

BUSINESS VALUATION UPDATE

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Calibration With OPM in Early-Stage Enterprises: A Fair Value Update

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In 2018, the AICPA released a Working Draft of a new accounting and valuation guide, *Valuation of Portfolio Company Investments of Venture Capital and Private Equity Funds and Other Investment Companies*¹ (the Working Draft), which is currently in the process of being revised based on public comments. In this article, we review the application of option pricing model (OPM) techniques to

the valuation of interests in early-stage enterprises (ESEs) based on the guidance provided in the Working Draft, and particularly on Case Study 9, "Biotech Investment With a Complex Capital Structure—Multiple Investors' Perspectives." We review how a calibration model can be established based on the initial transaction price of an ESE investment and how such a model could be used in subsequent measurement periods to estimate the fair value of the enterprise and of equity interests in a portfolio company.

Case Study 9 in the Working Draft is dedicated to the valuation of interests in a clinical-stage biotech company. The company has a strong and experienced management team that is focused on advancing the company's product through Phase 2² of its development and that is planning to eventually take the company public should it achieve FDA approval. Over time, the company's

1 This guide is based on the application of the "fair value" standard to the valuation of portfolio company investments under ASC 820. The definition of "fair value" under ASC 820 and IFRS 13 have certain similarities to the definition of "fair market value" in IRS Revenue Ruling 59-60 and to the "fair value-based" standard that applies to the valuation of privately held company securities issued as compensation under ASC 718. However, there are also relevant differences, which may affect other aspects of early-stage company valuation.

2 Phase 2 is the second phase in a sequence of tests the FDA requires to approve a drug.

Exhibit 1. Capitalization Table: Series A Preferred Round

Investor	Shares Outstanding	Issue Price	Invested Capital	Liquidation Preference (x)	Conversion Ratio (x)	Fully Converted	Fully Converted %
Ser. A preferred							
Investor A	4,000,000	\$1.00	\$4,000,000	1.00	1.00	4,000,000	26.67%
Investor B	3,000,000	\$1.00	\$3,000,000	1.00	1.00	3,000,000	20.00%
Investor C	3,000,000	\$1.00	\$3,000,000	1.00	1.00	3,000,000	20.00%
Total Ser. A preferred	10,000,000		\$10,000,000			10,000,000	66.67%
Common stock	5,000,000	N/A	N/A			5,000,000	33.33%
Total						15,000,000	100.00%

(Source of all exhibits: Based on the AICPA Working Draft of AVG on *Valuation of Portfolio Company Investments of Venture Capital and Private Equity Funds and Other Investment Companies*, Case Study 9)

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funding has resulted in a complex capital structure, which includes warrants and options as well as common and preferred stock.

Calibration at initial measurement. In its first round, the company raises \$10 million in Series A preferred shares from Investor A, Investor B, and Investor C. Series A preferred shares are issued at \$1 per share and have a 1x conversion ratio and a 1x liquidation preference. Series A preferred shares are nonparticipating and come with certain noneconomic rights. Exhibit 1 is a capitalization table after the first round of financing as described in the Working Draft.

The initial transaction is deemed at arm's length under ASC 820. Investor A, Investor B, and Investor C use the issue price of \$1 dollar per share as the fair value of their investment at the initial measurement date. In the Working Draft, Investor B is using a Black-Scholes-Merton option pricing model (BSM OPM) to set up a calibration model for the subsequent measurement of its preferred stock interest. To set up the OPM model, Investor B starts from the "known" value of a unit of Series A preferred stock (\$1 per share based on the issue price) and backsolves to the enterprise

**Exhibit 2. Calibration at Entry:
Series A Preferred Round Breakpoint Analysis**

	Liq. Preference	Ser. A Converts
Equity Class	No. 1	No. 2
Series A preferred	\$10,000,000	
Common	\$ -	\$5,000,000
Total	\$10,000,000	\$5,000,000
Cumulative Value		
Equity Class		
Series A preferred	\$10,000,000	\$10,000,000
Common		\$5,000,000
Total before proceeds	\$10,000,000	\$15,000,000
Cumulative Value Per Outstanding Share		
Equity Class		
Series A preferred	\$1.00	\$1.00
Common	\$ -	\$1.00

value using the OPM. The OPM is set up using the Black-Scholes-Merton formula with the following inputs:

1. *Volatility of the enterprise value.* This can be estimated based on the volatility of guideline companies, with adjustments to account for the risk profile of the ESE and based on an industry/sector analysis. The volatility is estimated at 100%.
2. *Exercise price.* Multiple exercise prices are determined based on the waterfall embedded in the company's capital structure, which in turn depends on the contractual rights of the various classes of securities. We discuss the exercise price in greater detail below.
3. *Time to exit.* This input represents the expected timing of an exit event. Based on the example in Case 9 of the Working Draft, the time to exit is set at three years from the measurement date.
4. *Risk-free rate.* This input is often based on the yield of U.S. treasury securities with a matching term. We have estimated it at 2% in our example (not specified in the Working Draft).
5. *Dividend yield.* Equity securities of ESEs do not typically generate cash dividends. This input is set to zero.

One of the key inputs in the option pricing model is the exercise price of the options, which is based on the "breakpoints" of the model, namely, the points at which there is a change in the contractual allocation of enterprise value among the various classes/series of shares. As indicated in Exhibit 2, there are two breakpoints in our example.

First, the enterprise value will be allocated to the preferred shares up to their liquidation preference. The first breakpoint corresponds to an exercise price of \$10 million, at which

point the value per outstanding share is equal to \$1 for preferred shares and zero for common shares. Once the liquidation preference of the preferred stock has been satisfied, value will be allocated only to common stock, until the unit value of common stock will equal the unit value of the preferred stock (Breakpoint 2). At Breakpoint 2, preferred stockholders will find it suitable to convert their shares into common stock. Any enterprise value remaining beyond Breakpoint 2 will go pro rata to all shareholders based on their percentage of ownership in the company on a fully converted basis.

Exhibit 3 presents the OPM based on the exercise prices and other inputs that we have discussed so far, using the Black-Scholes-Merton

Exhibit 3. Calibration at Entry: Series A Preferred Round				
Black-Scholes-Merton OPM Model				
	Total	No. 1	No. 2	End
Underlying asset value	\$13,862,769	\$13,862,769	\$13,862,769	\$13,862,769
Exercise price		\$10,000,000	\$15,000,000	
Expected volatility		100%	100%	
Risk-free rate		2%	2%	
Annualized dividend yield		0%	0%	
Time to exit (years)		3	3	
d(1)		1.09	0.86	
N(d1)		0.86	0.80	
d(1)		(0.64)	(0.88)	
N(d2)		0.26	0.19	
Value of call option	\$13,862,769	\$9,499,153	\$8,454,575	
Incremental option value		\$4,363,616	\$1,044,578	\$8,454,575
Breakpoint Participation Percentages				
Ser. A preferred stock		100.00%	0.00%	66.67%
Common stock		0.00%	100.00%	33.33%
Total		100.00%	100.00%	100.00%
Allocation of Incremental Option Value				
	Total Value			
Ser. A preferred stock	\$10,000,000	\$4,363,616	\$-	\$5,636,384
Common stock	\$3,862,769	\$-	\$1,044,578	\$2,818,192
Total	\$13,862,769	\$4,363,616	\$1,044,578	\$8,454,575
Ser. A preferred per share	\$1.00			
Common per share	\$0.77			

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formula to estimate the value of the call options as of each breakpoint.

The breakpoint values are inserted as an input in the “Exercise price” line. At Breakpoint 1 (exercise price of \$10 million), the incremental value assigned to the option is allocated 100% to preferred stock, to reflect its liquidation preference. At Breakpoint 2 (exercise price of \$15 million), the incremental option value of \$1.04 million is allocated entirely to common stock. Above the \$15 million breakpoint, all value is allocated pro rata to common and preferred stock.

Once the formulas for the model have been set up, using a proxy as the underlying asset value (the enterprise value), the model is then back-solved by inputting either the \$10 million investment from the Series A investors or the \$1 dollar per share of the Series A preferred stock in the bottom part of the exhibit and backsolving to find the underlying asset value of the enterprise at the top of the exhibit.³ In our example, the

OPM results in an enterprise value of \$13,862,769, which is consistent with a transaction price of \$1 per share for the Series A preferred, and with an estimated value of \$0.77 per share for the common stock. If Investor B also holds common shares, he or she may have to consider assessing the value of its common shares to coincide with the results of the calibrated model upon Series A Preferred issuance.

New rounds of financing and subsequent measurement. We now move forward a few years to the date of a new round with Series C preferred shares. The updated capitalization table after the new round is now as shown in Exhibit 4.

In addition to Series A shares (now \$20 million), the capitalization table as of June 30, 2X14, includes Series B preferred stock with a 1x liquidation preference and a \$1.50 issue price per share.

shares or the total \$10 million of the preferred shares issue price as an input and solving for the underlying asset value. See also “The Valuation of Early-Stage Enterprises” (BVR webinar, Dec. 18, 2018) for a practical example of the use of the What-If formula in an OPM model.

3 This can be done using, for instance, the “What-If” function in Excel, with the \$1 per unit of preferred

Exhibit 4. Capitalization Table: Series C Preferred Round

Investor	Shares Outstanding	Issue Price	Invested Capital	Liquidation Preference (x)	Conversion Ratio (x)	Fully Converted	Fully Converted %	Liquidation Preference A/B	Liquidation Preference A/B %
Series A preferred:									
Investor A	9,000,000	\$1.00	\$9,000,000	1.00	1.00	9,000,000	21.60%	\$9,000,000	30.00%
Investor B	3,000,000	\$1.00	\$3,000,000	1.00	1.00	3,000,000	7.20%	\$3,000,000	10.00%
Investor C	3,000,000	\$1.00	\$3,000,000	1.00	1.00	3,000,000	7.20%	\$3,000,000	10.00%
Investor D	5,000,000	\$1.00	\$5,000,000	1.00	1.00	5,000,000	12.00%	\$5,000,000	16.67%
Total Ser. A preferred	20,000,000		\$20,000,000			20,000,000	48.00%	\$20,000,000	66.67%
Series B preferred:									
Investor A	3,333,333	\$1.50	\$5,000,000	1.00	1.00	3,333,333	8.00%	\$5,000,000	16.67%
Investor D and other investors	3,333,333	\$1.50	\$5,000,000	1.00	1.00	3,333,333	8.00%	\$5,000,000	16.67%
Total Ser. B	6,666,666		\$10,000,000			6,666,666	16.00%	\$10,000,000	33.33%
Ser. C preferred	10,000,000	\$0.50	\$5,000,000	2.00	1.00	10,000,000	24.00%		
Common	5,000,000		N/A			5,000,000	12.00%		
Total						41,666,666	100.00%	\$30,000,000	100.00%

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Series B ranks pari passu with Series A, and both series are senior to common stock. Also, Series B shares are convertible into common stock at a 1x conversion ratio.

The Series C preferred round raises an additional \$5 million at \$0.50 per share. This round also includes new investors in a transaction at fair value. Series C shares have more favorable terms than Series A and B. The Series C shares have a 2x liquidation preference, which is senior to the claim of Series A and B shareholders. Similar to the Series A and Series B shares, the Series C shares convert into common stock at a 1x ratio and are nonparticipating.

Based on the new capitalization table, there are approximately 41.6 million shares on a fully converted basis, of which 48% are attributable to Series A, 16% to Series B, 24% to Series C, and the remaining 12% to the common shareholders. Total invested capital is now \$35 million, of which \$20 million was contributed by Series A, \$10 million by Series B, and \$5 million by Series C investors.

We now look at the results of the OPM model based on the contractual rights of the various classes/series of shares. Exhibit 5 shows the breakpoints that reflect the contractual rights of each series of shares. Series C shares receive \$10 million in liquidation preference (or 2x of their invested capital of \$5 million). The next \$30 million in enterprise value is allocated pro rata to satisfy the liquidation preference of Series A and Series B shares (Breakpoint 2). After this, \$5 million in enterprise value is allocated to common shares. At an enterprise value of \$45 million (Breakpoint 3), common shares, Series A preferred, and Series C preferred will have a value of \$1 dollar per unit.

This is the point at which it will be convenient for Series A and Series C shareholders to convert their shares into common stock so that they can participate in any further appreciation of value. The next \$17.5 million in value is allocated to Series A shares, Series C shares, and common shares pro rata on a converted basis. At \$62.5 million in enterprise value (Breakpoint 4), Series B shares convert into common. Any remaining enterprise value above \$62.5 million is allocated pro rata to all shareholders on a fully converted basis.

Exhibit 6 shows the results of the OPM based on the breakpoints that are discussed above. With an input issue price of \$0.50 for Series C preferred shares, the model backsolves to an enterprise value of \$11.5 million, which in turn results in a value of \$0.21 per unit of Series A preferred shares and \$0.24 per unit of series B

Exhibit 5. Calibration to Series C Preferred Round Breakpoint Analysis

	Ser. C Liq. Pref.	Ser. A/B Liq. Pref.	Ser. A/C Convert	Ser. B Converts
Equity Class	No. 1	No. 2	No. 3	No. 4
Series A preferred	-	20,000,000	-	10,000,000
Series B preferred	-	10,000,000	-	
Series C preferred	10,000,000	-	-	5,000,000
Common	-	-	5,000,000	2,500,000
Total	10,000,000	30,000,000	5,000,000	17,500,000
Cumulative Value Equity Class				
Series A preferred	-	20,000,000	20,000,000	30,000,000
Series B preferred	-	10,000,000	10,000,000	10,000,000
Series C preferred	10,000,000	10,000,000	10,000,000	15,000,000
Common	-	-	5,000,000	7,500,000
Total before proceeds	10,000,000	40,000,000	45,000,000	62,500,000
Cumulative Value Per Outstanding Share Equity Class				
Series A preferred	-	1.00	1.00	1.50
Series B preferred	-	1.50	1.50	1.50
Series C preferred	1.00	1.00	1.00	1.50
Common	-	-	1.00	1.50

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preferred shares, given a value of \$0.50 per share as an input for Series C shares. In the model, we have maintained the risk-free rate and the time to exit at 2% and 3 years, respectively. These inputs can be modified as deemed appropriate, based on the investor's expectations at the measurement date.

Investor B is aware that the Black-Scholes-Merton formula, in some circumstances, may understate

the value of the junior shares when it is calibrated to the price of a senior series of shares without adjustment. To address this limitation of the BSM OPM, Investor B could elect to make some adjustments to the OPM model in an attempt to reflect the value relationship between the various classes and series of shares. First, Investor B estimates the enterprise value under the assumption that the Series C preferred shares have the same liquidation preferences and seniority of

Exhibit 6. Calibration to Series C Preferred Round

Black-Scholes-Merton OPM Model						
	Total	No. 1	No. 2	No. 3	No. 4	End
UAV	11,467,722	11,467,722	11,467,722	11,467,722	11,467,722	11,467,722
Exercise price		10,000,000	40,000,000	45,000,000	62,500,000	
Expected volatility		100.00%	100.00%	100.00%	100.00%	
Risk-free rate		2.00%	2.00%	2.00%	2.00%	
Time to exit (years)		3.0	3.0	3.0	3.0	
d(1)		0.98	0.18	0.11	(0.08)	
N(d1)		0.84	0.57	0.54	0.47	
d(2)		(0.75)	(1.55)	(1.62)	(1.81)	
N(d2)		0.23	0.06	0.05	0.04	
Value of call option	11,467,722	7,463,772	4,280,451	4,015,580	3,308,793	
Incremental option value		4,003,951	3,183,321	264,871	706,787	3,308,793
Breakpoint Participation Percentages						
Investor						
Ser. A preferred stock		0.00%	66.67%	0.00%	57.14%	48.00%
Ser. B preferred stock		0.00%	33.33%	0.00%	0.00%	16.00%
Ser. C preferred stock		100.00%	0.00%	0.00%	28.57%	24.00%
Common stock		0.00%	0.00%	100.00%	14.29%	12.00%
Total		100.00%	100.00%	100.00%	100.00%	100.00%
Allocation of Incremental Option Value						
	Total Value					
Ser. A preferred stock	4,114,313	–	2,122,214	–	403,878	1,588,221
Ser. B preferred stock	1,590,514	–	1,061,107	–	–	529,407
Ser. C preferred stock	5,000,000	4,003,951	–	–	201,939	794,110
Common stock	762,896	–	–	264,871	100,970	397,055
Total	11,467,722	4,003,951	3,183,321	264,871	706,787	3,308,793
	Value per Share					
Ser. A pref. per share	0.21					
Ser. B pref. per share	0.24					
Ser. C pref. per share	0.50					
Common per share	0.15					

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the other preferred shares (Step 1). Given the unit price of Series C Preferred at \$0.50 per unit, the OPM model results in an enterprise value of \$23.6 million as shown in Exhibit 7.

Notice that Breakpoint 1 now corresponds to the liquidation preference of the cumulative Series A, Series B, and Series C shares as if they were pari passu.

The enterprise value generated on a pari passu basis is then used in the OPM model to allocate value to the various share classes based on their actual contractual rights (Step 2). Finally, the OPM value for Series C shares as generated by the model is discounted to calibrate to the actual Series C transaction price (Step 3). Exhibit 8 shows the OPM “with discount” as an alternative approach when securities with different seniority rights are present.

Exhibit 7. Step 1: Company Valuation						
Adjusted Black-Scholes-Merton OPM Model						
	Total	No. 1	No. 2	No. 3	No. 4	End
Underlying asset value	\$23,621,876	\$23,621,876	\$23,621,876	\$23,621,876	\$23,621,876	\$23,621,876
Exercise price		\$35,000,000	\$37,500,000	\$45,000,000	\$62,500,000	
Expected volatility		100.00%	100.00%	100.00%	100.00%	
Risk-free rate		2.00%	2.00%	2.00%	2.00%	
Annualized dividend yield		0%	0%	0%	0%	
Time to exit (years)		3.0	3.0	3.0	3.0	
d(1)		0.67	0.63	0.53	0.34	
N(d1)		0.75	0.74	0.70	0.63	
d(2)		(1.06)	(1.10)	(1.20)	(1.39)	
N(d2)		0.14	0.14	0.11	0.08	
Value of call option	\$23,621,876	\$12,932,744	\$12,602,150	\$11,721,522	\$10,130,545	
Incremental option value		\$10,689,132	\$330,594	\$880,628	\$1,590,977	\$10,130,545
Breakpoint Participation Percentages						
Investor						
Ser. A preferred stock		57.14%	0.00%	0.00%	57.14%	48.00%
Ser. B preferred stock		28.57%	0.00%	0.00%	0.00%	16.00%
Ser. C preferred stock		14.29%	0.00%	66.67%	28.57%	24.00%
Common stock		0.00%	100.00%	33.33%	14.29%	12.00%
Total		100.00%	100.00%	100.00%	100.00%	100.00%
Allocation of Incremental Option Value						
	Total Value					
Ser. A preferred stock	\$11,879,867	\$6,108,076	\$-	\$-	\$909,130	\$4,862,662
Ser. B preferred stock	\$4,674,925	\$3,054,038	\$-	\$-	\$-	\$1,620,887
Ser. C preferred stock	\$5,000,000	\$1,527,019	\$-	\$587,085	\$454,565	\$2,431,331
Common stock	\$2,067,084	\$-	\$330,594	\$293,543	\$227,282	\$1,215,665
Total	\$23,621,876	\$10,689,132	\$330,594	\$880,628	\$1,590,977	\$10,130,545
	Value Per Share					
Ser. A preferred per share	\$0.59					
Ser. B preferred per share	\$0.70					
Ser. C preferred per share	\$0.50					
Common per share	\$0.41					

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Exhibit 8. Steps 2 and 3: Allocation of Value and Discount to Series C Issue Price

Black-Scholes-Merton OPM With Actual Rights						
	Total	No. 1	No. 2	No. 3	No. 4	End
Underlying asset value	23,621,876	23,621,876	23,621,876	23,621,876	23,621,876	23,621,876
Exercise price		10,000,000	40,000,000	45,000,000	62,500,000	
Expected volatility		100.00%	100.00%	100.00%	100.00%	
Risk-free rate		2.00%	2.00%	2.00%	2.00%	
Time to exit (years)		3.0	3.0	3.0	3.0	
d(1)		1.40	0.60	0.53	0.34	
N(d1)		0.92	0.72	0.70	0.63	
d(2)		(0.34)	(1.14)	(1.20)	(1.39)	
N(d2)		0.37	0.13	0.11	0.08	
Value of call option	23,621,876	18,230,454	12,291,366	11,721,522	10,130,545	
Incremental option value		5,391,422	5,939,088	569,844	1,590,977	10,130,545
Breakpoint Participation Percentages						
Investor						
Ser. A preferred stock		0.00%	66.67%	0.00%	57.14%	48.00%
Ser. B preferred stock		0.00%	33.33%	0.00%	0.00%	16.00%
Ser. C preferred stock		100.00%	0.00%	0.00%	28.57%	24.00%
Common stock		0.00%	0.00%	100.00%	14.29%	12.00%
Total		100.00%	100.00%	100.00%	100.00%	100.00%
Allocation of Incremental Option Value						
	Total Value					
Ser. A preferred stock	9,731,183	–	3,959,392	–	909,130	4,862,662
Ser. B preferred stock	3,600,583	–	1,979,696	–	–	1,620,887
Ser. C preferred stock	8,277,318	5,391,422	–	–	454,565	2,431,331
Common stock	2,012,792	–	–	569,844	227,282	1,215,665
Total	23,621,876	5,391,422	5,939,088	569,844	1,590,977	10,130,545
	Value Per Share	Discount	FV Per Share			
Ser. A pref. per share	0.49		0.49			
Ser. B pref. per share	0.54		0.54			
Ser. C pref. per share	0.83	39.59%	0.50			
Common per share	0.40		0.40			

In the example, Investor B concludes that a value of \$0.49 per share for Series A preferred and of \$0.50 per share for Series C preferred (after discount) is reasonable and updates its valuations accordingly.

Summary. Now that we have gone through the math, let's summarize some of the main takeaways from our examples based on Case 9 of the Working Draft of the AICPA guide:

- The BSM OPM can be a suitable and defensible approach to estimate fair value in situations of high uncertainty concerning future enterprise value. It is especially suitable for early-stage enterprise valuations.
- The contractual rights of the different series/classes of shares significantly affects the results of the valuation under the BSM OPM.

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It is critical that the breakpoints in a BSM OPM model be set up to accurately reflect the rights of the various classes/series of securities in an ESE's capital structure.

- Investors may end up valuing the same series of shares at different valuation points based on different assumptions, inputs, and even different models. The different values may all be reasonable in terms of ASC 820 even though they may be materially different.
- To the extent there is a later, and more senior, round, it is likely that a valuation at the issue price for the earlier rounds may no

longer be acceptable under ASC 820. The Working Draft clearly points to the need to reconsider the valuation of earlier rounds when the capital structure of a company changes and that an approach that carries forward the issue price may result in a valuation that no longer reflects fair value when more senior rounds are introduced. ♦

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