Alternative Investments

Advanced Modeling Techniques for Pricing and Valuing Private Equity, Infrastructure and Real Estate

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Introduction

IBM has an integrated risk management and modeling framework which attributes risk to an individual security or can aggregate risk to a level such as total portfolio. The primary goal is help risk managers and investment managers answer the question of what will be the value of their portfolio at some future time horizon and what is driving this valuation. These questions can be answered by developing scenarios on the risk factors driving the pricing models of the securities [both public and private] in the portfolio. The scenarios on the risk factors can be correlated or non-correlated.

Using this framework, IBM can provide detailed insight into the risk of public investments, allowing for a detailed decomposition of the risk of these asset classes along many different parameters. However, for private market investments such as private equity, real estate, land, infrastructure etc. the data and valuation frequencies tend to be significantly different than those in the public market. Therefore, careful analysis and research work is required to properly select a meaningful model.

Clients of IBM have several options to model private market securities. The modeling choice clients select often depends on the available data and the characteristics of the private security being modeled.

The main objective in selecting the appropriate model is to:

- Provide accurate and timely forecast of the private securities volatility at the security and portfolio level
- Capture the risk relationship to public investments

Modeling Approaches

IBM provides the following models to capture the risk in private market securities at the security level.

Factor Models

IBM provides a framework for it clients to select from a variety of factor models for the purpose of risk measurement of their private market securities. Factor Models represent a natural framework for analyzing exposures by reducing the dimensionality of the risk factor space to a more manageable size which, in turn, may yield significant benefits in terms of performance gains and tractability.

IBM supports a variety of factor models including a single factor model (analogous to CAPM), an index-based multi-factor model, a statistical model and finally modeling the securities as its own returns.

In the case of private markets the security could be indexed to similar ETF's, indices or like companies. Additionally, the model could be adjusted to capture idiosyncratic risk in the security such as liquidity.

Sensitivity Instruments

IBMs' solution will allow clients to map the private market instruments as a vector of first and second order sensitivities (including cross-product sensitivities) with respect to certain underlying risk factors. The engine then uses a Taylor-series function to calculate the change in the value of the portfolio in question under each scenario by looking up the change in each risk factor and the vector of sensitivities.

Distribution Uploads

IBM offers clients the option to represent private market securities as a marginal distribution. The distribution can either be an empirical or parametric. For parametric distributions the following forms are available:

- Normal/Gaussian
- Log-Normal
- Student-T
- Binomial
- Poisson
- Gamma
- Weibull
- Makeham with Gompertz as special case
- Inverse Gaussian
- Univariate Generalized Hyperbolic

Other parametric distributions can also be specified via the user-defined equation builder functionality.

The distribution for the private market security is then aggregated with market traded risk factors by utilizing a copula approach. The output is a total correlated aggregate loss distribution for both the public and private market securities.

In this method the client needs to provide IBM with an empirical distribution of results or with the parametric parameters that represent the distribution of the private market security. Additionally, for generating aggregated risk they need to provide the correlations and volatility between the private market security and the other risk factor in the session.

Curve/Formula Fitting

The IBM solution has an optimization engine that allows clients to fit a curve to pre-calculated values under various user-defined stress (and joint stresses) of underlying risk drivers. Users have a great degree of flexibility in terms of defining the functional form of the curve being fitted using a custom expression builder that allows them to define any number of "terms" that make up a polynomial expression. The optimization engine finds the values of the linear coefficient for each of the selected term functions such that the difference between the actual and predicted values is minimized (either sum of absolute errors or sum of squared errors are supported as objective functions).

In using this method the client needs to provide values for the private market security under a variety of scenarios. Curve fitting is often selected if there are many risk factors driving the valuation of the security which are not necessarily correlated to the market.

Cash Flow Replication

The Cash Flow Replication approach involves determining a portfolio of financial instruments that replicates the cash flows of a given private market security under a range of scenarios. These portfolios can be used as a proxy for the valuation and simulation of the private markets security under different market conditions, without the need to re-generate the cash flows.

With the private market security represented as portfolios of standard financial instruments, the IBM solution allows clients to access a risk dashboard where end users can analyze the structure of the security and their corresponding assets/components, to arrive at various risk measures. Each day, Cash Flow Replication, and corresponding assets can be uploaded, together with up-to-date market data for "marking-to-market" and for calculation of changes in value, and sensitivities.

A key feature of Cash Flow Replication is the ability to revalue the private security under current market conditions in seconds and to decompose the security into its individual cash flow generating characteristics.

The Cash Flow Replication approach is similar to formula fitting except that each term in the polynomial expression corresponds to the value function of a selected financial instrument. That is, users can select a number of standard financial instruments and use the optimization engine to find a portfolio of these instruments (position units in each instrument is similar to coefficients for each term in a given formula) such that the portfolio values/sensitivities is as close as possible to the input stress values.

Under this approach, a number of stochastic cash flows for the private markets securities are generated by the clients in house or external valuation system. Under each scenario, cash flows are represented as either nominal or discounted cash inflows/outflows occurring on a given date. Clients can specify any frequency for the cash flow bucketing scheme (e.g. quarterly for 40 years; annual for 20 years; quarterly for first year and annual thereafter). Even though Cash Flow Replication does not require many scenarios, a wide range of scenarios is required for the output to produce reliable results. The scenarios and value under each scenario is provided to IBM as an input. The solution then provides a powerful optimization module that derives a portfolio of replicating instruments which match as closely as possible the private markets cash flows or value provided.

The IBM system supports more than 200 instrument types. The instrument types range from simple linear payoff instruments (e.g. forwards) and simple options to complex path dependent or structured instruments. For each supported instrument type, the solution provides valuation functions, cash flow generation functions and calibration routines. The selection of security types for the replicating universe involves a deep understanding of the underlying behavior and cash flow generating characteristics of the private market security.

The optimization engine is integrated with the risk dashboard (user interface accessed via a browser), and is a key component to the Cash Flow Replication problem. It provides for a rich set of choices in defining the replication problem including but not limited to:

1. User-defined objective function: Present Value of cash flows versus forward value; minimizing absolute deviations versus squared errors, etc.
2. Constraints: users can define constraints in terms of long/short, absolute positions, relative positions on any replicating instrument or user-defined grouping of replicating instruments (e.g. no long position on out of the money put options).
3. Trade penalties: users can specify trade penalties to ensure the derived Cash Flow Replication are meaningful in terms of number of instruments required to achieve a certain level of accuracy. Users can also specific minimum position sizes. Both hard and soft trade penalty and constraints are supported.
4. Maximum number of instruments in the Cash Flow Replication.
5. Bucketing: Users can perform replication based on present value of all cash flows (equivalent to terminal value basis), un-bucketed cash flows, or bucketed cash flows (e.g. first year cash flows; 1-5 years cash flows in one bucket; 5-10 years in one bucket; and 10-40 years in one bucket).
6. Value and sensitivity constraints: users can specify that the value and sensitivities of the Cash Flow Replication must match that the private market security under a user-defined stress scenario sets.

Finally, the solution provides extensive diagnostic reporting tools via the risk dashboard that allows users to evaluate and analyze the results (at scenario and time step level) and to assess the goodness of fit and reliability of the solution for both in-sample and out-of-sample testing. The quality of a Cash Flow Replication can be determined from a variety of metrics including R^2, 45 degree plots, mismatch of scenario dependent cash flows at time 0 both in the average and across scenarios, bar charts of the mean and standard deviation of cash flows across time, matching sensitivities, etc. on both an in-sample and out-of- sample basis. Even though a combination of these methods are used, a poor R^2 is an early sign of a lack of fit for a Cash Flow Replication.

Alternatively, if clients do not have sufficient data to project a number of valuations under different scenarios, then a Cash Flow Replication can be generated using best guess estimates on the appropriate security to include in the portfolio to represent the cash flow payoffs of the security.

Custom Equations

Custom equations allow clients the ability to setup private market securities using a bottom up approach which is consistent with a corporate finance style approach to modeling private markets. Additionally, the model aims to consistently capture the 3 main types of private market exposures:

- Investment in a fund containing private equities
- Direct investment into specific companies
- % ownership

Using custom equations clients can define a functional form to represent the current and future market value of a security they hold. The equation can be a combination of static and scenario dependent data. The difference between this model and a factor model is that it is not based on a regression, which is often difficult given the infrequent price history of private market securities. Additionally, the model allows clients the flexibility to intuitively build a representation of the valuation structure for the private market securities.

Conclusion

Pricing and valuing alternative investments is one of the most complex challenges in financial risk management. It is also a capability that is growing in importance as asset owners, faced with a volatile, low yield environment, seek to improve returns and diversify risk by increasing the allocation of their portfolios to alternative investments. In practice, there are a range of modeling approaches that are being adopted by leading firms to help price and value their alternative investments. Their choice of which model to use is largely dictated by the available data and the characteristics of the private security being modeled.

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IBM Business Analytics software delivers data-driven insights that help organizations work smarter and outperform their peers. This comprehensive portfolio includes solutions for business intelligence, predictive analytics and decision management, performance management, and risk management.

Business Analytics solutions enable companies to identify and visualize trends and patterns in areas, such as customer analytics, that can have a profound effect on business performance. They can compare scenarios, anticipate potential threats and opportunities, better plan, budget and forecast resources, balance risks against expected returns and work to meet regulatory requirements. By making analytics widely available, organizations can align tactical and strategic decision-making to achieve business goals.

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