Valuation of Cash Flows in Inflation

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Setting up the cash flow of a project in nominal prices requires an inflation forecast. This is a difficult, if not impossible, task. (pg 42)
Belli, P. et al.

The difficult can be done immediately,
the impossible takes a little longer.
Army Corp of Engineers

Chapter Ten

Valuation of Cash Flows in Inflation

10.1Introduction

In the complex example in Chapter 5, we constructed the financial statements in nominal terms by explicitly taking into account the expected inflation rates over the planning period.[1] All changes in the prices of the inputs and outputs were specified relative to the expected inflation rates. In addition, the discount rates for the cash flows were properly adjusted for the expected inflation rates. For the foreseeable future, the expected inflation rates are low and the reader may be tempted to avoid constructing nominal financial statements.

In this chapter we show that if the financial statements are **not** constructed in nominal terms, the analyst could make a **serious** mistake in the valuation of cash flows. Generally, we would expect that increases in the expected inflation rate would have negative impacts on the (present) value of the cash flow stream. Most importantly, compared with the financial statements that are constructed in real terms or alternatively

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[1]. Later, in Chapter 10 we show how we can use sensitivity analysis to examine the impact of different assumptions about profiles of the expected inflation rates on the present value of the cash flows.

in real terms[2], the nominal financial statements are closer models or representations of reality.

Here it is important to be clear about the meaning of the use of nominal cash flows. When we say we use nominal cash flows we mean that nominal prices are used to construct the financial statements that give rise to the free cash flows. When we mention real cash flows, it is understood that the financial statements for deriving the cash flows are stated at real prices.

It would have been simpler if we had "ignored" the issue of inflation and constructed the financial statements in real terms. Frequently financial statements are not constructed in nominal terms and it is widely believed that all two methods, nominal and real, give the same answers. It is important to distinguish the two approaches, and later, we define the two methods more precisely. We show that the results with the real price approach bias the results upwards, relative to the nominal price approach. The discrepancies between the two methods may be small if the expected inflation rates are low but nonetheless, there are systematic biases in the estimates from the two approaches.

Unquestionably, before the advent of the personal computer, modeling the impacts of inflation in valuation appraisal was an enormous task and the use of real prices was a necessary simplification. Currently, with the widespread availability of personal

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[2] Constant prices is a particular case of real prices. When real increase in prices is zero, we have constant prices. However, we have to say for the record that we know practitioners that stick to the use of constant prices.

computers, conducting investment appraisal by constructing nominal financial statements is a straightforward and simple task.[3]

In this chapter, we show that if special conditions are satisfied then the two approaches give the same answer. However, in general the special conditions are not satisfied and thus the two approaches do not give the same answers. We would like to persuade the reader (if indeed there is need for persuasion) that conducting valuation based on financial statements with real prices is potentially misleading and under certain circumstances, could result in the overvaluation of a firm, especially if inflation has a big impact on value of the cash flows.[4] As evidenced by the complex example in Chapter 5, we hope that the reader is convinced that valuation with nominal prices is feasible and is a relatively simple task with a spreadsheet program on a personal computer. The difficulty in modeling and using nominal prices for constructing financial statements has been greatly exaggerated.[5]

The chapter is organized as follows. In Section One, we examine the two approaches in greater detail. In Section Two, we review recommendations in the leading finance textbooks. In Section Three, we discuss some of the reasons why the real prices methodology may be appealing. In Section Four, we present the conditions that must be satisfied if the answers from the two approaches have to match.

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[3]. However, the proponents of investment appraisal with real prices continue to preach the merits of their approach and the continued acceptance of the "real prices" approach to investment appraisal is puzzling, indefensible and inexcusable.

[4]. For some readers, it might seem that we are attacking a "straw man". In other words, financial statements are not constructed in real prices. We wish that the real and constant prices approaches were straw men.

[5]. We hope that in the valuation of firms where the financial analysis is important, the use of real prices in constructing the financial statements is abandoned forthwith and forever. The hesitancy in harnessing the personal computer for the construction of financial statements in nominal prices for investment appraisal is incomprehensible.

SECTION ONE

10.2 Approaches to valuation under inflation

In practice, in the presence of expected inflation, analysts use three approaches to value cash flows[6]. In addition, we also define neutral inflation, which is a generalization of constant prices.

a)Nominal or current prices

b)Real prices

c)Constant prices

The nominal or current prices approach forecasts the prices for inputs and outputs, relative to the expected inflation rate, and discounts the nominal cash flows with the nominal discount rate. The nominal prices take account of the expected inflation rate and the real increases (if any) in relative prices.

The real prices approach forecasts the increases in relative prices and discounts the future cash flows with the real discount rate. It does not forecast the expected inflation rate, even though it is expected that there will be inflation. The analysis is conducted **as if** the expected inflation were zero.

The constant price approach does not forecast relative prices increases. It assumes that prices are held constant throughout the entire life of the firm and discount future cash flows with the real discount rate. The constant price methodology is a particular case of the real price methodology under the assumption that the expected inflation rate is zero and the real price increases are zero.

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[6] Although we will analyze only real and nominal prices, we present the three methods.

Neutral inflation is more general than constant prices. For a particular item, the nominal price increases may be exactly equal to the expected inflation rates and the real price increases are zero. We call this neutral inflation.

Many analysts and authors say that all the approaches give the same results. They only caution that the nominal cash flows should not be mixed with real interest rates and *vice versa*. This recommendation suggests that if there is consistency between the cash flows and the discount rates, then all the approaches give the same answer. However, as we show later, to obtain the same answer from all the approaches requires more than simple consistency between the cash flows and the corresponding discount rates.

First, we show how the changes in the expected inflation rate affect the (present) value of the FCF for the complex example in chapter 5 based on the financial statements that are constructed in nominal terms. As expected, there is a negative relationship between the expected inflation rate and the (present) value.

Table 1. Relationship between the expected inflation rate and the (present) value of the FCF for the complex example in Chapter 4

0%	47,334.0
1%	45,978.8
2%	44,779.1
3%	43,709.0
4%	42,748.2
5%	41,880.4
6%	41,092.4
7%	40,373.5
8%	39,714.8
9%	39,108.7
10%	38,549.0
11%	38,030.5

Next, with respect to the complex example of chapter 5, we show that the (present) values from the two approaches are different with and without the terminal value.

With terminal value

With nominal prices the (present) value is $43,708.98, and with real prices the (present) value is $52,282.9, deflating the cost of debt and 53,371.5 without deflating the cost of debt. This means an overvaluation from 19.62% to 22.11%.

Table 2.1: Free Cash Flow, discount rates and total value for nominal prices with terminal value

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
FCF		4,772.1	8,992.5	8,574.4	4,536.2	11,808.6
TV						45,047.8
cash excess						8,670.6
Total FCF (including TV)		4,772.1	8,992.5	8,574.4	4,536.2	65,527.0
WACC		19.46%	19.86%	20.16%	20.45%	20.41%
Total value	43,709.0	47,440.9	47,871.7	48,946.5	54,420.5	

Table 2.2: Free Cash Flow, discount rates and total value for real prices with terminal value

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
FCF		4,406.9	8,659.3	7,998.7	6,859.8	9,667.3
TV						55,341.3
cash excess						8,130.2
Total FCF (incl. TV)		4,406.9	8,659.3	7,998.7	6,859.8	73,138.8
WACC		16.55%	16.79%	16.97%	17.15%	17.25%
Total value	52,282.9					

We have used the same approach in calculating the real WACC as with nominal prices, this is ρ - TS/TotVal and solved the circularity that arises.

10.3 Nine conditions

For now we list the nine conditions that must be satisfied for the two[7] approaches to give the same results. Later, in Section Three, we discuss the conditions in detail.

The conditions are given below.

1. No taxes
2. Reinvestment of the intermediate cash flows should be made at the discount rate.
3. Price increases that occur (nominal increases) are equal to the inflation rate, which is included in the nominal discount rate. Price increases at real prices are the real price increases set at zero.
4. Income and payments for goods and services are in cash.
5. No salvage or terminal value.
6. There is no price elasticity of demand effect (see condition 3).
7. The nominal discount rate for the nominal cash flows follows the Fisher effect and includes inflation rate and real rate of interest and the discount rate for the real prices is equal to the real rate of interest.
8. The net cash for each year is included in the CFE and hence in the FCF.
9. When using real prices, the cost of debt is deflated by the inflation rate.

A cursory look at the conditions would convince the reader that only under special circumstances would ALL of the nine conditions be satisfied. Thus, in most practical situations, we would expect that the two approaches would give different answers.

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[7] These conditions are valid for constant prices approach as well.

SECTION TWO

10.4Review of textbooks in finance

When we review the textbooks in finance, we find that many authors are not sufficiently explicit about the right approach to use in cash flow valuation. The result is that in practice, and this is more critical in economies with relatively high rates of inflation, practitioners construct financial statements and conduct cash flow valuation in the wrong manner.

For instance, Canada and White, 1980, suggest that it is necessary to be careful and to be consistent: discount nominal cash flows with the nominal discount rate, and discount real cash flows with the real discount rate. However, they recognize that taxes and depreciation introduces some bias into the analysis.

Brealey, Myers, 1996 and Brealey, Myers and Marcus, 1995, say that the same NPV is obtained either with nominal cash flows, discounted with the nominal discount rate, or real cash flows discounted with the real discount rate. They warn the reader not to mix real rates and nominal cash flows and *vice versa*. However, it is not clear which approach Brealey et al are recommending.

Levy and Sarnat, 1982, say that the right answer is obtained with either approach and the only caution required is not to mix up rates of interest and free cash flows. They devote much effort to show that when taxes exist, depreciation introduces an upward bias when working with the real price approach.

Weston and Copeland, 1992, present a very detailed example to show that when there is no inflation, the results with the real approach are the same. When there are real price increases, the results differ. However, the reader may wrongly assume that both

approaches lead to the same decision. The example shows two positive NPV's and does not warn the reader that the final decision could be reversed with real price increases. In other words, a positive NPV project, based on financial statements constructed with real prices, could be a negative NPV project based on financial statements constructed under nominal prices.

Damodaran, 1996, presents an example to show that it is equivalent to work with either approach and warns the reader not to mix up rates and cash flows.

Dixon and Hufschmidt, 1986, recognize that zero inflation cannot be assumed (when working with constant prices) and they propose to work with the *increase in relative price or real prices*. They think that the results are identical once the increases in relative prices are included.

Copeland, Koller and Murrin, 2000, say that, "when done properly, the resulting value should be identical. (Nominal cash flows discounted at a nominal rate should equal the corresponding real cash flow discounted at the corresponding real rate.)" Again, this leaves the impression that the two methods are equivalent.

Very few authors clearly commit to the right approach: future estimates for the cash flows have to be made at nominal prices and future cash flows have to be discounted with the nominal rate of return. For instance, see Van Horne, 1997. Vélez, 1983, mentioned that for economic replacement decisions it is not equivalent to make decisions with real prices figures and nominal prices.

SECTION THREE

In practice, investors are not familiar with and do not encounter real prices and real interest rates; these are artificial constructs that are not observed in reality. However,

we discuss briefly the many reasons why the "real prices" method is appealing. First, many analysts believe that all the approaches give the same results, especially under neutral inflation.

Second, analysts believe that even if the results are not identical, the error in using the real prices method is sufficiently small and acceptable.

Third, analysts believe that the "simplicity" of real prices outweighs any marginal benefits of using the nominal prices approach, even though nominal values are the most familiar.

Fourth, analysts believe that it is too difficult to "forecast" future inflation rates and consequently, they prefer to do the analysis in real terms.

Below, we briefly comment on the strength (?) of these reasons.

10.5.1Equivalence

It is widely believed that the two methods, the real prices approach and the nominal prices approach, give the same answers.[8] Under certain stringent, unrealistic conditions, the equivalence between the two methods is true. For further details, see Vélez-Pareja (2000). However, in general, if the necessary conditions are not satisfied, then the answers from the two methods differ and there is a high probability that a firm could be incorrectly valuated because the impacts of inflation were improperly modeled. Later, we discuss the details of some of the conditions.

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[8]. The false logic of the argument in favor of the equivalence goes as follows. With nominal prices, we inflate the values by the expected inflation rates and then we discount with the nominal discount rate. With real prices, we simply discount with the real discount rate. Therefore, the answers from both methods must be the same. The argument fails to realize that for various other factors, such as credit transactions and taxes, create a wedge between the answers from the two methods.

In some cases, special conditions may hold for some projects or firms in the public sector.[9] That is, the firm pays no taxes and there are no credit transactions. However, with the continued involvement of the private sector in sectors that have traditionally been in the public domain, it becomes less and less likely that the conditions under which these two methods are equivalent will be appropriate in practice.

Consider one of the main conditions that must be satisfied for the equivalence between the two methods to hold. There must be no taxes. In some public sector projects, it is true there may be no tax payments. However, with the increased emphasis on the privatization of public companies, the presence of taxes will be more relevant in the financial analysis. Even in traditionally public sectors, such as water and power, there are accounts receivable. Moreover, the water and power tariffs rarely keep pace with inflation and with high rates of inflation, the present value of the cash revenues are eroded.[10] By constructing the financial statement in nominal rather than real terms, the impact of inflation is modeled explicitly and there is **less** likelihood of making errors in the analysis.

Another argument is a fallacy that has its origin in a procedure that forecasts the future cash flows with the inflation rate equal to the increase in all prices and thereafter deflates the cash flows with the same inflation rate. This is elementary arithmetic and the result is identical.

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[9]. For example, the use of the real prices approach may be suitable in an environmental project, where the financial analysis is irrelevant and the benefits and costs are mostly economic in nature.

[10]. Normally, water and power tariffs are not indexed to inflation and it would be a heroic assumption to model the tariffs as constant in real terms. In fact, tariffs are usually constant in nominal terms and therefore with increases in inflation, the PV of the tariffs decreases in real terms. Moreover, there are always lags in the inflation adjustments of the power and water tariffs.

Most importantly, the use of the real prices approach could lead to incorrect firm valuation. Typically, inflation has a negative impact on the present value of cash flows. Note that the expected inflation rate is an uncertain parameter in the analysis and we should analyze the impact of fluctuations in the expected inflation rate. Without explicitly modeling the impacts of inflation by constructing financial statements in nominal terms, incorrect project selection may occur.

10.5.2Good enough approximation

Admittedly, in the past, without the easy availability of computing power, the construction of financial statements with nominal prices was difficult because the sensitivity and scenarios analysis would have been extremely time consuming. Thus, the use of the real prices method with suitable approximations was justified. Currently, constructing financial statements in real prices is just not good enough because it is so easy to construct the financial statements in nominal prices and conduct the relevant sensitivity and scenario analyses.

10.5.3Misleading simplicity

Another supposed argument in favor of the real prices approach is its simplicity. In the days before spreadsheets, the simplicity argument had merit. These days, the simplicity argument is a poor excuse for avoiding the construction of financial statements in nominal terms.

Moreover, investors are not familiar with transactions in real prices. All the cash flows and returns in commercial transactions are in nominal terms. The term “real prices” is misleading and a misnomer. The financial statements constructed with real prices are

make-believe because the "real" values stated are not the **actual** values that the investor faces in the future years. For example, in year 3, the investor receives $1,000 in nominal terms. The investor does not receive some real amount X that has been adjusted in terms of a base year. Similarly, in year 3, the investor may have to make tax payments based on the nominal income in year 3. The actual tax payments are not based on the "real" income that has been calculated with respect to a base year. The tax payments for year n are based on the nominal income for that particular year n.

The same logic applies to the construction of the loan schedule. The interest payments are calculated with the nominal interest rate and have to be paid in nominal terms. It is simply a fiction to construct the loan schedule with the real interest rate. We do not observe the real interest rate nor do we make real loan repayments; the real interest rates and the real payments are artificial constructs.

10.5.6Forecasting inflation

Finally, another often-heard argument against the nominal prices approach is the belief that it is impossible to forecast inflation. Consequently, the analysis must be done in real terms. Everyone agrees that forecasting is a notoriously difficult activity. But it does **not** imply that the analysis must be conducted in real terms. It is no easier to forecast the future demand for outputs and inputs in **real** terms than it is to forecast the inflation rates. Nevertheless, the appropriate modeling and analysis with nominal prices can and should be done.[11] With scenario analyses, we can specify easily the likely

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[11]. Without the availability of computing power, this argument against nominal prices might have some merit. With the availability of inexpensive and widespread computing power and the means to conduct extensive sensitivity and scenario analyses without too much difficulty, the insistence on constructing financial statements with real prices seems anachronistic and betrays a lack of knowledge about the new

profiles for the expected inflation rates and examine the impact of the different inflation profiles on the present value of the cash flows.

Another reason some analysts have for promoting the real prices methodology is that they believe that any kind of subjective or arbitrary estimation of prices should be avoided. The financial institutions could avoid the problem of the subjectivity in defining prices, if they utilize the aggregated and industry information located at databases of central banks and/or statistics bureaus of any country. In fact, for a given project (mainly social projects) the financial institution could define some rates of increase in prices for each input and output, in order to eliminate the subjectivity ingredient included by each firm or analyst. They could even check the prices presented by the credit applicant with the prices calculated by the financial institution. More, they could establish a range of prices for different sectors of the economy.

SECTION FOUR

10.6Necessary conditions for consistency

Earlier we mentioned that the results from the two approaches would be the same if ALL of the nine conditions were satisfied. Next, we discuss each of the assumptions in greater detail.

1. No taxes

When taxes are included in the analysis, depreciation and interest charges give rise to a tax shield, which affects the cash flow. The depreciation charges would be

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techniques that are available in computing and modeling. Perhaps it reflects the typical slowness in adopting new techniques.

identical in absolute value terms for all the methodologies, *but* the relative value is greater with real prices than with nominal prices. Hence, the cash flow would be overvalued, because earnings before taxes are undervalued and the taxes are lower.

To achieve consistency in the results from the two approaches, we have two options. We can either assume that there are no taxes or there are no depreciation allowance and finance charges. Only in rare cases would it be reasonable to assume that there are no taxes. Some people have realized this and then they propose to deflate the depreciation! This procedure lacks any economic meaning and cannot be implemented unless the future inflation rate is forecasted, which was to be avoided in the first place.

Also, no taxes imply that any effect of losses carried forward (LCF) is null in the analysis. When the law allows carrying losses forward there is a recovery of the tax shield or tax savings in the subsequent years. In this case, with the assumption of no taxes, the future benefits are lost. Furthermore, in the analysis with real prices, the taxes are calculated on a basis that is a mix of real and non real figures, and thus the tax savings recovered with the LCF is also distorted.

Next, we present an analysis that is taken from Levy and Sarnat (1982). Assume that sales and purchases are on a cash basis and the taxes are paid the same year. Then the expression for the free cash flow is as follows.

$$FCF = (CB - Dep)x(1 - \tau) + Dep$$

$$= (1 - \tau)*CB + \tau*Dep(1)$$

Where

τ = tax rate

CB = Cash Balance

Dep = Depreciation allowance

If the expected inflation rate is zero and there are no real increases in prices, the expression for the present value with no inflation (PV_{NI}), discounted with the real discount rate i_r, is as follows.

$$PV_{NI} = \sum_{t=1}^{n} \frac{(1-\tau)CB_t}{(1+i_r)^t} + \sum_{t=1}^{n} \frac{\tau Dep_t}{(1+i_r)} \quad (2)$$

Suppose the expected inflation rate i_f is positive and there is neutral inflation. In any year t, the cash balance CB_t and the discount factor $(1 + i_r)^t$ increase by the factor $(1 + i_f)^t$. The expression for the present value with inflation is as follows.

$$\begin{aligned} PV_I &= \sum_{t=1}^{n} \frac{(1-\tau)CB_t(1+i_f)^t}{(1+i_r)^t(1+i_f)^t} + \sum_{t=1}^{n} \frac{\tau Dep_t}{(1+i_r)^t(1+i_f)^t} \quad (3) \\ &= \sum_{t=1}^{n} \frac{(1-\tau)CB_t}{(1+i_r)^t} + \sum_{t=1}^{n} \frac{\tau Dep_t}{(1+i_r)^t(1+i_f)^t} \end{aligned}$$

The difference between the present value in equation 2 calculated with real prices and the present value in equation 3 calculated with nominal prices is as follows.

$$PV_{NI} - PV_I = \sum_{t=1}^{n} \frac{\tau Dep_t}{(1+i_r)^t} - \sum_{t=1}^{n} \frac{\tau Dep_t}{(1+i_r)^t(1+i_f)^t} \quad (4)$$

With positive rates of expected inflation, the expression in equation 4 is positive, suggesting that the real prices approach overstates the present value of the cash flow. Equation 4 is a measure of the upward bias of the real prices approach, relative to the nominal prices approach.

Often, we do not know why a project with a positive NPV becomes a failure when it is implemented. The use of real prices in the appraisal could be a factor. The authors have some intuition, not supported by formal empirical data[12], that many public and private projects become failures because they have been accepted with present values calculated with the real prices methodology, and if the projects had been evaluated properly with the nominal prices methodology, they might have been rejected.

One could try to make an adjustment to the result with the real prices approach by subtracting the amount in equation 4, but we can only make the adjustment if the result at nominal prices PV_I is known! In fact, before hand, it is not known whether the firm will get the tax savings. This is known only when the pro-forma financial statements with real and nominal prices are estimated. And in order to know this, we have to forecast inflation and construct the financial pro-forma statements in nominal terms.

In any year t, the magnitude of the bias due to the tax saving from the depreciation allowance can be measured with the following ratio.

$$\frac{\dfrac{\tau Dep_t}{(1+i_r)^t}}{\dfrac{\tau Dep_t}{(1+i_r)^t(1+i_f)^t}} = (1+i_f)^n \quad (5)$$

[12].We have some isolated evidence about this issue. In 1986 one of the authors taught a course in a graduate program for the major ironworks factory in Colombia and tested this hypothesis with two real projects that failed. They reconstructed the analysis with the data that were available at the time the study was conducted with constant prices. The new results of the analysis at nominal prices showed that the projects should have been rejected.

Table 10.2: Effect of inflation on $1 in depreciation tax shield for different years

	Years	1	3	5	6	10
Inflation rate	0%	0.0%	0.0%	0.0%	0.0%	0.0%
	1%	1.0%	3.0%	5.1%	6.2%	10.5%
	2%	2.0%	6.1%	10.4%	12.6%	21.9%
	2.50%	2.5%	7.7%	13.1%	16.0%	28.0%
	5%	5.0%	15.8%	27.6%	34.0%	62.9%
	7.50%	7.5%	24.2%	43.6%	54.3%	106.1%
	10%	10.0%	33.1%	61.1%	77.2%	159.4%
	12.50%	12.5%	42.4%	80.2%	102.7%	224.7%
	15%	15.0%	52.1%	101.1%	131.3%	304.6%
	17.50%	17.5%	62.2%	124.0%	163.2%	401.6%
	20%	20.0%	72.8%	148.8%	198.6%	519.2%
	22.50%	22.5%	83.8%	175.9%	237.9%	661.0%

In this table it can be seen that the effect of the bias from inflation, which favors the real prices methodology, is greater than 5% for periods as short as 3 years for an inflation rate of 2%, and 5 years for an inflation rate of 1%.

In the next table, we show the bias of the real prices analysis for $1 in tax savings from the depreciation allowance with equal payments over 5 years for different combinations of real interest rates and inflation rates. The calculations are made with the following expression.

$$\frac{\text{Present value of tax savings at real interest rate}}{\text{Present value of tax savings at nominal rate}} - 1 \quad (6)$$

Table 10.2: Error in present value of tax savings for depreciation charges: real prices versus nominal prices

	Real interest rate					
Inflation	1%	3%	5%	6%	10%	12%
0.0%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
1.0%	3.00%	2.96%	2.92%	2.90%	2.83%	2.79%
2.0%	6.04%	5.96%	5.87%	5.84%	5.68%	5.61%
2.5%	7.57%	7.47%	7.36%	7.31%	7.12%	7.03%
5.0%	15.38%	15.16%	14.94%	14.84%	14.43%	14.23%
7.5%	23.41%	23.06%	22.72%	22.55%	21.91%	21.60%
10.0%	31.65%	31.16%	30.69%	30.45%	29.56%	29.13%
12.5%	40.10%	39.46%	38.84%	38.54%	37.36%	36.80%
15.0%	48.75%	47.94%	47.16%	46.78%	45.32%	44.62%
17.5%	57.58%	56.60%	55.66%	55.19%	53.41%	52.56%
20.0%	66.59%	65.43%	64.30%	63.75%	61.64%	60.63%
22.5%	75.78%	74.41%	73.10%	72.46%	69.99%	68.82%

Again, it can be observed that even in economies with a low inflation rate, the bias effect for the real price methodology is large, relative to the nominal prices methodology. We can construct a similar set of tables to show the bias in favor of the real prices approach relative to the nominal prices approach through the taxes on the interest payments.

Next, we present a simple example to show the differences in the present values of the net income and free cash flow for the two approaches through the impact of taxes on the depreciation allowance. We assume that the real interest rate is 6%, the expected inflation rate is 10%, and the real increase in output prices and input costs is 1%. In nominal terms, the discount rate is 16.6% and the nominal increase in output prices and input costs is 11.1%. We assume that there are no credit transactions and the taxes (T = 40%) are paid the same year in which they are incurred.

Real prices versus nominal prices

First we compare real prices with nominal prices.

Table 10.4: Simplified Income Statement

	Real prices		Nominal prices		Increase for each item
Sales	101	100.00%	111.1	100.00%	10.00%
Expenses	50.5	50.00%	55.55	50.00%	10.00%
Depreciation	10	9.90%	10	9.00%	0.00%
Profit before taxes	40.5	40.10%	45.55	41.00%	12.47%
Taxes	16.2	16.04%	18.22	16.40%	12.47%
Net profit	24.3	24.06%	27.33	24.60%	12.47%

The relative weight of the depreciation is greater for real prices and hence the net profits are lower at real prices. Taxes as a percentage of the sales, is 16.4% with nominal prices, which is higher than the 16.04% with real prices.

Part of this differences could be offset if the evaluation is made at real prices with taxes calculated *without taking* into account the adjustment for inflation in the financial statements *and* the evaluation at nominal prices is made *taking into account* those adjustments. However, this adjustment might not be enough.

If the projects to be compared are different in fixed assets capital intensity, then the difference *increases*.

The corresponding FCF statement for the real and nominal prices approaches are shown below.

Table 10.5: Cash flows compared (nominal and real prices)

Cash flow	Real prices	Nominal prices
Year 1	34,3	37,33
Present value	$32,36	$32,02

Using simple examples, we have shown that the presence of taxes through its impact on the depreciation allowance and interest payments creates a systematic bias in favor of the real prices approaches relative to the nominal price approach. All the approaches would give the same answer if there were no taxes or no depreciation

allowance. The absence of depreciation is unusual even for public firms. And with the increasing privatization of government companies, the absence of taxes will be more rare.

2. Reinvestment of intermediate cash flows should be made at the discount rate.

This means that when the cash flow is evaluated at nominal prices, the reinvestment rate should be the nominal discount rate, and when it is evaluated at real prices, the reinvestment rate should be the real discount rate. Everybody knows that in reality, this is not always possible. In the general case, it is not. When the evaluation of the cash flow is modeled with a spreadsheet, the cash surpluses are invested at the market rates[13]. To guarantee that reinvestment occurs at the discount rate, just eliminate the option to invest cash surpluses. In that way, when the future cash flows are discounted, the discount procedure automatically assumes that reinvestment rates are equal to discount rates.

In general, the interest rate at which the cash surpluses can be invested is different from $(1+i_f)(1+i_r)-1$[14], *which* is the discount rate that should be applied when working at nominal prices. This assumption also means that there is no Cash Required for Operations (CRO) in the model.

3.Price increases that occur (nominal increases) are equal to the expected inflation rate, which is included in the nominal discount rate.

The results from the two approaches are the same if we assume that the inflation is neutral with respect to ALL the line items in the financial statements. In other words,

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[13]. This means that in reality, the assumption that the present value calculations imply reinvestment of the intermediate cash flow at the discount rate is not true: what is reinvested is the cash surpluses from the cash flow, not from the free cash flow.

[14]. Recall that the relationship between the nominal or current interest rate and the real rate is given by $(1+i_c) = (1+i_r)(1+i_f)$.

for all the line items, the nominal price increases are exactly equal to the expected inflation rates, implying that there are no real increases. The inflation index, for example the Consumer Price Index (CPI), is a weighted average of the changes in the prices for a basket of goods and services. It is clearly unrealistic to assume that neutral inflation holds for all the line items in the financial statements.

In the rare case that neutral inflation holds for all the line items in the financial statements, the nominal free cash flow would be inflated by the expected inflation index. When the nominal FCF is discounted by the inflation adjusted discount rate, the PV of the nominal FCF would be the same as the PV of the FCF with the real prices approaches. However, it is more likely that the expected inflation rates and the nominal price increases are not equal, in which case there will be gains and losses that are not taken into account when the present value is computed with the real prices methodologies.[15]

4. Income and payments for goods and services are in cash

In the ideal situation, all income and payments for goods and services are in cash and there are no credit transactions. If there are credit transactions in the presence of inflation, the firm has to adjust the real price figures for the amount of credit received from the sellers and the credit to the customers. This means that we must estimate the expected inflation rates and one of the reasons to use real prices was to avoid estimating the expected inflation rate.

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[15]. There are gains when the increase in the income is greater than the expected inflation rate and the increase in the expenses is lower than the expected inflation rate. Similarly, there are losses when the increase in the expenses is greater than the expected inflation rate and the increase in the income is lower than the expected inflation rate.

Consider the following simple example, which compares the PV of revenues using the real (assuming neutral inflation) and nominal prices approaches.

The real rate of interest is 12%, the expected inflation rate is 20% and the nominal discount rate is 34.4%. First we assume that 100% of the sale is in cash. With an expected inflation rate of 20%, in year 1, the nominal revenues are $120. The PV of the revenues, with respect to year 0 and discounted with the nominal discount rate, is $89.29

Table 6a. Comparison of present values when credit is not granted

Sales 100% in cash	Year 1
Real rate of interest	12%
Inflation rate	20%
Nominal Revenues	$120
Nominal discount rate	1.12x 1.2 - 1 = 34.4%
PV at nominal prices	$120/1.344 = $89.286
Real Revenues	$100
Real discount rate	12%
PV at real prices	$100/1,12 = $89.286

The revenues, in real terms, is $100, and the PV of the revenues, with respect to year 0 and discounted with the real discount rate, is identical to the previous answer that was obtained with the nominal prices approach. Not surprisingly, the two PVs match because there are no credit sales.

Next, assume that 10% of the sales is on credit and will be repaid in year 2. With the nominal prices approach, we receive $108 in year 1 and $12 in year 2. Discounting the nominal revenues with the nominal discount rate, with respect to year 0, the present value of the revenues is $87.

Table 6.2: Comparison of present values when credit is granted

Sales 90% in cash	Year 1	Year 2
Nominal prices	$108	$12
PV at nominal prices	$108/1.344 = $80.357	$12/(1.344)2 = $6.643
Total present value	87.0	
Real prices	$90	$10
PV at real prices	$90/1.12= 80.357	10/(1.12)2 = 7.972
Total present value	88.329	

Discounting the real revenues with the real discount rate, with respect to year 0, the present value of the revenues is $88.329.

Clearly, the reason for the discrepancy is the credit sales that will be received in year 2. Taking into account the expected inflation rate, the PV of the nominal revenues in year 2 is $6.643. The real prices approach **overstates** the PV of the real revenues in year 2.

Table 6.3: Comparison of present values when credit is granted

Sales 90% in cash	Year 1	Year 2
Nominal prices	$108	$12
PV at nominal prices	$108/1.344 = $80.357	$12/(1.344)2 = $6.643
Total present value	$87.000	
Real prices	$90	$10/(1.20) = $8.333
PV at real prices	$90/1.12= 80.357	$8.333/(1.12)2 = $6.643
Total present value	$87.000	

To reconcile the PVs from the two approaches, we have to “deflate” the real revenues that will be received in year 2. This simple example shows that the nominal prices and real prices approach do not match if there are credit transactions.

5. No salvage or terminal value

If there is no salvage or terminal value, then the two methods give the same results. To assume that the terminal value is zero is very conservative. In some cases, the terminal value may be as high as 50% of the total value of the cash flow, and the investment decision may depend on the terminal value. When the terminal value is included, the relationship between the terminal or salvage value at nominal prices and real prices should be equal to $(1+i_f)^n$, where i_f is the inflation rate. In general, the inflation rates might be different in each period, in which case we should take into account the cumulative effect of the inflation.

6. There is no price elasticity of demand effect

If the analyst works with real prices and the elasticity is defined as the sensitivity of the demand to price variations, the model does not capture the variations, favorable or not, because there are no price changes.

To adjust the figures for this situation, the elasticity function has to consider zero *inflation* for the real price case and the increases in relative prices should be equal to the following expression.

(1 + increase in nominal prices)/(1+inflation rate) – 1(8)

The increase in real prices should not be calculated as shown in equation 9.

Increase in prices at nominal prices – inflation rate (9)

For nominal prices, we have the following expression.

$Q = 1 + \beta[(1 + \text{increase in nominal prices}) – 1]/(1 + i_f)$(10.1)

In turn, the increase in nominal prices can be expressed as follows.

Increase in nominal prices

$$= [1 + (1 + i_f)(1 + \text{Real increase in price})] - 1 \quad (10.2)$$

If the real increase in prices is calculated as in equation (10.2), the elasticity factor is equal with both methodologies.[16]

Substituting equation 10.2 into equation 10.1, and simplifying,

$$Q = 1 + \beta\,[(1 + i_f)\text{x Real increase in nominal price}]/(1 + i_f)$$

$$= 1 - \beta\ \text{Real increase in price} \quad (10.3)$$

If the adjustment in equation 8 is not made, then the elasticity effect has to be nullified by setting the elasticity factor to1.

7.The nominal discount rate for the nominal cash flows follows the Fisher effect and the discount rate for the real prices is equal to the real rate of return ir.

The expression for the nominal discount rate is as follows.

$$(1 + i_r)(1 + i_f) - 1 \quad (13)$$

The nominal discount rate also includes the risk perceived by the equity holders.

To obtain the real rate of return, we must use equation 13. The discount rate at real prices would not be the WACC. Instead, the discount rate at real prices would be calculated as follows.

$$i_{df} = (1 + \text{WACC})/(1 + i_f) - 1 \quad (14)$$

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[16]. This is the hypothetical elasticity function utilized in the complex example in chapter 4.

where i_{df} is the deflated discount rate and the WACC is the nominal discount rate, including the risk premium.

8.The net cash for each year is included in the CFE and hence in the FCF.

The net cash of the year (inflows minus outflows) after investment of surplus funds has to be included in as equity repurchase to avoid depositing funds in the firm. If these funds are deposited in cash, they do not generate a rate of return equal to the cost of capital and as discussed above, this distorts the present value.

9.When using real prices, the cost of debt is deflated by the inflation rate.

This means that the cost of debt has to be modified as explained in assumption 7. It is not only necessary to set prices to 0% or to real increases, but we have to adjust the cost of debt.

10.6.7Consistency in the present value

Using the complex example, we verify that if the nine conditions are satisfied, then the PV of the cash flow is the same across the two approaches.

It is extremely important to point out that the estimates from the two approaches are different because practitioners have the idea (at least as it can be seen from the recommendations of financial institutions such as, the Inter American Development Bank, IADB and the World Bank, WB) that the right procedure is the real price approach. The IADB supports the real price approach. Some economists argue that “the constant

price methodology could imply an increase in prices! ... relative prices." Obviously, this is contradictory.[17]

It seems to be that those who defend the real price methodology fail to recognize the implicit assumptions made when they accept 0% increase in prices and the conditions that are necessary to obtain the same present value with nominal, and real prices.

Reconciliation

Below we show the tables where the two approaches give the same answer when ALL nine conditions are satisfied.

Table 7a: Current prices with the nine conditions included

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
FCF		20,195.7	20,213.6	22,146.7	-20,822.1	26,387.1
Discount rate		6.09%	6.09%	6.09%	6.09%	6.09%
Total value	58,740.6					

Table 7b: Real prices with the nine conditions included

	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
FCF		19,607.5	19,053.2	20,267.4	-18,500.2	22,761.7
Discount rate		3.00%	3.00%	3.00%	3.00%	3.00%
Total value	58,740.6					

[17]. We wish to say, for the record, that some colleagues (economists) insist that constant price methodology does not imply increases in prices equals to 0%. They say that it should be called constant dollar methodology and not constant price methodology. And therefore, the analyst could consider changes in prices, relative prices. We insist: constant prices methodology implies that we keep prices constant and constant dollars implies that we deflate prices using a deflator, such as the Consumer Price Index. And in the latter procedure the increase in relative prices is implicit. Also, we insist that there has been a worldwide, generalized use of the constant price approach, which is wrong.
In this chapter, we present the problem associated to the use of these wrong procedures. It has to be said again, that constant price methodology implies that the initial year 0 prices do not change; constant dollar methodology is different from the former and it assumes that prices do change and this change is reflected in what is called relative prices. We do emphasize on the analysis and criticism of the constant price methodology, because its use is very common. It is used not only in social project evaluation but also in private or financial project evaluation.

10.7 Summary and concluding remarks

In this chapter, we have shown that the two different approaches for valuing cash flows in the presence of inflation gives the same results only if nine assumptions are satisfied. In practice, it is rare for the nine conditions to be satisfied. Since the real prices approach overstate the present value, relative to the nominal prices approaches, the use of the real prices approach may lead to the wrong investment decision.

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