## A Down-Rounds Math Primer

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## Background

Venture funded businesses often need to keep going back to investors to seek multiple rounds of funding as business grows. All is well so long as the business is increasing in value and everyone is benefiting, but when projections do not turn out to be what the initial VCs and the founders thought they would be, subsequent rounds of funding often get raised at lower valuations. Downrounds aren't fun, they are painful, involve difficult negotiations with initial investors, but are a reality every venture investor and entrepreneur needs to deal with particularly if business conditions aren't the easiest.

This paper looks at the math and provides an Excel based model to understand the calculations for price-based anti-dilution provisions. While the math is easy, the real purpose of doing this exercise is to allow an understanding of how different variables affect the future shareholding pattern after a down-round, particularly the founder's holding after a down-round, as that significantly affects motivation and incentives, and also how losses in value get shared between the entrepreneurs and the VCs. Down-rounds, or subsequent investments at prices lower than that paid by earlier investors, often trigger in price-based anti-dilution provisions that are intended to protect the prior round investors from a dilution in their percentage of ownership or value in the venture.

## Types of price-based anti-dilution provisions

Price-based anti-dilution clauses are really arrangements that recognize that the founders and the entrepreneurs are responsible for maintaining and increasing the value of the company and if they are unable to deliver on their promises and subsequent rounds of funding happen at lower valuations, they should compensate the initial investors by giving them more shares in the company to reduce the losses to the investors from reduced valuations. Reduced to their core, anti-dilution clauses are really nothing but the means of determining how losses in value between two rounds of funding get shared between the investors and the entrepreneur.

Like everything else in a term-sheet, anti-dilution clauses are negotiated carefully by all parties and can take many different forms. On one extreme, we may have a term sheet that has no pricebased anti-dilution, which means that if the venture loses value between two rounds of funding and new investors are sold shares at a price lower than the prior set of investors, there is no compensation for the previous investors. This is a situation where the entrepreneur and the VC investors are true partners in the new business and share losses exactly in the ratio of their holding in the venture. This form of term-sheet however is extremely rare in real life.

At the other extreme is a term sheet with a 'full-ratchet' anti-dilution provision, where the investors in a prior round of funding get the right to re-price their purchase at any new lower price at which new shares may be issued to new investors. In this situation, the value of their initial investment which may have fallen over time is 'topped-up' by the issue of enough new 'free' shares so that the investors' capital is preserved.

Full-ratchet anti-dilution provisions tend to be rather harsh on the founders should valuations decline, and 'weighted average' anti-dilution provisions that allow for an anti-dilution adjustments that are somewhere between no price-based anti-dilution and full-ratchet provisions are far more common.

## NewCo

Consider an example where a 'Series A' investor invests $\$ 2 \mathrm{~m}$ for 2 m convertible preferred shares that are set to convert at a price of $\$ 1$ per common share for a $20 \%$ stake in a new venture. In other words, the new business is valued at $\$ 10 \mathrm{~m}$ post-money at the time of the Series A funding. After the Series A funding, the capital structure of NewCo looks as follows:

Capital structure after Series A funding:

|  | \$ value of <br> investment | \# of Equivalent <br> Common Shares | $\%$ <br> of company | $\$$ value of <br> stake |  |
| :--- | :---: | :---: | :---: | :---: | ---: |
| Founders' shares | - | $8,000,000$ | 80 | $\$ 8,000,000$ |  |
| Series A Investment (Series |  | $2,000,000$ | $2,000,000$ | 20 | $\$ 2,000,000$ |
| A) |  | $10,000,000$ | 100 | $\$ 10,000,000$ |  |
| Total Post Money valuation <br> after Series A |  |  |  |  |  |

Now fast forward to a year later where the company needs additional capital and raises another $\$ 8 \mathrm{~m}$ as part of Series B funding for a $50 \%$ stake in NewCo. This means that the Series B premoney valuation is $\$ 8 \mathrm{~m}$, implying that between Series A and Series B NewCo has lost $\$ 2 \mathrm{~m}$ in value (as the valuation has dropped from $\$ 10 \mathrm{~m}$ to $\$ 8 \mathrm{~m}$ ).

Two important questions the answers to which are interrelated arise in this situation:

1. How is the $\$ 2 \mathrm{~m}$ loss in NewCo's value shared between the Series A investor and the entrepreneurs, and
2. What is the respective ownership stake of the founders, and two groups of investors once Series B financing is completed.

The answers to these questions are determined by the anti-dilution provisions in the term sheet. In the remaining part of this document, we consider the impact of each of the three key types of anti-dilution provisions on the way the Series B funding gets executed and what the capital structure of NewCo looks like after the funding.

## © NewCo without anti-dilution provisions

If there are no price-based anti-dilution provisions, then the loss in value will be shared between the founders and the Series A investors in the ratio of their respective holdings. Though not very common, it is only in this scenario that the investors and entrepreneurs are true partners, sharing equally in the fortunes and misfortunes of the venture. In this case, the post Series B financing capital structure of NewCo will look as follows:


Since the Series B investors have taken up $50 \%$ of NewCo, the old shareholders have equitably seen their share halved too, and the founder's new share is $40 \%$ after the Series B round as opposed to $80 \%$ before that. Consider column (6) above, and it is clear that in the absence of anti-dilution provisions the loss in value is shared in the 80-20 ratio, which was the respective stake of the Series A investor and the founders.

## (2) NewCo with full-ratchet anti-dilution

If the term sheet provides for full ratchet anti-dilution, the Series A investors would have their shares re-priced at the new lower price that the Series B investors would be receiving. In this case, the entire loss of value will be picked up by the founders, and the Series A investors will be able to preserve the value of their investments.

Capital Structure Post Series B financing - Full Ratchet Anti-Dilution

| (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\$$ value of investment | \# of Equivalent Common Shares (conversion ratio * conv pref shares) | Additional shares pursuant to anti-dilution provisions | Total Shares | \% <br> of company | \$ value of stake at new valuation | Series A postmoney value | Loss in value compared to position just after Series A | Loss sharing ratio |
| - | 8,000,000 |  | 8,000,000 | 37.5\% | 6,000,000 | 8,000,000 | $(2,000,000)$ | 100.0\% |
| \$ 2,000,000 | 2,000,000 | 666,667 | 2,666,667 | 12.5\% | 2,000,000 | 2,000,000 | - | 0.0\% |
| \$ 8,000,000 | 10,666,667 |  | 10,666,667 | 50.0\% | 8,000,000 |  |  |  |
|  | 20,666,667 | 666,667 | 21,333,333 | 100.0\% | 16,000,000 | 10,000,000 | (2,000,000) | 100.0\% |

As is clear from the table above, the founders have seen their equity stake in NewCo shrink from $80 \%$ to $37.5 \%$ (instead of $40 \%$ as would have been the case if there were no anti-dilution terms. Not only that, the value of their investment has reduced by $\$ 2 \mathrm{~m}$, which means they have picked up the loss in value of the venture in its entirety. The Series A investors are just as well off as the Series B investors, and have received additional shares to make up for the loss in value. The "additional shares" generally take the form of a change in the conversion ratio at which their preference shares will convert to common shares.

The mechanics of the anti-dilution provisions and the math involved deserves some attention here, and how the above capital structure was arrived at is explained in greater detail below.

A literal interpretation of the repricing term would require that new shares be issued to the Series A investor to bring their average price down to the new price that is paid by the Series B investor. In the case of NewCo, Series B investors plan to invest $\$ 8 \mathrm{~m}$ for a $50 \%$ stake in the company, effectively valuing the shares at $\$ 0.80$ (as opposed to the $\$ 1$ price paid by the Series A investors). Full-ratchet provisions would mean that Series A investors would have their $\$ 2 \mathrm{~m}$ investment converted at $\$ 0.80$ per share instead of $\$ 1.00$, implying that they effectively receive an extra 500,000 shares, calculated as $\$ 2 \mathrm{~m} / \$ 0.80$ $\$ 2 \mathrm{~m} / \$ 1.0$. However, upon this happening the capital structure of NewCo would look as follows:

|  | \$ value of investment |  | \# of Equivalent Common Shares (conversion ratio <br> * conv pref shares) | Additional shares pursuant to anti-dilution provisions | Total Shares | \% of company |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Founders' shares | - |  | 8,000,000 |  | 8,000,000 | 39.0\% |
| Series A investor | \$ | 2,000,000 | 2,000,000 | 500,000 | 2,500,000 | 12.2\% |
| Series B investor | \$ | 8,000,000 | 10,000,000 |  | 10,000,000 | 48.8\% |
|  |  |  | 20,000,000 | 500,000 | 20,500,000 | 100.0\% |

This would not be acceptable to the Series B investors as they would see their shares being diluted to $48.8 \%$ of NewCo, whereas they had intended to pay $\$ 8 \mathrm{~m}$ for a $50 \%$ stake. Therefore, more shares would need to be issued to the Series B investors than 10,000,000,
so as to bring their stake back up to $50 \%$ for the $\$ 8 \mathrm{~m}$. This however, would lead to a lowering of the average price, which would mean more shares to be issued to Series A investors, and so on.

In fact, the correct solution to giving effect to this anti-dilution provision is given in the table in the beginning of this section, where 666,667 'free' shares are issued to the Series A investors, and $10,666,667$ shares are issued to the Series B investors at an average price of $\$ 0.75$ per share. (The table is reproduced again for reference)


The above capital structure that reflects the full effect of the anti-dilution provision can be arrived at iteratively, or using the 'Goal Seek’ functionality in MS-Excel. However, a more elegant solution to the above problem is arrived at by algebraically deriving a formula for determining the new Series B price at which the needs of the both the Series A investor to be issued shares at the same lower price as subsequent investors is balanced with the need of the Series B investor to get a certain percentage of NewCo for a given dollar amount of investment.

For the purposes of the rest of this document, let

- AI represent the \$ amount of the Series A Investment funding
- BI represents th \$ amount of the Series B Investment funding
- NV be the new, pre-money valuation prior to Series B funding
- FS be the number of founder shares after the initial Series A funding round
- OP be the old price per share, i.e. the per share price paid by the Series A investor.
- NP be the new price per share, i.e., the price per share paid by the Series B investor.

We know that the New Price (to be called "NP") at which shares need to be issued to the Series B investor would equal the total post-money valuation divided by the total number of shares outstanding after the Series B funding.

In other words,

New issue price for Series B funding

New issue price for Series B funding
$=\quad \frac{\text { Total post-money valuation after Series B funding }}{\text { Total number of shares outstanding after Series B funding }}$
$=\quad \frac{\text { Pre-money valuation }+ \text { Series B investment }}{\text { Total number of shares outstanding after Series B funding }}$

Now we know Total number of shares outstanding after Series B funding will include the following:

1. Founders' shares, which is represented by "FS"
2. Series A investors' shares, which is nothing but the Series A original investment divided by the old price at which the Series A investors were issued shares, in other words, AI/OP
3. New 'free' shares issued to Series A investors under the anti-dilution provisions, which is the difference between the number of shares they would receive at the New Price and the shares they already have at the Old Price, in other words, $\mathrm{AI} / \mathrm{NP}$ - AI/OP.
4. Series B investors' shares, which is nothing but $\mathrm{BI} / \mathrm{NP}$

Using the above, the equation we had reduces to:

$$
\begin{aligned}
& \mathrm{NP}=\frac{\mathrm{NV}+\mathrm{BI}}{\mathrm{FS}+\mathrm{Al} / \mathrm{OP}+(\mathrm{Al} / \mathrm{NP}-\mathrm{Al} / \mathrm{OP})+\mathrm{BI} / \mathrm{NP}} \\
& \mathrm{NP}=\frac{\mathrm{NV}+\mathrm{BI}}{\mathrm{FS}+\mathrm{Al} / \mathrm{NP}+\mathrm{BI} / \mathrm{NP}} \\
& \mathrm{NP}=\frac{\mathrm{NP*}(\mathrm{NV}+\mathrm{BI})}{\mathrm{NP}^{*} \mathrm{FS}+\mathrm{Al}+\mathrm{BI}} \\
& \mathrm{NP*}(\mathrm{NP} * \mathrm{FS}+\mathrm{Al}+\mathrm{BI})=\mathrm{NP*}(\mathrm{NV}+\mathrm{BI})
\end{aligned}
$$

Or, solving for NP, we get

$$
N P=\frac{N V-A I}{F S}
$$

This equation may not appear to be very intuitive, but accurately reflects the correct price at which shares need to be issued to Series B investors and Series A investors' shares repriced.

In our NewCo example, this formula provides a value of $\$ 0.75$ correctly as follows:

$$
N P=(N V-A I) / F S=(\$ 8,000,000-\$ 2,000,000) / 8,000,000=\$ 0.75 .
$$

The formula and all workings can easily be modeled in Excel, and a screenshot of such a model showing the capital structure before and after appears in Appendix 1.

## (3) NewCo with weighted average anti-dilution

Weighted average anti-dilution clauses are the most common in real life, and provide for sharing the pain from the fall in NewCo's valuation between its investors and founders. Weighted average anti-dilution clauses come in a variety of flavors, though the most common one includes the calculation of an average price that is defined by a mutually agreed formula which often is as follows:

| Weighted average price to be |
| :--- |
| used for anti-dilution calculations |$=\frac{\text { Total shares before Series B shares are issued }+\frac{\text { Series B investment }}{\text { Old Price }}}{\text { Total shares before Series B shares are issued }+\frac{\text { Series B investment }}{\text { New Price }}} \times$ Old Price

Effectively, what this formula reflects is the ratio of the total number of shares that would have been issued had valuations been sustained at the old price to the total number of shares actually outstanding after the Series B funding.

In the case of NewCo, the new capital structure that gives effect to the weighted average anti-dilution would look as follows:

| Capital Structure Post Series B financing - Weighted Average Anti-Dilution |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|  | \$ value of investment | \# of Equivalent Common Shares (conversion ratio * conv pref shares) | Additional shares pursuant to anti-dilution provisions | Total Shares | \% of company | \$ value of stake at new valuation | Series A postmoney value | Loss in value compared to position just after Series A | Loss sharing ratio |
| Founders' shares | - | 8,000,000 |  | 8,000,000 | 39.0\% | 6,243,902 | 8,000,000 | $(1,756,098)$ | 87.8\% |
| Series A investor | \$ 2,000,000 | 2,000,000 | 250,000 | 2,250,000 | 11.0\% | 1,756,098 | 2,000,000 | $(243,902)$ | 12.2\% |
| Series B investor | \$ 8,000,000 | 10,250,000 |  | 10,250,000 | 50.0\% | 8,000,000 |  |  |  |
|  |  | 20,250,000 | 250,000 | 20,500,000 | 100.0\% | 16,000,000 | 10,000,000 | (2,000,000) | 100.0\% |

In the case of weighted average anti-dilution, the pain from the loss is shared more equitably between the founders and the Series A investors, who pay for some of the loss in value, but not to the extent of their stake in NewCo. Similarly, the new ownership stakes in NewCo are not linear relationships to what the pre-Series B funding stakes were, and in fact tend to punish the entrepreneurs more when the size of the new round is bigger.

Now on to the math - in the same way as before, we let

- AI represent the $\$$ amount of the Series A Investment funding
- BI represents th \$ amount of the Series B Investment funding
- NV be the new, pre-money valuation prior to Series B funding
- FS be the number of founder shares after the initial Series A funding round
- OP be the old price per share, i.e. the per share price paid by the Series A investor.

Also,

- NP be the new price per share, i.e., the price per share paid by the Series B investor
- WP be the weighted average price at which the anti-dilution provisions will be applied.

It may be noted that NP and WP are really derived from the other variables, and can be expressed as a formula that is based upon AI, BI, NV, FS and OP, but for the sake of simplicity and comprehension we have defined these here as well.

We can further reduce the weighted average to a formula as follows:


Again, calculations become iterative for the same reason as they do for full-ratchet provisions, the new investor needs to be issued more shares as the Series A investor gets additional shares pursuant to anti-dilution provisions, which in turn requires more shares to be issued to the Series B investor and so on.

With weighted average anti-dilution, the pain from reduced valuations is shared in a more complex non-linear way which is best examined doing a sensitivity analysis using Excel.

We know that the New Price (to be called "NP") at which shares need to be issued to the Series B investor would equal the total post-money valuation divided by the total number of shares outstanding after the Series B funding.

In other words,


Now we know Total number of shares outstanding after Series B funding will include the following:

1. Founders' shares, which is represented by "FS"
2. Series A investors' shares, which is nothing but the Series A original investment divided by the old price at which the Series A investors were issued shares, in other words, AI/OP
3. New 'free' shares issued to Series A investors under the anti-dilution provisions, which is the difference between the number of shares they would receive at the Weighted Average Price and the shares they already have at the Old Price, in other words, AI/NP - AI/OP.
4. Series B investors' shares, which is nothing but BI/NP

Or,
New issue price for Series B funding $=\frac{\text { Pre-money valuation + Series B investment }}{\begin{array}{c}\text { Founders' shares + Series A shares + New 'free' shares } \\ \text { to Series A investors + New shares to Series B investors }\end{array}}$
Using the above, the equation we had reduces to:


Now we know that

$$
W P=\frac{O P^{*} N P^{*}\left(O P^{*} F S+A I+B I\right)}{O P^{*} N P^{*} F S+N P^{*} A I+O P^{*} B I}
$$

Substituting and solving, we get:

This is a very daunting formula but it works, and is a more 'elegant' alternative to using an iterative method to arrive at the new issue price.

This formula can be seen in action using our hypothetical example of NewCo in Appendix 2. The Excel model where the formula is used can be downloaded from financeoutlook.com.

## Appendix 1 - Full-Ratchet Anti-Dilution <br> NewCo's Capital Structure before and after a down-round Series B financing

Data Entry Section (No other data needs to be entered in the remaining part of the spreadsheet)

| FS | Founder shares (in number <br> of shares) | $8,000,000$ | common shares |
| :--- | :--- | ---: | ---: |
| AI | Series A Investment <br> (complete \$ amount) | $\$ 8,000,000$ |  |
| OP | Series A investor price (in <br> \$s per share) | $\$ 1.00$ | per share |
| NV | Series B pre-money <br> valuation | $\$ 8,000,000$ |  |
| BI | Proposed Series B <br> investment (\$ amount) | $\$ 8,000,000$ |  |



Capital Structure Post Series B financing - Full Ratchet Anti-Dilution

|  |  | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | \$ value of investment |  | \# of Equivalent Common Shares (conversion ratio * conv pref shares) | Additional shares pursuant to anti-dilution provisions | Total Shares | \% of company | $\$$ value of stake at new valuation | Series A postmoney value | Loss in value compared to position just after Series A | Loss sharing ratio |
| Founders' shares | - |  | 8,000,000 |  | 8,000,000 | 37.5\% | 6,000,000 | 8,000,000 | $(2,000,000)$ | 100.0\% |
| Series A investor | \$ | 2,000,000 | 2,000,000 | 666,667 | 2,666,667 | 12.5\% | 2,000,000 | 2,000,000 | - | 0.0\% |
| Series B investor | \$ | 8,000,000 | 10,666,667 |  | 10,666,667 | 50.0\% | 8,000,000 |  |  |  |
|  |  |  | 20,666,667 | 666,667 | 21,333,333 | 100.0\% | 16,000,000 | 10,000,000 | (2,000,000) | 100.0\% |

Check:
Total value (Valuation x number of total shares)
Total value Series B pre-money + new investment
Difference

| 21333333 shares $\times \$ 0.7500$ | $\$ 16,000,000$ |
| :--- | :--- |
| $\$ 8000000+\$ 8000000$ | $\$ 16,000,000$ |
|  | $\$ 1$ |
|  |  |

# Appendix 2 - Weighted Average Anti-Dilution <br> NewCo's Capital Structure before and after a down-round Series B financing 

Data Entry Section (No other data needs to be entered in the remaining part of the spreadsheet)

| FS | Founder shares (in number <br> of shares) | $8,000,000$ | common shares |
| :--- | :--- | ---: | ---: |
| AI | Series A Investment <br> (complete \$ amount) | $\$ 8,000,000$ |  |
| OP | Series A investor price (in <br> \$s per share) | $\$ 1.00$ | per share |
| NV | Series B pre-money <br> valuation | $\$ 8,000,000$ |  |
| BI | Proposed Series B <br> investment (\$ amount) | $\$ 8,000,000$ |  |


| Initial Capital Structure prior to Series B Funding |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  | (1) | (2) | (3) |  | (4) |
|  |  |  | alue of estment | \# of Equivalent Common Shares | \% of company |  | \$ value of stake |
| FS | Founders' shares Series A Investment (Series |  | - | 8,000,000 | 80 | \$ | 8,000,000 |
|  |  |  |  |  |  |  |  |
| AI | A) | \$ | 2,000,000 | 2,000,000 | 20 | \$ | 2,000,000 |
|  | Total Post Money valuation after Series A |  |  | 10,000,000 | 100 | \$ | 10,000,000 |
| OP | Series A investor price |  | \$1.00 |  |  |  |  |
| Series B Funding Proposal |  |  |  |  |  |  |  |
| NV | Pre-money valuation | \$ | 8,000,000 |  |  |  |  |
| BI | Size of Series B investment Series B investor share | \$ | 8,000,000 |  |  |  |  |
|  |  |  | 50.00\% |  |  |  |  |
|  | Valuation per share for |  |  |  |  |  |  |
| NP | Series B funding | \$0.78 |  | Includes |  |  |  |
|  | Wt Avg rate (for calculating addl anti dilution shares for Series A Investor) |  |  |  |  |  |  |
|  |  |  | \$0.89 |  |  |  |  |
| Loss of value between Series A and Series B |  |  |  |  |  |  |  |
| Series A valuation |  |  | 10,000,000 |  |  |  |  |
| Series B pre-money before Series B |  |  | 8,000,000 |  |  |  |  |
| Loss in value |  |  | (2,000,000) |  |  |  |  |
| Shared between: |  |  |  |  |  |  |  |
| Founder share of value lost |  |  | $(1,756,098)$ | 87.8\% | refer Column (7) below refer Column (7) below |  |  |
| Series A investor's value lost |  |  | $(243,902)$ | 12.2\% |  |  |  |
|  |  |  | $(2,000,000)$ | 100.0\% |  |  |  |

Capital Structure Post Series B financing - Weighted Average Anti-Dilution


Check:
Total value (Valuation $x$ number of total shares)
Total value Series B pre-money + new investment
Difference

| 20500000 shares $\times \$ 0.7805$ | $\$ 16,000,000$ |
| :--- | :--- |
| $\$ 8000000+\$ 8000000$ | $\$ 16,000,000$ |
|  | $\$ 1$ |

