.53%
Geometric Mean	0.53%	0.63%	0.59%	0.45%
Monthly Volatility	4.29%	5.27%	4.58%	4.02%
Volatility Reduction	19%	0%	13%	24%
Annualized Sharpe Ratio	0.44	0.43	0.46	0.40
ACF(1)	0.11	0.11	0.10	0.09
Adjusted Sharpe Ratio	0.00	0.00	0.00	0.00

Exhibit VI
Returns to Annually Rebalanced Country Portfolios

Portfolio	Equal Weight	Equal Weight Levered	Optimized	Min. Var.
Leverage	1.00	1.48	1.00	1.00
Monthly Mean	0.73%	1.11%	0.99%	0.55%
Geometric Mean	0.63%	0.88%	0.86%	0.48%
Monthly Volatility	4.49%	6.62%	5.13%	3.81%
Volatility Reduction	32%	0%	23%	42%
Annualized Sharpe Ratio	0.50	0.48	0.61	0.45
ACF(1)	0.102	0.108	0.057	0.082
Adjusted Sharpe Ratio	0.46	0.44	0.58	0.42

Exhibit VII

Shows the mean annual excess return (over the T-bill rate) and annual volatility over every five-year sub period starting in January from 1956 to 2005 for the equal weight active portfolio. The dotted line is the market efficient frontier, using the mean and variance measured over the entire sample period. Circles represent five-year subperiods beginning before 1979 and X's represent subperiods beginning on or after 1979.



Equal weight trading strategy portfolio returns over time

	1956-1980	1981-2005
Monthly Mean	0.87%	0.95%
Monthly Volatility	2.29%	2.14%

Exhibit IX

Returns to portfolio of value-weight trading strategies

Mean monthly return	0.69%
Monthly volatility	2.52%
Annualized Sharpe ratio	0.99

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