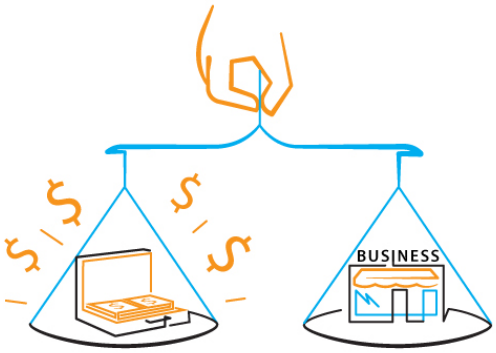
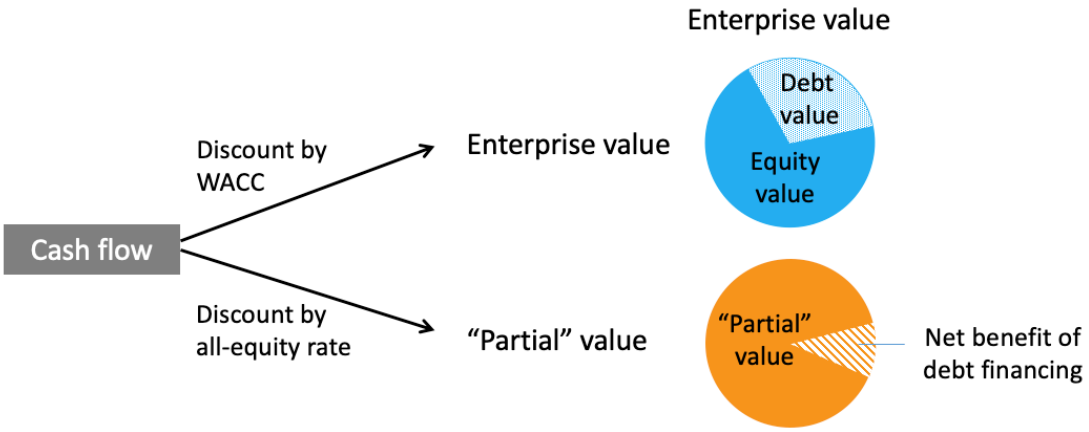


A Primer on Equity Valuation

This primer focuses on how we can estimate the equity value of companies, which is useful for stock picking, acquisition analysis, etc. However, the basic principles also apply to the estimation of total enterprise valuation and project valuation. I focus on two common methods for estimating value: (i) discounted cash flow (DCF) valuation and (ii) valuation by multiples. Both methods are heavily used in practice, and it is not clear that one method yields more precise estimates than the other. I also show how the valuations can be presented effectively in a graph. Finally, I show how we can value a target of an acquisition.

PART I: Discounted cash flow (DCF) valuation

We can value a firm by discounting its cash flow to the present. The most common approach is to use the weighted average cost of capital (WACC) as the discount rate, in which case we arrive at the total enterprise value, i.e., the sum of the debt and equity values. To get the equity value, we simply subtract the debt value from the total enterprise value. Alternatively, we can discount by a hypothetical "all-equity" rate, which would be the firm's cost of capital if it only had equity as a source of capital (and no debt). This gives us the "partial value," i.e., the total enterprise value less the net effect of debt financing on firm value. To arrive at the total enterprise value, we need to add the effect of debt financing separately.



1. Definition of cash flow used for valuation

The cash flow used for valuation is not the same as what you find in the company's cash flow statement. For the DCF valuation, we seek to identify future cash flow that is available to debtholders and equityholders, irrespective of what they receive. That means that debt payments (principal and interest payments) and dividends should not be subtracted from the cash flow used for valuation, even though both debt payments and dividends show up as negative cash flow in the company's cash flow statement.

The cash flow for valuation can be classified into three groups:

(i) Operating cash flow

The operating cash flow equals the earnings before interest and taxes (EBIT) less depreciation and taxes. There are a few things to emphasize here:

a. We do not subtract interest expenses, as stated above and implied by the acronym EBIT.
b. We subtract depreciation in the estimation of EBIT, but then we add it back afterward. Why, then, bother to subtract it when estimating EBIT in the first place? Depreciation is itself not a cash flow, but because it affects taxes, it has an indirect cash flow effect. Subtracting depreciation in the estimation of EBIT allows us to capture the tax effect, but once that is captured, we remove depreciation.

c. The estimate of taxes in the cash flow is not capturing the effect of interest, and, in that sense, the estimate of taxes for our cash flow calculation differs from the actual taxes. We will take care of the tax shield from interests later: When we discount using the WACC, the effect of interest is imbedded in the WACC formula. Alternatively, when we discount using the all-equity rate, we add the tax shield from interest expenses separately.

(ii) Changes in working capital

Firms are likely to change their working capital (defined as current assets minus current liabilities) over time. For example, as firms grow, they generally accumulate greater inventory, and the incremental inventory requires capital outlays. We capture these cash flow effects by including *changes* in working capital in each period.

(iii) Capital spending

This category includes capital investments, such as investments in buildings and machines. A couple of clarifications are helpful here:

a. Capital investments do not show up in the estimation of EBIT, but their associated depreciation does. However, as noted above, we add back depreciation in the operating cash flow after its tax effect has been captured. Thus, the main effect of capital investments is included in the capital spending category, whereas their tax effects are included in the operating cash flow category.
b. Capital investments do not include R&D expenses; rather R&D expenses are subtracted when estimating EBIT.

We should also be careful to only include *incremental* cash flow. I already noted this in the discussion of the working capital effect above, which is based on *changes* in (i.e., incremental) working capital. There are also several other implications. For example, we should *disregard sunk costs*, which are costs that have already incurred, and are, thus, clearly not incremental for future cash flow. Furthermore, we should *include all side effects like cannibalism and subsidization*. For example, if we aim to value the effect that Ford introducing a new car model has on Ford's overall value, we need to consider both the cash flow coming directly from the new model and the potential negative effect (cannibalization) on its other car models.

We should further adjust all cash flows, including revenues and costs, for inflation. This ensures consistency with the cost of capital, which is also adjusted for inflation (even if we do not deliberately make this adjustment).[1] An alternative in theory would be to estimate cash flow that is not inflation-adjusted along with the *real* (and not the *nominal*) cost of capital, but I have never seen anybody do that in practice.

Finally, we should use *expected* cash flow in our calculations. This is an important principle, but sometimes hard to grasp and implement. Suppose that the revenues next year will be one of the following:

- $8 million with 15% probability
- $10 million with 70% probability
- $12 million with 14% probability
- $100 million with 1% probability (if a new but risky product succeeds)

[1] The capital costs that are used for estimating the discount rate are *nominal*, i.e., the *real* capital costs plus the inflation rate.

Clearly, the most likely revenue is $10 million, and it is tempting to use this for the cash flow estimation. Furthermore, it is tempting to throw out the $100 million as an outlier. But in finance, outliers are important and relevant contributors of value. Why else are private equity investors so eager to invest in high-tech start-ups despite their small chance of success? The correct revenue to use here is the weighted average across all four scenarios, i.e., 0.15 × $8 million + 0.7 × $10 million + 0.14 × $12 million + 0.01 × $100 million = $10.88 million.

2. Estimating future cash flow

To estimate future cash flow, you should use historical figures along with information you possess (or can gather) about firm prospects. Let me illustrate with a fictitious IPO valuation.

The next page displays some historical financial data for a firm that is about to go public. Based on this data and my expectations for the firm in the future, I have projected cash flow for the next eight years. Important assumptions include the following:

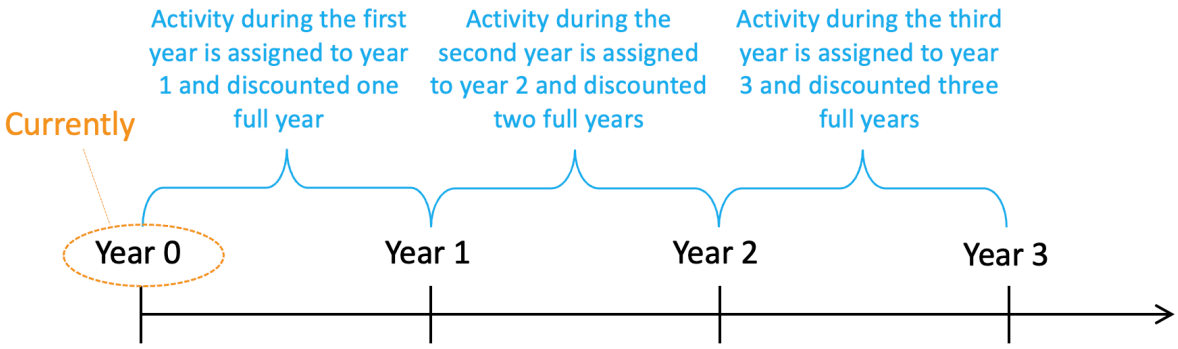
- Revenues have grown at 11% and 7% in the last couple of years, and I assume that the growth will slow to 5% in the next five years and then to 3% thereafter. (This should also account for inflation.)
- COGS as a fraction of revenues has hovered around 50% in the last few years, and I expect this fraction to stay at 51% in the foreseeable future. (A slightly higher COGS could reflect expectations of increasing competitive pressure.)
- Administrative costs are assumed to grow at 3%.
- The tax rate is 21%.
- I assume that capital expenditures will grow at 4% the next five years and 3% thereafter.
    - Note that there should be consistency between capital investments and revenues. That is, capital investments will fuel revenue growth, and it is unlikely that a firm can sustain high revenue growth without substantial capital investments.
    - It is useful to estimate the ratio of revenues to PP&E in each year as a sanity check.
- Depreciation is assumed to be 12.5% of the value of PP&E at the beginning of the year. (And, of course, PP&E at the beginning of the year equals the PP&E at the beginning of the prior year plus capital investments during the prior year minus depreciation during the prior year.)
- Working capital is assumed to be 10% of revenues.

The first few rows of my setup include an amputated income statement to estimate EBIT and taxes in the absence of interest expenses. Then I include several rows to estimate various growth rates and ratios, mostly for my own benefit when I make assumptions and estimate future cash flow. In addition, I include rows for working capital (WC) and PP&E, which allow me to readily estimate *changes* in WC and depreciation, respectively.

As a last step, I lay out the cash flow in the three categories I discussed earlier.

Finally, it is worth clarifying the standard convention for assigning cash flows to individual years. If we aim to value a project, we assign the upfront cash flow to year 0, which is not discounted later. Furthermore, irrespective of whether we value a project or a company, the cash flow during the next year is assigned to year 1 and later discounted a full year. Similarly, the cash flow during the second year is assigned to year 2 and later discounted two full years, and so on. The attentive reader will recognize that this convention tends to be overly conservative, because, e.g., the cash flow during the

first year occurs an average of a half a year from now and should, therefore, only be discounted a half a year. Consequently, you could justify deviating from the convention by discounting the first-year cash flow a half a year back, the second-year cash flow one-and-a-half year back, etc. But expect some confused looks and questions if you do that.



	2016	2017	2018	Projections 2019	2020	2021	2022	2023	2024	2025	2026
Revenues	$1,196,103	$1,330,774	$1,423,752	$1,494,940	$1,569,687	$1,648,171	$1,730,579	$1,817,108	$1,871,622	$1,927,770	$1,985,603
COGS	$626,639	$663,311	$707,934	$762,419	$800,540	$840,567	$882,596	$926,725	$954,527	$983,163	$1,012,658
Administrative costs	$304,567	$309,554	$322,054	$331,716	$341,667	$351,917	$362,475	$373,349	$384,549	$396,086	$407,968
Depreciation	$86,783	$88,456	$89,055	$92,964	$97,431	$101,982	$106,634	$111,400	$116,295	$121,142	$125,964
EBIT	$178,114	$269,453	$304,709	$307,840	$330,049	$353,704	$378,875	$405,634	$416,251	$427,380	$439,013
Taxes				$64,646	$69,310	$74,278	$79,564	$85,183	$87,413	$89,750	$92,193
Net Income				$243,194	$260,738	$279,427	$299,312	$320,451	$328,838	$337,630	$346,820
Revenue growth		11.3%	7.0%	5.0%	5.0%	5.0%	5.0%	5.0%	3.0%	3.0%	3.0%
COGS / Revenues	52.4%	49.8%	49.7%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%	51.0%
Adm. Costs / Rev.	25.5%	23.3%	22.6%	22.2%	21.8%	21.4%	20.9%	20.5%	20.5%	20.5%	20.5%
Taxes / EBIT				21.0%	21.0%	21.0%	21.0%	21.0%	21.0%	21.0%	21.0%
WC	$101,915	$125,448	$136,989	$149,494	$156,969	$164,817	$173,058	$181,711	$187,162	$192,777	$198,560
WC / Revenues	8.5%	9.4%	9.6%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
PP&E	$689,165	$709,025	$743,715	$779,445	$815,857	$853,071	$891,202	$930,356	$969,133	$1,007,715	$1,046,266
Deprec. / Beg. PP&E		12.8%	12.6%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%	12.5%
I. Operating cash flow:											
EBIT				$307,840	$330,049	$353,704	$378,875	$405,634	$416,251	$427,380	$439,013
Depreciation				$92,964	$97,431	$101,982	$106,634	$111,400	$116,295	$121,142	$125,964
Taxes				($64,646)	($69,310)	($74,278)	($79,564)	($85,183)	($87,413)	($89,750)	($92,193)
Total				$336,158	$358,169	$381,409	$405,945	$431,851	$445,133	$458,772	$472,785
II. Working capital:											
Changes in WC				($12,505)	($7,475)	($7,848)	($8,241)	($8,653)	($5,451)	($5,615)	($5,783)
III. Capital spending:											
Capital expenditures	($89,196)	($108,316)	($123,745)	($128,695)	($133,843)	($139,196)	($144,764)	($150,555)	($155,071)	($159,723)	($164,515)
Total cash flow				$194,959	$216,852	$234,364	$252,940	$272,644	$284,610	$293,433	$302,486
Growth rate					11.2%	8.1%	7.9%	7.8%	4.4%	3.1%	3.1%

3. Estimating WACC

The weighted average cost of capital (WACC) is defined as:

$$WACC = \frac{E}{D+E} \times k_E + \frac{D}{D+E} \times k_D \times (1 - \tau_c)$$

where E is the equity value, D is the debt value, k_E is the cost of equity, k_D is the cost of debt, and τ_c is the corporate tax rate.

3.1 The cost of equity, k_E

The cost of equity is most commonly estimated via the capital asset pricing model (CAPM):

$$k_E = r_f + \beta \times [E(r_m) - r_f]$$

where r_f is the risk-free rate, β is the beta of the company's equity, and $E(r_m)$ is the expected return of the overall market.

3.2 The risk-free rate, r_f

We generally assume that the government will not default on its debt, which allows us to use the yield on treasury securities as the risk-free rate. But treasury securities vary in their maturities, and, unless the yield curve is flat, their yields also vary. Which maturity should we use? The choice depends on the use of the cost of capital; if you want to estimate the appropriate rate to discount a cash flow, the horizon of the risk-free rate should math the horizon of the cash flow. In theory, we should estimate a one-year risk-free rate to estimate the cost of capital that we use to discount a cash flow one year out, a two-year risk-free rate to estimate the cost of capital that we use to discount a cash flow two years out, etc. However, this would be cumbersome and is not done in practice. Rather, as a rule of thumb, I suggest the use of a ten-year rate when valuing companies, because ten years is probably close to the average horizon of the cash flow that make up the bulk of a company's value.

3.3 The risk premium, $E(r_m) - r_f$

When applying the CAPM, we do not estimate $E(r_m)$ separately, because we lack a good way of doing so. Rather, we assume that the difference between $E(r_m)$ and r_f, which we call the risk premium, is constant over time. This allows us to estimate the risk premium based on historical data.

The table below shows some average returns from 1927 to 2020 for the S&P 500 index, 10-year T-Bonds, and one-year T-bills.

	S&P 500	10-year T-Bonds	T-Bills
Arithmetic average	11.6%	5.2%	3.4%
Geometric average	9.8%	4.9%	3.3%

If we assume that

- the S&P 500 is a reasonably proxy for the overall market,
- the appropriate horizon for the risk-free rate is ten years, and
- the arithmetic average is a good representation of expected returns (there is some controversy around that, but I will not get into that here),

then the risk-premium is 11.6% – 5.2% = **6.4%**.[2]

3.4 Beta, β

If a company's stock is publicly traded, we can estimate its beta by regressing the company's past stock return against the market returns. If you use the S&P 500 to represent the overall market when estimating the risk premium, I would do the same when estimating the beta to stay consistent.[3] And, as a general rule, I would use daily returns from the most recent year for the regression.

There are, however, several problems with estimating beta based on stock returns:

- *Betas vary over time*
  Betas vary as firms evolve, especially during the early lifecycle and if there is significant acquisition activity. Thus, we should use historical returns from the recent past, e.g., the last year, when estimating the beta. However, we do not want to use a period that is too short, because the precision of regression estimates deteriorates as the sample gets smaller.
- *The stock might be thinly traded*
  If the stock is thinly traded, e.g., there are only a couple of trades per day, the stock price at closing is a bit obsolete. The consequence is that the beta estimate is lower than the true beta, such that we get a "biased" beta estimate. There are possible remedies to this problem, for example using weekly returns instead of daily returns. Unfortunately, none of these remedies eliminate the bias, and they tend to introduce more "noise" in the estimates.
- *Extreme beta estimates tend to regress toward the market average of 1 over time*
  Chances are that if you get an extreme beta estimate, e.g., 2.7 (compared to the average of 1.0 across all securities in the market), it will drift toward 1.0 over time, perhaps because the return data contained some random and non-representative outliers. One possible solution is to adjust the beta estimate by calculating a weighted average of the beta estimate and one (e.g., ⅔ x β + ⅓ x 1.0).

If the company's stock is not publicly traded or you feel uncomfortable with the beta estimate based on stock returns (perhaps because of the problems listed above), you could "borrow" beta estimates from comparable companies. If so, the comparable companies should have a sensitivity to overall market

[2] Had we used data from 1927 to 2015 instead, we would get a risk-premium of 6.2%. In comparison, a 2016 report from JP Morgan lists an array of risk premium estimates: 4.8% (using the historical geometric mean since 1926, 5.0% (geometric academic survey), 5.1% (implied from the constant Sharpe Ratio), 6.0% (arithmetic academic survey), 6.6% (implied from A-rated bonds), 6.7% (historical US arithmetic mean since 1926), and 7.0% (implied from the dividend discount model).

[3] One could argue that a broader index, e.g., one that includes smaller stocks, debt instruments, real estate, and commodities, should be used both for the estimation of the risk premium and the estimation of beta. However, this is difficult to do in practice and therefore not done.

factors that is similar to the company we seek to value. In practice, we therefore choose companies that operate in the same industry.

However, comparable companies might have different debt ratios. This is a problem because the beta naturally increases with the debt ratio. To resolve this problem, we first "unlever" the beta estimate of the comparable company to get the asset beta (also called the unlevered beta or the all-equity beta) of the comparable company:[4]

$$\beta_A = \beta_E \times \frac{E}{E + D}$$

where β_A refers to the asset beta, β_E refers to the conventional equity beta, and *E* and *D* refer to the equity and debt values, respectively, of the comparable company.

Next, we assume that the company we seek to value has the same asset beta as the comparable company and then "lever" up the asset beta from above to get the estimate of the equity beta for the company we seek to value:

$$\beta_E = \beta_A \times \frac{E + D}{E}$$

where *E* and *D* now refer to the equity and debt values, respectively, of the company we seek to value.

3.5 The cost of debt, k_D

It is tempting to use the interest rate that the company pays on its debt as its cost of debt. However, the interest rate that the company negotiated at the time of borrowing might not reflect its current cost of debt, perhaps because the general interest rate environment or the risk profile of the company has changed since then.

To get a forward-looking cost of debt, we can use yields on publicly traded debt instruments. Unlike the interest/coupon rate, the yield changes continuously to reflect changes in both the interest rate environment and the risk of default. If the company we seek to value has publicly traded bonds, we can simply use the yield on these bonds as its cost of debt.[5] If not, we can use the yield on publicly traded bonds of companies that we deem to have a similar default risk (e.g., companies in the same industry with similar profitability and capital structure).

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[4] This is based on the assumptions that the asset beta is a weighted average of the equity beta and the debt beta, i.e.,

$$\beta_A = \beta_E \times \frac{E}{E + D} + \beta_D \times \frac{D}{E + D}$$

and that the debt beta equals zero. The latter assumption is, occasionally, a bit of a stretch.

[5] A caveat is that a company's publicly traded bonds might not be representative of all the debt the company has. For example, it could be that the company's bank debt has shorter maturity and has priority in case of default, in which case the bond yield will generally exceed the company's overall debt cost.

3.6 The debt and equity weights (*D* and *E*)

The debt and equity weights in the WACC formula should ideally be based on market values.

Generally, market values are not available for all types of debt that a company has, in which case we resort to book values instead. Unless the company is severely distressed (such that the debt is valued at a substantial discount to par), using the book value as an estimate for the market value of debt is reasonable.

It is much more likely that market values are available for companies' equity than their debt. Nevertheless, the vast portion of companies, especially small companies, do not have publicly traded equity. Furthermore, it is often the companies without publicly traded equity, e.g., companies that are about to go public in an IPO, that we seek to value. Can we use the book value of equity as a substitute for the market value of equity in the estimation of WACC then?

The market values of equity typically differ from the book values, and the difference can be substantial. Thus, the use of book values as a substitute for market values of equity is troublesome. But in a later section, I explain how the book value can serve as a temporary substitute until we arrive at a better estimate of the market value of equity.

4. Terminal value

To abbreviate the DCF setup, we provide complete cash flow estimates for a limited number of years (henceforth "estimation period). For cash flow beyond the estimation period, we make some simplifying assumptions about growth in cash flow. This allows us to estimate a terminal value based on the perpetuity formula. If the estimation period ends in year *t*, we can estimate the value of cash flow beyond year *t* as:

$$Value\ of\ CF\ beyond\ year\ t\ (as\ of\ year\ t) = \frac{CF_{t+1}}{k-g} = \frac{CF_t \times (1+g)}{k-g}$$

where *g* is the assumed growth rate in cash flow beyond year *t* and *k* is the cost of capital (i.e., WACC in most cases).[6]

Note that this formula is only suitable if the growth rate, *g*, is modest, and at least below the cost of capital, *k*. I get uncomfortable if we use a growth rate of more than 3–4%. But this depends on the inflationary environment; if the inflation is high, one can justify a higher growth rate, and in that case the cost of capital will also be correspondingly higher.

How many years should we include in the estimation period? As a rule of thumb, I estimate cash flow until the annual growth rate has stabilized at less than 5%. That way, I can comfortably use a growth rate in the perpetuity formula of 2–4%.

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[6] Because we get an estimate as of year *t*, we also need to discount this *t* years to get the value as of year 0. Thus, we get:

$$Value\ of\ CF\ beyond\ year\ t\ (as\ of\ year\ 0) = \frac{CF_t \times (1+g)}{k-g} \Big/ (1+k)^t$$

5. Putting it all together in an example

Suppose that we gather the following information for the hypothetical firm that is about to go public described earlier.

Debt value	$1,500,000
Equity value (based on book value)	$2,000,000
Risk-free rate	3.0%
Beta (based on comparables)	1.2
Risk-premium	6.0%
Cost of equity (based on CAPM)	10.2%
Cost of debt	5.2%
Tax rate	21.0%
WACC	7.59%

Because the market value of equity is unavailable, the book value of $2 million was used to estimate the WACC of 7.59%. From the cash flow estimates provided earlier, we can calculate the growth rate in cash flow for the last two years provided to be 3.1%. Thus, I use a growth rate of 2.5% in the terminal value calculation.

Discounting the cash flow at 7.59% and using a terminal growth rate of 2.5%, I estimate the enterprise value to be $4.9 million. Given a debt value of $1.5 million, this gives an equity value **$3.4 million**.

I could consider myself done at this point. But there is a problem here. I used an equity value of $2 million to estimate the WACC, but the estimated equity value based on the WACC and cash flow is $3.4 million. I could go back to the WACC calculation and plug in $3.4 million as the equity value, which gives a WACC of 8.34% and a new estimated equity value of $2.7 million. Now there is greater consistency between the equity value used to estimate WACC and the estimated equity value, but I am still not content. I could go back to the WACC calculation again and plug in $2.7 million as the equity value, which gives a WACC of 8.02% and a new estimated equity value of **$3.0 million**. If I am still not content, I could repeat the iteration process until the convergence is even greater.[7]

6. Problems with WACC

While discounting cash flow using WACC is a dominating valuation approach, the use of WACC in this context comes with some problems.

First, as we observed earlier, WACC requires an assumed equity value, but our goal with the analysis is precisely to estimate this equity value. So, we have a circularity problem. Fortunately, we were able to work around this with an iterative procedure.

[7] We could use Excel's *Solver* to run this iteration until we get complete convergence. If you open *Solver*, you can set the objective of the difference between the assumed equity value and the estimated equity value to be zero by changing the assumed equity value. If I do that here, I get a WACC of 8.12% and an equity value of $2,887,377.

Second, our WACC estimate assumes that the capital structure is stable in future years. That might not be expected to be the case for some companies. For example, firms occasionally lever up (e.g., in an LBO) with the intention to pay down a chunk of the debt over time. In that case we could estimate WACC for each of the future years by making appropriate adjustments to the cost of debt (which would be expected to drop over time), the cost of equity (which is also expected to drop over time as the beta drops), and the weights on debt and equity. But in practice, this is nearly impossible to do correctly.

Third, the WACC formula implicitly assumes that we can fully use the tax shields from debt in the year that we pay the interest. But this can be overly optimistic, especially if the company is unprofitable or has accumulated substantial NOLs.

Thus, I recommend an alternative valuation procedure in cases in which problems with the use of WACC are likely to be severe.

7. Estimating value based on the all-equity rate

An alternative approach to discounting the cash flow is to assume first that the company has no debt. In that case, the company's cost of capital would equal the all-equity rate, i.e., the cost of equity assuming that the company only has equity in its capital structure. The all-equity rate can be estimated as:

$$k_E = r_f + \beta_A \times \left[E(r_m) - r_f\right]$$

where β_A is the asset beta (also called all-equity beta), which, as we noted before, can be estimated by unlevering the equity beta:

$$\beta_A = \beta_E \times \frac{E}{E + D}$$

The resulting value is a "partial value" reflecting what the enterprise value would have been in the case that the company had no debt. Thus, we also need to add the effect that debt has on the value.

We generally think of debt as having two major effects on firm value. First, debt gives rise to debt tax shields, such that higher debt leads to higher value. To capture this effect, we can discount the future debt tax shields, and it is common to use the cost of debt as the discount rate when doing so. In the simple case that the debt level is expected to remain constant and we can use the debt tax shields in the years they incur, we get a very simple expression for the debt tax shield based on the perpetuity formula:

$$Value\ of\ debt\ tax\ shields = \frac{Interest\ expense \times \tau_c}{k_D} = \frac{D \times k_D \times \tau_c}{k_D} = D \times \tau_c$$

Second, debt gives rise to expected financial distress costs, because the probability of default (and, therefore, the probability of incurring distress costs) increases with the debt burden. This is trickier to estimate. Thus, unless the company has so much debt that there is a substantial probability of default, it is common to ignore these costs in the calculation of firm value. But, of course, if the firm is financially distressed, we should also try to incorporate these expected financial distress costs.

8. Returning to our example with the all-equity rate

Suppose that the asset beta (based on comparables) is 0.8. Then the all-equity cost of capital is 3% + 0.8 × 6% = 7.8%. Using this as the discount rate yields a present value of the cash flow of $4.658 million. This is the partial value, and we also need to add the effect of debt to get the enterprise value.

In this case, the annual interest payments are about $1,500,000 × 5.2% = $78,000, which would reduce the taxes by 21% × $78,000 = $16,380. Because the company's taxes in each of the years are expected to exceed $60,000 in the absence of the interest tax shield (see earlier cash flow calculations), we can use the interest tax shield in the year that the interest payments are made. If we assume that the tax shield is a perpetuity and that we can use the 5.2% cost of debt as the discount rate for this perpetuity, we get a value of the interest tax shield of $16,380 / 5.2% = $315,000.[8] Note that this can also be calculated with our shortcut formula: $D \times \tau_c = \$1{,}500{,}000 \times 21\% = \$315{,}000$.[9]

The enterprise value is, consequently, about $4.658 million + $0.315 million ≈ $5 million, and the equity value is about $5 million – $1.5 million = **$3.5 million**.

In theory this should be equal to the value that we estimated using the WACC method. So, what accounts for the difference of a half a million or so?

There are at least two possible sources of the discrepancy. First, we have not adjusted the partial value for the effect that debt has on expected distress costs. However, the firm seems quite healthy, and it is unlikely that the effect of the debt on expected distress costs is more than $100K.[10]

Second, the betas might not be internally consistent. I used an equity beta of 1.2 for the WACC calculation and an asset beta of 0.8 for the all-equity cost calculation. If the debt value is $1.5 million and the equity value is about $3,000,000, these betas are consistent with our earlier unlevering formula:

$$\beta_A = \beta_E \times \frac{E}{E+D} = 1.2 \times \frac{3}{1.5+3} = 0.8$$

However, as I noted earlier in a footnote, the formula assumes that the debt beta is zero. If it is nonzero, we have:

$$\beta_A = \beta_E \times \frac{E}{E+D} + \beta_D \times \frac{D}{E+D} = 1.2 \times \frac{3}{1.5+3} + \beta_D \times \frac{1.5}{1.5+3} = 0.8 + \frac{\beta_D}{3}$$

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[8] If the debt is expected to increase by 2.5% each year, we can use the growth perpetuity formula to find the value of the interest tax shield as $16,380 / (5.2% – 2.5%) = $506,667.

[9] If the company is not expected to use the interest tax shield in the years that the interest payments are made, we must estimate the interest tax shield separately in each year. For example, in the first year, the maximum interest tax shield is $22,050. But if the taxes in the absence of the interest tax shield is only expected to be $15,000 in that year, the interest would reduce taxes to $0, such that the interest tax shield for that year is $15,000 and the remainder $22,050 – $15,000 = $7,050 would be carried forward. Thus, in the second year, the maximum interest tax shield is $22,050 + $7,050. And you would have to repeat this calculation for each year. While the company still might be able to use its interest tax shields fully, the delay in doing so will reduce the present value of the tax shields.

[10] For example, suppose that the debt increases the probability of distress by 20% and that distress would impose costs of $0.5 million (which comes in addition to the reduction in value that the firm suffers from its economic struggles that contributed to the distress). Then a back-of-the-envelope calculation suggest that the expected costs are 20% × $0.5 million = $100K, not considering time value of money effects.

If, the debt beta is, say, 0.3, then the asset beta is 0.9, the all-equity rate is 8.4%, and the estimated equity value based on the all-equity rate is about $3 million.[11]

[11] Adding debt to the capital structure should generally lower the cost of capital because of the benefit of debt tax shields. Thus, the WACC, which we calculated to be 8.12% (see earlier footnote), should be lower than the all-equity cost of capital. In other words, the all-equity cost of capital is likely somewhat higher than 8.12%. Thus, the estimate of an all-equity rate of 8.4% is more reasonable that the earlier estimate of the all-equity rate of 7.8%.

PART II: Valuation by multiples

Investors and investment bankers often resort to valuation by multiples, presumably because of its ease of use and intuitive nature. Research shows that valuation by multiples yield estimates that are comparable in accuracy to those based on DCF, and it is therefore a useful complementary valuation tool.

1. Selecting multiples

To estimate the value of real estate, it is common to use the multiplier Price/Area (where area is measured in square-feet or square-meters.) This makes sense to the extent that we believe that the area is the major contributor to real estate value.

To estimate the value of companies, we are looking for factors that drive corporate value. The DCF analysis suggests that cash flow is an important factor. When using multiples, we often use earnings instead (which is, perhaps, the most important component of the cash flow). Or we might simplify further and say that revenues and the book value are the major determinants of corporate value. This leads us to an array of possible multiples we could use, including:

- Revenue-based multiple:
  - Enterprise value/Revenues
- Earnings-based multiples:[12]
  - P/E (i.e., Price per share / Net income per share, and, incidentally, this is the same as Equity value / Net income)
  - Enterprise value/EBIT
- Book-value-based multiples:
  - Enterprise value/Book value of assets
  - Equity value/Book value of equity

Importantly, there is consistency between the numerator and the denominator in all multiples above in that

- if the numerator is the enterprise value (i.e., equity value + debt value), the denominator is also a value that is immune to the debt level (either the book value of assets, the earnings before interest and taxes, or revenues), or
- if the numerator is the equity value (i.e., the enterprise value less the debt value), the denominator also subtracts out the debt effect (either net income or equity value).

Thus, examples of inappropriate multiple that you should avoid include Equity value/Revenues and Enterprise value/Net income.

Each of the multiples has their strengths and weaknesses. For example, while the earnings-based multiples are most closely aligned with the DCF analysis in capturing the notion that earnings (or cash

[12] Earnings-based multiples can be based on either trailing, i.e., historical, earnings, or forecasted earnings.

flow) is a primary driver of corporate value, earnings-based multiples are useless when valuing companies that are unprofitable. Furthermore, based on my own analysis, I have found that:

- The accuracy and bias of various multiples depend greatly on firms' profitability. If the company that we seek to value has particularly strong earnings, the earnings-based multiples tend to produce valuations that are too high, whereas the other multiples tend to produce valuations that are too low.[13] If the company that we seek to value has particularly weak, yet positive, earnings, the earnings-based multiples tend to produce valuations that are too low, whereas the other multiples tend to produce valuations that are too high. These findings suggest that we should use both earnings-based multiples and other multiples in our valuation in the hope that we will encompass the true value.
- When using earnings-based multiples, forecasted earnings perform better than trailing earnings. This makes sense in that corporate value derives primarily from future performance.
- Adjusting for cash balances when using multiples, as some like to do, appears to make little difference in practice.[14]

In sum, I recommend that a mix of multiples be used to estimate the value.

2. Selecting comparables ("comps")

Selecting comparable companies is a true art, and research shows that skilled appraisers outperform mechanical algorithms. We are essentially looking for companies with the same general outlook in terms of profitability, risk, and growth as the company we seek to value. It is common, therefore, to use firms of similar size in the same industry. But that does not mean that all firms in the same industry are suitable as comparables. Nor does it mean that we should refrain from using comparables from different industries. In fact, you will often find that it is difficult to find firms that are truly operating in the same industry, because so many firms operate in several industries or at the intersection of industries.

How many comparables should you use then? In general, more is better. But chances are that you will find some companies that are very suitable to serve as comparables and others that are less suitable. Thus, you need to balance the suitability of the companies to serve as comparables against the goal to have many comparables. As a rule of thumb, I would aim for a half a dozen comparables.

[13] The reason that non-earnings-based multiples, such as the book-value based multiples, tend to produce values that are too low in this case is that it they fail to capture the strong earnings of the company in the valuation. Conversely, a likely reason that the earnings-based multiples tend to produce values that are too high in this case is that they put too much emphasis on current earnings, which might be expected to revert toward the industry norm over time.

[14] The idea behind adjusting for cash is that cash is easy to value. That is, $1 of cash should be worth $1, irrespective of which company holds the cash. If so, we can set the cash aside when we apply the multiples and add the cash back at the end. However, investors might value $1 of cash higher if the company can put it to good use, and vice versa. If so, the cash should also be valued using multiples, and it makes less sense to make cash adjustments.

3. Selecting summary statistics and dealing with outliers

Once we have estimated the multiples for our comparables, we need to summarize these multiples into one. The simplest technique is to estimate the average. But what if there are outliers or some of the earnings-based multiples are negative?

It makes sense to simply remove negative earnings-based multiples. In fact, we probably should not have even calculated an earnings-based multiples when earnings are negative.

But we should be more hesitant about removing outliers. First, it is not clear what constitutes an outlier. Second, outliers can be informative and critical for accurate valuation. Lottery tickets are a good analogy. What gives rise to the value of a lottery ticket? It is the dream and remote possibility that the ticket will be a big winner, right? And without that possibility, the lottery ticket would essentially be worthless. Similarly, among the many tech start-ups there will only be a small fraction of big winners, and it might be the dream that a tech start-up becomes the next Apple that explains the chunk of its high valuation.

Instead of removing outliers, we can use summary statistics that are less susceptible to outliers. The most obvious is the median. But I have the same reservations when using the median as I have when removing outliers, i.e., that I am throwing out valuable information imbedded in outliers.

In sum, I prefer to use the average as the summary statistic when using multiples. It is the most consistent with finance theory, which suggests that all scenarios should be considered. (I mentioned this in the earlier discussion of the calculation of expected cash flow as well.) Yet, there might be situations with "wacky" outliers whose impact on the valuation should be mitigated by removing them or using the median as a summary statistic. So, *you* must figure out whether outliers are just wacky or useful for the valuation.

4. Example

PdG Inc. is a maker of software designed to teach languages, and it will soon undertake an IPO. The information below is available for PdG and three similar but publicly traded companies. We will use this information to estimate a range for PdG's stock value.

	PdG Inc.	Company A	Company B	Company C
Price	na	$18	$45	$9
Shares	80,000	100,000	50,000	150,000
Debt	$300,000	$500,000	$900,000	$200,000
EBIT	$150,000	$180,000	$350,000	$90,000
Sales	$1,900,000	$3,100,000	$3,300,000	$1,300,000
BV assets	$1,600,000	$1,700,000	$2,800,000	$900,000
BV equity	$1,300,000	$1,200,000	$1,900,000	$700,000
EPS	$0.99	$0.86	$3.43	$0.31

Below I have estimated various multiples. I do not see any "wacky" outliers here, so I summarized the multiples using a simple average. Based on the average multiples, I estimated the price for PdG Inc. I also included some footnotes in the table to show the calculation of some of the numbers.

	Company A	Company B	Company C	Average	Est. price of PdG
P/E	20.98	13.11	29.22	21.10	$20.89
P/BV per share	1.50	1.18	1.93	1.54	$24.99
Ent. value / EBIT	12.78	9.00	17.22	13.00	$20.63
Ent. value / Sales	0.74	0.95	1.19	0.96	$19.12
Ent. value / BV assets	1.35*	1.13	1.72	1.40	$24.25†

* Enterprise value / BV of assets = (($18 x 100,000) + $500,000) / $1,700,000

† Estimated enterprise value = 1.4 x $1,600,000 = $2,240,000
Estimated price = ($2,240,000 – $300,000) / 80,000 shares= $24.25

Based on the multiples analysis, the estimated stock price for PdG Inc. ranges from about $19 to $25.

PART III: Presenting the valuations graphically

It is useful and common practice to present the valuations graphically. In this section, I show how the valuations can be presented in a so-called "football-field" graph.

Suppose that we have the valuations in the table below for an IPO. Note that each of the valuation methods include a range of estimates. For example, when we use DCF, it is common to estimate a range of values using different terminal growth rates. And for multiples, we might get a range of values using different comps and summary statistics for the multiples.

	Min	Max
M/B	$40	$50
P/E	$34	$68
DCF	$27	$49

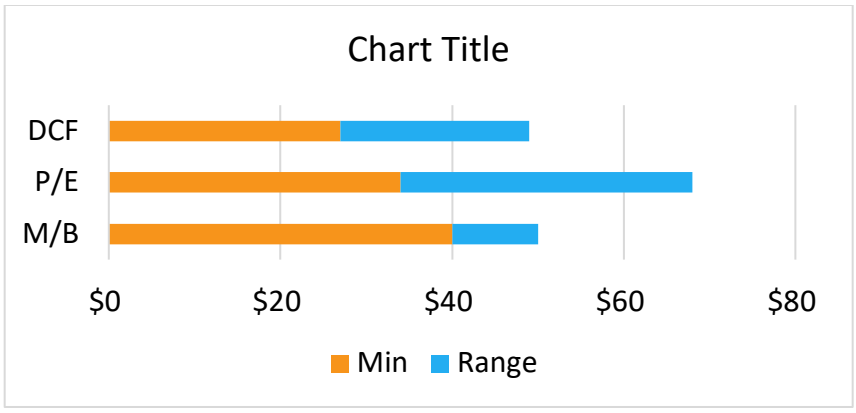
Also, suppose that we would like to compare these valuations to the IPO price of $42.

I will first make a stacked bar where the first stack is the minimum value and the second is the difference between the maximum and minimum values.[15] To do so, I added an additional column with the difference:

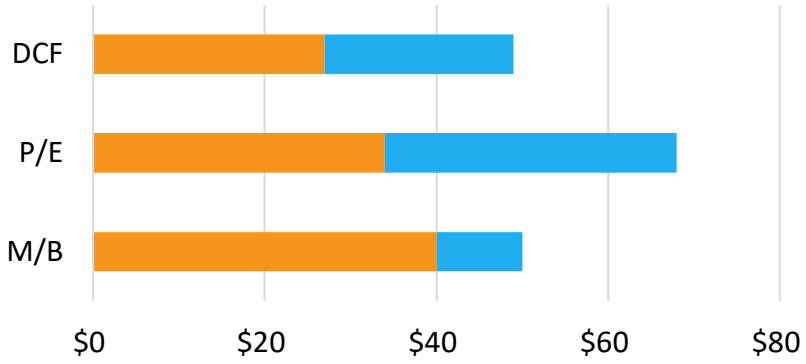
	Min	Range	Max
M/B	$40	$10	$50
P/E	$34	$34	$68
DCF	$27	$22	$49

Then I highlight the first three columns of the table (but not the maximum values), click *Insert* from the Excel menu, and choose a stacked bar.

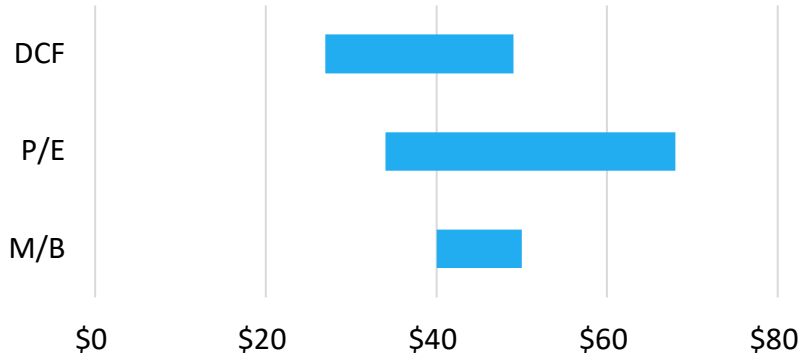
[15] Alternatively, we could make a clustered bar based on the minimum and maximum values and then choose for the bars to be perfectly overlapping.



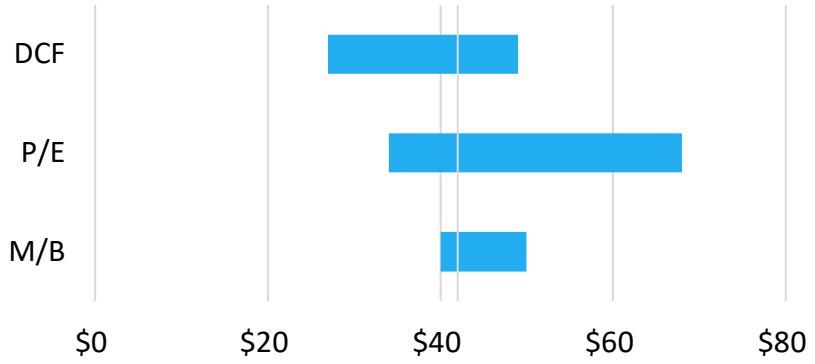
Then I remove the chart title, legend, and border.



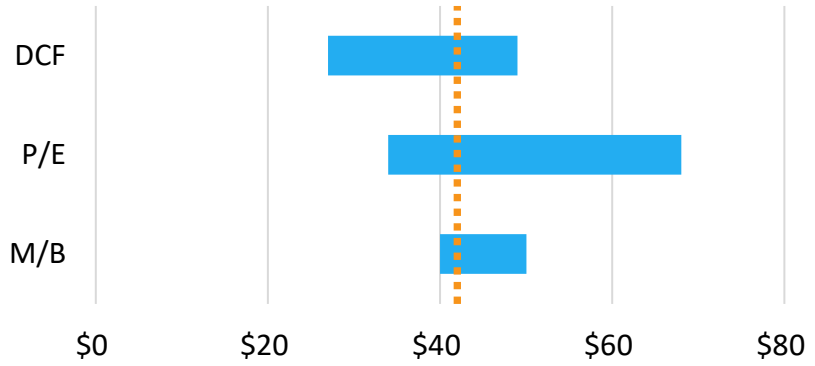
Then I click on the blue Min bar, right click, select Format Data Series, and choose no fill and no border.



Now I need to indicate the IPO price of $42 with a vertical line. To do so, I prefer to use the vertical axis.[16] First, I click the horizontal (X) axis, select axis options, and select for the vertical axis to cross at a value of 42. Then I click the vertical (Y) axis and select the label position to be low.



Finally, I change the format of the vertical (Y) axis to make it a thick and dashed line. And you may certainly insert text boxes with additional information as well.

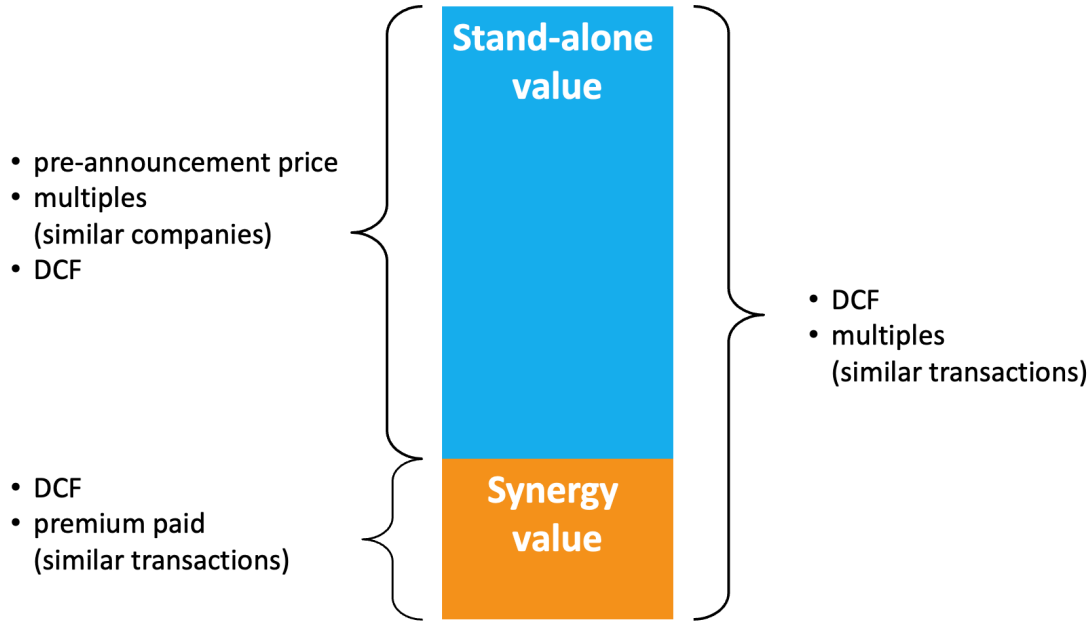


[16] An alternative is to draw a line manually, but this can be inaccurate and can get messed up when we change the formatting of the graph, e.g., the graph size.

PART IV: Valuing an acquisition target

In principle, valuing an acquisition target is no different than valuing other companies or projects. But the acquisition transaction itself affects the value, thus adding a layer of complexity. In particular, the change in ownership generally produces so-called synergies, e.g., because the new owners (which could be anything from an individual to another company) bring some expertise in how to improve the operation of the target or because the merger of firms facilitate greater economies of scale.

One approach would be to start from scratch by estimating the cash flow (including those stemming from synergies) under the new ownership structure, and then discount by the cost of capital under the new ownership structure to arrive at the target value. Alternatively, we could use multiples from comparable targets that have recently undergone similar ownership changes (and produced similar synergies) to arrive at the target value.[17]



We can alternatively partition the valuation into two components, in which we value (i) the target as a stand-alone entity under the current ownership structure and (ii) the synergy value as the incremental value from the change in ownership structure.

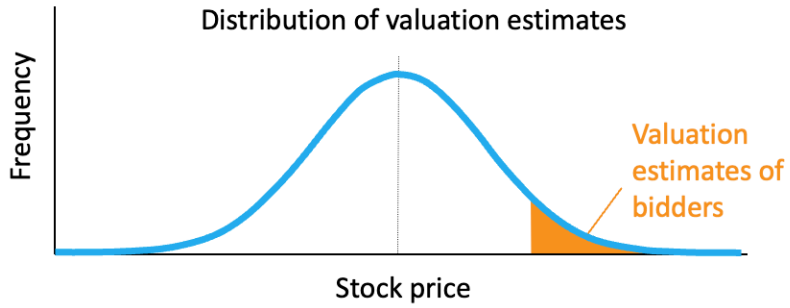
The first valuation component can be estimated in the standard way with DCF and multiples from comparable companies. Furthermore, if the target is publicly traded, we can simply use the stock price

[17] To implement a multiple valuation based on comparable transactions typically requires the use of transaction prices as estimates of the market value under the new ownership structure. However, the transaction price might deviate significantly from the market value under the new ownership structure. Indeed, the acquirer is presumably seeking to gain from the transaction by paying *less* than the fair market value.

as a valuation estimate. The stock price reflects the consensus valuation of all market participants, and, as such, should be a more precise estimate of the true value than estimates by only one market participant (like me). The caveat to using the stock price is that that market might already have anticipated the acquisition, such that the stock price reflects both the stand-alone value plus the expected synergy value. Thus, it is critical that we use a stock price that precedes news of the acquisition, and, ideally, even before rumors of the acquisition.

The second valuation component can be estimated by identifying the cash flow from synergies, e.g., the after-tax cost savings from combining similar operations, and discounting by the cost of capital.[18] As a validation analysis, we can use the premium paid in similar transactions, assuming that those transactions produced similar levels of synergies and that the bid prices in those transactions fully captured the synergies.

I want to end with a warning on bidding on other firms. When we buy shares in companies in the open market, it is likely that we believe that the shares are worth *more* than the prevailing stock price (and unlikely that we believe that the shares are worth *less* than the prevailing stock price). And if we are wrong, the market is very forgiving, in that we only pay the stock price and not what we believe the stock is worth. However, the M&A market is not so forgiving. When we bid on a firm in an M&A context, we are likely to have greater valuation estimates than other market participants. Furthermore, we are likely to offer a takeover price that falls somewhere between the prevailing stock price and our valuation estimate. In that case, there is a good chance that our valuation estimate is biased upward, and that if we bid up the takeover price to this estimate, we end up overpaying. That is the bidder's curse.



[18] Identifying and quantifying the cash flow from synergies is critical but very challenging, so much so that it can be considered the holy grail of M&A.