Proper Determination of the Growth Rate for Growing Perpetuities:

The Growth Rate for the Terminal Value

(Draft)

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Abstract

In this paper we find restrictions for the value of a parameter used in defining the cost of capital for perpetuities and terminal values: the growth rate for the free cash flow. When defining the growth rate for the free cash flow the usual warning is to set it below the growth of the economy or the industry because in the long run the firm would be larger than the economy or the industry. This approach might be considered somewhat standard in the sense that usually they either take the growth of NOPLAT (mathematically) and/or check that it complies with the previous statement. However, in this paper we propose to find another objective limits deriving them from the formulation for the cost of capital in perpetuity and the traditional formula for the terminal value in a world where the discount rate for the tax savings is Kd, the cost of debt. These limits give additional criteria for determining the value of g. The limits are calculated in terms of real rate of growth. We use an example to show the effects of violating these limits.

Calculating these limits is very important in valuation because usually the terminal value is a substantial portion of the levered value of the firm.

Key Words

Cash flows, free cash flow, cash flow to equity, valuation, levered value, levered equity value, terminal value, cost of levered equity, cost of unlevered equity, tax savings, cost of capital for growing perpetuities, growth rate for the free cash flow.

JEL Classification

M21, M40, M46, M41, G12, G31, J33

Introduction

In this paper we find restrictions for the value of a parameter used in defining the cost of capital for perpetuities and terminal values: the growth rate for the free cash flow. When defining the growth rate for the free cash flow the usual warning is to set it below the growth of the economy or the industry because in the long run the firm would be larger than the economy or the industry. This approach might be considered somewhat standard in the sense that usually they either take the growth of NOPLAT (mathematically) and/or check that it complies with the previous statement. However, in this paper we propose to find another objective limits deriving them from the formulation for the cost of capital in perpetuity and the traditional formula for the terminal value in a world where the discount rate for the tax savings is Kd, the cost of debt. These limits give additional criteria for determining the value of g. The limits are calculated in terms of real rate of growth. We use an example to show the effects of violating these limits.

Calculating these limits is very important in valuation because usually the terminal value is a substantial portion of the levered value of the firm.

In this paper, first we present the formula for the cost of capital in a growing perpetuity with two assumptions for ψ, the discount rate for the tax savings, TS, namely, Kd and Ku. We derive the limits that g has to observe in order to obtain consistent results in the calculation of the $WACC_{perp}$ and the terminal value. In addition, we show how when g is in the vicinity of some critical point, the increase in the terminal value TV, is extremely large. Finally we conclude.

Formulations for Perpetuities

In this section we present the formulation for the cost of capital for growing perpetuities and the calculation of the terminal value TV.

A general formulation for the WACC for a growing perpetuity is

$$WACC_{perp} = Ku - \frac{(Ku - g)V^{TS}}{V^{L}} \tag{1a}$$

$$WACC_{perp} = Ku - \frac{(Ku - g)TD\%Kd}{(\psi - g)} \tag{1b}$$

For the particular case of growing perpetuities and Kd as discount rate for the TS, we have

$$WACC_{perp} = Ku - \frac{(Ku - g)TD\%Kd}{(Kd - g)} \tag{1c}$$

For the particular case of growing perpetuities and Ku as discount rate for the TS, we have

$$WACC_{perp} = Ku - \frac{(Ku - g)TD\%Kd}{(Ku - g)} = Ku - TD\%Kd \tag{1d}$$

The formulation for the terminal value is

$$TV = \frac{NOPLAT(1+g)\left(1 - \frac{g}{ROIC}\right)}{WACC_{perp} - g} \tag{2a}$$

The term g/ROIC is necessary to sustain the growth g.

When ROIC is equal to WACC then the term (WACC − g) disappears. And the formula looks like if g = 0, but it is not. Then for ROIC equal to WACC the formula for TV is

$$TV = \frac{NOPLAT(1+g)}{WACC_{perp}} \tag{2b}$$

In equations 1a to 2b the variables are: Ku, the cost of unlevered equity, Kd, the cost of debt, T the tax rate, D% the constant leverage, TS is the tax savings, V^{TS} is the present value of the TS at ψ the discount rate for the TS, V^L is the total levered value, g is the growth rate for the FCF and the debt, TV is the terminal value, ROIC is the return on invested capital, NOPLAT is the net operating profit less adjusted taxes and $WACC_{perp}$ is the constant Weighted Average Cost of Capital for perpetuity. We assume this condition of ROIC = $WACC_{perp}$ to derive the restrictions to g.

The derivation of this set of formulas is presented in Vélez-Pareja and Burbano, 2003, Tham and Vélez-Pareja 2004, Vélez-Pareja and Tham (2001) and Tham and Vélez-Pareja, 2002. The general formula for the terminal value (see Copeland *et al*. 2000 and 1995, Tham and Vélez-Pareja, 2004[1]) is

Limitations derived from the terminal value TV and the WACC in perpetuity

Equations 1c and 2a impose some restrictions to the values of g, the growth rate for the FCF.

First we present the restrictions when ψ is Kd. Considering that in general the WACC should be positive, determined and in the range Kd < WACC < Ke, assuming that the ROIC = $WACC_{perp}$, and that the terminal value TV, should be in general positive and determined, these restrictions are[2]

1. If $WACC_{perp}$ should be **at least equal to Kd**, then real

$$g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

[1] Tham and Vélez-Pareja 2004 use ROMVIC (return on market value of invested capital). ROIC uses book value.
[2] See Appendix A for the algebra supporting these limits.

2. If $WACC_{perp}$ should be **at most equal to Ke**, then real

$$g \geq \frac{Kd\dfrac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

3. The limit of $WACC_{perp}$ when g increases indefinitely is $Ku - TD\%Kd$.

4. In determining the real g it should not lie within the interval

$$\frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f} \leq g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

5. There is a critical value for real g that makes the terminal value indefinite (extremely high or extremely negative). This critical point is

$$g = \frac{Kd\dfrac{KuTD\% - Ku}{TD\%Kd - Ku} - i_f}{1 + i_f}.$$

If ROIC is not the $WACC_{perp}$, then the limits for real g are only

$$g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

When ψ is Ku, fortunately the g is not involved in the formulation of WACC for perpetuities ($Ku - TD\%Kd$).

Calculating the Restrictions for g

To illustrate these ideas we will use a very simple example. For that example we have the following information regarding value calculation.

Table 1a. Input variables

Input	Value	Input	Value
Inflation	2%	T	39.00%
Real Ke	8.6762%	Kd	8.50%
Real Kd	6.37%	Kd(1-T)	5.19%
Real g	5.5588%	D%	15.00%
Real ROIC	8.33%	g	7.67%
Ke	10.8497%	$NOPLAT_N$	613.31

In the next table we calculate the limiting values for real g when ψ is Kd.

Table 1b Limiting conditions for real g and its values

Restriction	Limiting condition for real g	Value
WACCperp = 0%	$g = \frac{Kd\frac{KuTD\% - Ku}{TD\%Kd - Ku} - i_f}{1 + i_f}$	6.27040%
WACCperp ≤ Ke	$g \geq \frac{Kd\frac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$	7.7978%
WACCperp ≥Kd	$g \leq \frac{Kd\frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$	5.7358%

We can see that all the conditions for real g are met.

Then there is a range where g is not permitted because $WACC_{perp}$ would lie outside the limits of Kd and Ke. Assuming ROIC = $WACC_{perp}$

$$\frac{Kd\frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f} \leq g \leq \frac{Kd\frac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

Assuming ROIC different from $WACC_{perp}$

$$g \geq \frac{Kd \frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

except $g = \frac{Kd \frac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$ when $WACC_{perp}$ might be equal to Ke.

These critical points are heavily affected by inflation. For instance, *ceteris paribus*, the behavior of the value of real g to grant that WACCperp be at least equal to Kd is as follows:

Table 2. Behavior of a limiting condition,
WACCperp ≥Kd with change in the inflation rate

Inflation rate	$\frac{Kd \frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$
0.00%	5.92%
2.00%	5.74%
4.00%	5.53%
6.00%	5.31%
8.00%	5.06%
10.00%	4.77%
12.00%	4.45%
14.00%	4.08%
16.00%	3.65%
18.00%	3.14%
20.00%	2.54%
22.00%	1.82%
24.00%	0.93%
25.00%	0.40%

This means that if an economy has high rates of inflation, say from 14% to 25% (which has not been uncommon in some areas of the world) in our example the real g might be around or even below a typical level of growth of the economy or the industry.

Once we know these limits, then we can compare the initial estimate for g with the growth rate for the economy and/or the industry and verify if real g is within these limits and the new limits imposed by the growth rate for the economy and/or the industry.

We can see this in the next table

Table 3. Intervals for Kd ≤ $WACC_{perp}$ ≤ Ke

Real g	$WACC_{perp}$	Terminal value
5.0%	9.371%	7,009.76
5.1%	9.311%	7,061.05
5.2%	9.242%	7,120.77
5.3%	9.160%	7,191.53
5.4%	9.061%	7,277.12
5.5%	8.939%	7,383.33
5.6%	8.785%	7,519.38
5.7%	8.586%	7,700.97
5.73579%	(Kd) 8.500%	7,781.91
5.9%	7.936%	8,348.29
6.0%	7.348%	9,024.19
6.1%	6.330%	10,486.13
6.2704009037606%	0.000%	8,377,824,387,966,790.00
6.2704009037608%	0.000%	(5,789,751,009,233,040.00)
6.4%	47.797%	1,392.6
6.5%	18.238%	3,653.00
6.6%	14.671%	4,545.54
6.7%	13.282%	5,025.44
6.8%	12.543%	5,326.44
6.9%	12.085%	5,533.79
7.0%	11.772%	5,685.99
7.1%	11.546%	5,802.99
7.2%	11.374%	5,896.15
7.3%	11.239%	5,972.41
7.4%	11.131%	6,036.26
7.5%	11.041%	6,090.73
7.6%	10.967%	6,137.94
7.7%	10.903%	6,179.41
7.79778%	(Ke) 10.849706%	6,215.49
7.9%	10.801147%	6,249.35
8.0%	10.759545%	6,279.33
8.1%	10.722760%	6,306.70
8.2%	10.690001%	6,331.88
8.3%	10.660641%	6,355.19
8.4%	10.634177%	6,376.89
8.5%	10.610201%	6,397.19
8.6%	10.588378%	6,416.29
8.7%	10.568430%	6,434.32

The WACC for perpetuity and the Terminal Value

Although the critical value of real g for $WACC_{perp}$ equal to zero is in the "forbidden" interval, we wish to call the attention of the reader that the issue of the critical values for g is very important because in the vicinity of the critical values (in particular real g= 6.2704009037607%, when $WACC_{perp}$ is zero) a very small change in g might represent millions dollars of difference in the valuation. To have a rough idea of this we present the next table where we show the changes in real g and in TV near the critical value of real g.

Table 4. Behavior of the TV in the vicinity of $WACC_{perp}$ = 0

Real g	$WACC_{perp}$	TV	% change in TV	% change in real g
6.1750%	4.8892%	13,585.37		
6.1800%	4.7532%	13,974.56	2.86%	0.08097%
6.1850%	4.6100%	14,409.29	3.11%	0.08091%
6.1900%	4.4590%	14,898.04	3.39%	0.08084%
6.1950%	4.2995%	15,451.57	3.72%	0.08078%
6.2000%	4.1307%	16,083.69	4.09%	0.08071%
6.2050%	3.9518%	16,812.41	4.53%	0.08065%
6.2100%	3.7620%	17,661.73	5.05%	0.08058%
6.2150%	3.5601%	18,664.30	5.68%	0.08052%
6.2200%	3.3449%	19,865.72	6.44%	0.08045%
6.2250%	3.1152%	21,331.70	7.38%	0.08039%
6.2300%	2.8693%	23,160.47	8.57%	0.08032%
6.2350%	2.6056%	25,505.73	10.13%	0.08026%
6.2400%	2.3220%	28,622.33	12.22%	0.08019%
6.2450%	2.0162%	32,965.78	15.18%	0.08013%
6.2500%	1.6854%	39,438.13	19.63%	0.08006%
6.2550%	1.3264%	50,112.85	27.07%	0.08000%
6.2600%	0.9356%	71,050.54	41.78%	0.07994%
6.2650%	0.5084%	130,754.67	84.03%	0.07987%
6.2700%	0.0396%	1,679,689.50	1,184.61%	0.07981%

We can see that in the vicinity of 6.27% a very low increase in g induces a huge increase in TV.

Concluding Remarks

We have shown the limits in which real g should lie when working with growing perpetuities and ψ equal to Kd. We showed that when using values for real g outside the allowed limits we have calculated, can generate unexpected and uncomfortable values for $WACC_{perp}$ and/or terminal value. These limits allow the analyst to compare with the growth rates for the economy and/or the industry and setting revised limits for the estimation of real g. We have shown as well that when real g is in the vicinity of a critical point very small changes in real g generate enormous changes in the terminal value.

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Appendix

Some restrictions to the value of g the growth rate

It can be shown that the general formulation for the terminal value, TV is

$$TV = \frac{NOPLAT(1+g)\left(1 - \frac{g}{ROIC}\right)}{WACC_{perp} - g} \qquad (A1)$$

Where TV is the terminal value, ROIC is the return on invested capital, NOPLAT is the net operating profit less adjusted taxes, g is the growth rate for the NOPLAT and $WACC_{perp}$ is the constant Weighted Average Cost of Capital for perpetuity.

It can be shown as well, that the proper and general calculation of the WACC when there is a growing perpetuity is as follows:

$$WACC_{perp} = Ku_i - \frac{(Ku_i - g)TD\%Kd}{\psi - g} \qquad (A2)$$

Where ψ is the discount rate for the tax savings TS, Ku is the cost of unlevered equity, g is the nominal growth rate for the FCF (and for the CFD in normal conditions where there is no change in debt to adjust for a given leverage), T is the tax rate, Kd is the cost of debt and D% is the constant leverage at perpetuity.

The restrictions to real g are

1. If $WACC_{perp}$ should be **at least equal to Kd**, then real

$$g \leq \frac{Kd\frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

2. $WACC_{perp}$ should be **at most equal to Ke**, then

$$g \geq \frac{Kd\dfrac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

3. The limit of $WACC_{perp}$ when g increases indefinitely is $Ku - TD\%Kd$.

4. In determining real g it should not lie within the interval

$$\frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f} \leq g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

5. There is a critical value for real g that makes the terminal value indefinite (extremely high or extremely negative). This critical point is real

$$g = \frac{Kd\dfrac{KuTD\% - Ku}{TD\%Kd - Ku} - i_f}{1 + i_f}.$$

6. If ROIC is not the $WACC_{perp}$, then the limits for real g are only

$$g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

7. When ψ is Ku, fortunately the g is not involved in the formulation of WACC for perpetuities ($Ku - TD\%Kd$).

WACC in general should be greater than zero and should lie between Kd and Ke. Hence, if we accept that ***$WACC_{perp}$ should be at least equal to Kd*** we have

$$Ku_i - \frac{(Ku_i - g)TD\%Kd}{\psi - g} \geq Kd \qquad \text{(A5a)}$$

Subtracting Kd in both sides we have

$$Ku_i - Kd \geq \frac{(Ku_i - g)TD\%Kd}{\psi - g} \qquad \text{(A5b)}$$

Multiplying by $\psi - g$

$$\left(Ku_i - Kd\right)\left(\psi - g\right) \geq (Ku_i - g)TD\%Kd$$

$$\psi\left(Ku - Kd\right) \geq g\left(Ku - Kd\right) + TD\%Kd\left(Ku - g\right)$$

$$\psi\left(Ku - Kd\right) \geq g\left(Ku - Kd\right) - gTD\%Kd + TD\%KdKu$$

$$\psi\left(Ku - Kd\right) \geq g\left(Ku - Kd - TD\%Kd\right) + TD\%KdKu$$

$$\psi\left(Ku - Kd\right) - TD\%KdKu \geq g\left(Ku - Kd - TD\%Kd\right)$$

$$\frac{\psi\left(Ku - Kd\right) - TD\%KdKu}{Ku - Kd - TD\%Kd} \geq g$$

if $\psi = Kd$

$$\frac{Kd\left(Ku - Kd\right) - TD\%KdKu}{Ku - Kd - TD\%Kd} \geq g$$

$$\frac{Kd\left(Ku - Kd - TD\%Ku\right)}{Ku - Kd - TD\%Kd} \geq g$$

$$g \leq \frac{\psi\left(Ku - Kd\right) - TD\%KdKu}{Ku - Kd - TD\%Kd}$$

$$g \leq Kd\frac{Ku - Kd - TD\%Ku}{Ku - Kd - TD\%Kd}$$

$$\text{real } g \leq \frac{Kd\frac{Ku - Kd - TD\%Ku}{Ku - Kd - TD\%Kd} - i_f}{1 + i_f}$$

If we accept that $WACC_{perp}$ ***should be at most equal to Ke*** we have

$$Ku_i - \frac{(Ku_i - g)TD\%Kd}{\psi - g} \leq Ke$$

$$Ku_i - Ke - \frac{(Ku_i - g)TD\%Kd}{\psi - g} \leq 0$$

$$Ku\left(\psi - g\right) - Ke\left(\psi - g\right) - (Ku_i - g)TD\%Kd \leq 0$$

$$Ku\psi - gKu - Ke\psi + gKe - KuTD\%Kd + gTD\%Kd \leq 0$$

$$g\left(Ke - Ku + TD\%Kd\right) + Ku\psi\ - Ke\psi - KuTD\%Kd \leq 0$$

$$g\left(Ke - Ku + TD\%Kd\right) \leq -Ku\psi\ + Ke\psi + KuTD\%Kd$$

Multiplying by -1

$$g\left(- Ke + Ku - TD\%Kd\right) \geq Ku\psi\ - Ke\psi - KuTD\%Kd$$

$$g \geq \frac{Ku\psi\ - Ke\psi - KuTD\%Kd}{Ku - Ke - TD\%Kd}$$

For $\psi = Kd$

$$g \geq \frac{KuKd\ - KeKd - KuTD\%Kd}{Ku - Ke - TD\%Kd}$$

$$g \geq Kd\frac{Ku\ - TD\%Ku - Ke}{Ku - TD\%Kd - Ke}$$

$$\text{real}\, g \geq \frac{Kd\dfrac{Ku\ - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

The critical value for real g when TV is undetermined is when $WACC_{perp}$ is equal to zero

$$Ku_i - \frac{(Ku_i - g)TD\%Kd}{\psi - g} = 0 \qquad \text{(A3a)}$$

and

$$Ku_i = \frac{(Ku_i - g)TD\%Kd}{\psi - g} \qquad \text{(A3b)}$$

Multiplying by $\psi - g$, then

$$Ku\left(\psi - g\right) \geq (Ku - g)TD\%Kd \qquad \text{(A3c)}$$

Grouping terms with g

$$gTD\%Kd - gKu = KuTD\%Kd - Ku\psi \qquad \text{(A3d)}$$

solving for g

$$g = \frac{KuTD\%Kd - Ku\psi}{TD\%Kd - Ku} \qquad \text{(A4e)}$$

For ψ equal to Kd,

$$g = \frac{KuTD\%Kd - KuKd}{TD\%Kd - Ku}$$

$$g = Kd\frac{KuTD\% - Ku}{TD\%Kd - Ku}$$

$$\text{real}\, g = \frac{Kd\dfrac{KuTD\% - Ku}{TD\%Kd - Ku} - i_f}{1 + i_f}$$

In summary, in order that Kd ≤WACCperp ≤ Ke we should have

for $WACC_{perp} \geq Kd$

$$\text{real}\, g \leq \frac{Kd\dfrac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

For $WACC_{perp} \leq Ke$

$$\text{real}\, g \geq \frac{Kd\dfrac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

If ROIC is not equal to $WACC_{perp}$ in the formula for TV

$$TV = \frac{NOPLAT(1+g)\left(1 - \dfrac{g}{ROIC}\right)}{WACC_{perp} - g}$$

the TV is zero for g = ROIC. For a g > ROIC the TV will be negative.

The limit for $WACC_{perp}$ when g increases

$$WACC_{perp} = Ku_i - \frac{(Ku_i - g)TD\%Kd}{\psi - g}$$

deriving and using the l'Hospital rule

$$\frac{\partial\left(\frac{(Ku_i - g)TD\%Kd}{\psi - g}\right)}{\partial g} = TD\%Kd$$

Then the limit of $WACC_{perp}$ when ψ = Kd is Ku − TD%Kd. This is the $WACC_{perp}$ when ψ = Ku. In the limit TV is undefined.

Then there is a range where real g is not permitted because $WACC_{perp}$ would outside the limits of Kd and Ke.

Assuming ROIC = $WACC_{perp}$

$$\frac{Kd\frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f} \leq \text{real g} \leq \frac{Kd\frac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$$

Assuming ROIC different from $WACC_{perp}$

$$\text{real g} \leq \frac{Kd\frac{Ku - TD\%Ku - Kd}{Ku - TD\%Kd - Kd} - i_f}{1 + i_f}$$

Except $\text{real g} = \frac{Kd\frac{Ku - TD\%Ku - Ke}{Ku - TD\%Kd - Ke} - i_f}{1 + i_f}$ when $WACC_{perp}$ might be equal to Ke.