VAN DIJK
MANAGEMENT CONSULTANTS

Evaluating Economic Depreciation Methodologies for the Telecom Sector

BUREAU VAN DIJK

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Assessing the yearly capital expenditure (CAPEX) related to fixed assets is a great challenge when implementing of a regulatory costing model in the telecommunications sector. Given the direct and sizeable impact on the resulting tariffs and thereby the bottom line result of the regulated operator, careful consideration is required when selecting a depreciation method and the accounting for the cost of capital.

A well-accepted reference on regulatory cost modelling is the European Commission's Recommendation on Accounting separation and Cost Accounting of 1998, which is currently under review in the ERG Consultation of April 27th, 2004[1]. The general objective is illustrated in the following quote:

> *'As stated several times in the text, the use of current cost evaluation is intended to replicate the approach of a competitor in a market, which, willing to contend shares or profits in that market, has to offer services at a price that allows him to recover current costs.'*

The statement above has identified the need for defining a depreciation method that provides a good proxy for the depreciations that would be reflected in prices set in a competitive environment. This will be handled in chapter 1, Economic Depreciation.

Furthermore the recommendation raises an important issue when deciding on a depreciation method:

> *'There are two different approaches to Current Cost Accounting (CCA). The approaches differ in their definition of 'Capital Maintenance'.'*

The significance of the Capital Maintenance method and its implication on depreciation methods are further analysed and commented on in chapter 2, Capital Maintenance.

Based on their experiences in regulatory cost modelling, BvD Management Consultants have distinguished a number of depreciation methods that can be used for calculating a proxy for economic depreciation, depending on the circumstances and specific services for which regulatory cost models are developed. The depreciation methods that where identified, analysed and evaluated, are:

1) Straight line method;
2) Tilted straight line method;
3) Annuity method;
4) Annuity method with capital gains and losses;
5) Tilted annuity method.

[1] Cf. Annex to the "Draft ERG Opinion on the proposed Review of the Recommendation on cost accounting and accounting separation" – Draft text prepared by the IRG Working Group on Cost Accounting.

1. ECONOMIC DEPRECIATION

This chapter covers the issue of economic depreciation. First the concept of economic depreciation is elaborated on. Thereafter several depreciation methods are analysed.

1.1. *THE CONCEPT OF ECONOMIC DEPRECIATION*

'Economic depreciation' corresponds to the depreciation that an operator would take into account in a fully competitive telecommunications market.

From this description, BvD Management Consulting derived the following characteristics of *'economic depreciation'*:

1) An economic depreciation methodology results in a yearly capital expenditure (CAPEX), i.e. depreciation and cost of capital, that ensures the recuperation of the initial investment and a reasonable remuneration of the capital employed, but without any further profit or loss:

    The Net Present Value (NPV) equals the initial investment, i.e. the NPV of the yearly CAPEX in each year of the asset's lifetime discounted back to the year of investment at a discount rate equal to the WACC.

2) The CAPEX is consistent with the change in the underlying production costs that a new entrant would experience.

The first characteristic results from the assumption that:

- The investment would not have been made, if it would have been expected that the initial investment plus a reasonable remuneration of the capital employed can not be recuperated and by consequence, losses would be made;
- Full competition would ensure that not more than the initial investment (incl. a reasonable return on the capital employed) can be recuperated.

The second characteristic indicates that, if the operator lives in a competitive world, costs need to be aligned with the costs of an efficient new entrant and this during the whole lifetime of the investment. This implies that an operator should stay competitive in the second year even if in that second year, a new player can invest at lower (higher) prices. By consequence, in the first year 'deflationary costs'[2] ('inflationary benefits'[3]) should be included in the total costs of the operator, so that he can remain competitive during the second year as well.

[2] 'Deflationary costs' refer to the extra costs that an operator needs to take into account in year X when lower prices (referred to as 'deflation') for the equipment used are expected for year X+1. After all, the value of the equipment will be less in year X+1 than in year X; this value loss is reflected in an extra cost in year X which brings the remaining cost for the equipment at the same level of the market prices in year X+1.

[3] 'Inflationary benefits' are the opposite of 'deflationary costs'. They refer to the extra benefits that an operator needs to take into account in year X when higher prices (referred to as 'inflation') for the equipment used are expected for year X+1. In the case of inflationary benefits, the value of the equipment will be higher in year X+1 than in year X; this value gain is reflected as an extra benefit in year X that brings the remaining cost for the equipment at the same level of the market prices in year X+1.

1.2. *THE STRAIGHT-LINE METHOD*

The simplest depreciation method is the straight-line method: the investment is evenly written off over the whole lifespan of the asset. As a result the depreciation cost is the same each year.

The cost of capital of the investment is however not yet included in this calculation.

Hence a first possibility is to incorporate the cost of capital based on the Net Book Value (NBV); in practice that comes down to multiplying the NBV by the weighted average cost of capital (WACC). Such a method causes however an enormous blow in the cost of capital when a totally depreciated good is replaced by a new good with full NBV. This shock is difficult to defend economically. First the provision of services remains basically the same, but the price (cost) fluctuates. Secondly the timing difference of competitors causes an imbalance in the production costs of the different market players, which contradicts the second characteristic of economic depreciation.

A second possibility is to avoid this shock by the incorporation of the cost of capital based on the average NBV over the whole lifecycle, which can be justified by the assumption that the age of the assets is uniformly distributed over the lifetime of the asset. Consequently the average, expected NBV corresponds to half of the initial investment.

As the cost of capital in that case is considered constant over the total lifetime and the annual depreciation is also taken a constant, the annual cost is also a constant over the total lifetime, which corresponds to an annuity[4].

Example

Straight line (HCA)								
Year	Discount factor	NBV	Replacement value	Depreciation	Cost of Capital (based on NBV)	CAPEX	Cost of Capital (based on average NBV)	Totaal
0		100,00	100,00					
1	*0,909*	95,00	99,00	5,00	10,00	15,00	5,00	10,00
2	*0,826*	90,00	98,01	5,00	9,50	14,50	5,00	10,00
3	*0,751*	85,00	97,03	5,00	9,00	14,00	5,00	10,00
4	*0,683*	80,00	96,06	5,00	8,50	13,50	5,00	10,00
5	*0,621*	75,00	95,10	5,00	8,00	13,00	5,00	10,00
6	*0,564*	70,00	94,15	5,00	7,50	12,50	5,00	10,00
7	*0,513*	65,00	93,21	5,00	7,00	12,00	5,00	10,00
8	*0,467*	60,00	92,27	5,00	6,50	11,50	5,00	10,00
9	*0,424*	55,00	91,35	5,00	6,00	11,00	5,00	10,00
10	*0,386*	50,00	90,44	5,00	5,50	10,50	5,00	10,00
11	*0,350*	45,00	89,53	5,00	5,00	10,00	5,00	10,00
12	*0,319*	40,00	88,64	5,00	4,50	9,50	5,00	10,00
13	*0,290*	35,00	87,75	5,00	4,00	9,00	5,00	10,00
14	*0,263*	30,00	86,87	5,00	3,50	8,50	5,00	10,00
15	*0,239*	25,00	86,01	5,00	3,00	8,00	5,00	10,00
16	*0,218*	20,00	85,15	5,00	2,50	7,50	5,00	10,00
17	*0,198*	15,00	84,29	5,00	2,00	7,00	5,00	10,00
18	*0,180*	10,00	83,45	5,00	1,50	6,50	5,00	10,00
19	*0,164*	5,00	82,62	5,00	1,00	6,00	5,00	10,00
20	*0,149*	0,00	81,79	5,00	0,50	5,50	5,00	10,00
		0,00		**100,00**		**100,00**		**85,14**
		Residual value		*Accumulated depreciation*		*Net Present Value*		*Net Present Value*

Table 1: Straight-line method (HCA)

[4] The annuity method is very much used in the financial world with which a constant amount is paid at regular intervals during a certain time period to reimburse a borrowed amount.

BvD Management Consulting uses the same example throughout the document, namely an initial investment of 100 with an expected lifetime of 20 years and without residual value. In addition the weighted average cost of capital (WACC) corresponds to 10% of the capital employed. Moreover an annual price trend of -1% does apply.

Table 1 illustrates the example of the straight-line method with both possibilities for the cost of capital. The NBV is annually reduced by the depreciation amount, which spreads the total investment in equal amounts over the whole life duration. Then the cost of capital is calculated and added to the depreciation. In a first case the cost of capital is calculated with the actual NBV, in a second case with the average NBV. The latter results clearly in a constant annual cost.

The Net Present Value (NPV) is subsequently calculated using the discounted annual cost. The Discount factors are given in the second column of the table. The NPV calculated with the method using the cost of capital assimilated to the NBV corresponds to the initial investment cost. In other words this investment costs are fairly compensated with an average profit, in contrast to above average or below average profits. The NPV calculated with the method using the cost of capital assimilated to the average NBV gives however a lower amount than the initial investment, in other words the investment cost is insufficiently compensated. A method whereby a constant annual cost results in an NPV equal to the initial investment will be discussed in section 1.3 The Standard annuity.

Note that both possibilities of the Straight-line method do not satisfy the second characteristic of economic depreciation: consistency with the changes in the underlying production costs that a new entrant would experience. Let us take the example of a new entrant making an investment in year 2. Since the price trend amounts to -1% he will have to invest only 99 instead of 100. As a consequence the yearly depreciation amounts to 4,95 (= 99/20). Since this is lower than what is paid by the incumbent (= 100/20 = 5), the new entrant has a competitive advantage. Adjusting the Straight-line method needs the adoption of Current Cost Accounting (CCA) instead of the Historical Cost Accounting (HCA) implicit used in the example above, a further adjustment will result in the Tilted Straight-line method (see section 1.4 The Tilted straight-line method).

HCA versus CCA

The example above implicitly used HCA, however CCA is the Recommendation of the ERG. BvD now reworks the example above to use CCA.

Example

Table 2 illustrates the example when applying Current Cost Accounting for the two possible implementations. The NBV is annually reduced by the depreciation amount, which spreads the replacement value over the asset lifetime. Then the cost of capital is calculated and added to the depreciation.

Current Cost Accounting results for both possible implementations of Straight-Line depreciation in Accumulated Depreciations lower than the initial investment and a Net Present Value lower than the initial investment. As such the initial investment is not fairly remunerated and thus the first characteristic of 'Economic Depreciation' is not satisfied. BvD will comment on an adjusted Straight-line method in section 1.4 The Tilted straight-line method.

Straight line (CCA)								
Year	Discount factor	NBV	Replacement value	Depreciation	Cost of Capital (based on NBV)	CAPEX	Cost of Capital (based on average NBV)	Totaal
0		100,00	100,00					
1	0,909	95,05	99,00	4,95	10,00	14,95	4,95	9,90
2	0,826	90,15	98,01	4,90	9,51	14,41	4,90	9,80
3	0,751	85,30	97,03	4,85	9,01	13,87	4,85	9,70
4	0,683	80,50	96,06	4,80	8,53	13,33	4,80	9,61
5	0,621	75,74	95,10	4,75	8,05	12,80	4,75	9,51
6	0,564	71,03	94,15	4,71	7,57	12,28	4,71	9,41
7	0,513	66,37	93,21	4,66	7,10	11,76	4,66	9,32
8	0,467	61,76	92,27	4,61	6,64	11,25	4,61	9,23
9	0,424	57,19	91,35	4,57	6,18	10,74	4,57	9,14
10	0,386	52,67	90,44	4,52	5,72	10,24	4,52	9,04
11	0,350	48,19	89,53	4,48	5,27	9,74	4,48	8,95
12	0,319	43,76	88,64	4,43	4,82	9,25	4,43	8,86
13	0,290	39,37	87,75	4,39	4,38	8,76	4,39	8,78
14	0,263	35,03	86,87	4,34	3,94	8,28	4,34	8,69
15	0,239	30,73	86,01	4,30	3,50	7,80	4,30	8,60
16	0,218	26,47	85,15	4,26	3,07	7,33	4,26	8,51
17	0,198	22,26	84,29	4,21	2,65	6,86	4,21	8,43
18	0,180	18,08	83,45	4,17	2,23	6,40	4,17	8,35
19	0,164	13,95	82,62	4,13	1,81	5,94	4,13	8,26
20	0,149	9,86	81,79	4,09	1,40	5,48	4,09	8,18
		9,86		**90,14**		**98,53**		**79,06**
		Residual value		*Accumulated depreciation*		*Net Present Value*		*Net Present Value*

Table 2: Straight-line method (CCA)

Example

Table 3 shows an alternative implementation of the CCA Straight-line method: the Price Trend is now also taken into account when calculating the NBV. The NBV of the previous year is first adapted to follow the price trend, i.e. multiplied by (1+Price Trend). Afterwards the depreciation is deducted to obtain the NBV of the current year. The only difference with the previous method is the NBV and the Cost of Capital on NBV.

Straight line (CCA)								
Year	Discount factor	NBV	Replacement value	Depreciation	Cost of Capital (based on NBV)	CAPEX	Cost of Capital (based on average NBV)	Totaal
0		100,00	100,00					
1	0,909	94,05	99,00	4,95	10,00	14,95	4,95	9,90
2	0,826	88,21	98,01	4,90	9,41	14,31	4,90	9,80
3	0,751	82,48	97,03	4,85	8,82	13,67	4,85	9,70
4	0,683	76,85	96,06	4,80	8,25	13,05	4,80	9,61
5	0,621	71,32	95,10	4,75	7,68	12,44	4,75	9,51
6	0,564	65,90	94,15	4,71	7,13	11,84	4,71	9,41
7	0,513	60,58	93,21	4,66	6,59	11,25	4,66	9,32
8	0,467	55,36	92,27	4,61	6,06	10,67	4,61	9,23
9	0,424	50,24	91,35	4,57	5,54	10,10	4,57	9,14
10	0,386	45,22	90,44	4,52	5,02	9,55	4,52	9,04
11	0,350	40,29	89,53	4,48	4,52	9,00	4,48	8,95
12	0,319	35,46	88,64	4,43	4,03	8,46	4,43	8,86
13	0,290	30,71	87,75	4,39	3,55	7,93	4,39	8,78
14	0,263	26,06	86,87	4,34	3,07	7,42	4,34	8,69
15	0,239	21,50	86,01	4,30	2,61	6,91	4,30	8,60
16	0,218	17,03	85,15	4,26	2,15	6,41	4,26	8,51
17	0,198	12,64	84,29	4,21	1,70	5,92	4,21	8,43
18	0,180	8,35	83,45	4,17	1,26	5,44	4,17	8,35
19	0,164	4,13	82,62	4,13	0,83	4,97	4,13	8,26
20	0,149	0,00	81,79	4,09	0,41	4,50	4,09	8,18
		0,00		**90,14**		**94,50**		**79,06**
		Residual value		*Accumulated depreciation*		*Net Present Value*		*Net Present Value*

Table 3: Straight-line method (CCA), with revaluation of NBV

1.3. *THE STANDARD ANNUITY*

The Straight Line method with a Cost of Capital on the Average NBV is probably the most straightforward method of depreciation. However the recuperation of the initial value is not guaranteed. A similar method, but with a fair remuneration, is the standard annuity: it has also a constant annual cost and an NPV equal to the initial investment.

Example

Standard annuity (HCA)						
Year	Discount factor	Replacement Value	NBV	CAPEX	Cost of Capital	Depreciation
0		100,00	100,00			
1	*0,909*	99,00	98,25	11,75	10,00	1,75
2	*0,826*	98,01	96,33	11,75	9,83	1,92
3	*0,751*	97,03	94,22	11,75	9,63	2,11
4	*0,683*	96,06	91,90	11,75	9,42	2,32
5	*0,621*	95,10	89,34	11,75	9,19	2,56
6	*0,564*	94,15	86,53	11,75	8,93	2,81
7	*0,513*	93,21	83,44	11,75	8,65	3,09
8	*0,467*	92,27	80,03	11,75	8,34	3,40
9	*0,424*	91,35	76,29	11,75	8,00	3,74
10	*0,386*	90,44	72,17	11,75	7,63	4,12
11	*0,350*	89,53	67,65	11,75	7,22	4,53
12	*0,319*	88,64	62,66	11,75	6,76	4,98
13	*0,290*	87,75	57,18	11,75	6,27	5,48
14	*0,263*	86,87	51,16	11,75	5,72	6,03
15	*0,239*	86,01	44,53	11,75	5,12	6,63
16	*0,218*	85,15	37,23	11,75	4,45	7,29
17	*0,198*	84,29	29,21	11,75	3,72	8,02
18	*0,180*	83,45	20,39	11,75	2,92	8,82
19	*0,164*	82,62	10,68	11,75	2,04	9,71
20	*0,149*	81,79	0,00	11,75	1,07	10,68
			0,00	**100,00**		**100,00**
			Residual Value	*Net Present Value*		*Accumulated depreciation*

Table 4: Standard Annuity (HCA)

The annuity method calculates the CAPEX (5th column of Table 4) as follows:

$$\text{CAPEX} = \text{Investment} \times \frac{\text{WACC}}{1 - \left(\frac{1}{1+\text{WACC}}\right)^{N}}$$

with N the total lifetime of the Asset

The depreciated amount (last column) follows by reducing the annual cost (5th column) by the cost of capital (6th column), which is based on the NBV (third column) at the end of the previous year. Reducing the NBV by the depreciated amount determines the NBV at the end of the current year. Through this calculation it appears not only that the NPV is equal to the initial investment, but also that the total amount is written off at the end of the lifetime.

Remark that in year 2 an investment of only 99 instead of 100 is needed. As a consequence an operator investing in year 2 will face a lower annual cost, which is in contradiction to the second characteristic of the economic depreciation: consistency with the changes in the underlying production costs that a new entrant would experience. Adjusting the Standard Annuity method needs the adoption of Current Cost Accounting (CCA) instead of the Historical Cost Accounting (HCA) implicit used in the example above, a further adjustment will result in the Standard Annuity method with capital gain/loss (see section 1.5) and in the Tilted Annuity method (see section 1.6).

HCA versus CCA

The example above implicitly used HCA, however CCA is the Recommendation of the ERG. Therefore BvD now reworks the above example to use CCA.

Example

Standard annuity (CCA)						
Year	Discount factor	Replacement Value	NBV	CAPEX	Cost of Capital	Depreciation
0		100,00	100,00			
1	*0,909*	99,00	97,27	11,63	10,00	1,73
2	*0,826*	98,01	94,42	11,51	9,73	1,88
3	*0,751*	97,03	91,42	11,40	9,44	2,05
4	*0,683*	96,06	88,28	11,28	9,14	2,23
5	*0,621*	95,10	84,96	11,17	8,83	2,43
6	*0,564*	94,15	81,47	11,06	8,50	2,65
7	*0,513*	93,21	77,77	10,95	8,15	2,88
8	*0,467*	92,27	73,85	10,84	7,78	3,14
9	*0,424*	91,35	69,69	10,73	7,39	3,42
10	*0,386*	90,44	65,27	10,62	6,97	3,72
11	*0,350*	89,53	60,57	10,52	6,53	4,05
12	*0,319*	88,64	55,54	10,41	6,06	4,42
13	*0,290*	87,75	50,18	10,31	5,55	4,81
14	*0,263*	86,87	44,44	10,20	5,02	5,24
15	*0,239*	86,01	38,30	10,10	4,44	5,70
16	*0,218*	85,15	31,70	10,00	3,83	6,21
17	*0,198*	84,29	24,62	9,90	3,17	6,76
18	*0,180*	83,45	17,01	9,80	2,46	7,36
19	*0,164*	82,62	8,82	9,70	1,70	8,02
20	*0,149*	81,79	0,00	9,61	0,88	8,73
			0,00	**92,86**		**87,44**
			Residual Value	*Net Present Value*		*Accumulated depreciation*

Table 5: Standard Annuity (CCA)

Table 5 shows the behaviour of the example when applying Current Cost Accounting on the Standard Annuity method. Each year the CAPEX is determined starting from the replacement value instead of the initial investment. The calculation of the NBV is now adjusted to reflect better the residual economic value of the asset: $NBV_x = NBV_{x-1}$ *x (1+Price change) – depreciation.*[5]

The Current Cost Accounting in Table 5 results in an Accumulated Depreciation lower than the initial investment and a Net Present Value lower than the initial investment. As such the initial investment is not fairly remunerated and thus the first characteristic of 'Economic Depreciation' is not satisfied. BvD will comment on an adjusted Standard Annuity method in section 1.5 The Standard annuity with inflationary benefits/ deflationary losses and section 1.6 The Tilted annuity method.

1.4. *THE TILTED STRAIGHT-LINE METHOD*

None of previous methods satisfies both characteristics of Economic Depreciation. Therefore the pursuit of BvD continues and leads to the Tilted straight-line method (section 1.4), Standard annuity method with inflationary benefits/ deflationary losses (section 1.5) and Tilted Annuity Method (section 1.6).

The Tilted Straight Line method is based on the Straight Line method, but adds an extra term/tilt: a correction of the CAPEX due to costs/benefits caused by price changes of the underlying asset. As such they will be called costs of deflation (benefits of inflation) in the remainder of the text. The Tilted Straight Line corrects the Straight Line depreciation so that it complies with the second characteristic of 'Economic Depreciation', implemented in such a way that a new entrant will suffer similar annual costs if assets are depreciated Straight-line from that moment on. Note that the latter is a key assumption.

[5]This document uses Managerial Accounting, i.e. Cost Accounting, as opposed to Financial Accounting. Therefore the Net Book Value should not be seen as a financial account, but rather as the expected remaining economic value.

The loss (gain) due to the revaluation of the assets results in a cost (revenue) equal to *NBV x (-Price evolution)*. If this cost can be recuperated during the year on top of the usual depreciation cost, then the operator can also be competitive the following year in front of a new entrant. The Straight-line depreciation cost is calculated on the base of the replacement value of the asset after deflation (inflation), i.e. the replacement value at the end of the year.

The formula for the determination of the depreciation according to Tilted straight line method thus becomes:

$$\text{Tilted straight line} = \text{Book Value} \times (-\text{Price evolution}) + \frac{\text{Replacement value}}{\text{N}}$$

with N the lifetime of the asset

Note that this method only determines the depreciation cost. As a consequence the cost of capital still needs to be added, which can be seen as an issue separate from the Tilted Straight-line method. The issue was already highlighted in section 1.2 and the proposed methods can be summarised as:

- The first possibility was to incorporate the cost of capital based on the NBV. Such a method causes however an enormous blow in the cost of capital when a totally depreciated good is replaced by a new good with full NBV. This shock is difficult to defend economically.
- The second possibility did avoid this shock by the incorporation of the cost of capital based on the average NBV over the whole lifecycle. Though the disadvantage is that the NPV falls below the initial investment cost.

Example

Tilted straight line										
Year	Discount factor	NBV	Replacement value	Inflationary benefit/ Deflationary loss	Depreciation (CCA)	Total Depreciation	Loss of Cost of Capital due to Price change	Cost of Capital based on NBV	Cost of Capital based on NBV adjusted for price change loss	CAPEX
0		100	100,00							
1	*0,909*	94,05	99,00	-1,00	4,95	5,95	-0,10	9,90	10,00	15,95
2	*0,826*	88,21	98,01	-0,94	4,90	5,84	-0,09	9,31	9,41	15,25
3	*0,751*	82,48	97,03	-0,88	4,85	5,73	-0,09	8,73	8,82	14,55
4	*0,683*	76,85	96,06	-0,82	4,80	5,63	-0,08	8,17	8,25	13,88
5	*0,621*	71,32	95,10	-0,77	4,75	5,52	-0,08	7,61	7,68	13,21
6	*0,564*	65,90	94,15	-0,71	4,71	5,42	-0,07	7,06	7,13	12,55
7	*0,513*	60,58	93,21	-0,66	4,66	5,32	-0,07	6,52	6,59	11,91
8	*0,467*	55,36	92,27	-0,61	4,61	5,22	-0,06	6,00	6,06	11,28
9	*0,424*	50,24	91,35	-0,55	4,57	5,12	-0,06	5,48	5,54	10,66
10	*0,386*	45,22	90,44	-0,50	4,52	5,02	-0,05	4,97	5,02	10,05
11	*0,350*	40,29	89,53	-0,45	4,48	4,93	-0,05	4,48	4,52	9,45
12	*0,319*	35,46	88,64	-0,40	4,43	4,83	-0,04	3,99	4,03	8,86
13	*0,290*	30,71	87,75	-0,35	4,39	4,74	-0,04	3,51	3,55	8,29
14	*0,263*	26,06	86,87	-0,31	4,34	4,65	-0,03	3,04	3,07	7,72
15	*0,239*	21,50	86,01	-0,26	4,30	4,56	-0,03	2,58	2,61	7,17
16	*0,218*	17,03	85,15	-0,22	4,26	4,47	-0,02	2,13	2,15	6,62
17	*0,198*	12,64	84,29	-0,17	4,21	4,39	-0,02	1,69	1,70	6,09
18	*0,180*	8,35	83,45	-0,13	4,17	4,30	-0,01	1,25	1,26	5,56
19	*0,164*	4,13	82,62	-0,08	4,13	4,21	-0,01	0,83	0,83	5,05
20	*0,149*	0,00	81,79	-0,04	4,09	4,13	0,00	0,41	0,41	4,54
		0,00				**100,00**				**100,00**
		Residual value				*Accumulated Depreciation*				*Net Present Value*

Table 6: Tilted Straight-line method

Table 6 reflects the required calculations. Following CCA, the Straight-line depreciation is based on the replacement value of the year considered. Total depreciation is the sum of the Straight-line depreciation and a compensation for the inflationary benefit/ deflationary loss, which comes down to the price change on the NBV of the previous year: *NBV of year n-1 x Price change*. Then the NBV of the current year can be determined as $NBV_n = NBV_{n-1}$ - *inflationary benefit/ deflationary loss - depreciation*. Finally adding the cost of capital should not be forgotten. Only the cost of capital based on the actual NBV is illustrated in the table. Note that the method depreciates the whole investment and results in a NPV equal to the cost of the initial investment.

Moreover a new entrant will still experience another annual cost, when in the year considered the price trend is different from 0%. In the example with a constant price trend of –1% a new entrant will write off 5,89 in the second year (= 4,90 + 1% x 99,00), opposed to the 5,84 of the incumbent (= 4,90 + 1% x 94,05). A new entrant will write off 4,92 in the twentieth year (= 4,09 + 1% x 82,62), opposed to the 4,13 of the incumbent (= 4,09 + 1% x 4,13). The second characteristic of Economic Depreciation is thus only satisfied under specific circumstances.

The difference in depreciation between the incumbent and the new entrant is due to the difference in NBV, which brings us to another problem. Using the tilted straight-line method requires the NBV, not the NBV from the financial accounts[6], but the NBV obtained when the tilted straight-line method is consistently applied since the day of the acquisition of the asset. Note that this NBV could also be determined as the replacement value multiplied by the ratio of the time in use to the total lifetime of the asset, or as the remaining asset life times the yearly Straight-line depreciation. As a consequence the age of the asset is sufficient to determine the NBV.

BvD concludes that applying the Tilted Straight Line method raises a number of questions, namely how to determine the cost of capital, how to estimate the NBV and is it reasonable to assume that the price trend for the coming years will be 0%?

1.5. *THE STANDARD ANNUITY WITH INFLATIONARY BENEFITS/ DEFLATIONARY LOSSES*

The Standard Annuity method with Inflationary Benefits/ Deflationary losses is based on the Standard Annuity method as the name says, and adds an extra term so that it complies with the second characteristic of Economic Depreciation: a correction of the CAPEX due to the costs of deflation (benefits of inflation). The Tilted Straight Line corrects the Straight Line depreciation in such a way that a new entrant will suffer similar annual costs if assets are depreciated following the Standard Annuity method from that moment on. Note that the latter is a key assumption.

Example

The CAPEX (column 8) in Table 7 is the sum of three parts:

CAPEX calculated on the basis of the replacement value (Column 5)
The formula employed is:

$$\text{CAPEX}_{\text{on replacement value}} = \text{Replacement value} \times \frac{\text{WACC}}{1 - \left(1/1+\text{WACC}\right)^{N}}$$

with N the total lifetime of the Asset

Delta Cost of Capital (Column 6)

[6] This document uses Managerial Accounting, i.e. Cost Accounting, as opposed to Financial Accounting. Therefore the Net Book Value should not be seen as a financial account, but rather as the expected remaining economic value.

The Cost of Capital is implicitly included in the annuity and therefore based on the replacement value of the year considered (column 3). The capital required should however be based on the capital needs at the beginning of the year/ the end of the previous year. The first year for example requires capital equal to 100, and not 99. Therefore the annuity is increased with a delta Cost of Capital, equal to delta value of the asset x WACC. The NBV (column 4) represents the value of the asset and thus the delta value of the asset is *NBV x (-Price evolution)*. Thus finally the delta Cost of Capital is determined as *NBV x (-Price evolution) x WACC.*

<u>Inflationary benefits/deflationary losses </u>(Column 7)
Furthermore is the CAPEX augmented with a compensation for the inflationary benefits/ deflationary losses, equal to *NBV x (-Price evolution).*

Standard annuity with Inflationary benefits/ Deflationary losses									
Year	Discount factor	Replacement Value	NBV	CAPEX on replacement value	Delta Cost of Capital	Inflationary benefits/ Deflationary losses	Total CAPEX	Cost of capital	Depreciation
0		100,00	100,00						
1	*0,909*	99,00	97,27	11,63	0,10	1,00	12,73	10,00	2,73
2	*0,826*	98,01	94,42	11,51	0,10	0,97	12,58	9,73	2,86
3	*0,751*	97,03	91,42	11,40	0,09	0,94	12,44	9,44	2,99
4	*0,683*	96,06	88,28	11,28	0,09	0,91	12,29	9,14	3,15
5	*0,621*	95,10	84,96	11,17	0,09	0,88	12,14	8,83	3,31
6	*0,564*	94,15	81,47	11,06	0,08	0,85	11,99	8,50	3,50
7	*0,513*	93,21	77,77	10,95	0,08	0,81	11,84	8,15	3,70
8	*0,467*	92,27	73,85	10,84	0,08	0,78	11,69	7,78	3,92
9	*0,424*	91,35	69,69	10,73	0,07	0,74	11,54	7,39	4,16
10	*0,386*	90,44	65,27	10,62	0,07	0,70	11,39	6,97	4,42
11	*0,350*	89,53	60,57	10,52	0,07	0,65	11,23	6,53	4,71
12	*0,319*	88,64	55,54	10,41	0,06	0,61	11,08	6,06	5,02
13	*0,290*	87,75	50,18	10,31	0,06	0,56	10,92	5,55	5,36
14	*0,263*	86,87	44,44	10,20	0,05	0,50	10,76	5,02	5,74
15	*0,239*	86,01	38,30	10,10	0,04	0,44	10,59	4,44	6,15
16	*0,218*	85,15	31,70	10,00	0,04	0,38	10,42	3,83	6,59
17	*0,198*	84,29	24,62	9,90	0,03	0,32	10,25	3,17	7,08
18	*0,180*	83,45	17,01	9,80	0,02	0,25	10,07	2,46	7,61
19	*0,164*	82,62	8,82	9,70	0,02	0,17	9,89	1,70	8,19
20	*0,149*	81,79	0,00	9,61	0,01	0,09	9,70	0,88	8,82
			0,00				**100,00**		**100,00**
			Residual Value				*Net Present Value*		*Accumulated depreciation*

Table 7: Standard Annuity with Inflationary benefits/ Deflationary losses

The Standard Annuity Method with Inflationary benefits/ Deflationary losses results in an accumulated depreciation and a NPV equal to the cost of the initial investment. As such the method is in line with the first characteristic of Economic depreciation: the recuperation of the investment cost and the reasonable remuneration of the capital employed is guaranteed, without any additional profits (losses) on top of the average rate of return.

The second characteristic of Economic Depreciation however is not always guaranteed, since a new entrant will experience a different cost, when in the year considered the price trend is different from 0%. In the example with a constant price trend of –1% a new entrant will have a CAPEX of 12,60 in the second year (= 11,51 + 99 x 10% x 1% + 99 x 1%), opposed to the 12,58 of the incumbent (= 11,51 + 97,27 x 10% x 1% + 97,27 x 1%). A new entrant will write off 10,51 in the twentieth year (= 9,61 + 82,26 x 10% x 1% + 82,26 x 1%), opposed to the 9,70 of the incumbent (= 9,61 + 8,82 x 10% x 1% + 8,82 x 1%). The second characteristic of Economic Depreciation is thus only satisfied under specific circumstances.

The difference in depreciation between the incumbent and the new entrant is due to the difference in NBV, which brings us to another problem. Using the Standard Annuity method with Inflationary benefits/ Deflationary losses requires the NBV, not the NBV from the financial accounts[7], but the NBV obtained when the Standard Annuity method with Inflationary benefits/ Deflationary is consistently applied since the day of the acquisition of the asset.

Note that this NBV could also be determined as the NPV of the CAPEX of the remaining years of the asset, with all the CAPEX equal to the Standard Annuity on the replacement value of the current year. As a consequence the age of the asset is sufficient to determine the NBV.

Example

In year 10, the replacement cost is 90,44. The CAPEX on the replacement value is then calculated to be 10,62. The assumption of the Standard Annuity method with Inflationary benefits/ Deflationary losses is that the asset's life extends to year 20 and the replacement value remains the same. Therefore 10 years with a CAPEX equal to 10,62 remain. The NPV can then be calculated to be 65,27, which indeed equals the NBV of year 10.

	Replacement Value	CAPEX
Year 11	90,44	10,62
Year 12	90,44	10,62
Year 13	90,44	10,62
Year 14	90,44	10,62
Year 15	90,44	10,62
Year 16	90,44	10,62
Year 17	90,44	10,62
Year 18	90,44	10,62
Year 19	90,44	10,62
Year 20	90,44	10,62
NPV		**65,27**

Note that another method could be constructed based on the Standard Annuity method with inflationary benefits/ deflationary losses, namely by using an estimate for the NBV instead of the actual NBV. A good estimate of the NBV[8] could be half of the replacement value.

Example

The calculations in Table 8 are much the same as in Table 7 except for the two items based on the NBV. The changed formulas are given below:

- Delta Cost of Capital (Column 6): *Estimate of NBV x (-Price evolution) x WACC*
- Inflationary benefits/deflationary losses (Column 7):
  Estimate NBV x (-Price evolution).

The advantages of the adjusted method are that:

- the NBV is not anymore required;
- the CAPEX evolve at the same rate as the price change. In the example above it means decreasing at -1%.
- the CAPEX does not jump at replacement of an old asset by a new one.

[7] This document uses Managerial Accounting, i.e. Cost Accounting, as opposed to Financial Accounting. Therefore the Net Book Value should not be seen as a financial account, but rather as the expected remaining economic value.

[8] Note that determining the best estimate of the NBV allows a great flexibility in the design of a depreciation method. Elaboration on the matter is unfortunately not suited for the current document.

Year	Discount factor	Replacement Value	NBV	CAPEX on replacement value	Delta Cost of Capital	Inflationary benefits/ Deflationary losses	Total CAPEX	Cost of capital	Depreciation
Standard annuity with Inflationary benefits/ Deflationary losses									
0		100,00	100,00						
1	0,909	99,00	97,83	11,63	0,05	0,50	12,17	10,00	2,17
2	0,826	98,01	95,56	11,51	0,05	0,49	12,05	9,78	2,27
3	0,751	97,03	93,18	11,40	0,05	0,49	11,93	9,56	2,37
4	0,683	96,06	90,69	11,28	0,05	0,48	11,81	9,32	2,49
5	0,621	95,10	88,07	11,17	0,05	0,48	11,69	9,07	2,62
6	0,564	94,15	85,30	11,06	0,05	0,47	11,58	8,81	2,77
7	0,513	93,21	82,37	10,95	0,05	0,47	11,46	8,53	2,93
8	0,467	92,27	79,26	10,84	0,05	0,46	11,35	8,24	3,11
9	0,424	91,35	75,95	10,73	0,05	0,46	11,23	7,93	3,31
10	0,386	90,44	72,42	10,62	0,05	0,45	11,12	7,59	3,53
11	0,350	89,53	68,66	10,52	0,04	0,45	11,01	7,24	3,77
12	0,319	88,64	64,62	10,41	0,04	0,44	10,90	6,87	4,03
13	0,290	87,75	60,30	10,31	0,04	0,44	10,79	6,46	4,33
14	0,263	86,87	55,64	10,20	0,04	0,43	10,68	6,03	4,65
15	0,239	86,01	50,63	10,10	0,04	0,43	10,58	5,56	5,01
16	0,218	85,15	45,23	10,00	0,04	0,43	10,47	5,06	5,41
17	0,198	84,29	39,38	9,90	0,04	0,42	10,36	4,52	5,84
18	0,180	83,45	33,06	9,80	0,04	0,42	10,26	3,94	6,32
19	0,164	82,62	26,21	9,70	0,04	0,41	10,16	3,31	6,85
20	0,149	81,79	18,77	9,61	0,04	0,41	10,06	2,62	7,44
			18,77				97,21		81,23
			Residual Value				*Net Present Value*		*Accumulated depreciation*

Table 8: Standard Annuity with Inflationary benefits/ Deflationary losses based on average NBV

Section '1.6 The Tilted annuity method' presents a method that incorporates the advantages above, but in addition has a NPV equal to the initial investment (First characteristic of 'Economic Depreciation'.[9]

1.6. *THE TILTED ANNUITY METHOD*

The TAM-method is independent of the NBV/age of the underlying asset, does take into account the cost of capital and above all corresponds better to the second characteristic of Economic depreciation: consistency with the changes in the underlying production costs that a new entrant would experience.

As stated in section 1.1, an 'economic depreciation' method is characterised by:

1. A Net Present Value equal to the initial investment (Characteristic 1);
2. An evolution that is consistent with the underlying inflation or deflation[10] of the asset purchase price (Characteristic 2).

Translation in mathematical language

Those characteristics form the base from which the TAM method is devised. Translated in mathematical language it becomes:

1. $GRC = NPV = \sum_{i=1}^{N} \frac{ACC_i}{(1+WACC)^i}$
2. $ACC_i = ACC \times (1+P)^i$ *(for i = 1 to L)*

With

GRC: *Gross Replacement Cost of the investment*
L: *Lifetime of the asset*
ACC_i: *Annual Capital Cost in year i (for i = 1 to L)*
ACC: *Constant*
P: *Price trend*

---

[9] As a consequence the 'Standard Annuity with Inflationary benefits/ Deflationary losses based on the average NBV' will not be tackled any further (neither in the conclusion).

[10] The concepts 'inflation' and 'deflation' refer to the technology specific price changes of the equipment that is depreciated.

Notice that the second point assumes that the same price change is maintained throughout the lifetime of the investment; hence the constant price change will be called the price trend.

After using some math on above formulas, it is obtained that for each i (i = 1 to L):

$$ACC_i = GRC_{i-1} \times (1 + WACC) \times \frac{1 - \frac{1+P}{1+WACC}}{1 - \left(\frac{1+P}{1+WACC}\right)^L}$$

Notice that the Standard annuity is a special case of the TAM method, namely TAM with a price trend equal to 0.

Example

TAM							
Year	Discount factor	Replacement Value	NBV	CAPEX	Change CAPEX	Cost of Capital	Depreciation
0		100,00	100				
1	*0,909*	99,00	97,48	12,52		10,00	2,52
2	*0,826*	98,01	94,83	12,40	-1,00%	9,75	2,65
3	*0,751*	97,03	92,04	12,27	-1,00%	9,48	2,79
4	*0,683*	96,06	89,09	12,15	-1,00%	9,20	2,95
5	*0,621*	95,10	85,97	12,03	-1,00%	8,91	3,12
6	*0,564*	94,15	82,66	11,91	-1,00%	8,60	3,31
7	*0,513*	93,21	79,14	11,79	-1,00%	8,27	3,52
8	*0,467*	92,27	75,38	11,67	-1,00%	7,91	3,76
9	*0,424*	91,35	71,36	11,56	-1,00%	7,54	4,02
10	*0,386*	90,44	67,06	11,44	-1,00%	7,14	4,30
11	*0,350*	89,53	62,44	11,33	-1,00%	6,71	4,62
12	*0,319*	88,64	57,47	11,21	-1,00%	6,24	4,97
13	*0,290*	87,75	52,12	11,10	-1,00%	5,75	5,35
14	*0,263*	86,87	46,34	10,99	-1,00%	5,21	5,78
15	*0,239*	86,01	40,09	10,88	-1,00%	4,63	6,24
16	*0,218*	85,15	33,33	10,77	-1,00%	4,01	6,76
17	*0,198*	84,29	26,01	10,66	-1,00%	3,33	7,33
18	*0,180*	83,45	18,05	10,56	-1,00%	2,60	7,96
19	*0,164*	82,62	9,41	10,45	-1,00%	1,81	8,65
20	*0,149*	81,79	0,00	10,35	-1,00%	0,94	9,41
			0,00	**100,00**			**100,00**
			Residual Value	*Net Present Value*			*Accumulated depreciation*

Table 9: TAM depreciation method

The CAPEX comes directly from the formula. The cost of capital can be deduced from the NBV at the end of the previous year. The depreciation is the CAPEX minus the cost of capital. The depreciation subsequently determines the NBV at the end of the current year. Note that TAM completely depreciates the initial investment and results in a NPV equal to the investment cost.

Furthermore it is clear in the example that the CAPEX evolves the same way as the purchasing price does, i.e. each year a decrease of 1% (= price trend). Moreover the ratio between the total yearly cost and the replacement value remains constant. Thus a new entrant will have a yearly cost identical to one of an operator that invested earlier.

Note that each year the total yearly cost was determined on the basis of the price trend, the WACC, the expected total economic lifetime of the investment and the replacement value of the investment in that year. These are all parameters independent of the age of the underlying asset. If each year the calculations are made as if one was in the first year, then the results would still be the same as shown in Table 9.

Price trend leverage effect

An important characteristic of the TAM-method is the leverage effect of the price trend:

$$ACC_1 = \frac{ACC_L}{(1+P)^{L-1}} \approx ACC_L - L \times P \times ACC_{L/2}.$$

The consequence of the leverage effect is that relative small variations in the price trend P lead to big changes in the CAPEX. The used leverage corresponds to the lifetime L: the longer L, the bigger the leverage of the price trend.

Due to the leverage effect, the determination of the price trend P is vital. Changing the price trend in Table 9 to +1% would lead to a CAPEX equal to 10,99, which is 12,2% lower then the 12,52 in Table 9. Note however that the Tilted Straight-line method[11] amplifies the price change in a similar way.

Small fluctuations in the price trend from one year to another result in big fluctuations in the final tariffs (See Table 10). Thus the TAM method is only valid for a price trend that is constant during the entire life of the investment. Consequently it is not always recommended to use the price change of the previous year as best estimation for the price evolution in the years to come.

In Table 10 the yearly cost is calculated on the basis of a price trend fluctuating lightly between –1% and 1% (See column 3). The leverage effect amplifies them to fluctuations up to 15% (See column 7).

TAM								
Year	Discount factor	Price trend	Replacement Value	NBV	CAPEX	Change CAPEX	Cost of Capital	Depreciation
0			100,00	100				
1	*0,909*	-1,00%	99,00	97,48	12,52		10,00	2,52
2	*0,826*	1,00%	99,99	96,34	10,88	-13,08%	9,75	1,14
3	*0,751*	-1,00%	98,99	93,45	12,52	15,04%	9,63	2,89
4	*0,683*	1,00%	99,98	91,92	10,88	-13,08%	9,35	1,54
5	*0,621*	-1,00%	98,98	88,59	12,52	15,04%	9,19	3,33
6	*0,564*	1,00%	99,97	86,57	10,88	-13,08%	8,86	2,02
7	*0,513*	-3,00%	96,97	81,08	14,14	29,93%	8,66	5,48
8	*0,467*	1,00%	97,94	78,53	10,66	-24,60%	8,11	2,55
9	*0,424*	-1,00%	96,96	74,12	12,26	15,04%	7,85	4,41
10	*0,386*	1,00%	97,93	70,87	10,66	-13,08%	7,41	3,25
11	*0,350*	-1,00%	96,95	65,69	12,26	15,04%	7,09	5,18
12	*0,319*	-1,00%	95,98	60,12	12,14	-1,00%	6,57	5,57
13	*0,290*	-1,00%	95,02	54,12	12,02	-1,00%	6,01	6,01
14	*0,263*	-1,00%	94,07	47,63	11,90	-1,00%	5,41	6,49
15	*0,239*	-1,00%	93,13	40,61	11,78	-1,00%	4,76	7,02
16	*0,218*	-1,00%	92,20	33,01	11,66	-1,00%	4,06	7,60
17	*0,198*	-1,00%	91,28	24,77	11,55	-1,00%	3,30	8,24
18	*0,180*	-1,00%	90,37	15,81	11,43	-1,00%	2,48	8,95
19	*0,164*	-1,00%	89,46	6,08	11,32	-1,00%	1,58	9,73
20	*0,149*	-1,00%	88,57	-4,52	11,20	-1,00%	0,61	10,60
				-4,52	**100,67**			**104,52**
				Residual Value	*Net Present Value*			*Accumulated depreciation*

Table 10: TAM with fluctuations in the price trend

[11] In fact, all the FCM methods (see section 2) amplify the price change in a similar way.

1.7. SUMMARY

The BvD analysis of the different depreciation methods started with the simple Straight-line depreciation (Section 1.2). Two key drawbacks led to the introduction of other methods:

- The difficult integration of the Cost of Capital led to the Standard Annuity method (Section 1.3);
- The CCA implementation having a NPV different from the initial investment led to the Tilted Straight line method (Section 1.4).

The combination of the two key drawbacks led to the 'Standard Annuity method with Inflationary benefits/ deflationary losses' (Section 1.5). A whole new approach did tackle both drawbacks as well and led to the Tilted Annuity Method (Section 1.6), which matches the requirements of 'Economic Depreciation'.

	CAPEX as sum of two separate parts: depreciation and cost of capital	Incorporation of the Cost of Capital in the formula of the CAPEX	
NPV not equal to initial investment	Straight-line depreciation	Standard Annuity Method	
NPV equal to the initial investment	Tilted Straight-line depreciation	Standard Annuity method with Inflationary benefits/ deflationary losses	Tilted Annuity Method

Table 11: Overview of the depreciation methods

Economic depreciation

As stated in section 1.1, an 'economic depreciation' method is characterised by:

1. A Net Present Value equal to the initial investment (Characteristic 1);
2. An evolution that is consistent with the underlying inflation or deflation[12] of the asset purchase price (Characteristic 2).

The methods complying are shown in (Characteristic 1) and Figure 2 (Characteristic 2). Note that only the TAM method is depicted in both figures.

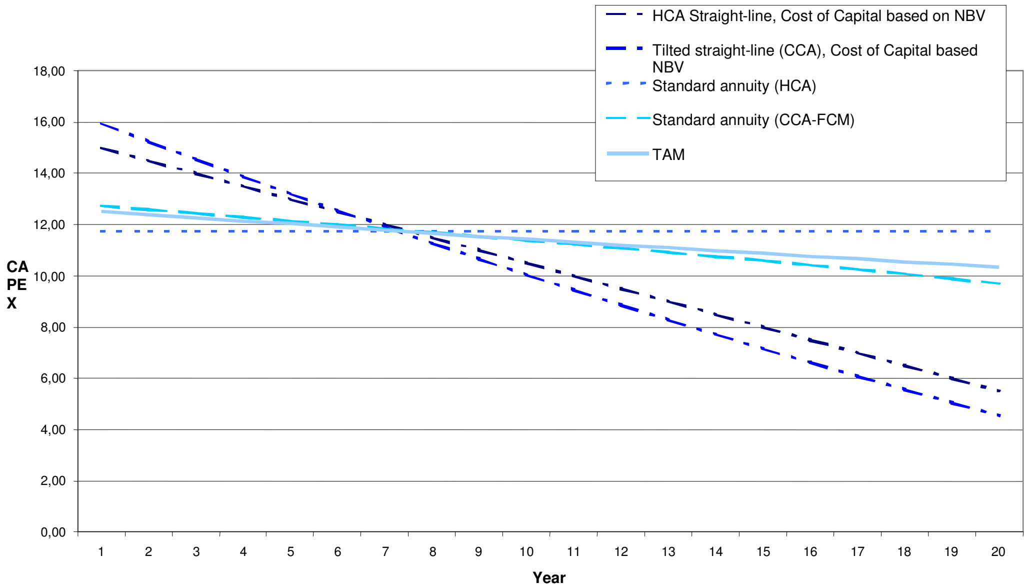

Figure 1: Methods with NPV equal to the initial investment

[12] The concepts 'inflation' and 'deflation' refer to the technology specific price changes of the equipment that is depreciated.

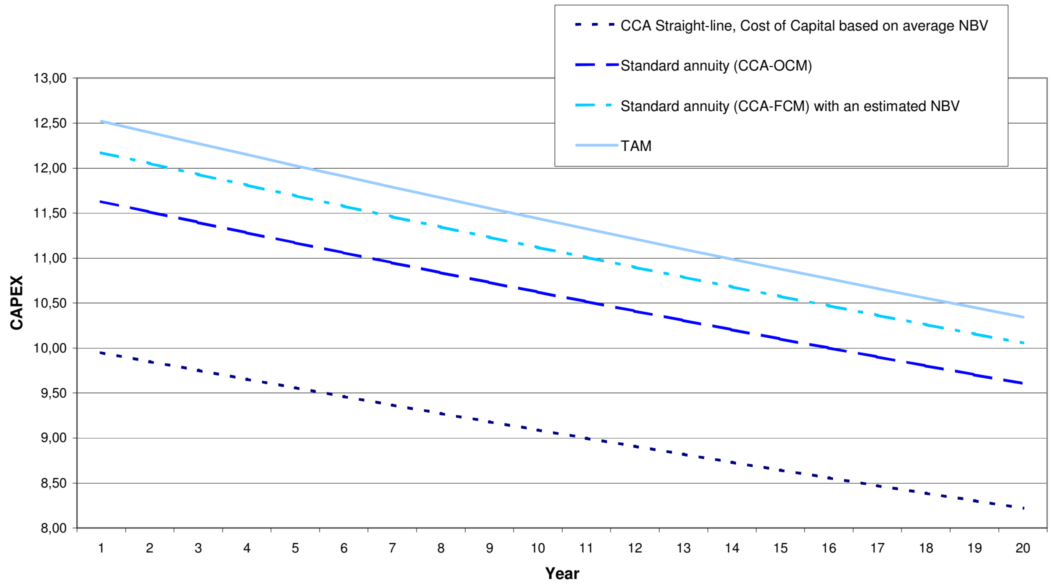

Figure 2: Methods following the price trend

The depreciation methods can roughly be divided into two groups: Straight-line based and Standard Annuity based. Lets compare their performance.

Straight-line based depreciation methods

From Figure 3, the Straight-line based depreciation methods can roughly categorised on the basis of their Cost of Capital calculation: based on NBV on the one hand and based on the average NBV on the other hand. The huge difference stresses the need for a more integrated approach, which lead to the Annuity based depreciation methods.

Note that the CAPEX all seem to evolve linearly. Yet with a higher price trend the evolution of the CCA methods will follow a convex curve.

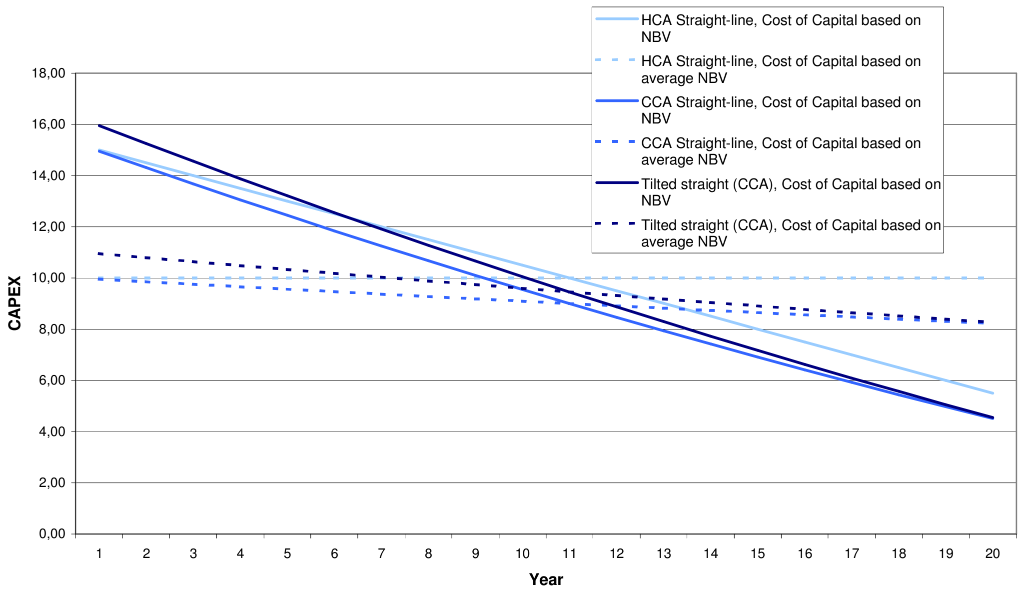

Figure 3: Straight-line depreciation Methods

Annuity based depreciation methods

Figure 4 shows the other 'Annuity based depreciation methods'. Note that the vertical axis only starts at 9, and hence the CAPEX are more or less similar. Only the HCA annuity really stands out of the pack by having no tilt at all.

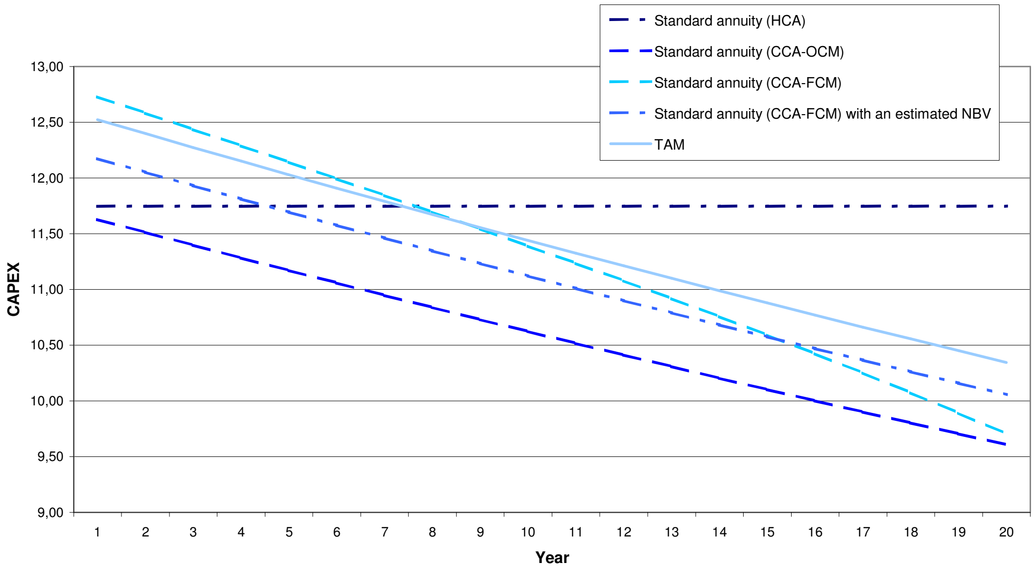

Figure 4: Annuity Methods

2. Capital Maintenance

The ERG Consultation regarding the European Commission's Recommendation on Accounting separation and Cost Accounting outlines stated: *‘There are two different approaches to Current Cost Accounting (CCA). The approaches differ in their definition of ‘Capital Maintenance’.*

This chapter will start off with some further highlights out of the above-mentioned document, followed by BvD’s explanations and interpretation. Thereafter BvD analyses the significance of the Capital Maintenance method when deciding on a depreciation method.

2.1. *The concept of Capital Maintenance*

The Annex to the “Draft ERG Opinion on the proposed Review of the Recommendation on Cost Accounting and Accounting Separation” discusses Capital Maintenance[13]. Some important highlights include:

> ‘There are two different approaches to Current Cost Accounting (CCA). The approaches differ in their definition of ‘capital maintenance’:
>
> - OCM: Operating Capital Maintenance requires that the company has as much operating capability (productive capacity) at the end of the period as at the beginning.
>
> - FCM: Financial Capital Maintenance considers the financial capital of the company is maintained in current price terms. Capital is assumed to be maintained if shareholders' funds at the end of the period are maintained in real terms at the same level as at the beginning of the period.’
>
> ‘The effects of the methods are not the same.’
>
> The main adjustments under OCM
> ‘One of the signification adjustments relates to the revaluation of fixed assets to current cost. Due to this revaluation additional adjustments are then required to *restate depreciation amounts*.’
>
> Further adjustments under financial capital maintenance (FCM)
> ‘Under FCM … further adjusted to take into account *holding gains or losses* that arise due to the effect of asset-specific price change on the current cost value of assets and the effect of general inflation on shareholders’ funds.’
>
> The choice of capital maintenance concept
> ‘If OCM was used to determine charges, the revenue requirement would be derived as the sum of operating costs, historical cost depreciation, supplementary depreciation and a return on net assets. Under FCM, the revenue requirement would be the sum of operating costs, historical cost depreciation, supplementary depreciation and a return on net assets *less holding gains/losses* plus the adjustment to shareholders' funds. Required revenue therefore differs depending on the capital maintenance concept used.’

[13] See page 28 and further.

Interpretation and examples

The choice of a Capital Maintenance concept has practical consequences for the implementation of the depreciation method, more specifically for the implementation of the CCA-revaluation, which causes windfall gains or losses, called capital gains/losses[14] by the ERG. The OCM principle advocates that these should not be taken into account. The FCM principle on the contrary defends a compensation for these windfall gains or losses.

Since the Annex to the "Draft ERG Opinion on the proposed Review of the Recommendation on cost accounting separation" remains quite general and high-level in its explanations, some practical examples follow based on the interpretation by the BvD consultants.

Operating Capital Maintenance

The ERG document already contains a practical example of an implementation of a depreciation method (without considering the cost of capital). BvD implemented an example analogous to the given example, but using an initial investment of 100, a price trend of –1% and a total life time of 20 years, instead of the ERG's initial investment of 10.000, price trend of –10% and life time of 4 years.

	Operating Capital Maintenance						
		Depreciation (No capital cost!)					
Year	Current Cost	Current Cost	Historical	Supplementary	Cumulative	Required	Backlog
0	100,00						
1	99,00	**4,95**	5,00	-0,05	4,95	4,95	0,00
2	98,01	**4,90**	5,00	-0,10	9,85	9,80	-0,05
3	97,03	**4,85**	5,00	-0,15	14,70	14,55	-0,15
4	96,06	**4,80**	5,00	-0,20	19,50	19,21	-0,29
5	95,10	**4,75**	5,00	-0,25	24,26	23,77	-0,49
6	94,15	**4,71**	5,00	-0,29	28,97	28,24	-0,72
7	93,21	**4,66**	5,00	-0,34	33,63	32,62	-1,01
8	92,27	**4,61**	5,00	-0,39	38,24	36,91	-1,33
9	91,35	**4,57**	5,00	-0,43	42,81	41,11	-1,70
10	90,44	**4,52**	5,00	-0,48	47,33	45,22	-2,11
11	89,53	**4,48**	5,00	-0,52	51,81	49,24	-2,56
12	88,64	**4,43**	5,00	-0,57	56,24	53,18	-3,06
13	87,75	**4,39**	5,00	-0,61	60,63	57,04	-3,59
14	86,87	**4,34**	5,00	-0,66	64,97	60,81	-4,16
15	86,01	**4,30**	5,00	-0,70	69,27	64,50	-4,77
16	85,15	**4,26**	5,00	-0,74	73,53	68,12	-5,41
17	84,29	**4,21**	5,00	-0,79	77,74	71,65	-6,09
18	83,45	**4,17**	5,00	-0,83	81,92	75,11	-6,81
19	82,62	**4,13**	5,00	-0,87	86,05	78,49	-7,56
20	81,79	**4,09**	5,00	-0,91	90,14	81,79	-8,35
		90,14					
		Accumulated depreciation					

Table 12: Depreciation following OCM with a price trend = -1% (Straight-line)

Observation of Table 12 learns that the accumulated depreciation (90,14) exceeds the required investment at the end of the asset's life (81,79), otherwise told more 'operating capital' than necessary is maintained. With the benefit of hindsight, i.e. once in year 20, it is easy to see that the required annual depreciation was a mere 4,09. As a consequence too much is depreciated each year, except the last year. However no correction with retroactive effect is made, since CCA doesn't take into account 'sunk' costs/revenues, only 'current' costs. Ideally, nevertheless impossible, is to use the future replacement costs. As such the Operating Capital Maintenance principle is implemented on a best effort basis.

[14] BvD did call these windfall gains/losses inflationary benefits or deflationary losses in earlier sections.

The ‘financial capital’ (100) on the contrary is insufficiently maintained in the accumulated depreciation (90,14), since the current cost depreciation consistently falls short of the historical cost depreciation.

For the sake of completeness an example with a positive price trend of 1% is added.

	Operating Capital Maintenance						
		Depreciation (No capital cost!)					
Year	Current Cost	Current Cost	Historical	Supplementary	Cumulative	Required	Backlog
0	100,00						
1	101,00	**5,05**	5,00	0,05	5,05	5,05	0,00
2	102,01	**5,10**	5,00	0,10	10,15	10,20	0,05
3	103,03	**5,15**	5,00	0,15	15,30	15,45	0,15
4	104,06	**5,20**	5,00	0,20	20,51	20,81	0,31
5	105,10	**5,26**	5,00	0,26	25,76	26,28	0,52
6	106,15	**5,31**	5,00	0,31	31,07	31,85	0,78
7	107,21	**5,36**	5,00	0,36	36,43	37,52	1,10
8	108,29	**5,41**	5,00	0,41	41,84	43,31	1,47
9	109,37	**5,47**	5,00	0,47	47,31	49,22	1,90
10	110,46	**5,52**	5,00	0,52	52,83	55,23	2,40
11	111,57	**5,58**	5,00	0,58	58,41	61,36	2,95
12	112,68	**5,63**	5,00	0,63	64,05	67,61	3,56
13	113,81	**5,69**	5,00	0,69	69,74	73,98	4,24
14	114,95	**5,75**	5,00	0,75	75,48	80,46	4,98
15	116,10	**5,80**	5,00	0,80	81,29	87,07	5,78
16	117,26	**5,86**	5,00	0,86	87,15	93,81	6,65
17	118,43	**5,92**	5,00	0,92	93,07	100,67	7,59
18	119,61	**5,98**	5,00	0,98	99,05	107,65	8,60
19	120,81	**6,04**	5,00	1,04	105,10	114,77	9,68
20	122,02	**6,10**	5,00	1,10	111,20	122,02	10,82
		111,20					
		Accumulated depreciation					

Table 13: Depreciation following OCM with a price trend = +1% (Straight-line)

Table 13 shows that the accumulated depreciation (111,20) now fails to cover the required investment on the end of the assets life (122,02), i.e. the ‘operating capital’ is not maintained. However again the implementation is on a best effort basis.

Financial Capital Maintenance

The ‘Annex: Accounting Separation and Cost Accounting’ does not contain an elaborated example following the FCM principle. The recommendation does nonetheless state it is similar to following OCM with the exception of adding a Capital gain/loss and incorporating the effect of general inflation to shareholders’ funds. The interpretation of BvD results in Table 14.

The accumulated depreciation in Table 14 (100) is exactly the same as the initial investment (100); as such the ‘financial capital’ is maintained. Note that accumulated depreciation exceeds the investment required to replace the asset at the end of its life (81,79), i.e. too much ‘operating capital’ is maintained.

The effect of general inflation on shareholders’ funds is not tackled in the above implementation as it can easily be incorporated in an indirect way. Either the inflation is taken into account when calculating the appropriate WACC, which will be the nominal WACC instead of the real WACC. Another possibility is to add in each year a cost of inflation (benefit of deflation), which is calculated in a similar way as the capital gain/loss: the NBV is reduced with the rate of inflation (deflation). The loss in NBV has to be compensated through a charge augmenting the yearly depreciation.

		Financial Capital Maintenance					
		Depreciation (No Capital Cost)					
Year	Current Cost	CCA Cost after revaluation	CCA cost before revaluation	Bookvalue after revaluation	Bookvalue before revaluation	Capital gain/loss	CCA (FCM)
0	100,00	5,00					
1	99,00	4,95	5,00	99,00	100,00	-1,00	**5,95**
2	98,01	4,90	4,95	93,11	94,05	-0,94	**5,84**
3	97,03	4,85	4,90	87,33	88,21	-0,88	**5,73**
4	96,06	4,80	4,85	81,65	82,48	-0,82	**5,63**
5	95,10	4,75	4,80	76,08	76,85	-0,77	**5,52**
6	94,15	4,71	4,75	70,61	71,32	-0,71	**5,42**
7	93,21	4,66	4,71	65,24	65,90	-0,66	**5,32**
8	92,27	4,61	4,66	59,98	60,58	-0,61	**5,22**
9	91,35	4,57	4,61	54,81	55,36	-0,55	**5,12**
10	90,44	4,52	4,57	49,74	50,24	-0,50	**5,02**
11	89,53	4,48	4,52	44,77	45,22	-0,45	**4,93**
12	88,64	4,43	4,48	39,89	40,29	-0,40	**4,83**
13	87,75	4,39	4,43	35,10	35,46	-0,35	**4,74**
14	86,87	4,34	4,39	30,41	30,71	-0,31	**4,65**
15	86,01	4,30	4,34	25,80	26,06	-0,26	**4,56**
16	85,15	4,26	4,30	21,29	21,50	-0,22	**4,47**
17	84,29	4,21	4,26	16,86	17,03	-0,17	**4,39**
18	83,45	4,17	4,21	12,52	12,64	-0,13	**4,30**
19	82,62	4,13	4,17	8,26	8,35	-0,08	**4,21**
20	81,79	4,09	4,13	4,09	4,13	-0,04	**4,13**
							100,00
							Accumulated Depreciation

Table 14: Depreciation following FCM with a price trend = -1% (Straight-line)

2.2. *THE STRAIGHT-LINE METHOD*

The example[15] of the depreciation following OCM uses in fact the straight-line method with Current Cost Accounting, which is indeed a depreciation method that does not take into account windfall gains or losses due to CCA-revaluation. Table 15 places the Straight-line method (CCA) as described in section 1.2 next to the OCM example of section 2.1 (see Table 12) to illustrate the correspondence.

		Straight line (CCA)		**OCM**					
Year	Current Cost	NBV	Depreciation	Current Cost	Historical	Supplementary	Cumulative	Required	Backlog
0	100,00								
1	99,00	94,05	**4,95**	**4,95**	5,00	-0,05	4,95	4,95	0,00
2	98,01	88,21	**4,90**	**4,90**	5,00	-0,10	9,85	9,80	-0,05
3	97,03	82,48	**4,85**	**4,85**	5,00	-0,15	14,70	14,55	-0,15
4	96,06	76,85	**4,80**	**4,80**	5,00	-0,20	19,50	19,21	-0,29
5	95,10	71,32	**4,75**	**4,75**	5,00	-0,25	24,26	23,77	-0,49
6	94,15	65,90	**4,71**	**4,71**	5,00	-0,29	28,97	28,24	-0,72
7	93,21	60,58	**4,66**	**4,66**	5,00	-0,34	33,63	32,62	-1,01
8	92,27	55,36	**4,61**	**4,61**	5,00	-0,39	38,24	36,91	-1,33
9	91,35	50,24	**4,57**	**4,57**	5,00	-0,43	42,81	41,11	-1,70
10	90,44	45,22	**4,52**	**4,52**	5,00	-0,48	47,33	45,22	-2,11
11	89,53	40,29	**4,48**	**4,48**	5,00	-0,52	51,81	49,24	-2,56
12	88,64	35,46	**4,43**	**4,43**	5,00	-0,57	56,24	53,18	-3,06
13	87,75	30,71	**4,39**	**4,39**	5,00	-0,61	60,63	57,04	-3,59
14	86,87	26,06	**4,34**	**4,34**	5,00	-0,66	64,97	60,81	-4,16
15	86,01	21,50	**4,30**	**4,30**	5,00	-0,70	69,27	64,50	-4,77
16	85,15	17,03	**4,26**	**4,26**	5,00	-0,74	73,53	68,12	-5,41
17	84,29	12,64	**4,21**	**4,21**	5,00	-0,79	77,74	71,65	-6,09
18	83,45	8,35	**4,17**	**4,17**	5,00	-0,83	81,92	75,11	-6,81
19	82,62	4,13	**4,13**	**4,13**	5,00	-0,87	86,05	78,49	-7,56
20	81,79	0,00	**4,09**	**4,09**	5,00	-0,91	90,14	81,79	-8,35
			90,14	**90,14**					
			Accumulated depreciation	*Accumulated depreciation*					

Table 15: The OCM example placed next to the straight-line method

[15] The example as given in Table 12 is based on the example on page 29 of the Annex to the "Draft Opinion on the proposed Review of the Recommendation on cost accounting and accounting separation"

2.3. *THE TILTED STRAIGHT-LINE METHOD*

Remember that the Tilted Straight Line method is based on the Straight Line method, but adds an extra term/tilt so that the CAPEX is corrected with the costs of deflation (benefits of inflation). The Tilted Straight Line corrects the Straight Line depreciation so that it complies with the second characteristic of 'Economic Depreciation'. The latter is implemented in such a way that a new entrant will suffer similar annual costs if assets are depreciated Straight-line from that moment on.

Table 16 clearly shows that the Tilted straight-line method corresponds with the BvD interpretation of depreciation following FCM (See Table 14), which is no surprise given that the method takes into account the windfall gains or losses caused by the CCA-revaluation. BvD did call these windfall gains/losses inflationary benefits or deflationary losses in earlier sections.

		Tilted Straight-line depreciation				Financial Capital Maintenance			
Year	Current Cost	NBV	Inflationary benefits/ Deflationary losses	Depreciation (CCA)	Total depreciation	CCA Cost after revaluation	CCA cost before revaluation	Capital gain/loss	CCA (FCM)
0	100,00	100,00				5,00			
1	99,00	94,05	-1,00	4,95	**5,95**	4,95	5,00	-1,00	**5,95**
2	98,01	88,21	-0,94	4,90	**5,84**	4,90	4,95	-0,94	**5,84**
3	97,03	82,48	-0,88	4,85	**5,73**	4,85	4,90	-0,88	**5,73**
4	96,06	76,85	-0,82	4,80	**5,63**	4,80	4,85	-0,82	**5,63**
5	95,10	71,32	-0,77	4,75	**5,52**	4,75	4,80	-0,77	**5,52**
6	94,15	65,90	-0,71	4,71	**5,42**	4,71	4,75	-0,71	**5,42**
7	93,21	60,58	-0,66	4,66	**5,32**	4,66	4,71	-0,66	**5,32**
8	92,27	55,36	-0,61	4,61	**5,22**	4,61	4,66	-0,61	**5,22**
9	91,35	50,24	-0,55	4,57	**5,12**	4,57	4,61	-0,55	**5,12**
10	90,44	45,22	-0,50	4,52	**5,02**	4,52	4,57	-0,50	**5,02**
11	89,53	40,29	-0,45	4,48	**4,93**	4,48	4,52	-0,45	**4,93**
12	88,64	35,46	-0,40	4,43	**4,83**	4,43	4,48	-0,40	**4,83**
13	87,75	30,71	-0,35	4,39	**4,74**	4,39	4,43	-0,35	**4,74**
14	86,87	26,06	-0,31	4,34	**4,65**	4,34	4,39	-0,31	**4,65**
15	86,01	21,50	-0,26	4,30	**4,56**	4,30	4,34	-0,26	**4,56**
16	85,15	17,03	-0,22	4,26	**4,47**	4,26	4,30	-0,22	**4,47**
17	84,29	12,64	-0,17	4,21	**4,39**	4,21	4,26	-0,17	**4,39**
18	83,45	8,35	-0,13	4,17	**4,30**	4,17	4,21	-0,13	**4,30**
19	82,62	4,13	-0,08	4,13	**4,21**	4,13	4,17	-0,08	**4,21**
20	81,79	0,00	-0,04	4,09	**4,13**	4,09	4,13	-0,04	**4,13**
		0,00			**100,00**				**100,00**
		Residual value			*Accumulated Depreciation*				*Accumulated Depreciation*

Table 16: The FCM example placed next to the Tilted straight-line method

2.4. *THE STANDARD ANNUITY METHOD*

First the standard annuity method without considering inflationary benefits or deflationary losses is looked at. It thus can be expected to follow the OCM principle.

		Standard annuity				
Year	Discount factor	Replacement Value	Book Value	CAPEX (CCA)	Cost of Capital	Depreciation
0		100,00	100,00			
1	*0,909*	99,00	97,27	11,63	9,90	1,73
2	*0,826*	98,01	94,42	11,51	9,63	1,88
3	*0,751*	97,03	91,42	11,40	9,35	2,05
4	*0,683*	96,06	88,28	11,28	9,05	2,23
5	*0,621*	95,10	84,96	11,17	8,74	2,43
6	*0,564*	94,15	81,47	11,06	8,41	2,65
7	*0,513*	93,21	77,77	10,95	8,07	2,88
8	*0,467*	92,27	73,85	10,84	7,70	3,14
9	*0,424*	91,35	69,69	10,73	7,31	3,42
10	*0,386*	90,44	65,27	10,62	6,90	3,72
11	*0,350*	89,53	60,57	10,52	6,46	4,05
12	*0,319*	88,64	55,54	10,41	6,00	4,42
13	*0,290*	87,75	50,18	10,31	5,50	4,81
14	*0,263*	86,87	44,44	10,20	4,97	5,24
15	*0,239*	86,01	38,30	10,10	4,40	5,70
16	*0,218*	85,15	31,70	10,00	3,79	6,21
17	*0,198*	84,29	24,62	9,90	3,14	6,76
18	*0,180*	83,45	17,01	9,80	2,44	7,36
19	*0,164*	82,62	8,82	9,70	1,68	8,02
20	*0,149*	81,79	0,00	9,61	0,87	8,73
			0,00	**92,86**		**87,44**
			Residual Value	*Net Present Value*		*Accumulated depreciation*

Table 17: Standard Annuity Method without considering inflationary benefits deflationary losses

Note that the accumulated depreciation (92,86) is bigger than the replacement value at the end of the asset's lifetime (81,79), so more operating capital is maintained than strictly necessary. With the benefit of hindsight, i.e. once in year 20, it is easy to see that the required annual CAPEX was a mere 9,61 and as a consequence too much is depreciated each year, except the last year. However no correction with retroactive effect is made, since CCA doesn't take into account 'sunk' costs/revenues, only 'current' costs. As such the Operating Capital Maintenance principle is implemented on a best effort basis.

2.5. *THE STANDARD ANNUITY WITH INFLATIONARY BENEFITS/ DEFLATIONARY LOSSES*

Standard Annuity with inflationary benefits/ deflationary losses does take into account the windfall gains/losses and as such can be expected to follow the FCM principle. Indeed Table 18 shows that the accumulated depreciation (100) is equal to the initial investment, which means that the Financial Capital is maintained.

Standard annuity with Inflationary benefits/ Deflationary losses									
Year	Discount factor	Replacement Value	NBV	CAPEX on replacement value	Delta Cost of Capital	Inflationary benefits/ Deflationary losses	Total CAPEX	Cost of capital	Depreciation
0		100,00	100,00						
1	*0,909*	99,00	97,27	11,63	0,10	1,00	12,73	10,00	2,73
2	*0,826*	98,01	94,42	11,51	0,10	0,97	12,58	9,73	2,86
3	*0,751*	97,03	91,42	11,40	0,09	0,94	12,44	9,44	2,99
4	*0,683*	96,06	88,28	11,28	0,09	0,91	12,29	9,14	3,15
5	*0,621*	95,10	84,96	11,17	0,09	0,88	12,14	8,83	3,31
6	*0,564*	94,15	81,47	11,06	0,08	0,85	11,99	8,50	3,50
7	*0,513*	93,21	77,77	10,95	0,08	0,81	11,84	8,15	3,70
8	*0,467*	92,27	73,85	10,84	0,08	0,78	11,69	7,78	3,92
9	*0,424*	91,35	69,69	10,73	0,07	0,74	11,54	7,39	4,16
10	*0,386*	90,44	65,27	10,62	0,07	0,70	11,39	6,97	4,42
11	*0,350*	89,53	60,57	10,52	0,07	0,65	11,23	6,53	4,71
12	*0,319*	88,64	55,54	10,41	0,06	0,61	11,08	6,06	5,02
13	*0,290*	87,75	50,18	10,31	0,06	0,56	10,92	5,55	5,36
14	*0,263*	86,87	44,44	10,20	0,05	0,50	10,76	5,02	5,74
15	*0,239*	86,01	38,30	10,10	0,04	0,44	10,59	4,44	6,15
16	*0,218*	85,15	31,70	10,00	0,04	0,38	10,42	3,83	6,59
17	*0,198*	84,29	24,62	9,90	0,03	0,32	10,25	3,17	7,08
18	*0,180*	83,45	17,01	9,80	0,02	0,25	10,07	2,46	7,61
19	*0,164*	82,62	8,82	9,70	0,02	0,17	9,89	1,70	8,19
20	*0,149*	81,79	0,00	9,61	0,01	0,09	9,70	0,88	8,82
			0,00				**100,00**		**100,00**
			Residual Value				*Net Present Value*		*Accumulated depreciation*

Table 18: The Standard Annuity with inflationary benefits/ deflationary losses

2.6. *THE TILTED ANNUITY METHOD*

The Tilted Annuity Method (TAM) is a bit more complex, since the windfall gains and losses are only implicitly taken account of, i.e. they are spread over the whole lifetime of the asset.

TAM									
Year	Discount factor	Replacement Value	NBV	CAPEX	Cost of Capital	Depreciation	Straight-line depreciation	Implicit Capital gain/loss (TAM)	Implicit Capital gain/loss (FCM)
0		100,00	100						
1	*0,909*	99,00	97,48	12,52	10,00	2,52	4,95	2,43	-1,00
2	*0,826*	98,01	94,83	12,40	9,75	2,65	4,90	2,25	-0,94
3	*0,751*	97,03	92,04	12,27	9,48	2,79	4,85	2,06	-0,88
4	*0,683*	96,06	89,09	12,15	9,20	2,95	4,80	1,86	-0,82
5	*0,621*	95,10	85,97	12,03	8,91	3,12	4,75	1,64	-0,77
6	*0,564*	94,15	82,66	11,91	8,60	3,31	4,71	1,40	-0,71
7	*0,513*	93,21	79,14	11,79	8,27	3,52	4,66	1,14	-0,66
8	*0,467*	92,27	75,38	11,67	7,91	3,76	4,61	0,86	-0,61
9	*0,424*	91,35	71,36	11,56	7,54	4,02	4,57	0,55	-0,55
10	*0,386*	90,44	67,06	11,44	7,14	4,30	4,52	0,22	-0,50
11	*0,350*	89,53	62,44	11,33	6,71	4,62	4,48	-0,14	-0,45
12	*0,319*	88,64	57,47	11,21	6,24	4,97	4,43	-0,54	-0,40
13	*0,290*	87,75	52,12	11,10	5,75	5,35	4,39	-0,97	-0,35
14	*0,263*	86,87	46,34	10,99	5,21	5,78	4,34	-1,43	-0,31
15	*0,239*	86,01	40,09	10,88	4,63	6,24	4,30	-1,94	-0,26
16	*0,218*	85,15	33,33	10,77	4,01	6,76	4,26	-2,50	-0,22
17	*0,198*	84,29	26,01	10,66	3,33	7,33	4,21	-3,11	-0,17
18	*0,180*	83,45	18,05	10,56	2,60	7,96	4,17	-3,78	-0,13
19	*0,164*	82,62	9,41	10,45	1,81	8,65	4,13	-4,51	-0,08
20	*0,149*	81,79	0,00	10,35	0,94	9,41	4,09	-5,32	-0,04
			0,00	**100,00**		**100,00**		**-0,49**	**-0,49**
			Residual Value	*Net Present Value*		*Accumulated depreciation*		*Average*	*Average*

Table 19: Tilted Annuity Method

The accumulated depreciation (100) in Table 19 is equal to the initial investment (100), which indicates that the Financial Capital is maintained (=FCM). TAM however only determines the capital gain/loss implicitly.

The last two columns show the difference between the capital gain/loss according to TAM and the capital gain/loss according to Straight-line depreciation following FCM. The average capital gain/loss is equal in both cases. It is thus correct to say that TAM spreads the capital gain/ loss over the whole lifetime of the asset.

Spreading the capital gain/loss however implies it is not guaranteed that the Financial capital to be maintained in all cases. Namely when price fluctuations occur, the constant price trend is not adhered to and as consequence the accumulated depreciation can defer from the initial investment.

2.7. *FINAL REMARKS*

Remark that the fulfilment of the first characteristic of 'Economic Depreciation' necessarily leads to the FCM approach: An economic depreciation methodology results in a CAPEX that ensures the recuperation of the initial investment and a reasonable remuneration of the capital employed, but without any further profit or loss, i.e. the Net Present Value (NPV) equals the initial investment.

The other remark comes back to the leverage of the price change when using the FCM approach. If the estimate of the price change is difficult to obtain, it can result in large fluctuations in the tariffs. Moreover the risk exists that the price change used does not correspond with the actual evolution of the replacement values from year to year. Therefore estimating the price change deserves careful attention.

3. CONCLUSION

Different depreciations methods have been analysed in the previous two sections. The first section focused on the characteristics of an 'economic depreciation'. The second section then elaborated on the Capital Maintenance principle.

As a result many elements were analysed. Table 20 indicates for the most important depreciation methods which of the following characteristics they possess:

- NPV = Initial investment
- Consistency of the CAPEX with the underlying costs
- The CAPEX does not jump at the moment the old asset is renewed.
- CCA, as opposed to HCA
- FCM, as opposed to OCM
- NBV is not needed

	NPV = Initial investment	Consistency with underlying costs	CAPEX does not jump at replacement	CCA	FCM	NBV is not needed
Straight-line						
HCA, Cost of Capital based on NBV	Yes	No	No	No	Yes(1)	No
HCA, Cost of Capital based on average NBV	No	No	No(6)	No	No	No(5)
CCA, Cost of Capital based on NBV	No	No	No	Yes	No	No
CCA, Cost of Capital based on average NBV	No	Yes(2)	Yes	Yes	No	Yes
Tilted Straight-line						
CCA, Cost of Capital based on NBV	Yes	Yes(3)	No	Yes	Yes	No
CCA, Cost of Capital based on average NBV	No	Yes(3)	No(6)	No	Yes(4)	No
Standard annuity						
HCA	Yes	No	No	No	Yes(1)	No(5)
CCA-OCM	No	Yes(2)	Yes	Yes	No	Yes
CCA-FCM	Yes	Yes(3)	No	Yes	Yes	No
TAM						
	Yes	Yes(2)	Yes	Yes	Yes	Yes

Table 20: Overview of characteristics of the various depreciation methodologies

Clarification of the annotations in Table 20:

(1) The HCA Straight-line method with cost of capital based on the NBV and the HCA Annuity method have an NPV equal to the initial investment and thus maintain strictly speaking the financial capital. However FCM and OCM are both approaches to CCA, which the aforementioned do not implement.

(2) The CCA Straight-line method with Cost of Capital based on the average NBV, the CCA-OCM Standard Annuity method and TAM are consistent with the underlying costs as their CAPEX evolve at same rate as the underlying

costs (See Figure 2). In the case of TAM the necessary condition is that the underlying costs follow a constant price trend.

(3) The CCA Tilted Straight-line method with Cost of Capital based on the NBV, the CCA Tilted Straight-line method with Cost of Capital based on the average NBV and the CCA-FCM Standard Annuity method are consistent with the underlying costs in so far that the underlying costs are expected to remain at their current price levels after they changed in the year considered.

(4) The CCA Tilted Straight-line method with Cost of Capital based on the average NBV does not have an NPV equal to the initial investment and so strictly speaking does not maintain the financial capital. Then again the accumulated depreciated is equal to the initial investment. In the end, BvD prefers to look at the depreciation part when determining the Capital Maintenance method, as the ERG document focuses on depreciations as well.

(5) For the HCA Straight-line method with cost of capital based on the average NBV and the HCA Standard Annuity, it can be defended that the NBV is not needed, but the Historical purchase price would be needed instead, and thus the burden remains.

(6) The HCA Straight-line method with the cost of capital based on the average NBV and the CCA Tilted Straight-line method with the cost of capital based on the average NBV do have a jump in CAPEX when the written-off asset is replaced with a new one, however the jump is not quite as large as their counterparts with the cost of capital based on the NBV, instead of the average NBV.

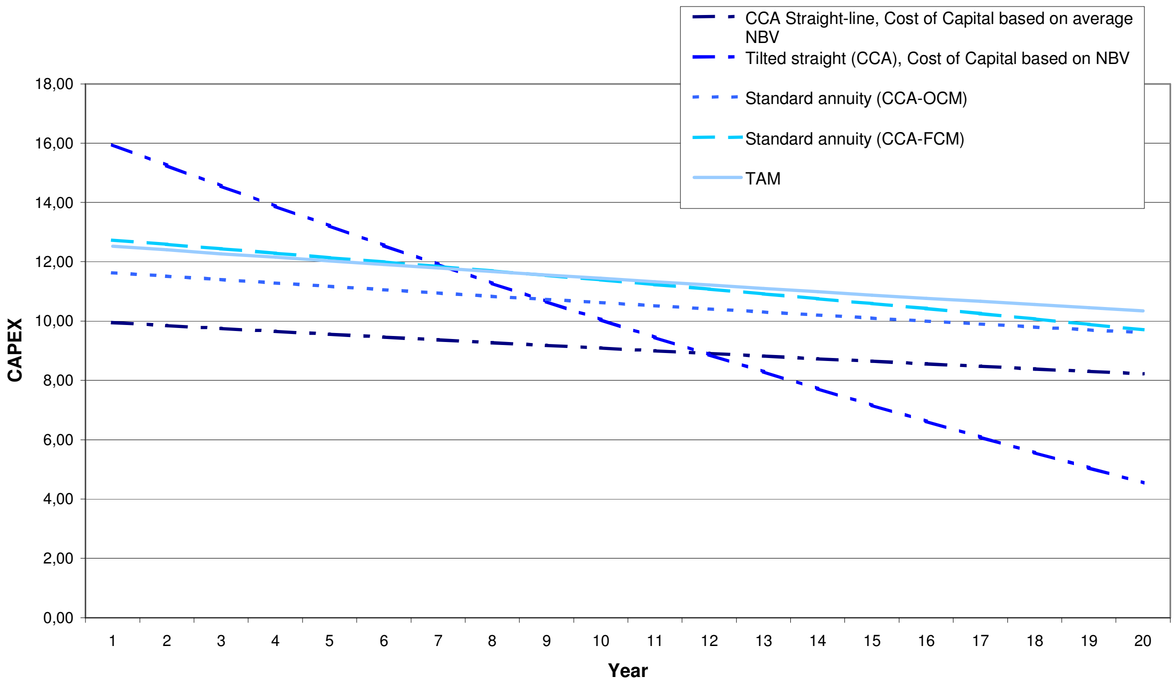

Figure 5: The five best depreciation methods according to Table 20

Table 20 gives a good first impression of the adequateness of a depreciation method. Five methods seem to satisfy the conditions in an acceptable way, namely (See Figure 5):

- The CCA Straight-line method with Cost of Capital based on the average NBV;
- The CCA Tilted Straight-line method with Cost of Capital based on the NBV;

- The CCA-OCM Standard Annuity method;
- The CCA-FCM Standard Annuity method;
- And TAM (Tilted Annuity Method).

Table 20 answers in a yes or no, black or white fashion, which does not allow to differentiate shades of grey. Figure 5 plotted the CAPEX of the five methods and indeed it can be seen that two methods greatly differ from the others:

- The CCA Straight-line method with Cost of Capital based on the average NBV lies well beneath the others. The consequence is that the NPV (79,46) does not compare to the initial investment (100). As a result BvD would not recommend it as an appropriate depreciation method.
- The CAPEX of the CCA Tilted Straight-line method with Cost of Capital based on the NBV declines much steeper then the others, which is for a large part due to the fast decline in cost of capital, and for a smaller part due to the tilt. Moreover the use of a Cost of Capital based on the NBV has an even worse effect when replacing an old asset with a new one, as it causes a shock in CAPEX with a magnitude that makes the method entirely inappropriate.

As a result only three depreciation methods remain appropriate (See Figure 6):

- The CCA-OCM Standard Annuity method;
- The CCA-FCM Standard Annuity method;
- And the TAM (Tilted Annuity Method).

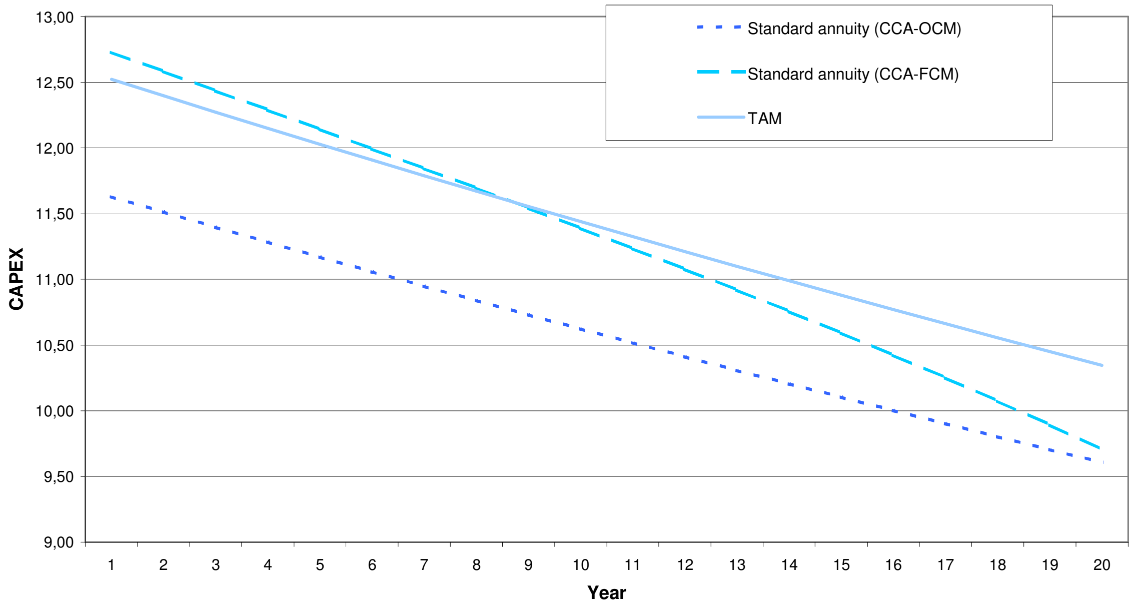

Figure 6: The three best depreciation methods

The three remaining depreciation methods have in common that the calculation of the cost of capital cannot be separated from the calculation of the depreciation cost. The only formula used is to determine the CAPEX. As a result, the determination of the capital required during the year is sidestepped as an issue.

On the other hand important differences do exist between the three depreciation methods, as can be seen in the following summary:

The CCA-OCM Standard Annuity method is the only method, which follows the OCM principle. As a consequence the maintenance of the financial capital is not guaranteed or said otherwise the NPV will not equal the initial investment.

The main advantage of the method is that the price change does not have a large impact on the method; no leverage effect of the price change is present. As a consequence, it is the method of choice when a lot of uncertainty exists about the current price change.

The CCA-FCM Standard Annuity method is the counterpart of the CCA-OCM Standard Annuity method and is arguable the lesser of the three, as the age of the asset is needed or needs to be assumed and the CAPEX makes a jump on replacement of the asset.

However the CCA-FCM Standard Annuity method is appropriate when the current price change can easily be determined and when no further price changes are expected in the future (or when the best estimate of them is 0%), as this corresponds with the underlying assumption of the method.

The Tilted Annuity Method is the only method that got a complete green light in Table 20. The main drawback includes that TAM assumes a constant price trend over the total lifetime of the asset. As a consequence it is the preferred method when the price trend is expected to remain constant for a considerable time to come.

Closing remark

Even at the end of the elaborate analysis of different depreciation methods no obvious preferred method can be found. BvD is convinced that the outcome strongly depends on the peculiarities of the situation. This document does provide extensive information up to the point at which the decision process moves away from the technical understanding part towards the managerial part of making trade-offs and weighing arguments, in which BvD has build up extensive expertise.

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Tine Debusschere
Head of the Department

BUREAU VAN DIJK

Tine Debusschere
Head of Telecom Department

250, av. Louise - bte 14 - B-1050 Brussels (Belgium)
Tel. +32 2 639 06 06 - Fax : +32 2 648 82 30
e-mail: tdb@bvdmc.com

BUREAU VAN DIJK

Svetlana Juin
Account Manager

57, bd. de Montmorency - F-75016 Paris
Tel. +33 1 45 24 49 10 - Fax : +33 1 45 25 08 04
e-mail: sju@bvdic.com