Model Update: Global Multi-Asset Model 3.0 for Architect

The Next Generation of Portfolio Analytics

Modeling Challenges with Alternative Investments

1 Data

Limited and infrequent reporting data

What is the fund's long-term performance?

2 Complexity

Valuation and reporting process

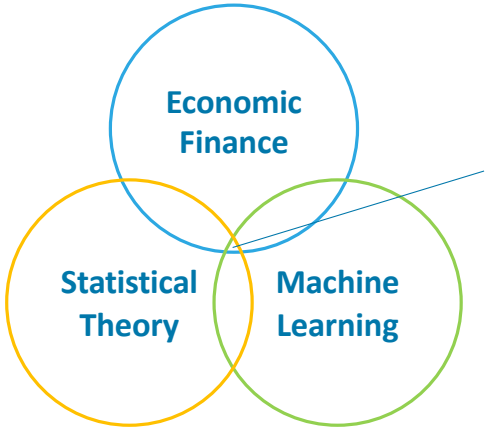
What are the risk and return drivers (betas and alpha)?

3 Uniqueness

Reporting metrics don't fit the whole portfolio

What is the optimal allocation to alts in my portfolio?

Our Solution



Global Multi-asset Model (GMAM) 3.0

Powerful simulation designed to work with limited input data

Backcasting, forecasting, advanced scenario analysis, etc.

True economic risk and return resulting in realistic portfolio allocation

Monthly de-smoothed returns and volatilities

Upside and downside scenarios for all the analytical metrics

Full distribution on simulated returns

High-level Overview: Global Multi-asset Model (GMAM) 3.0

- **Problem Statement:** There is an industry-wide need for risk and return analytics that are jointly applicable to private capital, other alternative investments, and traditional asset classes. Traditional analytics require a large amount of reporting data, which is often not available for alternatives. GMAM 3.0 solves for this issue.

- **GMAM 3.0 Value Proposition:**
  - GMAM 3.0 provides a complete set of portfolio analytics for any asset, of any age, in any economic conditions, with a wide tolerance for different levels of data quality.
  - GMAM 3.0 lays the foundation for a full set of analytics, including advanced scenario analysis, backcasting, forecasting, portfolio proposals among many other potential features.
  - GMAM 3.0 provides distributions for both estimated exposures and de-smoothed returns.

- **The Model:**
  - GMAM 3.0 is a probabilistic factor model which estimates the magnitude and timing of an asset's comovements with observed and unobserved factors.

GMAM 3.0: Taking Private Funds Seriously

- Standard portfolio decision making relies on knowledge of each investment's volatility and return.
    - Private capital funds do not report these metrics, which cannot be easily derived from IRR and MOIC.
- Naïve calculations of volatility and returns for private capital funds lead to absurdly large portfolio allocations to private capital assets in traditional asset allocation models.
    - This combined with the limited track records create a substantive barrier for home offices and advisors considering an investment in alternatives.
- Solving these problems is core to GMAM 3.0's value proposition. We know of no market alternatives.

GMAM 3.0: Taking Private Funds Seriously

How do private capital funds generate returns?

- Naïve estimation of linear regression models provide coarse estimates are generally statistically sound only for long return histories.

- Modeling the fund return reporting process dramatically improves the efficiency and insights provided relative to a model that eschews the underlying structure of fund returns.

- Put into a probabilistic framework, the statistical model provides the distribution of all relevant quantities both in isolation and coupled with other parameters of interest.

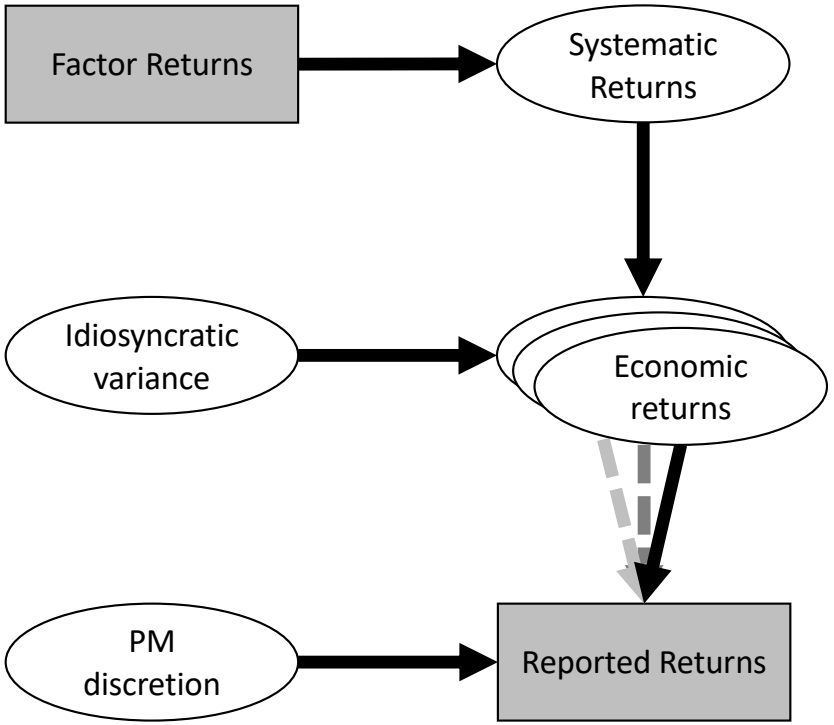
- **Intuitive design:** while advanced econometrics and statistics make the model feasible and the results rich, the structure of the model is intuitively based on fund operating procedures.

How Private Funds Generate Reported Returns

1) A set of factors drive the systematic returns of a portfolio of private companies. These combined the with idiosyncratic variation form the desmoothed or economic returns of the fund.

2) A portfolio manager receives infrequent but periodic valuation information about the assets in their portfolio. Alternatively, the valuation information a manager receives may be influenced by the events of past reporting periods.

3) For each reporting date, the manager uses their expertise to arrive at a best estimate as to the value of the portfolio assets. The manager may include additional contemporaneous information when forming their estimates.



Model Input. All other quantities are estimated via the model.

GMAM 3.0: Taking Private Funds Seriously

Pillar 1: Use a Multi-Factor Model

- A small number of economic and technical forces drive the returns of both public and private assets. Factors proxy for these forces.
    - For instance, the market return factor explains much of the variance for both public and private assets.
- As with previous versions of the Global Multi-Asset Model, GMAM 3.0 provides a full set of factor exposure estimates and standard risk analytics.

GMAM 3.0: Taking Private Funds Seriously

Pillar 2: Economic Returns Matter

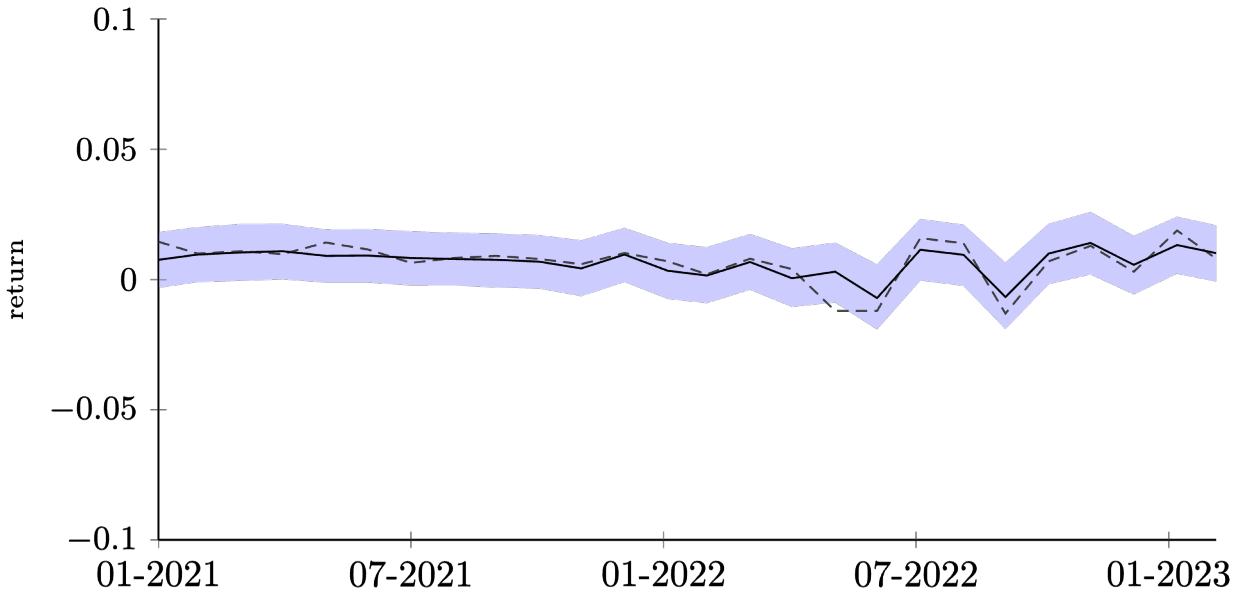
- GMAM 3.0 uses factor movements to both estimate de-smoothed monthly returns for the reporting period and predict smoothed and de-smoothed returns for longer historical periods.
- Using the de-smoothed returns to estimate the factor model leads to more insightful estimates on the same underlying reported data.
- By effectively estimating the length of time that a particular factor movement manifests in the reported returns, GMAM 3.0 separates the return reporting process from underlying changes in the portfolio's market value.
    - E.g., consider a 10% spike in the market return and a fund with a market beta of 1.0. This is observed by the manager as a contemporaneous 5% return and a 5% return in the subsequent month.

GMAM 3.0: Modeling Private Funds

Pillar 3: Funds are more than their track record

- The information available about any fund extends beyond the fund's track record.
- As shown by ChatGPT and kin, Bayes theorem provides a rigorous and highly effective mechanism for estimating complex models containing disparate information.
- We encode additional information about performance in a Bayesian framework. GMAM 3.0 objectively weighs the outside information against a fund's realized performance.
- Outside information may include:
  - A manager's past vintages
  - A profile of similar assets

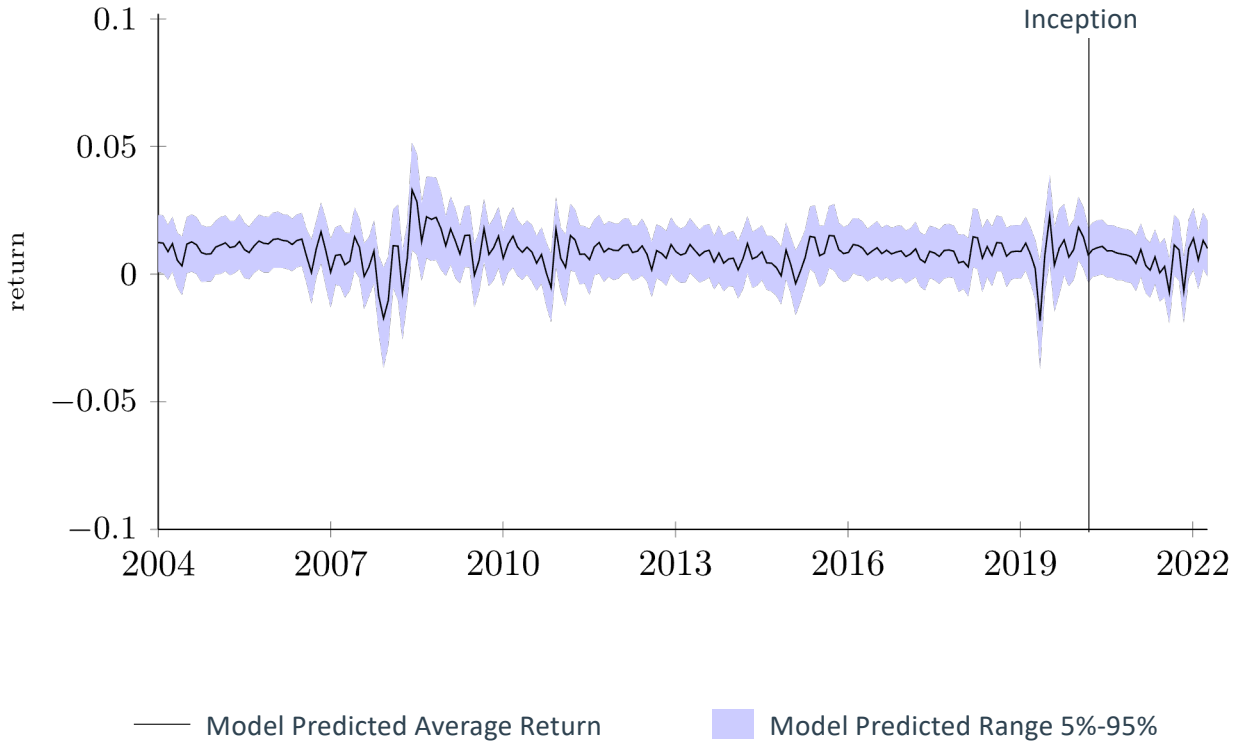
Example Fund: BCRED



Model Predicted Average Return Reported Return Model Predicted Range 5%-95%

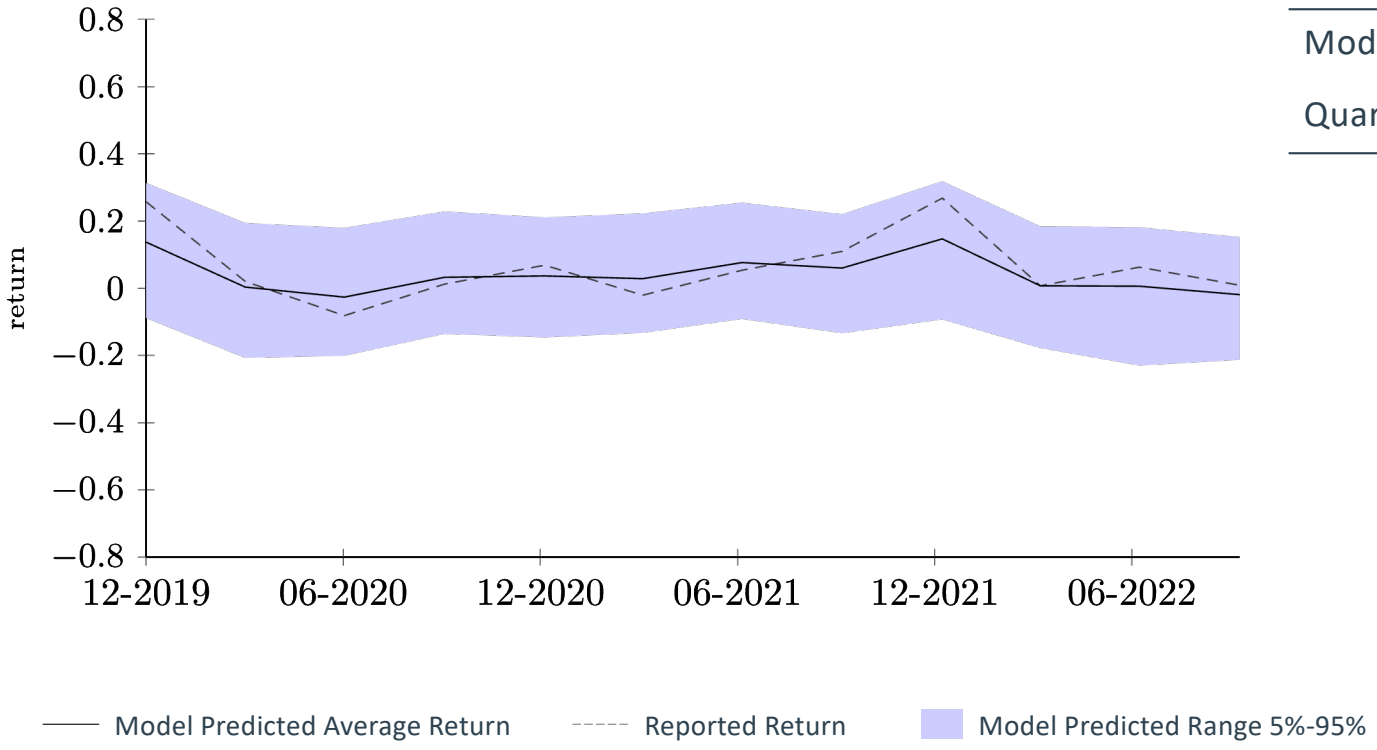
	Value
Model Fit (R^2)	74%
Months Reported	26

Example Fund: BCRED



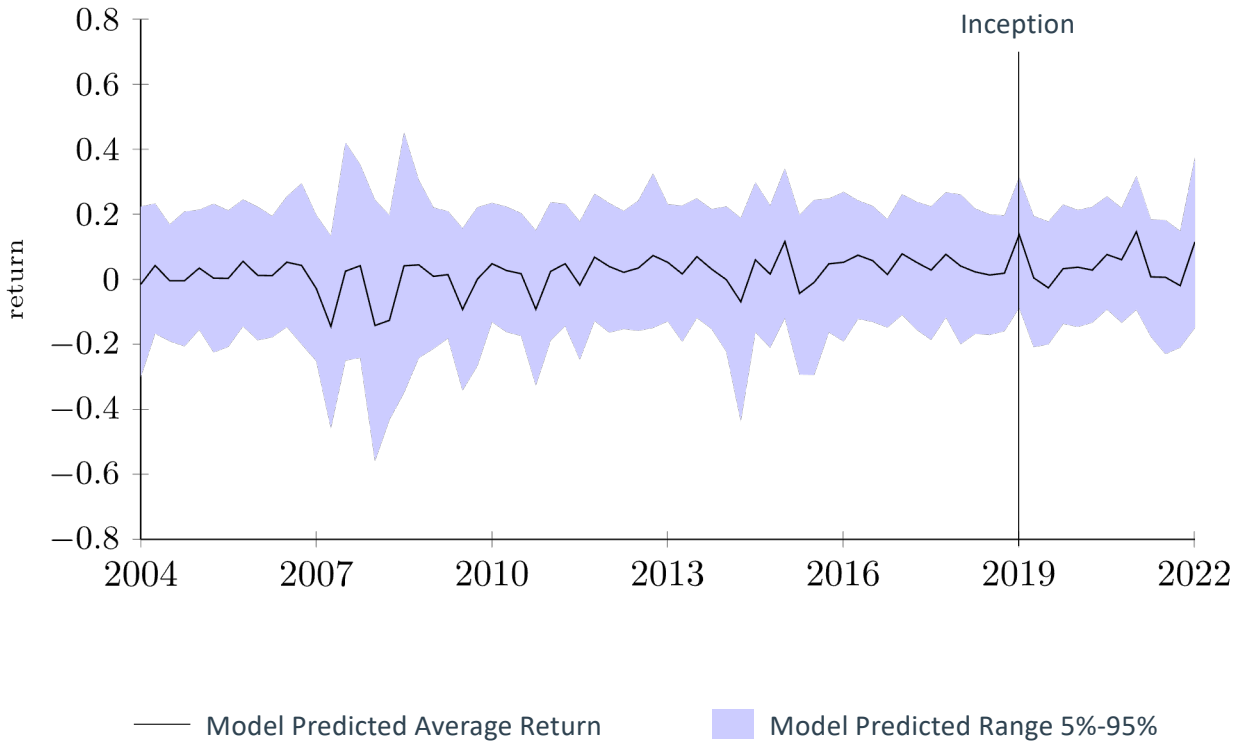
	Value
Model Fit (R^2)	74%
Months Reported (Predicted)	26 (194)

Example Fund: iCapital-SP RE VII Access Fund



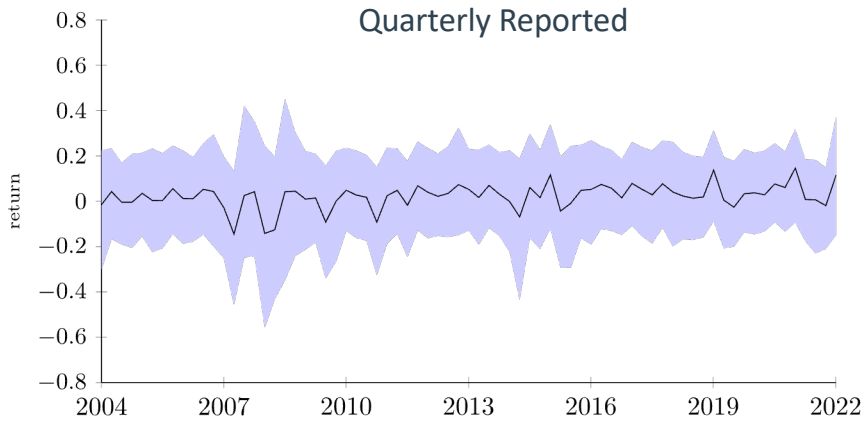
	Value
Model Fit (R^2)	85%
Quarters Reported	12

Example Fund: iCapital-SP RE VII Access Fund



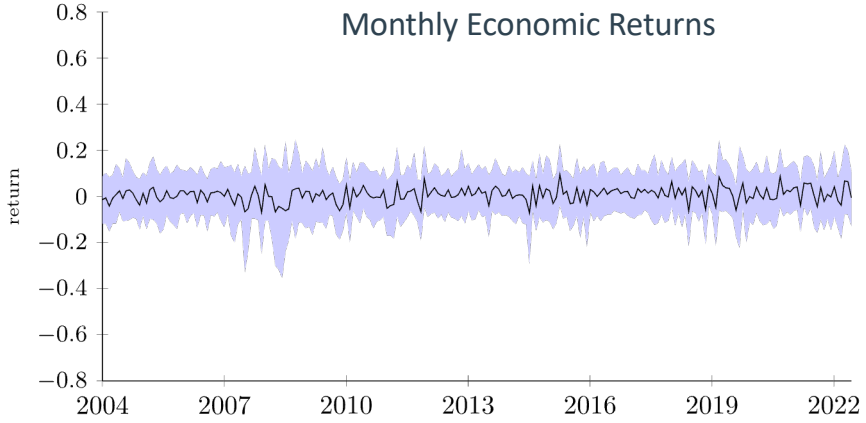
	Value
Model Fit (R^2)	85%
Quarters Reported (Predicted)	12 (60)

Example Fund: iCapital-SP RE VII Access Fund



Model-predicted 90% Quantile Interval

Expected Return (Quarterly)



Model-predicted 90% Quantile Interval

Expected Economic Returns (Monthly)

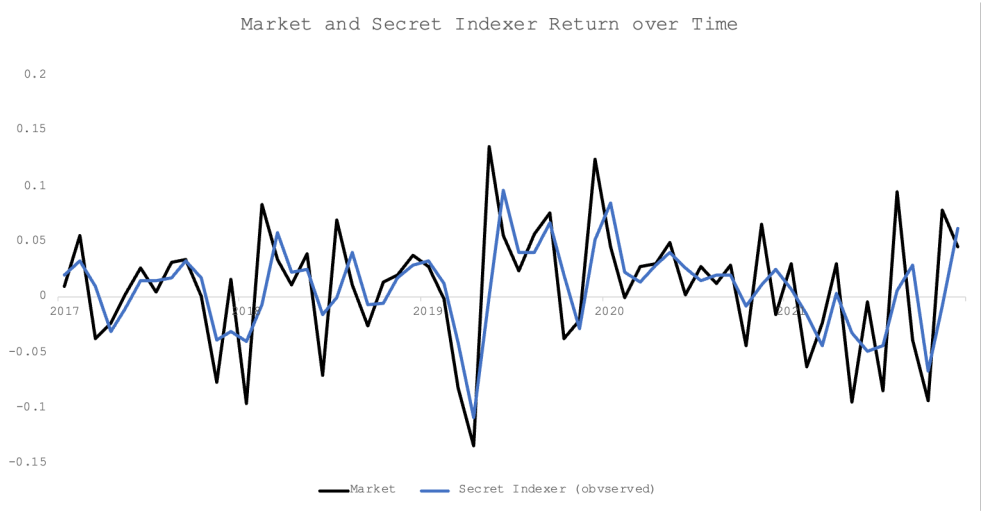
Why is Desmoothing Useful?

Challenges

- Consider the following fund:

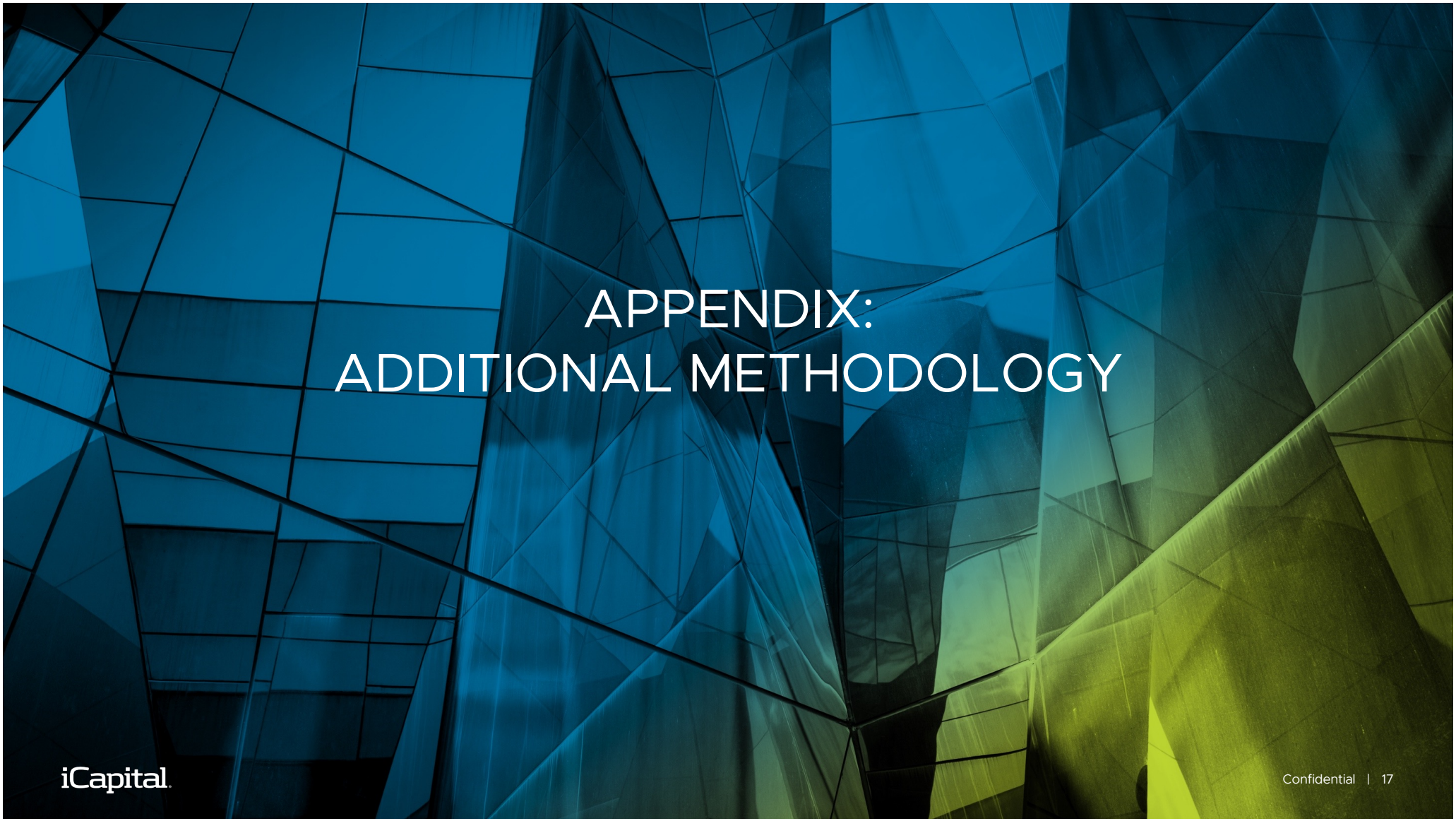
Metric (Monthly)	Market	Fund 1
Beta	1.00	0.43
Alpha	-	0.5%
Volatility	5.5%	3.6%
R2		66%

Looks Great!

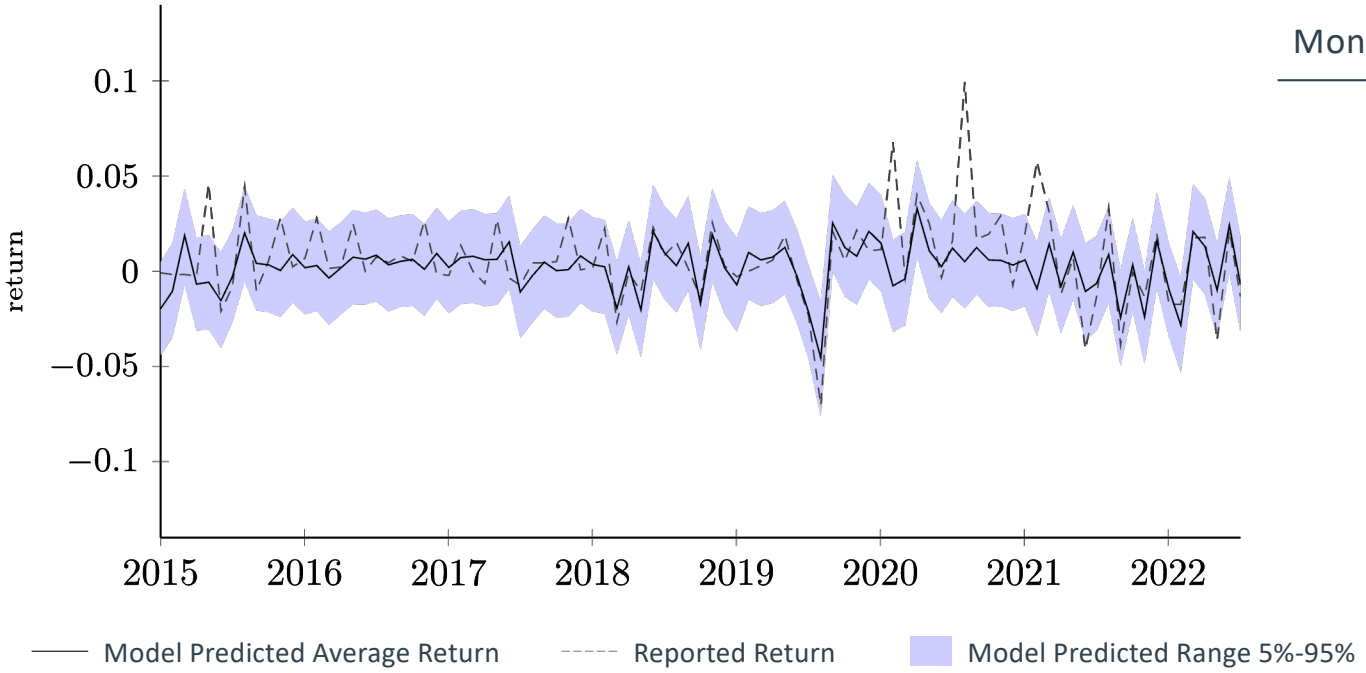


- The above fund is designed to represent a mutual fund that invests half its assets in a diversified market portfolio and invests the other half in an illiquid microcap, which itself invests in the market index.
- Due to illiquidity, the fund only accounts for the value of the microcap on a one-month lag.

By modeling how private capital funds generate returns, GMAM 3.0 solves the above.

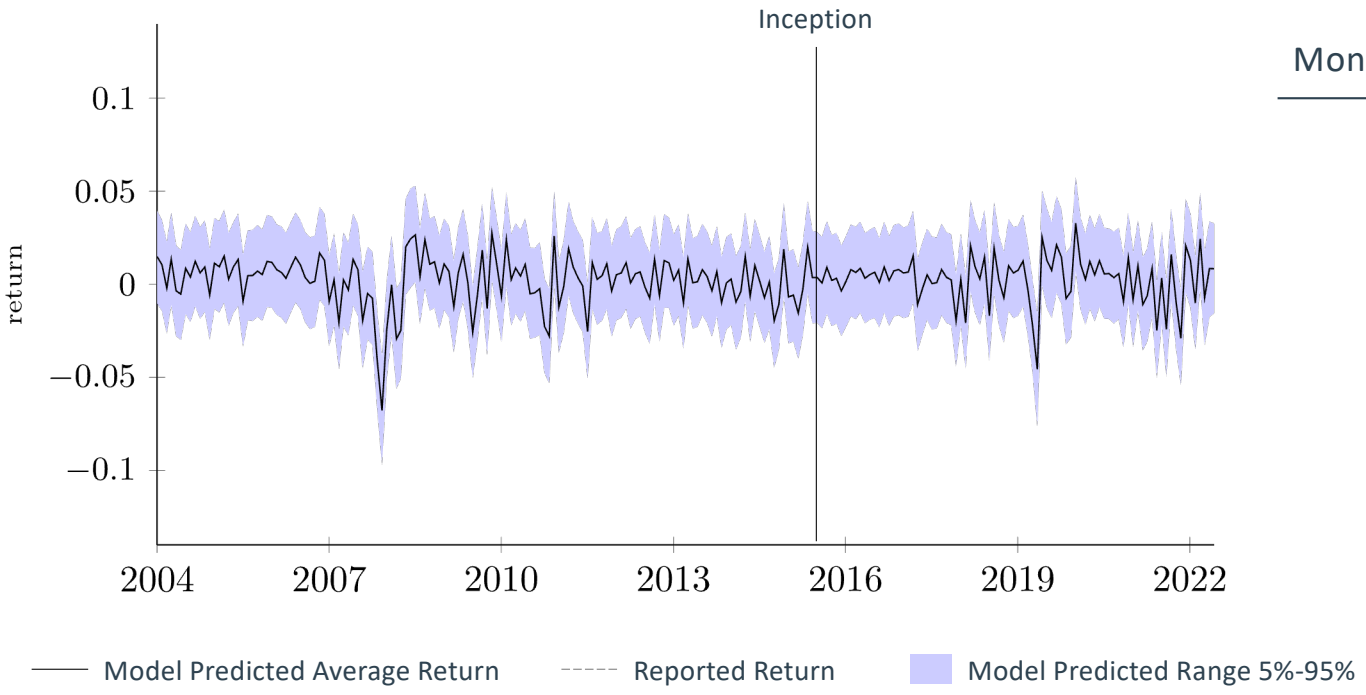

APPENDIX:
ADDITIONAL METHODOLOGY

Example Fund: iCapital KKR Private Markets Fund



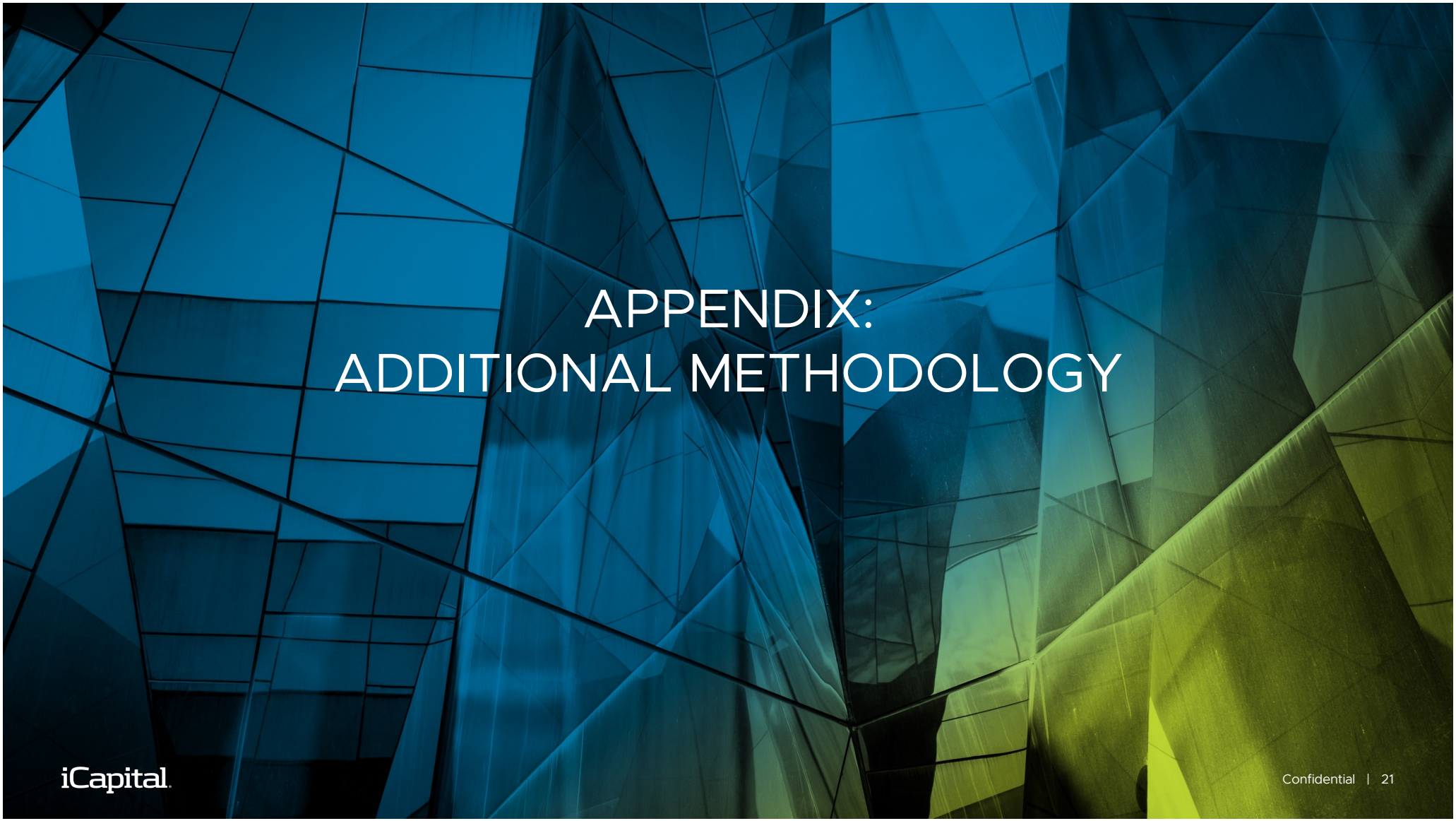
	Value
Model Fit ($R^{2)}$	31%
Months Reported	91

Example Fund: iCapital KKR Private Markets Fund



	Value
Model Fit ($R^{2)}$	31%
Months Reported	91


APPENDIX:
DESIGN PHILOSOPHY


APPENDIX:
ADDITIONAL METHODOLOGY

How do we estimate the model?

- The parameters are estimated in accordance with Bayes rule:

$$p(parameters|data) = \frac{p(data|parameters) \times p(priors)}{p(data)}$$
$$\propto p(data|parameters) \times p(priors)$$

- In words, the distribution of the parameters given the data is proportional to the data given the parameters (called the likelihood) times the priors.

- We estimate the joint probability distribution for the hundreds of parameters in our model using a proprietary methodology.

- The procedure is a synthesis of 75 years of literature on Bayesian statistics, drawing knowledge from the fields of applied statistics, finance, economics, and biostatistics.

Priors

- Most priors in the model are “weakly informative,” in that they constrain the distribution of relevant parameters to sensible quantities (e.g. a factor loading β may be -1, 0, or 2, but it is highly unlikely to be 500.)

- With respect to the factor loadings of private capital funds, absent an overriding informed view, the model assigns a low precision (weak) prior loading of 1.0 to the market and 0.0 to all other loadings.

- Informative priors are a topic of ongoing research. These may include:
  - A manager’s past vintages (informed prior to use at launch)
  - A cross-section of similar assets (on our 2023 research roadmap)
  - Analysis of the iCapital due diligence team and other analysts

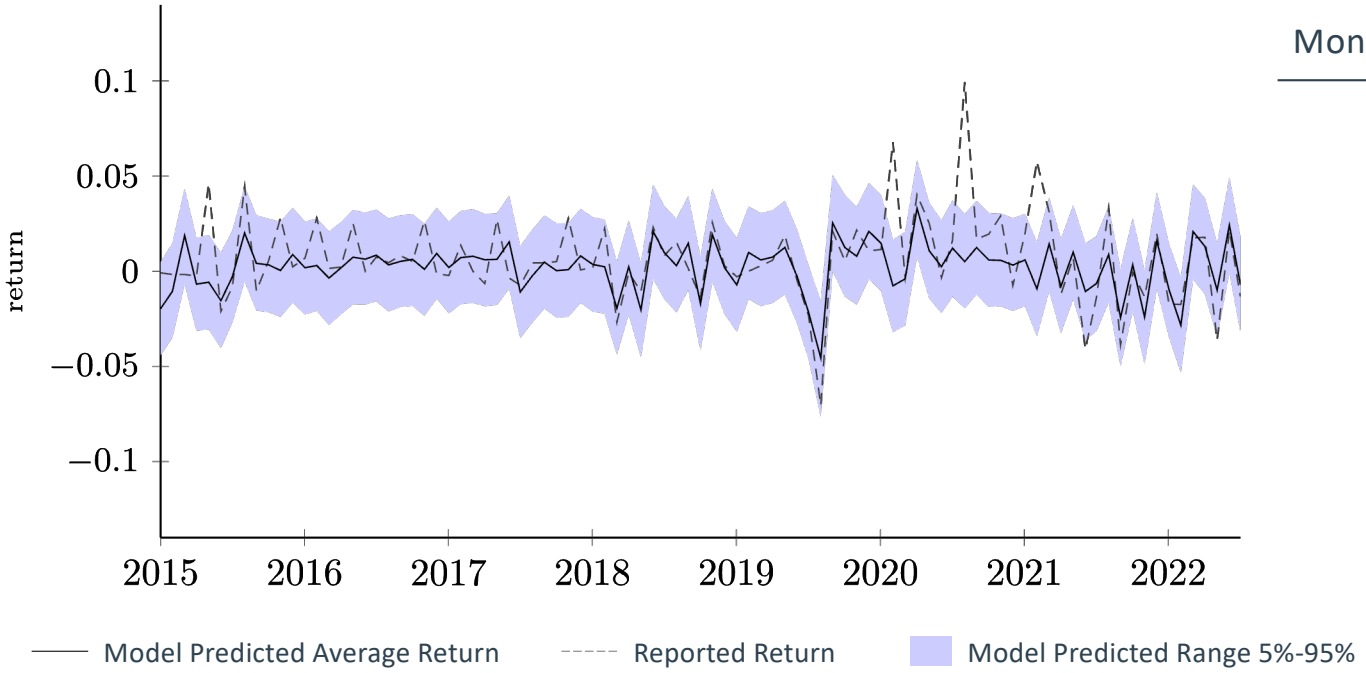
Time-Weighted Returns

- Time-weighed returns are not a traditional measure of private capital performance.
- Yet they are necessary to analyze the risk characteristics of a portfolio, as well as asset class-level performance.
- They are also important for a variety allocation decisions. For example, consider a manger that holds a PE investment who is allocating to stocks and bonds.
- GMAM3 relies on time-weighted returns to measure changes in portfolio value. Time weighted returns are calculated for investment vehicles as:

$$R_t = \frac{NAV_t + Distributions_t}{NAV_{t-1} + Contributions_t}$$

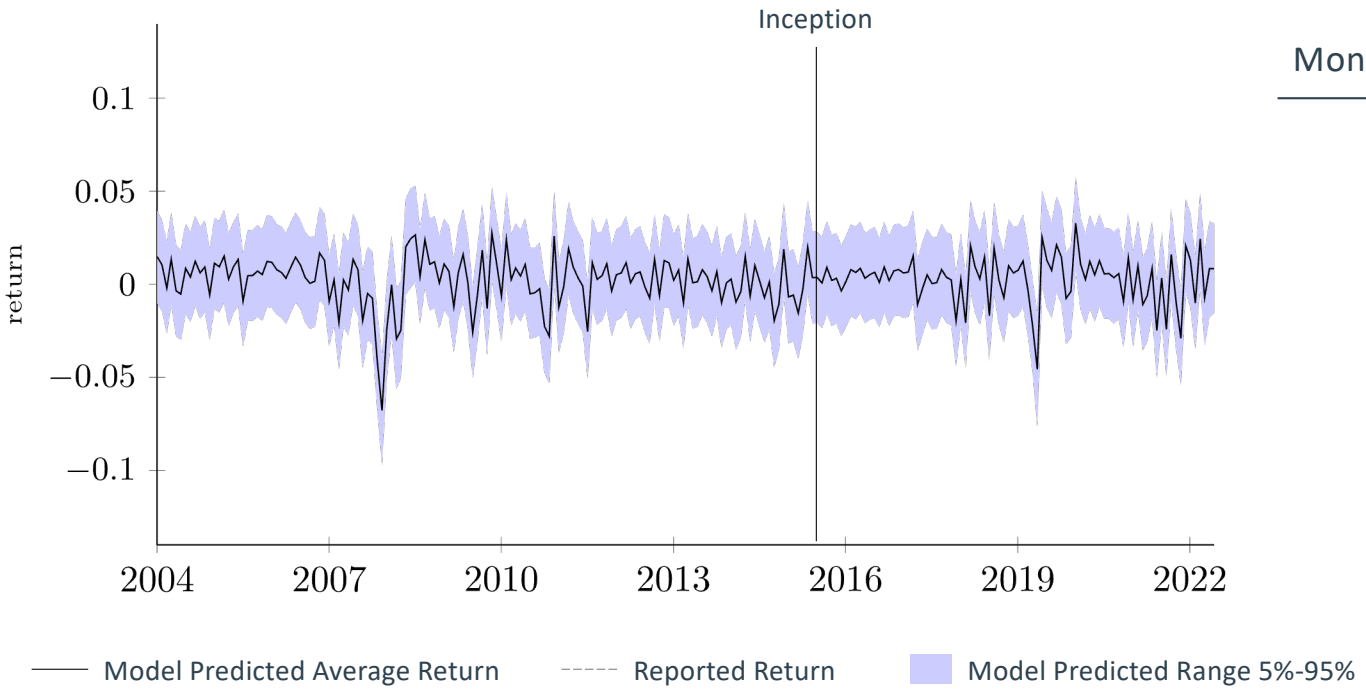
APPENDIX:
KKR PRIVATE MARKETS

Example Fund: iCapital KKR Private Markets Fund



	Value
Model Fit ($R^{2)}$	31%
Months Reported	91

Example Fund: iCapital KKR Private Markets Fund



	Value
Model Fit ($R^{2)}$	31%
Months Reported	91


APPENDIX:
FACTOR DEFINITIONS

Factor Descriptions

- **Alt Commodities**: The returns of a broad basket of commodities.
- **Alt HF Crowding**: The returns of positions commonly held by hedge funds net of the return of the US stock market.
- **Alt Oil**: The return of a global basket of crude oil futures.
- **Alt Trend**: The return of macro trend-following strategies covering a variety of asset classes. Trend following strategies enter long or short positions exposed to asset class indices based on their respective past performance.
- **Emerging Markets**: The return of an emerging markets equity index net of the return of a developed markets index.
- **Equity Market**: Market capitalization weighted global equity index. Contains both developed and emerging market equities.
- **Equity Momentum**: The return of a broad market index with a tilt towards "high momentum" firms net of a broad global equity index. Momentum is measured by performance over the past year.
- **Equity Quality**: The return of a broad market index with a tilt towards “high quality” firms net of a broad global equity index. Quality is measured by return on equity, stability of earnings growth, and low financial leverage.
- **Equity SmallCap**: The return of small firms net of the returns of large firms as determined by firm market capitalization.
- **Equity Value**: The return of firms with high value, as measured by the book-to-market ratio, net of the returns of low value firms.
- **Fixed Credit**: The return of high yield bonds net of the return of investment grade US bonds.
- **Fixed Duration**: The return of medium term US Treasuries net of the return of a representative short-run risk-free rate.
- **US Dollar**: The return driven by the US dollar value movement against a basket of developed market currencies.

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