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Construction Rules for the Morningstar Mark-to-Model Pricing Methodology for Venture Capital-Backed Companies

Morningstar Indexes

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Contents

Overview

The Morningstar Mark-to-Model pricing methodology brings transparency and timeliness to private company valuations. It is designed to produce realistic levels of volatility and returns for private companies by generating daily implied private company prices based on three factors:

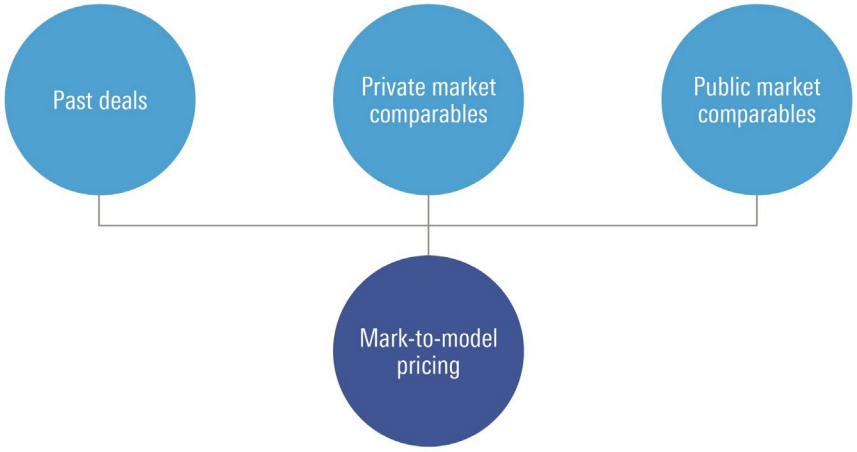
- Past deals data
- Comparable private company deals
- Changes in comparable public company valuations

To estimate a daily price for a private company, a numerical optimization routine is employed. The optimization routine determines factor weights, which evolve dynamically based on the time elapsed since the last deal.

The main purpose of the pricing model is to estimate mark-to-model valuations of private companies that enable the estimation of implied valuations for private market indexes.

Data from PitchBook, a leading provider of private-market data and research and an independent subsidiary of Morningstar, underpins the model. See Appendix 3 for more information on PitchBook.

Exhibit 1 Three-Factor Model for Determining Private Company Valuation



Source: Morningstar.

Morningstar Mark-to-Model Pricing Methodology

The Morningstar Mark-to-Model pricing methodology consists of the following steps:

1. Factors calculation
2. Factors weighting
3. Calculating mark-to-model valuation

Factors Calculation

The Mark-to-Model pricing methodology is designed to generate implied daily private company prices based on three factors.

Past Deals Factor: The past deals factor uses real-world private company deal data to infer an implied equity valuation for the company. However, as time elapses from the deal date, the ability of the past deal value to imply the current valuation of the company diminishes. Therefore, the past deals factor takes the most recent post-money valuation and decays the information based on the number of days since the last funding round.

Thus, the model pricing methodology uses past deals data and decays the information exponentially ($\lambda = e^{-t/252}$) where **t** is the number of trading days since the last funding round. The exponential decay function is derived empirically from patterns in the past deals data.

Exhibit 2 Past Deals Factor Construction for Revolut

	Date	Pre-money Valuation	Deal Size	Post-money Valuation	Decay Factor	Past Deals Information Contribution
Deal happens →	7/24/2020	4768.94	562.19	5331.13	1.00	5331.13
	8/24/2020				0.91	4866.11
	9/24/2020				0.84	4459.30
	10/24/2020				0.77	4086.51
	11/24/2020				0.70	3744.88
	12/24/2020				0.65	3445.45
	1/24/2021				0.59	3169.97
	2/24/2021				0.54	2904.96
	3/24/2021				0.50	2662.11
	4/24/2021				0.46	2439.56
	5/24/2021				0.42	2235.61
	6/24/2021				0.38	2048.72
Deal happens →	7/15/2021	35578.04	807.08	36385.12	1.00	36385.12

Source: Morningstar, PitchBook Data.

Private Comparable Factor: The private comparable factor calibrates the valuation of the company by using recent deal data of other privately owned comparable companies that are similar to the subject company.

Steps to calculate private comparable factor for a given private company are as follows:

1. PitchBook analysts identify comparable companies based on characteristics like deal type, location, product mix, industry vertical, and size of company. In addition, a comparability score is assigned, ranging from 1 (limited comparability) to 4 (high comparability), for each comparable.
2. The latest deal information (as of the evaluation date) for each private comparable company is collected.
3. Deals data is decayed, just like the past deals factor, based on the comparable company's deal date.
4. Past deals returns are weighed by the comparability score and by the last known post-deal valuation of each private comparable. The latter is akin to market-cap weighting of information in public markets and allows us to reduce the impact of outliers. The weighted returns are then aggregated to create the net private comparable factor.

   Exhibit 3 demonstrates the private comparable factor calculation for a company, Revolut, using two comparable companies.

Exhibit 3 Private Comparable Factor Construction for Revolut

Source: Morningstar, PitchBook Data.

Public Comparable Factor: The public comparable factor reflects the public market performance of the closest thematic index to a given unicorn. It results from public comps analysis—comparing public market thematic indexes with the unicorns and assigning each unicorn a thematic index of best fit. Respective Morningstar Thematic Indexes are used as baselines here. When a company touches multiple themes, Morningstar analysts match it to the theme that is most relevant. In contrast to private comps analysis, public comps analysis is generally easier to perform because public companies are required to

publish a wide variety of information. While baselining to public thematic indexes, we use multiple criteria such as sector, geographical location, revenue, and business lines.

We then create a public market factor based on the performance of the comparable public thematic indexes between the past deal date and valuation evaluation date. For an illustrative example, in Exhibit 4, we show a company deal for Revolut on July 24, 2020. Between deals, the public comparable index grew, growing the public comparable factor accordingly.

Exhibit 4 Public Comparable Factor for Revolut

	Date	Pre-money Valuation	Deal Size	Post-money Valuation	Public Market Growth Factor	Public Market Factor Value
Deal happens →	7/24/2020	4768.94	562.19	5331.13	1.00	5331.13
	8/24/2020				1.09	5787.01
	9/24/2020				1.03	5490.45
	10/24/2020				1.12	5970.87
	11/24/2020				1.18	6313.15
	12/24/2020				1.29	6874.66
	1/24/2021				1.36	7240.66
	2/24/2021				1.38	7349.41
	3/24/2021				1.31	6994.41
	4/24/2021				1.41	7504.26
	5/24/2021				1.36	7250.34

Source: Morningstar.

Risk Adjustment Factor (RAF)

While incorporating new public comps based on themes makes the model valuations representative of emerging trends and opportunities across different sectors, they still lag the numbers during periods of extreme market volatility. Based on several published artifacts, the increased volatility in public markets can affect private market valuations in several ways:

- Reduced investor appetite for less liquid private market investments: Investors exhibit higher risk-aversion during periods of market volatility and are usually unwilling to invest in the riskier and more-illiquid private markets.
- Increase in the risk of private market investments: Private companies are more likely to be affected by economic downturns and other market disruptions than public companies.
- Denominator effect: Public markets fall faster than private markets; as a result, the weight of public markets in an investor's overall portfolio diminishes, leaving a high net exposure to private markets.
- Private companies find it increasingly difficult to raise fresh capital during periods of high uncertainty in the public markets.

This justifies the use of a risk adjustment factor that accounts for the current risk sentiment of the public markets. As and when the risk sentiment increases, our valuation model needs to be able to increase the sensitivity of valuations to the public markets. Static weights assigned to public and private comparables may not accurately capture the dynamic nature of the market. The RAF dynamically adjusts the weights assigned to public and private comps based on market conditions. We use trailing three-month volatility as a measure of the market risk sentiment.

- On the valuation date, the trailing three-month return of public comps is calculated, and the median of historical rolling three-month returns over the past three years is determined.
- To assess the volatility of public comps relative to their historical median, a percentile score is derived by comparing the current three-month return with the historical three-month volatility.
- If the percentile rank exceeds 50, RAF is calculated, indicating the necessary adjustment for public comps.

This dynamic approach, facilitated by the RAF, ensures that the weights assigned to public and private comps are responsive to changing market conditions and reflect the evolving landscape over time. By incorporating and adjusting for volatility, the valuation models become more reliable and introduce a certain degree of volatility in the valuations that is usually missing in private company valuations.

Factor Weighting and Calculating Mark-to-Model Valuation

The model uses a numerical optimization routine to determine factor weights. These weights dynamically change based on the time elapsed since the last deal for a given company. The optimization prioritizes private market factors during up markets and public market factors during down markets. However, down rounds boosted the private comparable factor as private companies' valuations "catch up" to public markets.

Optimization Objective:

The optimization problem, used to calculate the three factor weights, is:

$$\min_{w_{pd}} \sum (PD_t - Estimated\_Price_t)^2 \quad (1)$$

Subject to the constraints:

$$w_{pd} + w_{pur} + w_{pvr} = 1 \quad (2)$$

$$w_{pd}\ ,\ \ w_{pur}\ ,\ w_{pvr} \geq 0 \quad (3)$$

where:

$$Estimated\_Price_t = \left(\mathrm{W_{pd}} * \lambda_t + \mathrm{W_{pur,t}} * \mathrm{R_{pur(t-1,t)}} + \mathrm{W_{pvr,t}} * \mathrm{R_{pvr(t-1,t)}} \right) * \mathrm{PD}_{t-1} \quad (4)$$

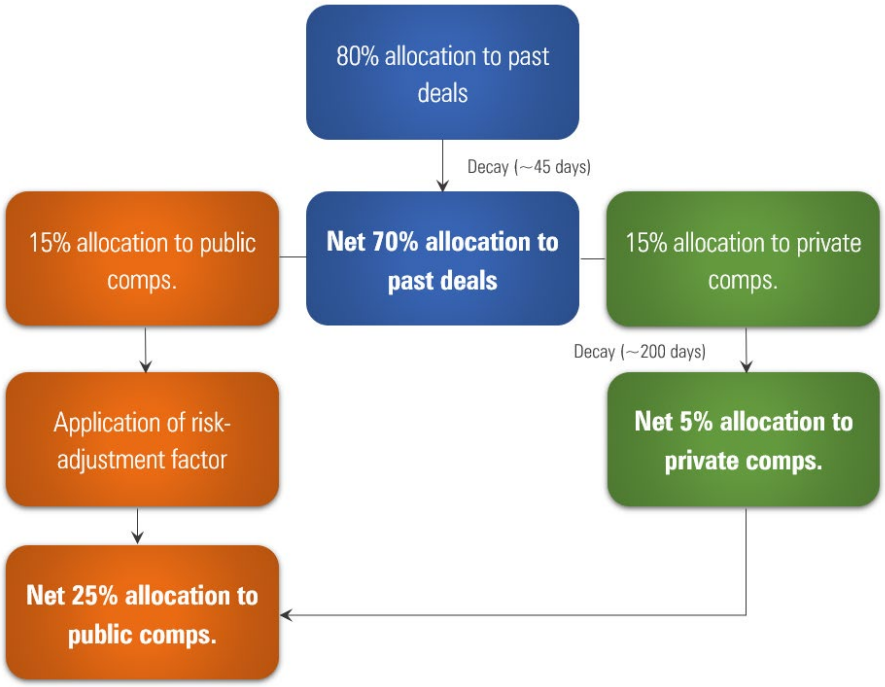
and:

$W_{pd} = Weight\ of\ past\ deals\ as\ determined\ by\ the\ optimizer$
$W_{pvr,t} = Weight\ of\ private\ market\ returns\ at\ time\ t$
$W_{pur,t} = Weight\ of\ public\ market\ returns\ at\ time\ t$
$PD_{t-1} = Last\ Known\ Post\ Deal\ Valuation\ for\ the\ unicorn\ prior\ to\ t$
$\lambda_t = Exponential\ Decay\ factor\ demonstrating\ relevance\ of\ PD_{t-1}\ at\ time\ t$
$R_{pvr(t-1,t)} = Private\ Comparable\ Factor\ between\ t\ and\ t-1$
$R_{pur(t-1,t)} = Public\ Comparable\ Factor\ between\ t\ and\ t-1$

The optimization model was executed on the private company data from January 2014 to the present. This comprises more than 9,000 deals. The optimization resulted in weights to be applied to past deals, public comparables, and private comparables for all constituents. Once relevant weights were determined, we populated the valuation series for all unicorns based on the formula for calculating the mark-to-model valuations as discussed above.

At a high level, our model relies on the past deals factor, when possible, but will fill in the gaps from private comparable deals and public comparable indexes. Exhibit 5 depicts the relative factor importance in estimating mark-to-model valuations for a sample company. We assume that the three-information factor source weights add up to one. On deal dates, we prioritize the post-money valuation as the best estimate of the worth of the private company. As time passes, the relative weighting to past deals is decayed (70% as per Exhibit 5), and we increase priority of private and public comparables. We initially allocate the remaining weights (30%) equally between the factors, and we then rely on the performance of the public market (relevant thematic index). At the same time, we also introduce the risk adjustment factor to establish the final weight to the public comparable factor. As discussed on the section on RAF, based on the risk sentiment, we linearly increase the allocated weight to the public comparable factor. Next, the remainder weight is allocated to the private comparable factor. Since private comparable deals may have happened at a lag of several days from the evaluation date, we need to decay this factor as well. The weight of private comparable gets reduced subsequently. The weight that gets reduced from the private comparable factor subsequently gets added to the public comparable factor to give us the final allocations.

Exhibit 5 Price-Information Waterfall



Source: Morningstar.

Appendixes

Appendix 1: Key Considerations for the Mark-to-Model Pricing Methodology

Our model makes several assumptions, outlined below. As we consume additional data and information, we anticipate the need to update our assumptions and our model to best reflect realized valuations.

- PitchBook analysts provide comparable companies for private companies, which are available for approximately 35% of the eligible 1,502 unicorns. In the absence of private comparables, we reallocate the weight to public comparables. In such cases, the RAF plays no role.
- Our private and public comparable data is only available going forward. We assume our initial mappings are consistent historically, which may be less than ideal and potentially introduces some look-ahead bias. To the extent that business models or goals have radically changed, some comparables may be a poor fit for some historical periods. As we support this dataset over time, we would expect accuracy to improve.
- During visible down rounds of private comparable companies, the private comparables factor gets relatively more weight than public comparables. We believe private comparable information is more relevant during such periods.
- Public markets trade 252 days of the year, but private deals can occur over weekends. We assume that private deals occur only when public markets are in business. Any deals that happen on nonbusiness days are brought into effect on the next business day.
- When a company raises new money, it issues new shares to these new shareholders, and consequently, the existing investors undergo a stake dilution. As mentioned earlier, we intend for the valuation levels to be indicative of realized investor returns. To that end, we adjust the estimated valuation on the day a new deal happens. Accordingly, we transform the final valuation levels on such days based on the returns between the previous day's valuation and the deal date's pre-money valuation.
- The decay function has been empirically determined to be exponential based on distribution of the deals data.

Appendix 2: Challenges and Limitations of the Mark-to-Model Pricing Methodology

Estimating asset valuations in the absence of public, liquid markets is challenging. Earlier asset-pricing models have several drawbacks. Some limitations of our mark-to-model pricing methodology are:

- The methodology considers only company-sponsored financing rounds and does not consider secondary transactions in company securities.
- The methodology calculates implied subject company transaction value on an as-converted basis, which ignores liquidation preferences and other security rights and privileges.
- The methodology calculates implied subject company transaction value without considering all stock options.

- The methodology utilizes the most recent subject company deal and assumes the deal represents fair value. There may be circumstances where the deals are not indicative of fair value.
- The methodology is intended to be used to capture the behavior of broader private markets tracked through a basket of securities or indexes. To this end, the methodology outcomes should be treated cautiously for valuing individual private companies.
- Private market observed returns are smoother than public market returns because they have significantly fewer observable transactions, leading to serial correlation and a lower level of reported volatility. Our methodology's use of public and private comparable data makes the return series less smooth. To this end, our index series may still have some serial-correlation, which may be a subject of future research.
- Many thematic indexes have been launched only after or during 2021. The model is bound to use thematic indexes as and when they become available. For valuations of unicorn during periods before their respective thematic index was launched, we must use Global Industry Classification Standard industry mapping.

Appendix 3: **PitchBook Data**

- Headquartered in Seattle, PitchBook, a Morningstar company, is the largest provider of data on private markets. PitchBook employs over 1,600 employees and covers 3.4 million private companies.
- PitchBook provides data, research, and analysis on private and public companies. The company specializes in researching global mergers and acquisitions, private equity and venture capital investments along with all participating parties, including limited partners, investors, service providers, and the professionals involved.
- PitchBook provides the investment community with a proprietary data platform, research tools, and custom analysis to enable better investment decisions.

For more details, please visit: http://www.pitchbook.com/

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