Goldman
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Asset
Management

Maybe It Really Is Different This Time

Presentation to:
Nomura Quantitative Investment Strategies Conference
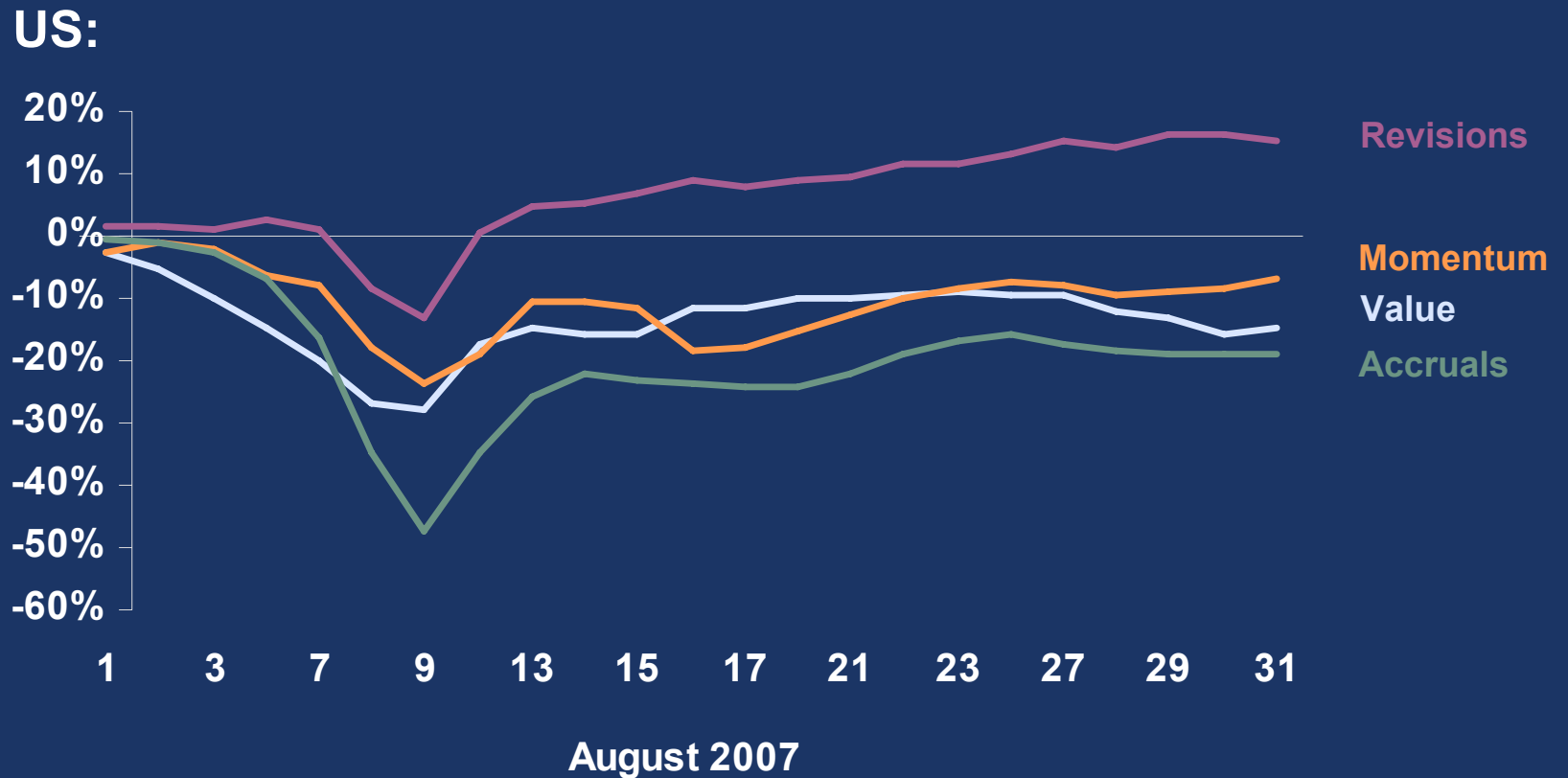June 16, 2009

Robert C. Jones
Bob.Jones@GS.com

Agenda

A   Review of August, 2007

B   The "Stickers" versus the "Adapters"

C   The Stickers' case:

          Long-term perspective: HML and WML

          Normal ebb and flow

D   The Adapters' case:

          Quant crowding

          Adjusting for trading and liquidity

E   The future of quantitative equity management

Sudden and dramatic underperformance of previously uncorrelated common quant factors
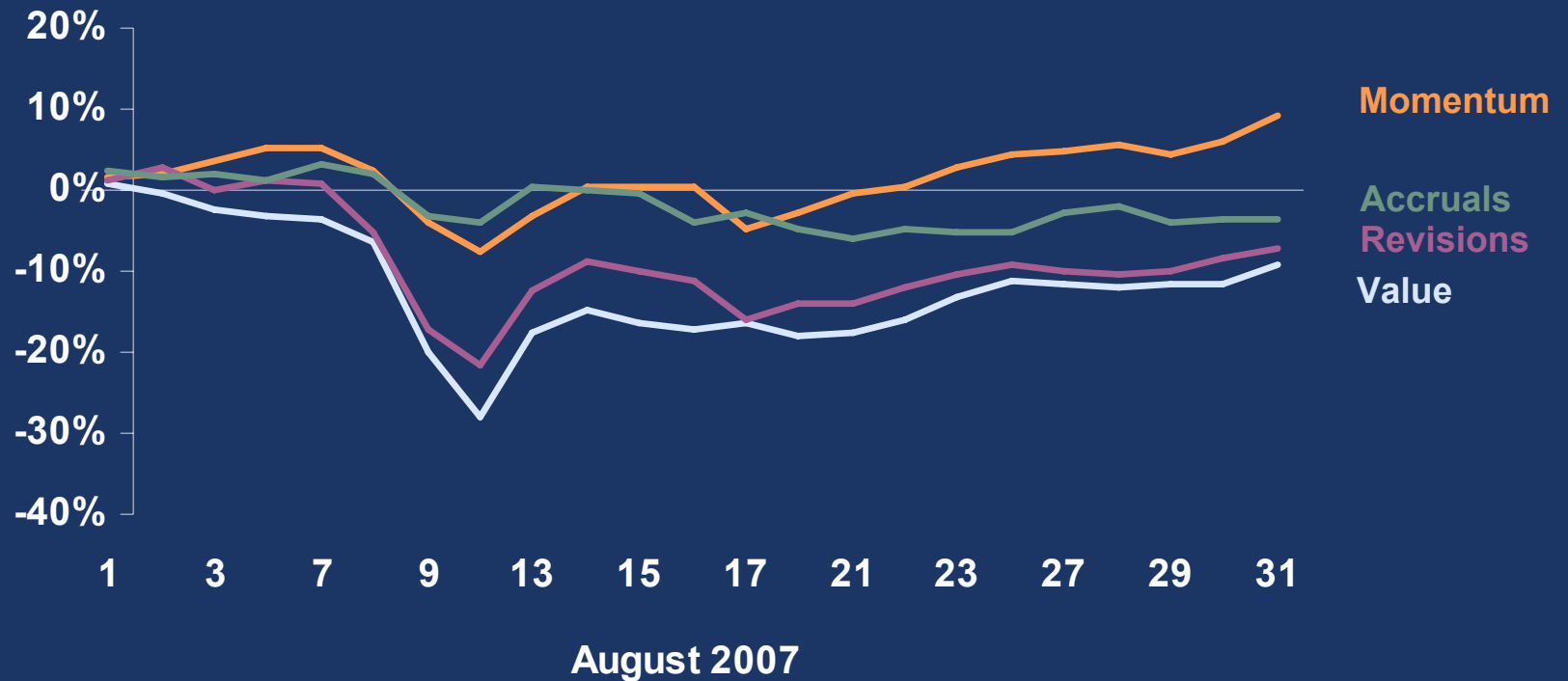## Factor performance in August 2007 scaled to 1% daily volatility[1]

US:

August 2007

Sudden and dramatic underperformance of previously uncorrelated common quant factors
Factor performance in August 2007 scaled to 1% daily volatility[1]

Japan:

Momentum

Accruals
Revisions

Value

August 2007

Sudden and dramatic underperformance of previously uncorrelated common quant factors
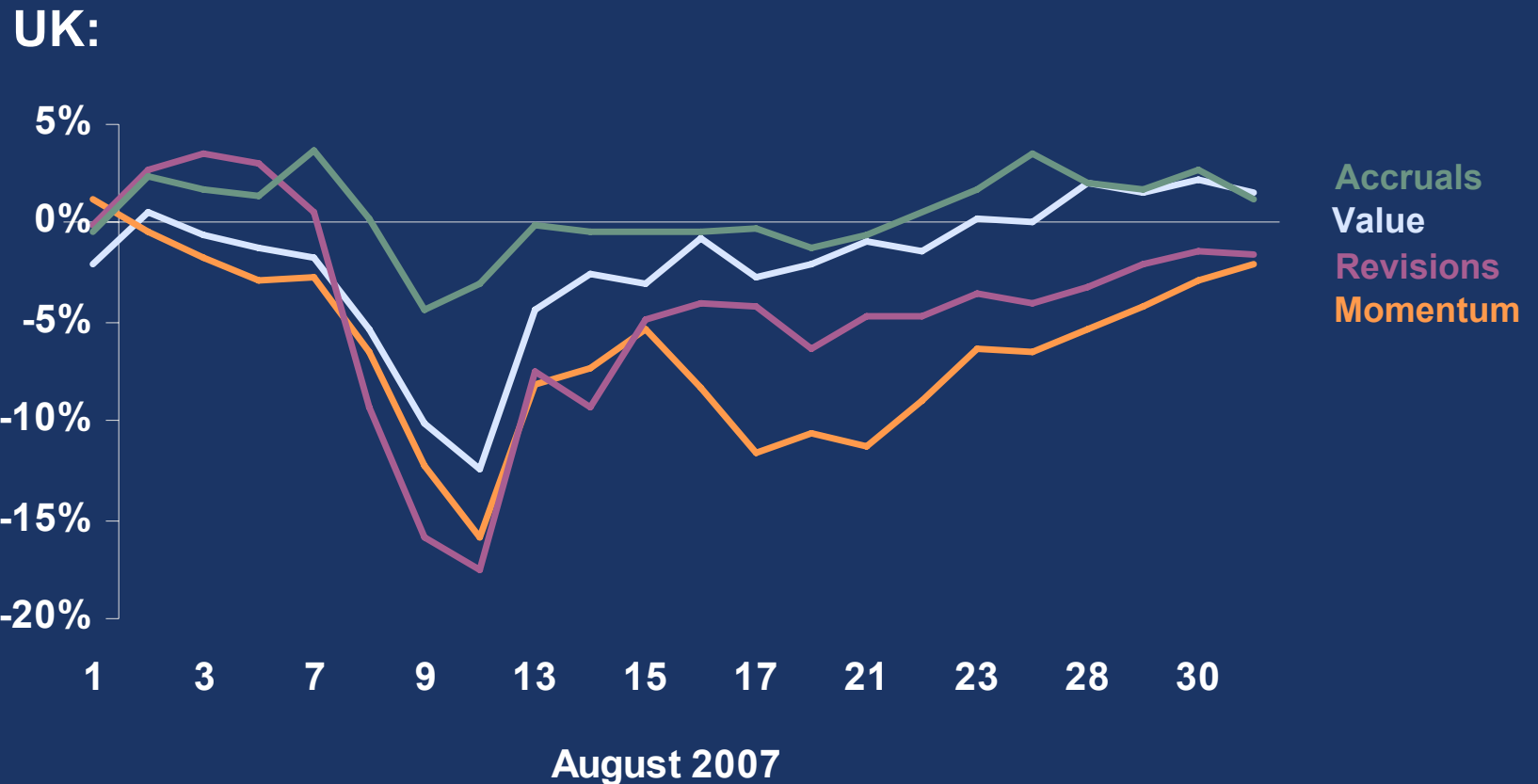## Factor performance in August 2007 scaled to 1% daily volatility[1]

Continental Europe:

Momentum
Revisions
Value
Accruals

August 2007

The Stickers vs. the Adapters

The <u>Stickers</u> believe this is part of the normal volatility of such strategies

- **Long-term perspective: results for HML and WML not outside historical experience.**

- **Investors who stick to their process will end up amply rewarded**

The <u>Adapters</u> believe that quant crowding has fundamentally changed the nature of these factors

- **Likely to be more volatile and offer lower returns going forward**

- **Need to adapt your process if you want to add value consistently in the future**

Who is right?

Historical perspective – HML[1]
Recent US results for HML do not seem extraordinary relative to historical trends

Cumulative HML daily return, July 1926 – February 2009

Historical perspective – WML[1]
Recent US results for WML are also consistent with historical trends

Cumulative WML daily return, January 1927 – February 2009

Quant crowding

- **Leading up to 2007, quantitative investing had become an increasing percentage of the overall market.**

- **When quantitative investors were forced to unwind their positions simultaneously in August 2007, it created the dramatic moves that were synchronized across factors and markets.**

- **There is always the potential for more risk and higher correlations for quant factors whenever quant crowding is evident.**

Total Quant AUM as a percentage of the Russell 3000 Market Cap, March 1999 – December 2008
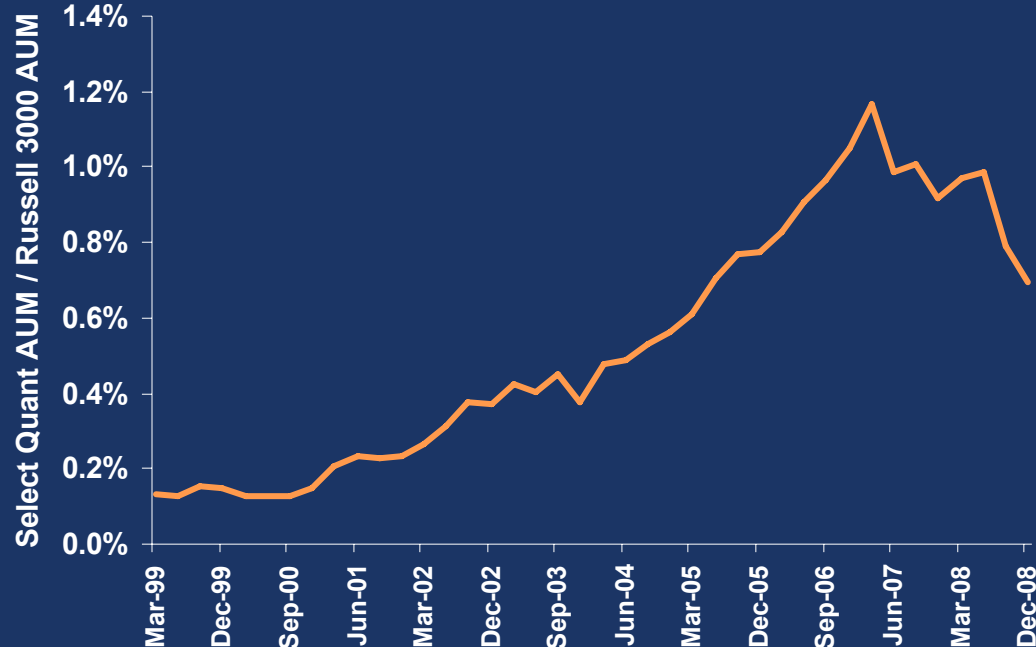
For illustrative purposes only.
The chart shows selected active quantitative manager assets as a percentage of the Russell 3000 Index. The universe of managers examined were those institutions filing holdings data with 13Fs which were picked up in the Thomson ownership database. We screened for quantitative managers who we consider our main competitors based on investment philosophy and other factors we deemed relevant.

Historical perspective – Value
5-day standardized returns (Dec-90 to Dec-08)

Looking at intra-month data, results for US Value in August 2007 were well outside of historical norms.
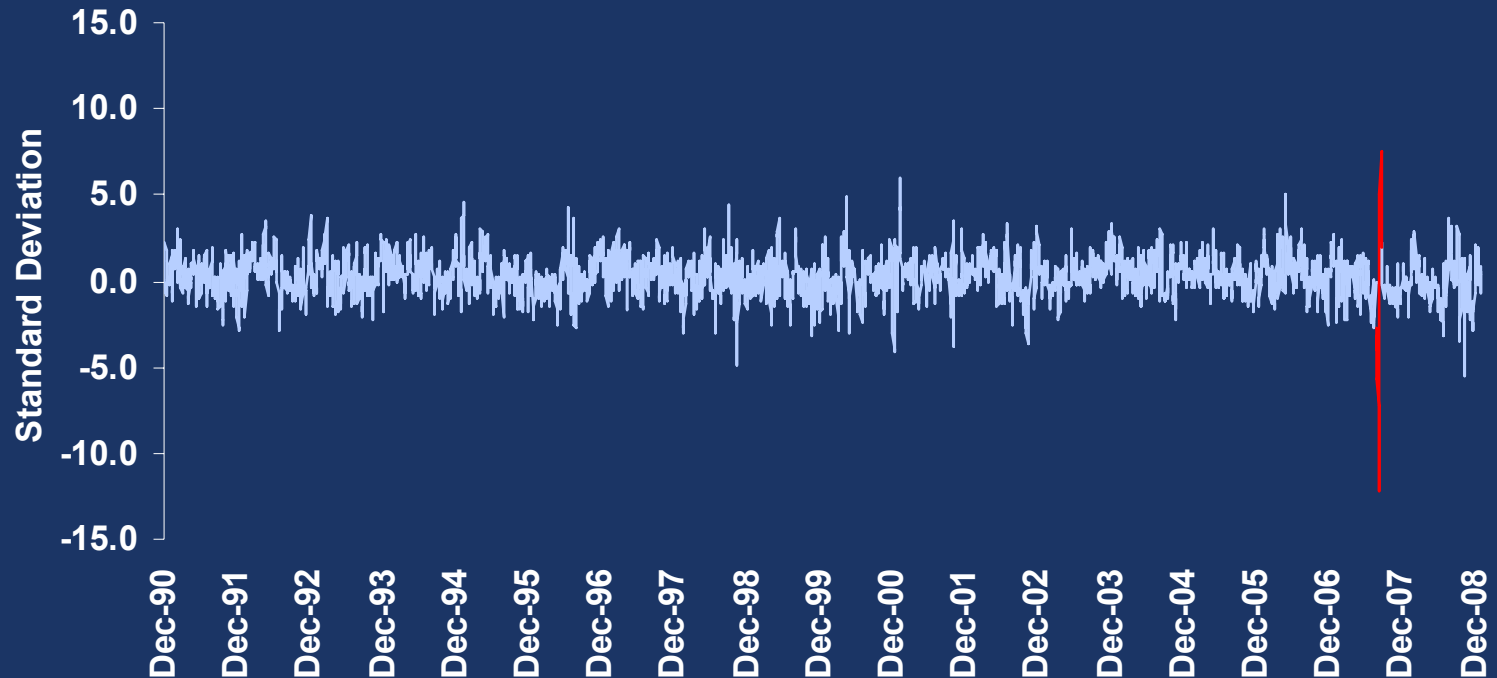
These performance results are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational purposes only. Please see additional disclosures. Source: Goldman Sachs Asset Management. The OTP is an optimized, unconstrained long-short portfolio which does not take transactions costs into account. It is not meant to reflect performance achieved in any realized accounts, but rather to measure the success of the model's predictions. The returns presented herein are gross and do not reflect the deduction of investment advisory fees, which will reduce returns. These performance results for optimal tilt portfolios are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational purposes only. With regard to our simulation methodology, we generate risk and return estimates for all assets in our research database using our proprietary model. Simulated performance results do not reflect actual trading and have inherent limitations. Please see additional disclosures. We standardize the 5-day OTP returns by dividing by the rolling 90 day volatility. The time period shown above (1990 – 2008) was selected due to data availability.

Historical perspective –Momentum
5-day standardized returns (Dec-90 to Dec-08)

Daily US data for Momentum also shows extreme results

These performance results are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational 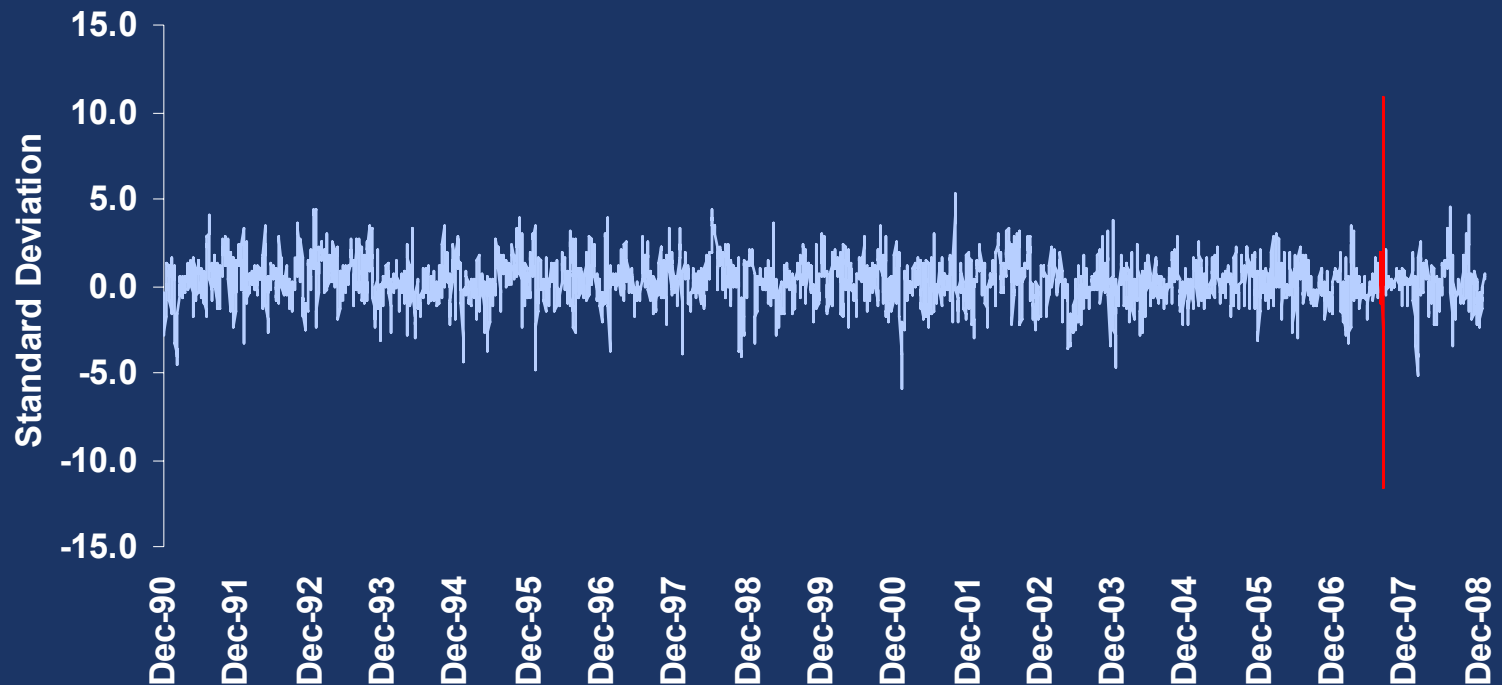purposes only. Please see additional disclosures. Source: Goldman Sachs Asset Management. The OTP is an optimized, unconstrained long-short portfolio which does not take transactions costs into account. It is not meant to reflect performance achieved in any realized accounts, but rather to measure the success of the model's predictions. The returns presented herein are gross and do not reflect the deduction of investment advisory fees, which will reduce returns. These returns are lagged by 20 days for illustrative purposes and are generated by creating an optimal single-factor momentum portfolio and looking at the subsequent returns to the Momentum portfolio 20 days later. We have used returns for the 20 day lagged Momentum portfolio in the above chart to account for short term price reversals. These performance results for optimal tilt portfolios are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational purposes only. With regard to our simulation methodology, we generate risk and return estimates for all assets in our research database using our proprietary model. Simulated performance results do not reflect actual trading and have inherent limitations. Please see additional disclosures. We standardize the 5-day OTP returns by dividing by the rolling 90 day volatility. The time period shown above (1990 – 2008) was selected due to data availability.

A closer look – Value

When we look only at liquid stocks, the value effect is more muted and exhibits a flat trend for 20 years

Cumulative daily return of Value; largest US stocks by market capitalization versus full universe, July 1926 – December 2008

A closer look- Momentum

When we look only at liquid stocks, the momentum effect is more muted for 20 years

Cumulative daily return of Momentum; largest US stocks by market capitalization versus full universe, July 1926 – December 2008

The impact of transaction costs - Value

When we adjust our Value portfolio to deduct (assumed) trading costs, results look much worse, especially at higher levels of AUM

Cumulative daily returns to optimal Value portfolio, February, 1987 – December, 2008
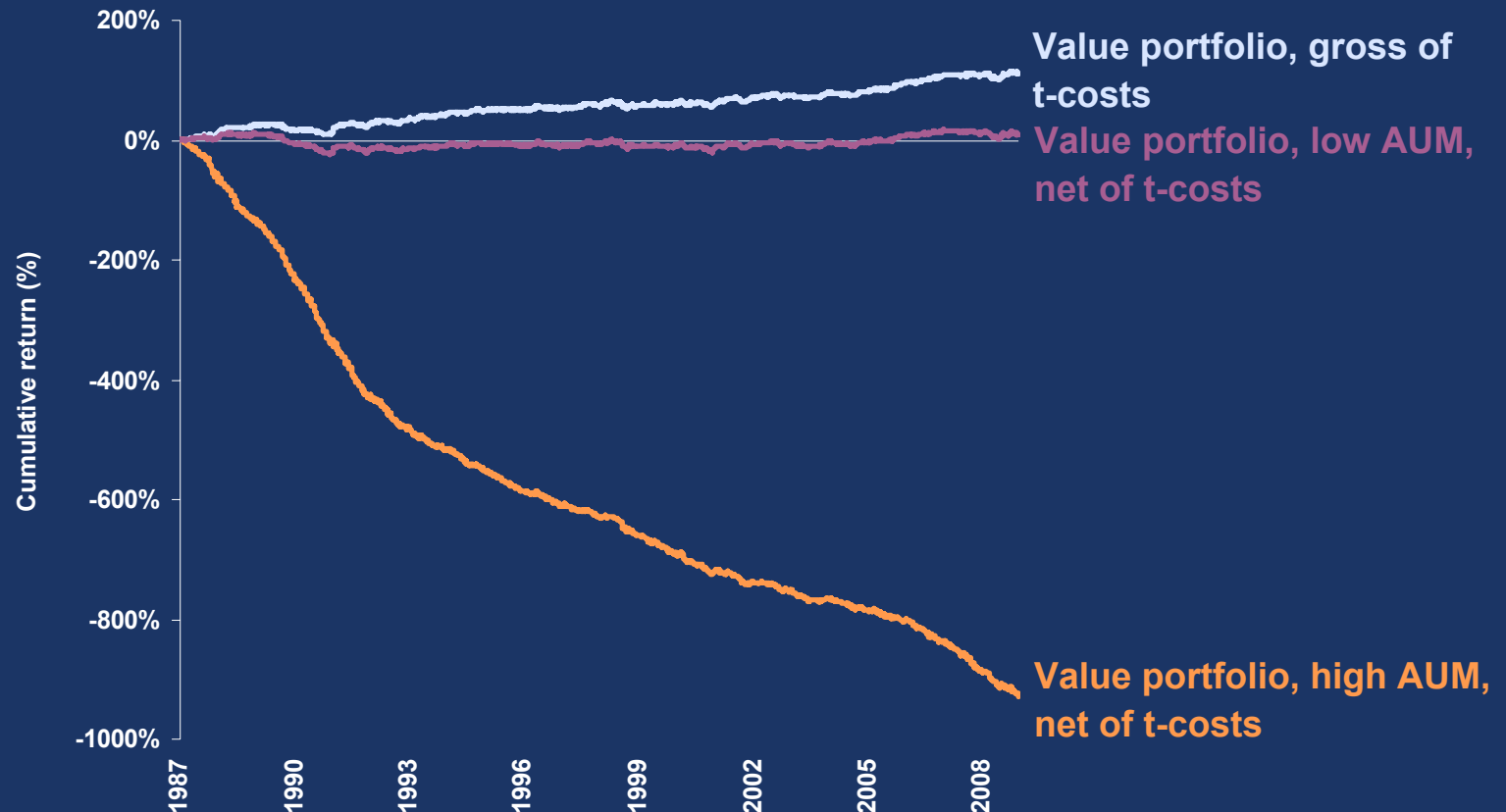
Value portfolio, gross of t-costs

Value portfolio, low AUM, net of t-costs

Value portfolio, high AUM, net of t-costs

Please refer to page 10 for the backtesting methodology used in the Value (B / P) portfolio's shown above. We define low assets under management (AUM) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

The impact of transactions costs - Momentum

When we adjust our Momentum portfolio to deduct (assumed) trading costs, results look much worse, especially at higher levels of AUM

Cumulative daily returns to optimal Momentum portfolio, February, 1987 – December, 2008

Momentum portfolio, gross of t-costs

Momentum portfolio, low AUM, net of t-costs

Momentum portfolio, high AUM, net of t-costs

Please refer to page 10 for the backtesting methodology used in the Momentum (Price Momentum: 2 – 12 month return) portfolio's shown above. We define low AUM (assets under management) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

Considering t-costs during optimization - Value

When we add t-costs to the objective function, turnover goes down and net returns improve, but gross returns are much weaker than in the no t-cost case

**Information Ratios
Feb 1987 – Dec 2008**

	Gross of T-cost	Net of T-cost
High AUM	0.27	0.08
Low AUM	0.70	0.51

Cumulative daily return to t-cost optimized Value portfolios, February 1987 – December 2008

Low AUM, gross of t-costs

Low AUM, net of t-costs

High AUM, gross of t-costs
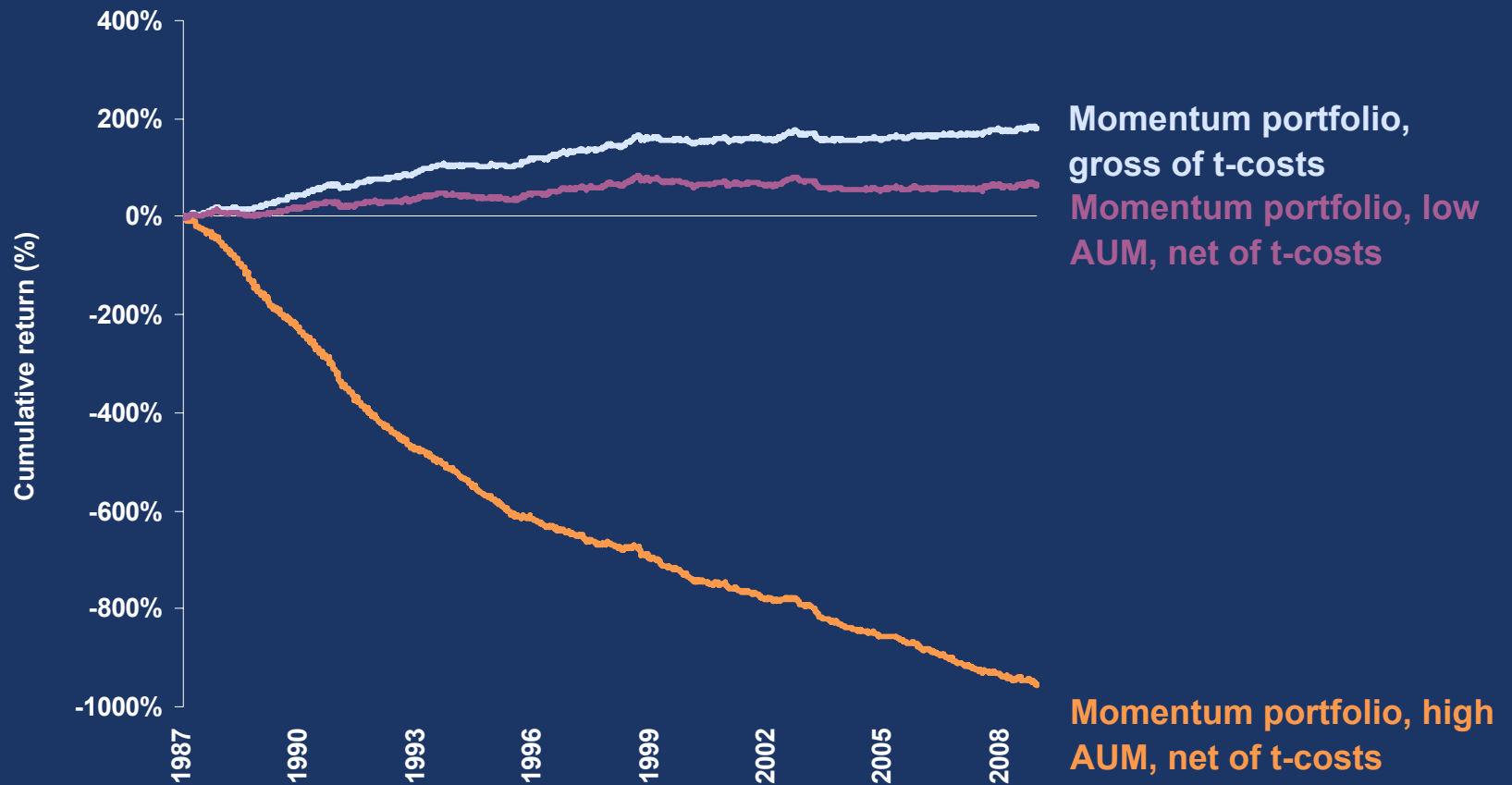
High AUM, net of t-costs

Please refer to page 10 for the backtesting methodology used in the Value (B / P) portfolio's shown above. We define low assets under management (AUM) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

Considering t-costs during optimization - Momentum

When we add t-costs to the objective function, turnover goes down and net returns improve, but gross returns are much weaker than in the no t-cost case

Information Ratios Feb 1987 – Dec 2008

	Gross of T-cost	Net of T-cost
High AUM	0.73	0.42
Low AUM	1.63	1.34

Cumulative daily return to t-cost optimized Momentum portfolio, February 1987 – December 2008

Low AUM, gross of t-costs

Low AUM, net of t-costs

High AUM, gross of t-costs

High AUM, net of t-costs

Cumulative return (%)

Please refer to page 10 for the backtesting methodology used in the Momentum (Price Momentum: 2 – 12 month return) portfolio's shown above. We define low AUM (assets under management) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

Exposure to current and legacy factors - Value

When we add t-costs to the optimizer, our Value portfolio has exposures to both current and legacy (lagged) factor values

Partial correlations of US optimal and lagged Value portfolios, February 1987 – December 2008
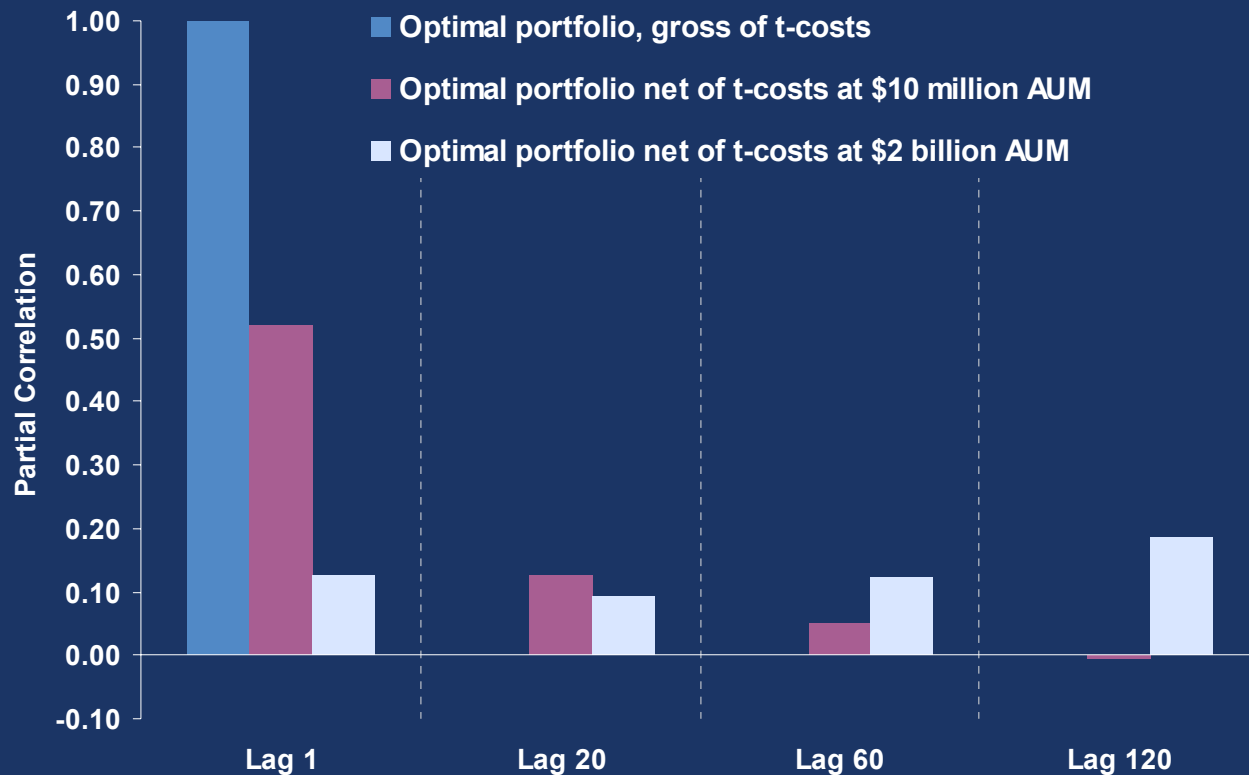
Legend:
- Optimal portfolio, gross of t-costs
- Optimal portfolio net of t-costs at $10 million AUM
- Optimal portfolio net of t-costs at $2 billion AUM

Y-axis: Partial Correlation (-0.10 to 1.00)
X-axis: Lag 1, Lag 20, Lag 60, Lag 120

Source: Goldman Sachs Asset Management. Partial correlation measures the degree of association between the lagged single-factor Value portfolio and the Value optimal tilt portfolio, with the effect of a set of controlling random variables removed.
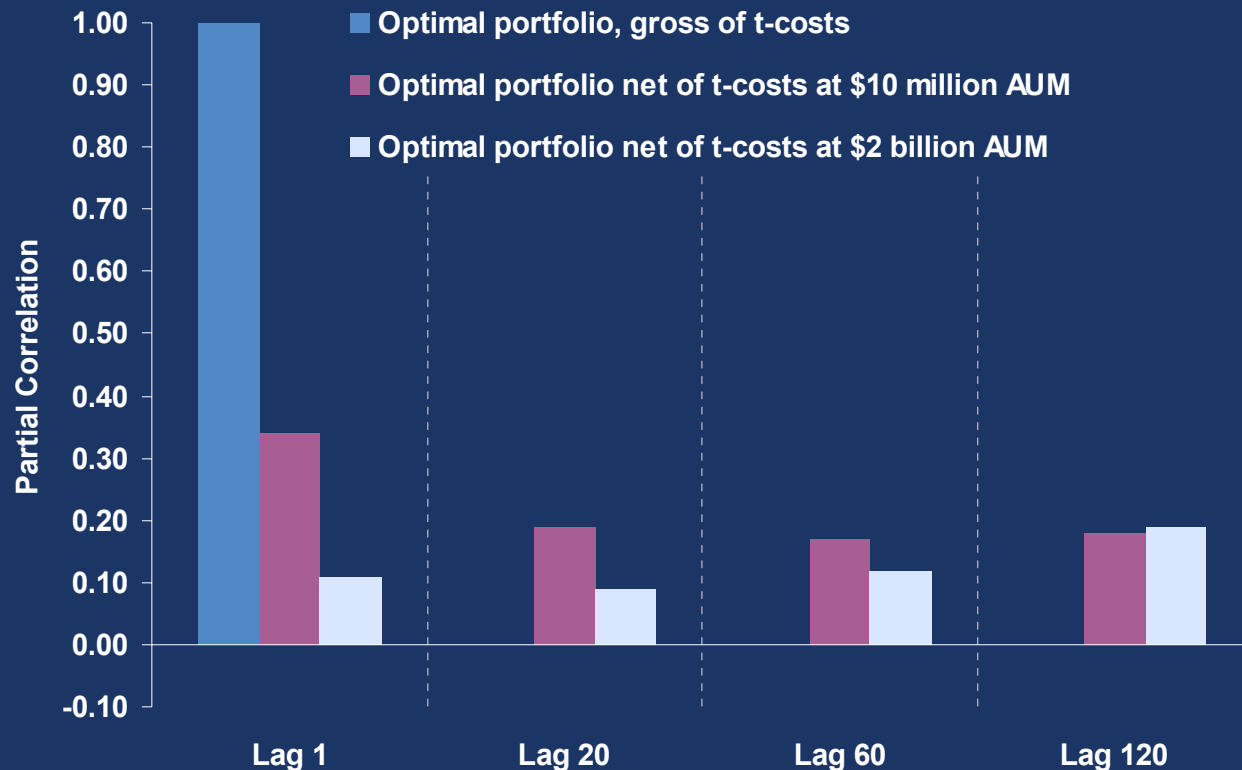Please refer to page 10 for the backtesting methodology used in the single-factor Value (B / P) portfolio's shown above. We have shown the above portfolios at various lags (days) to illustrate the effect of factor decay. We define low assets under management (AUM) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

Exposure to current and legacy factors - Momentum

When we add t-costs to the optimizer, our Momentum portfolio has exposures to both current and legacy (lagged) factor values

Partial correlations of US optimal and lagged Momentum portfolios, February 1987 – December 2008

Legend:
- Optimal portfolio, gross of t-costs
- Optimal portfolio net of t-costs at $10 million AUM
- Optimal portfolio net of t-costs at $2 billion AUM

Y-axis: Partial Correlation
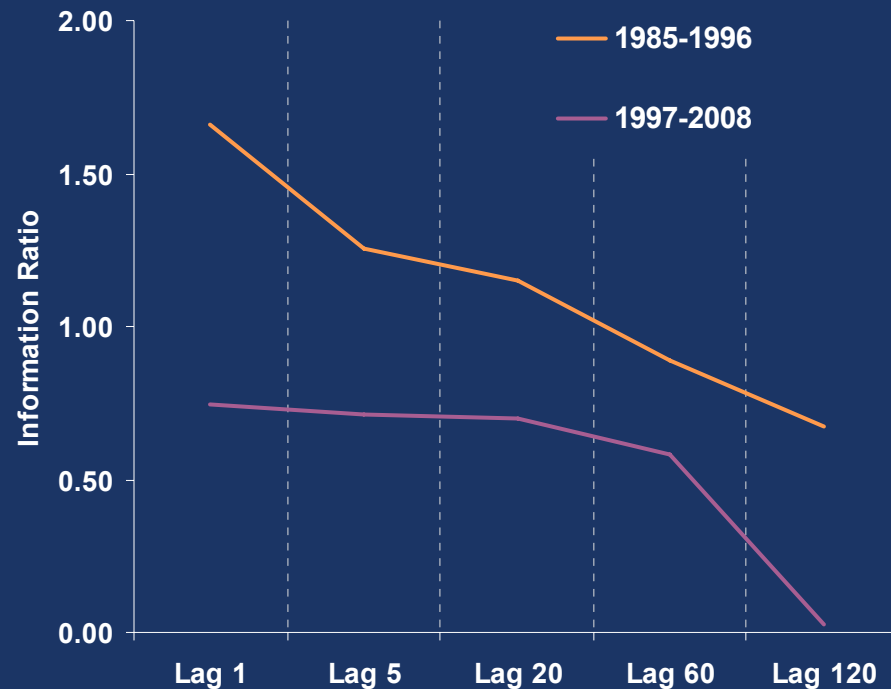X-axis: Lag 1, Lag 20, Lag 60, Lag 120

Source: Goldman Sachs Asset Management. Partial correlation measures the degree of association between the lagged single-factor Momentum portfolio and the Momentum optimal tilt portfolio, with the effect of a set of controlling random variables removed.
Please refer to page 10 for the backtesting methodology used in the single-factor Momentum (Price Momentum: 2 – 12 month return) portfolio's shown above. We have shown the above portfolios at various lags (days) to illustrate the effect of factor decay. We define low assets under management (AUM) as an initial portfolio size of $10mm and high AUM as an initial portfolio size of $2bn. These results are gross and net of transactions costs, as defined by our proprietary transaction cost model. The time period shown above (1987 - 2008) was selected due to data availability.

Factor decay - Value

- **The factor decay graphs show how the returns to legacy portfolios decline relative to the returns of current portfolios**

- **Recent results show lower means and faster decays than older results, a sign of quant crowding (i.e., faster response to new information)**

Factor decay - Momentum

- **The factor decay graphs show how the returns to legacy portfolios decline relative to the returns of current portfolios**

- **Recent results show lower means and factor decays than older results, a sign of quant crowding (i.e., faster response to new information)**
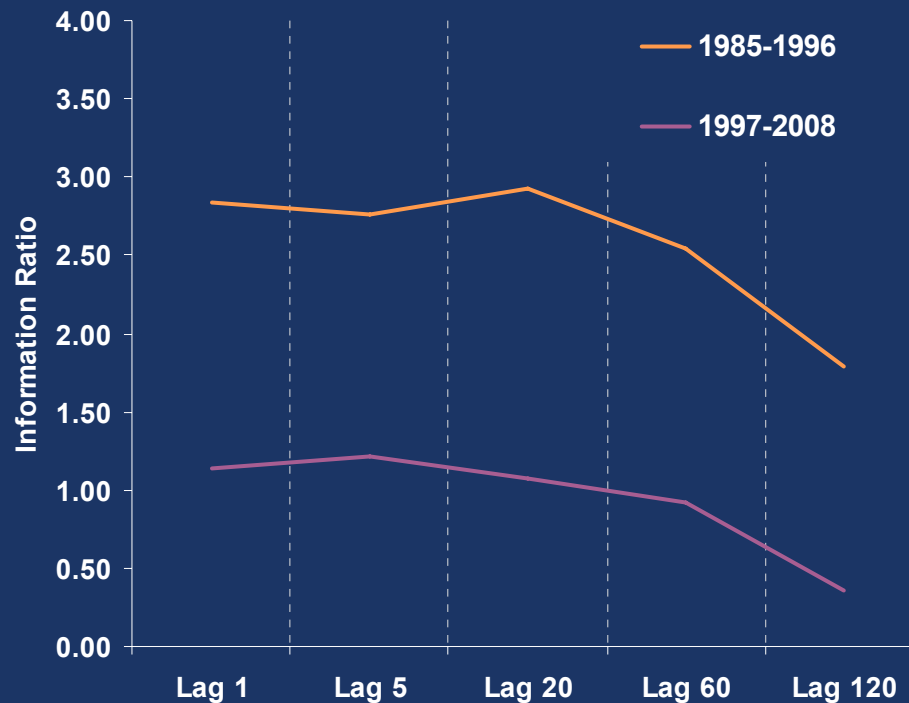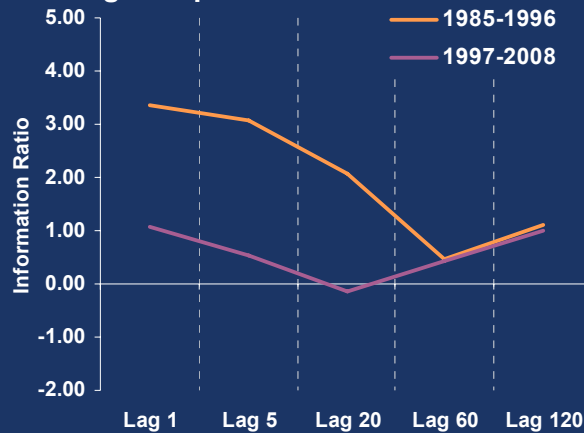

Source: Goldman Sachs Asset Management. Please refer to page 10 for the backtesting methodology used in the single-factor Momentum (Price Momentum: 2 – 12 month return) portfolio's shown above. We have shown the above portfolios at various lags (days) to illustrate the effect of factor decay. These results are gross of transaction costs. The time series has been split into two equal time periods to show how factor decay has changed for the more recent time period relative to the historical time period. The time period shown above (1985 - 2008) was selected due to data availability.
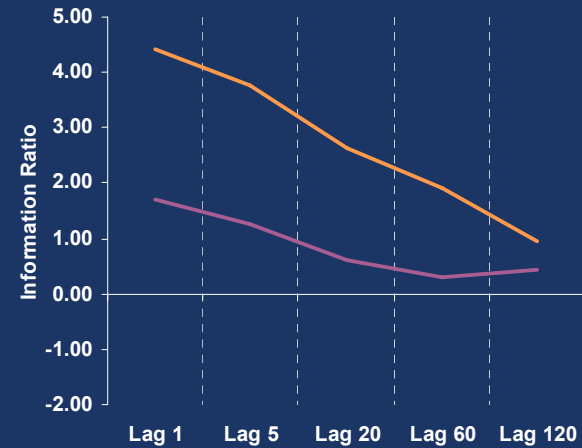
Decay rates for other popular factors

Other well-known and popular quant factors have also seen their returns decline and decay rates speed up in recent years
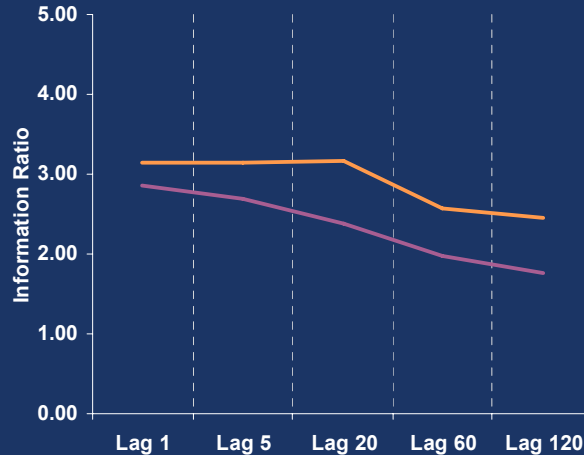

Earnings Surprise:

Revisions:

Accruals:

Reversal:

So now what?

When properly adjusted for liquidity and trading costs, popular quant factors have indeed become less effective recently.

The Stickers solution:

- **Live with it**

- **Sharpe ratios still attractive**

The Adapters solution:

- **Develop proprietary factors**

- **Dynamic allocation to popular factors**

- **Incorporate human judgment, but chastened**

Source: Goldman Sachs Asset Management.

Sources of alpha

- Alpha can only be derived when prices don't accurately reflect all public information (i.e., price ≠ fair value).

- This can only happen when investors over- or under-react to information.

- Thus, the Value effect is really an over-reaction effect; Momentum is an under-reaction effect.

- Investors tend over-react to information that confirms their prior beliefs and under-react to information that contradicts those beliefs.

- We can develop proprietary factors by looking for other situations where investors systematically over- or under-react to information.

Factor results in August 2007
Scaled to 1% daily volatility[1]

US:

Legend: — Mostly proprietary factors — Proprietary factors — More well-known factors

X-axis: August 2007

Factor results in August 2007
Scaled to 1% daily volatility[1]

Japan:

Legend:
— **Mostly proprietary factors** — **Proprietary factors** — **More well-known factors**

[1] Equivalent to 16% annualized volatility. Scaled to normalize different return series.
The graphs above illustrate backtested average daily returns to our target investment portfolios without taking into account transactions costs. These returns are reported for informational purposes only and do not reflect the performance of any GSAM product. These performance results are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational purposes only.
The factor categorizations shown above were determined based on what QIS perceives to be the level of crowding and popularity of quantitative factors. The most common factors are included in the "more well-known" category, while the most unique factors included in the "mostly proprietary factors" category.
Source: QIS

Factor results in August 2007
Scaled to 1% daily volatility[1]

UK:

Legend:
Mostly proprietary factors — **Proprietary factors** — **More well-known factors**

[1] Equivalent to 16% annualized volatility. Scaled to normalize different return series.
The graphs above illustrate backtested average daily returns to our target investment portfolios without taking into account transactions costs. These returns are reported for informational purposes only and do not reflect the performance of any GSAM product. These performance results are backtested based on an analysis of past market data with the benefit of hindsight, do not reflect the performance of any GSAM product and are being shown for informational purposes only.
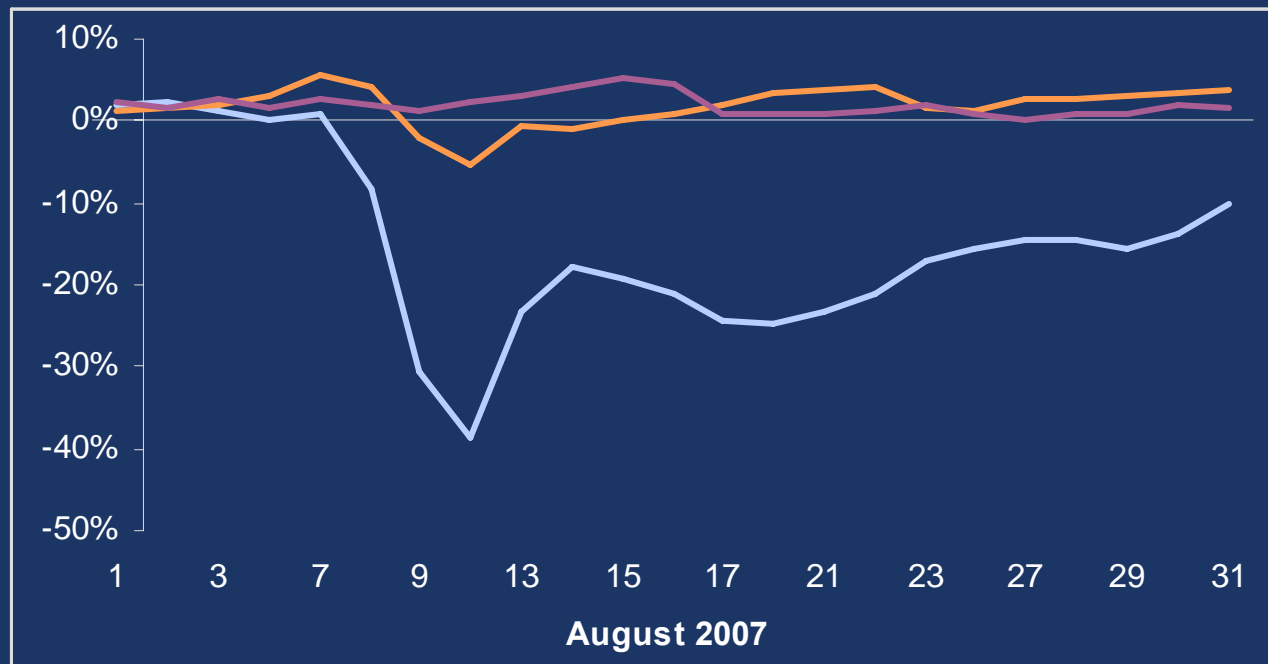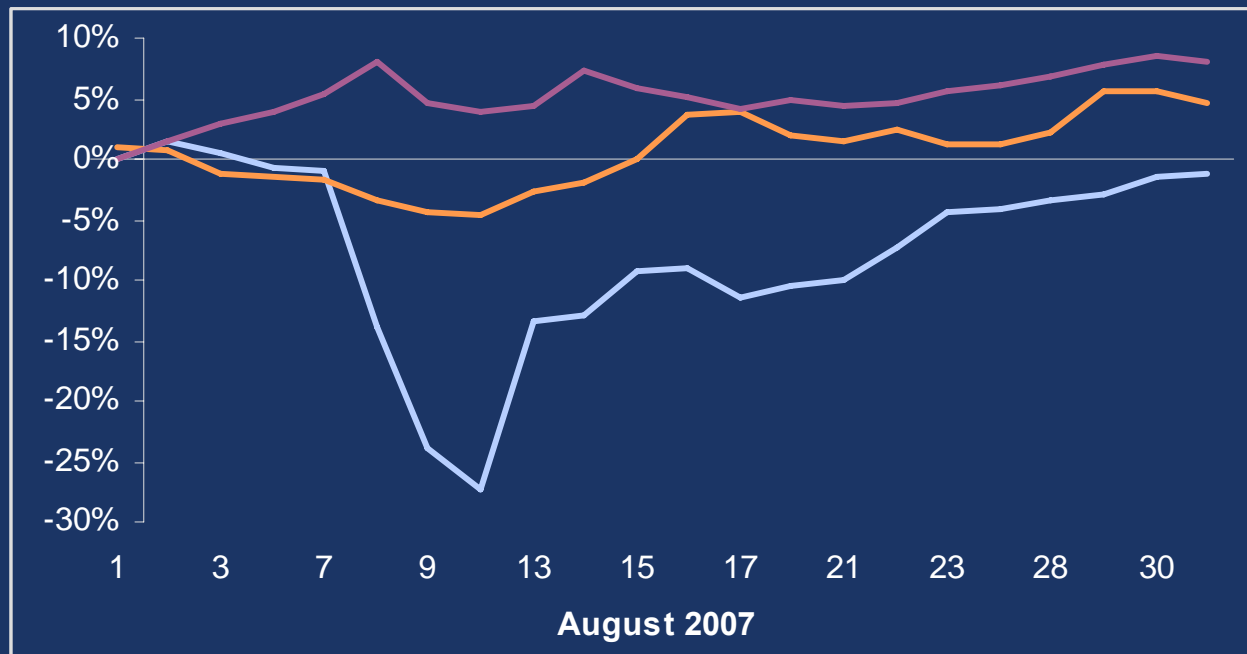The factor categorizations shown above were determined based on what QIS perceives to be the level of crowding and popularity of quantitative factors. The most common factors are included in the "more well-known" category, while the most unique factors included in the "mostly proprietary factors" category.
Source: QIS

Factor results in August 2007
Scaled to 1% daily volatility[1]

Continental Europe:

Legend:
— **Mostly proprietary factors**   — **Proprietary factors**   — **More well-known factors**

Decay rates for popular factors

An equal-weighted portfolio of Value and Momentum has experienced lower means and accelerated decay rates in recent times
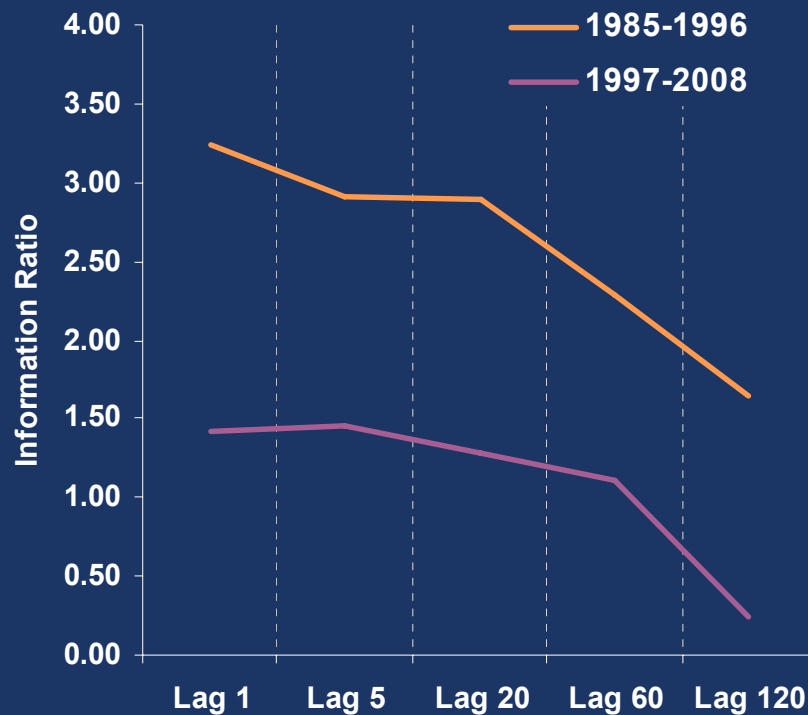
Source: Goldman Sachs Asset Management. Please refer to page 10 for the backtesting methodology used in the equal-weighted Value and Momentum factor (Value =B / P, Momentum = 2 – 12 month return) portfolio's shown above. We have shown the above portfolios at various lags (days) to illustrate the effect of factor decay. These results are gross of transaction costs. The time series has been split into two equal time periods to show how factor decay has changed for the more recent time period relative to the historical time period. The time period shown above (1985 - 2008) was selected due to data availability.

Decay rates for proprietary factors

However, our proprietary factors have not seen the same decline in mean and/or acceleration in decay rates in recent times

Factor timing

- **Factors become vulnerable (riskier) when they become "too popular"**

- **By monitoring factor popularity, we can adjust exposures to reflect changes in risk or expected return**

Cumulative performance of intra-industry Value strategy in the US, January 1928 – February 2009

Subsequent 12-month return (%) to HML when Value spread is:	
Above average:	5.9
Below average:	3.6

Value spread —— Return to value

[1] The QIS value spread is a metric formulated by the QIS team to capture the industry-adjusted dispersion in company over/under valuations.
The above strategy was formed based on industry-adjusted B / P metrics. The value strategy is a portfolio that overweights those equities with high B / P (undervalued firms) and underweights those equities with low B / P. We then calculated the return to the portfolio and repeated the process on a monthly frequency. Simulated performance results do not reflect actual trading and have inherent limitations.
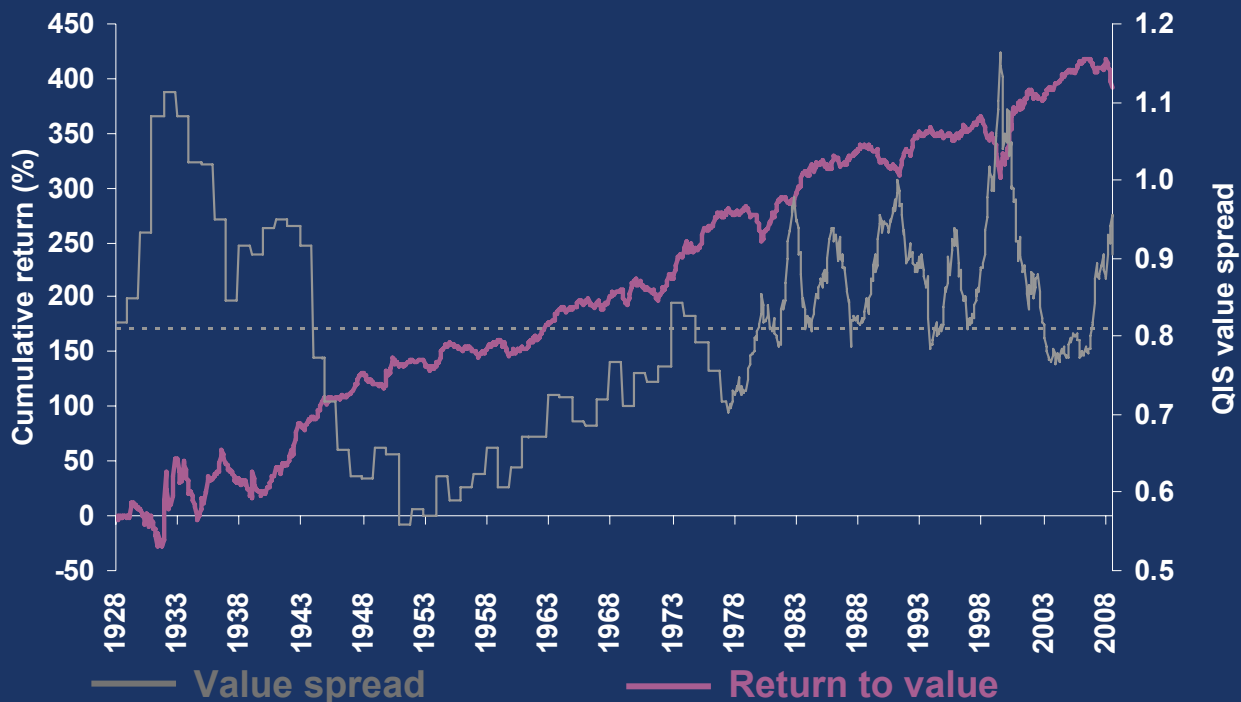*Source of return data: Kenneth French Data Library. http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html. Source of firm book data (value spread): Kenneth French, Compustat.* Due to data availability, we used Kenneth French Data Library for return to value and value spread data prior to 1978 (annual availability). Subsequently, we used *Compustat* for value spread data (monthly availability) and Kenneth French Data Library for return data after 1978. Due to the different nature of the value spread data before and after 1978, we indexed data in the latter period to have the same starting point as in the former. This information discusses general market activity, industry or sector trends, or other broad-based economic, market or political conditions and should not be construed as research or investment advice. Please see additional disclosures.

Fix the underlying problem

- **Quants have embraced objective models to forecast returns because they do not trust biased human judgment**

- **An alternative solution is to train analysts and traders to recognize and control their biases**

- **Not strictly a quant approach, but uses insights gleamed from quantitative analysis**

- **Can also use quant/statistical models to improve analysts forecasts of the underlying fundamentals (EPS, ROE, growth, payout, etc.)**

Source: Goldman Sachs Asset Management.

Conclusions

- **Historical results for many popular quant factors look much weaker when we adjust for liquidity and trading costs**

- **Crowding has fundamentally changed the outlook for many of these factors:**
  - **Likely to prove more volatile and provide lower Sharpe ratios in the future**
  - **Stronger results still possible for smaller managers who focus in less liquid stocks or markets**

- **Some opportunities for quant managers**
  - **Develop proprietary factors that capitalize on over- and under-reaction**
  - **Dynamic allocation to popular factors based on perceived crowding**
  - **Work with traditional analysts and traders to minimize over- and under-reaction**

Source: Goldman Sachs Asset Management.

General notes

Tracking Error (TE) is one possible measurement of the dispersion of a portfolio's returns from its stated benchmark. More specifically, it is the standard deviation of such excess returns. TE figures are representations of statistical expectations falling within "normal" distributions of return patterns. Normal statistical distributions of returns suggests that approximately two thirds of the time the annual gross returns of the accounts will lie in a range equal to the benchmark return plus or minus the TE if the market behaves in a manner suggested by historical returns. Targeted TE therefore applies statistical probabilities (and the language of uncertainty) and so cannot be predictive of actual results. In addition, past tracking error is not indicative of future TE and there can be no assurance that the TE actually reflected in your accounts will be at levels either specified in the investment objectives or suggested by our forecasts.

References to indices, benchmarks or other measures of relative market performance over a specified period of time are provided for your information only and do not imply that the portfolio will achieve similar results. The index composition may not reflect the manner in which a portfolio is constructed. While an adviser seeks to design a portfolio which reflects appropriate risk and return features, portfolio characteristics may deviate from those of the benchmark.

The strategy may include the use of derivatives. Derivatives often involve a high degree of financial risk because a relatively small movement in the price of the underlying security or benchmark may result in a disproportionately large movement in the price of the derivative and are not suitable for all investors. No representation regarding the suitability of these instruments and strategies for a particular investor is made.

Past performance is not indicative of future results, which may vary. The value of investments and the income derived from investments can go down as well as up. Future returns are not guaranteed, and a loss of principal may occur.

Backtested Performance
Backtested performance results do not represent the results of actual trading using client assets. They do not reflect the reinvestment of dividends, the deduction of any fees, commissions or any other expenses a client would have to pay. If GSAM had managed your account during the period, it is highly improbable that your account would have been managed in a similar fashion due to differences in economic and market conditions.

Simulated Performance
Simulated performance is hypothetical and may not take into account material economic and market factors that would impact the adviser's decision-making. Simulated results are achieved by retroactively applying a model with the benefit of hindsight. The results reflect the reinvestment of dividends and other earnings, but do not reflect fees, transaction costs, and other expenses, which would reduce returns. Actual results will vary.

Expected Returns
Expected return models apply statistical methods and a series of fixed assumptions to derive estimates of hypothetical average asset class performance. Reasonable people may disagree about the appropriate statistical model and assumptions. These models have limitations, as the assumptions may not be consensus views, or the model may not be updated to reflect current economic or market conditions. These models should not be relied upon to make predictions of actual future account performance. GSAM has no obligation to provide updates or changes to such data.

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