Overview of Annual Asset Study Methodology

- In order to construct an optimal portfolio from a risk-return standpoint, conventional financial wisdom dictates that one develop return, volatility, and correlation expectations over the relevant investing horizon.

- Given the uncertainty surrounding financial and economic forecasts, expectations development is challenging, and any of several methodological approaches may meaningfully contribute to this complex task.

- Meketa Investment Group's process relies on both quantitative and qualitative methodologies.

- First, we employ a large set of quantitative models to arrive at a set of baseline expected ten-year annualized returns for major asset classes.

- These models attempt to forecast a gross "beta" return for each *public market* asset class; that is, we specifically do not model "alpha," nor do we apply an estimate for management fees or other operational expenses[1].

- Our models are fundamentally based (based on some theoretically defined return relationship with current observable factors).

- Some of these models are more predictive than others. For this reason, we next overlay a qualitative analysis, which takes the form of a data-driven deliberation among the research team and our Investment Policy Committee.

- Return assumptions for hard-to-predict asset classes as well as those with limited data will be influenced more heavily by our qualitative analysis.

- As a result of this process, we form our ten-year annualized return expectations, which serve as the primary foundation of our longer-term, twenty-year expectations.

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[1] Our expectations are net of fees where passive management is not available (e.g., private markets and hedge funds).

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Overview of Annual Asset Study Methodology (continued)

- We form our twenty-year annualized return expectations by systematically considering historical returns on an asset class by asset class level. Specifically, we construct a weighted average of our ten-year expectations and average historical returns in each asset class.

- The weights are determined by a qualitative assessment of the value of the historical data. Generally, if we have little confidence that the historical average return is representative of what an investor can expect[1], we will weight our ten-year forecast more heavily. Therefore, the weight on our ten-year forecasts ranges from 0.5 to 0.9.

- We develop our twenty-year volatility and correlation expectations differently. We rely primarily on historical averages, with an emphasis given to the experience of the trailing ten years.

- Qualitative adjustments, when applied, usually serve to increase the correlations and volatility over and above the historical estimates (e.g., using the higher correlations usually observed during a volatile market).

- We also make adjustments to the volatility based on the historical skewness of each asset class (e.g., increasing the volatility for an asset class that has been negatively skewed).

- In the case of private markets and other illiquid asset classes where historical volatility and correlations have been artificially dampened, we seek public market equivalents on which to base our estimates before applying any qualitative adjustments.

- These volatility and correlation expectations are then combined with our twenty-year return expectations to assist us in subsequent asset allocation work, including mean-variance optimization and scenario analyses.

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[1] For example, we have less confidence in historical data that do not capture many possible market scenarios or that are overly polluted by survivorship bias.

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Meketa Investment Group 2018 Annual Asset Study
Twenty-Year Annualized Return and Volatility Expectations for Major Asset Classes

Asset Class	Annualized Expected Return[1] (%)	Annualized Volatility (%)
Fixed Income		
Cash Equivalents	2.9	1.0
Short-term Investment Grade Bonds	3.1	1.5
Investment Grade Bonds	3.7	4.0
Investment Grade Corporate Bonds	4.4	7.0
Intermediate Government Bonds	2.8	3.5
Long-term Government Bonds	4.3	13.0
Long-term Strips	5.7	20.0
TIPS	3.6	7.5
Short-term TIPS	2.9	4.5
Global Inflation Linked Bonds	3.0	9.5
High Yield Bonds	6.2	12.5
Bank Loans	5.5	10.0
Private Debt Composite	8.2	17.0
Foreign Bonds	2.5	9.0
Emerging Market Bonds (major)	5.6	11.5
Emerging Market Bonds (local)	6.5	14.5

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[1] Expected returns are geometrically compounded.

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Meketa Investment Group 2018 Annual Asset Study
Twenty-Year Annualized Return and Volatility Expectations for Major Asset Classes (continued)

Asset Class	Annualized Expected Return[1] (%)	Annualized Volatility (%)
Equities		
US Large Cap	8.9	17.5
US Small Cap	9.7	22.5
Developed Market Equity (non-US)	9.1	20.0
Emerging Market Equity	12.5	25.0
Global Equity	9.4	19.0
Long-Short	4.9	10.0
Private Equity/Debt	11.8	24.0
Private Equity	12.9	27.0
Buyouts	12.4	25.0
Venture Capital	15.3	35.0
Real Assets		
Real Estate	8.3	18.0
Core Private Real Estate	6.2	12.0
Natural Resources (Public)	9.8	23.0
Natural Resources (Private)	11.5	23.0
Commodities (naive)	6.2	18.0
Infrastructure (Public)	8.8	18.0
Core Infrastructure	7.7	15.0
Other		
Hedge Funds	5.5	8.5
Global Macro	5.6	8.0
Fixed Income/Long-Short Credit	4.7	10.0
Relative Value/Arbitrage	6.4	9.0
Tactical Asset Allocation	5.4	12.5

[1] Expected returns are geometrically compounded.

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Meketa Investment Group 2018 Annual Asset Study: Correlation Expectations

	Cash Equiv.	Inv. Grade Bonds	Long-Term Gov't Bonds	TIPS	High Yield Bonds	Bank Loans	Emerging Market Bonds (major)	Emerging Market Bonds (local)	U.S. Equity	Dev. Market Equity (non-US)	Emerging Market Equity	Global Equity	Real Estate	Core Private Real Estate	Comm. (naive)	Infra. (Public)	Hedge Funds
Cash Equivalents	1.00																
Investment Grade Bonds	0.05	1.00															
Long-term Government Bonds	0.00	0.85	1.00														
TIPS	0.05	0.80	0.60	1.00													
High Yield Bonds	0.00	0.20	-0.20	0.30	1.00												
Bank Loans	0.05	0.00	-0.35	0.20	0.80	1.00											
Emerging Market Bonds (major)	0.05	0.50	0.25	0.50	0.70	0.40	1.00										
Emerging Market Bonds (local)	0.00	0.35	0.05	0.40	0.65	0.40	0.80	1.00									
U.S. Equity	0.00	0.05	-0.30	0.00	0.70	0.60	0.60	0.65	1.00								
Developed Market Equity (non-U..S)	0.00	0.05	-0.25	0.15	0.70	0.60	0.60	0.75	0.90	1.00							
Emerging Market Equity	0.00	0.05	-0.25	0.15	0.70	0.55	0.65	0.80	0.80	0.90	1.00						
Global Equity	0.00	0.05	-0.25	0.10	0.70	0.60	0.60	0.70	0.90	0.95	0.90	1.00					
Real Estate	0.15	0.20	0.05	0.10	0.50	0.45	0.30	0.30	0.50	0.45	0.40	0.45	1.00				
Core Private Real Estate	0.20	0.25	0.10	0.10	0.45	0.45	0.25	0.20	0.40	0.35	0.30	0.35	0.90	1.00			
Commodities (naive)	0.00	0.05	-0.15	0.35	0.40	0.40	0.40	0.45	0.35	0.55	0.60	0.50	0.15	0.10	1.00		
Infrastructure (Core)	0.10	0.20	-0.10	0.30	0.70	0.55	0.65	0.75	0.80	0.90	0.80	0.85	0.55	0.50	0.55	1.00	
Hedge Funds	0.10	0.05	-0.30	0.20	0.70	0.65	0.55	0.65	0.80	0.85	0.85	0.80	0.45	0.40	0.65	0.80	1.00